TRANSACTIONS

OF THE

SOCIETY OF MOTION PICTURE ENGINEERS

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Number Twenty-one

MEETING OF MAY 18, 19, 20, 21, 1925

SCHENECTADY, N. Y.

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RADIO MOVIES

C. Francis Jenkins*

THE year 1824 saw the beginnings of a photographic process for pictorially recording persons and places; to be visually exhibited later, and at a distance. But the persons and other animates in the picture were without movement, so later, when differentiation required it, we called these pictures "stills."

Some thirty-five years ago I came to Washington with a rather definite idea that I could add to the record and reproduction, the activity of the scene, the movement of the persons in the picture.

In 1892 my work had so far progressed that I was able to project onto a silk handkerchief pictures with action depicted therein. I used an oil lantern, for illumination, bought of J. B. Chamberlain, a lantern in form strikingly like some of those illustrating the presidential address of Mr. Lloyd A. Jones as it appears in the Transactions of the Chicago meeting of this Society.

The picture ribbon was made of kodak roll film, bought of E. J. Pullman, a pioneer Eastman photo supply dealer, and slit into narrow strips, and spliced into a single length, in the dark room.

Photographer I. D. Boyce developed most of both the camera negatives and the prints therefrom.

The first "motion picture artist" who performed before my camera was Arthur J. McElhone, athlete and stenographer.

In 1894, with the assistance of electrician D. N. Washburn, an arc lamp was fitted to the machine and life-size pictures were projected before many friends, one report of which appears in the Photographic Times, July 6, 1894, copies of which can be found in most libraries.

The next year I built a motion picture theatre in Atlanta, Ga., financed by Thomas Armat. The admission charged was twenty-five cents, the first sale of tickets, for a theatre built exclusively for pictures.

To all my various machines I gave the fanciful name "Phantoscope," and many newspaper accounts refer to my machines by this name.

In order to get sufficient screen illumination, (1) this apparatus gave the film a step-by-step motion, with a relatively long rest period, during all of which time the film was illuminated.

To reduce to a minimum the strain on the film by reason of this jerky motion at the exposure aperture, (2) means were provided to create a loop in the film between the intermittent feed devices and the unwinding roll of picture film.

* Jenkins Laboratories, Washington, D. C.

These two fundamentals in exactly the arrangement in that old 1894 machine have been in use in every projector in every theatre the world over to this very day.

So, as photographic matters now stand, that early Daguerrotype process of a hundred years ago has been refined and developed, as the years have gone by, until to the original photographic record has been added (1) stereoscopic plasticity, (b) natural color, (c) the living action, and (d) appropriate sound.

The addition of smell and taste and touch has been proposed, although I hardly think I shall live to clasp hands with my friend across the continent.

Beside the intermittently moved motion picture film mechanism described above, there has been but a single other method attempted, namely, continuous running film, preferably with full uninterrupted illumination, which I made the subject of U. S. Patent No. 560,800, where a series of lenses run with the film.

I mention this here for the reason that it is the scheme I employed when I susbstituted radio for film to carry movies into the home, notice of the initial accomplishment of which appeared in the Washington Star for June 13, 1925, and sent to other papers by the Associated Press at the time.

To lay down a convenient foundation for an understanding of our subject, let me mention two basic facts; namely, (a) that speed is the only difference between magic lantern "still" pictures and projected motion pictures; and (b) that our radio picture is built up by a point of light moving in successive parallel adjacent lines until the picture is complete.

Don't you remember that mother entertained us on a winter night by covering a penny with a piece of white paper, and rubbing across it with the unsharpened end of a lead-pencil she made a picture of the Indian appear?

Well that is exactly the way we make pictures by radio, except that instead of the pencil of lead we employ a pencil of light, and that radio builds up the blacks of the picture just as did the humps on the penny.

By speeding up the process to a persistence-of-vision rate, say, sixteen complete pictures per second, we get Movies by Radio.

And that's exactly the way we do it. Perfectly easy, isn't it? You can go home now and do it yourself.

But if I suggest that my thirty-five years experience in motion picture development has materially facilitated the attainment of radio movies, perhaps I may be permitted to mention a few essentials to aid you in more quickly solving the problem.

First of all, then, you must make that impossible shape in glass, the Prismatic Ring, for I now believe that Motion-Pictures-by-Radio is not likely ever to be accomplished without them.

The function of the Prismatic Rings is to sweep the image of a point-like source of light across the picture-receiving surface in parallel adjacent lines until the whole surface is covered.

The Rings are set with their diameters at right angles where the light passes through the overlapped Rings. One of the Rings draws the lines, while the other distributes the successive lines over the picture surface. The Ring that makes each line, rotates, say, four hundred times to the other one's once, one turn of the latter completing each single picture frame.

It must be remembered that the incoming radio-carried current is fluctuating the lamp to build up areas of light and shade; and it is lights and shadows out of which our picture is made, of course.

As the picture is built up line-by-line at the receiving station, obviously it must be taken to pieces line-by-line at the sending station.

This is done by projecting the picture through other Prismatic Rings, which, in rotation, sweep the picture many times across a light-sensitive cell. The picture is thus sliced up, figuratively, into slides, like a bacon cutter in the market, each slice showing light and dark. The varying light values of each slice falling on the cell are converted into corresponding values of electric current; which, put on a radio carrier wave, cause the light source at each receiving set to fluctuate in intensity correspondingly.

If, then, all the receiving stations are in synchronism with the sending station the light values fall in the proper places on each picture receiving screen, and the motion picture at the sending station is duplicated in a thousand homes.

The machines make a complete picture frame every sixteenth of a second, continuously, and we have motion pictures on a plain white surface. But if the slow Prismatic Ring turns over once in six minutes to make a "still" picture, then a photographic negative must be used to receive and record the light values.

We have made some very superior pictures by radio in six minutes, of which I will show you examples presently. However, it is a "whale-of-a-jump" from a six-minute picture to a picture in one-sixteenth of a second; but it can, and is being done daily.

To be sure, on account of the speed involved, I had to substitute a lens-disc for one of the Prismatic Rings, the fast one, but this lens-disc worked with the other Ring, the slow rotating Ring, perfectly, and Radio Movies and Radio Vision are both accomplished facts.

The radio Vision receiving set and the Radio Movies set are identical, and one may, therefore, see in one's home what is happening in a distant place (an inaugural parade, football, or polo game, and we call it Radio Vision), or one may see the motion picture then running on the screen of a distant theatre, or in our broadcasting studio (and we call it Radio Movies).

Perhaps at a later convention meeting I may have the privilege of demonstrating the process and mechanisms before you.

Though spectacular, theoretically it is not a very difficult thing to do; speech is carried by radio, and sight should just as easily be so carried.

To get music by radio, a microphone converts sound into electrical modulation, which carried by radio to a distant place is there changed back into sound and we hear the music.

To get pictures by radio our sensitive cell converts light into electrical currents, and at radio distances changes these currents back into light values; and we see the distant scene.

To further show the close relation, I might add that in receiving sets these same electrical values can be put back either into sound with headphones or into light with a radio camera; although, I admit we don't make much sense out of it when with headphones we listen to a picture.

Radio Vision is now a daily demonstration, and while it is not yet finished and ready for your use, it soon will be, for if I should be obliged to stop for lack of funds to carry forward the necessary refinement, some one else would complete the work, for the public is now ready for Visual Radio entertainment in the home.

I am indebted to my friend Professor D. McFarlan Moore for a word name for this new device, namely, telorama, and teloramaphone. I didn't particularly like the name when he first urged my adopting it, but since I have become more accustomed to the sound, I don't mind it so much. I remember it stunned me the first time I tried to introduce Mrs. Jenkins as "my wife," but it didn't sound so awful after awhile.

In due course, then, folks in California and in Maine, and all the way between, will be able to see the inaugural ceremonies of their President, in Washington; the Army and Navy football games at Franklin Field, the struggle for supremacy in our national sports, and after eighteen years of trying see Walter Johnson win.

The new machine will come to the fireside as a fascinating teacher and entertainer, without language, literacy, or age limitation; a visitor to the old homestead with photoplays, the opera, and a direct vision of world activities, without the hindrance of muddy roads or snow blockades, making farm life still more attractive to the clever country-bred boys and girls.

Already audible radio is rapidly changing our social order; those who may now listen to a great man or woman are numbered in the millions. Our President frequently talks to practically the whole citizenship of the United States at the same time.

When to this audible radio we add visible radio, we may both hear and see great events; inaugural ceremonies, a football, polo, or baseball game; a regatta, mardi gras, flower festival, or baby parade; and an entire opera in both action and music.

And from our easy chairs by the fireside, we stay-at-homes can watch the earth below as that great ship, the Shenandoah, carries our flag and a broadcasting lens, over the mountains and plains, the cities and lakes, of our wonderful country.

A speaker representing the Westinghouse Company, at the last Radio Conference, predicted that we may all listen to the next

Olympic games. But I objected that the entertainment should only be addressed to the ear, why shouldn't we stay-at-homes also *see* the games. It seems to me a reasonable request. Radio is carrying pictures today just as it is carrying sound. Logically, then, we should both see and hear the next Olympic games.

When the teloramaphone is made generally available, then pictures at the fireside sent from such distant world points will be the daily source of news; the daily instructional class; and the evening's entertainment; and equally the long day of the sick and shut-ins will be more endurable, and life in the far places less lonely, for the flight of Radio is not hindered by rain, or storm, or snow blockades.

Before I put on the lantern pictures I should like to pay tribute to the unselfish assistance received from the General Electric and Westinghouse Electric Companies; and particularly to mention the loyalty and confidence of Mr. L. C. Porter, Professor D. McFarlan Moore, and Dr. W. R. Whitney, of the General Electric Company, and of Mr. H. P. Davis, Vice-President of the Westinghouse Electric & Manufacturing Co., and of Mr. S. M. Kintner, head of the Research Laboratory.

And I think it is only fair that I should also mention the splendid young folks who are my laboratory assistants, Sybil Almand, Florence Anthony, John Ogle, James Robinson, Stuart Jenks and Thornton Dewhirst, to whom in no small measure credit is due for Radio Movies.

And me? Oh, I am the fellow who sat by and watched them at work; scratched for money to pay rent and salaries; and looked as wise and dignified as possible when we had distinguished visitors.

DISCUSSION

Mr. Richardson: Is there a probability that the receiving mechanism optically and mechanically can be made at a reasonable cost, and can it be mechanically and optically so made that almost anybody can operate it?

Mr. Jenkins: Anybody can easily operate it and the price we believe they can be sold for when available is about $150 for the machine which will give you motion pictures. I am going to use the word "motion pictures" as illustrating pictures on the screen on which the pictures we send you are put, whether they are sent from the ball game or from the theatre screen. When we add music or appropriate sounds to the same set it may increase it $100. These are tentative prices based on what we now see of the machine as it will be marketed—$150 for motion pictures alone, and for the "Teleramaphone" which adds sound it will probably be $250, i. e., both music and action.

If you will give me three or four minutes more, with your permission I will tell you why we can send music and motion pictures on the same wave-length. All superheterodyne radio sets of today have two detector tubes, one for 60,000 cycles, and another for the speech or music, each amplified three or four times. This is the usual construction. So I said, "Why can't we send pictures on the first half of the superheterodyne set that we can't hear and then send music on the audible cycle?" So that we have our carrier wave modulating a 60,000 cycle picture wave which we further modulate for audibility and we get the music also. It is not difficult but only tedious. In the laboratory we can do this, but at the Naval Station we have been trying to do it for a week.

HOW THEATERS SHOULD BE VENTILATED

F. R. Still*

MOST of the owners of theatres and the engineers who design heating and ventilating plants for theatres have largely failed to consider the wide difference in the requirements of a standard theatre and moving picture theatre. There is hardly any more resemblance in their respective requirements than there is in the provisions to be made to ventilate a school house or a church, yet it has been the general practice to apply the same proportions and employ about the same standards of apparatus for both types of theatre buildings.

The Standard Theatre is occupied for perhaps three hours at a time usually after sun-down, during six days of the week, and is closed throughout the warm summer months. An adequate and dependable heating system is, of course, necessary to maintain a comfortable temperature in cold weather. The usual standards for ventilating auditoriums will apply to such theatres, and will prove to be entirely adequate under normal weather conditions.

In winter weather there is very little moisture in the outside air. As the temperature of the outside air is raised to the room temperature, the relative humidity is lowered; hence the air should be humidified in cold weather so as to maintain 40 to 45% relative humidity inside the building.

In the late spring and early fall, the outside temperature and humidity sometimes become almost as high as during the summer. During these periods it may become uncomfortable inside, but these periods are so short that artificial cooling is hardly warranted.

The Moving Picture Theatre is an altogether different problem. It is occupied, more or less to full capacity, for twelve hours per day, every day in the week including Sundays, and every week throughout the year. The heating and ventilating plant must be designed to meet the requirements of the two extremes of outside weather conditions, viz., winter and summer, both of which extend over several months.

In the winter time, the place must be heated to a comfortable temperature. The air must be clean and pure, devoid of odors and humidified to a comfortable extent.

In the summer time, both the temperature and the relative humidity must be reduced to get satisfactory results. It is impossible to reduce the temperature of the air discharged into the building very much below the normal inside temperature without causing dis-

* Vice president, American Blower Co., New York City.

comfort; hence it becomes necessary to provide for the circulation of a very much larger volume of air in the summer than during the winter to absorb the natural heat radiated from the walls, the roof, the lights and the people. If this large volume is properly distributed and diffused over the whole area of the house, an excellent air motion can be maintained which has a most marked effect on the comfort of the audience in warm weather, because it feels as though the temperature is much lower than it really is, instead of feeling chilly and clammy as is so noticeable in those theatres wherein an attempt has been made to cool them with a small volume of recirculated air which has been lowered to a very low temperature so as to absorb the heat.

It is not infrequent that the volume of air required to maintain comfortable conditions in a Moving Picture Theatre in the summer time will be two or more times the volume of air that would be normally provided for a Standard Theatre of the same size, yet we see plans and specifications right along wherein this difference is entirely ignored, and no greater provision is made for a movie house than would be made for a Standard Theatre.

There are two reasons for this. One is that few designers understand exactly what sort of an atmospheric condition should prevail to attain perfect comfort. The other is, that the majority of the architects and engineers did not appreciate fully the great difference there is in the requirements of a Standard Theatre and a Moving Picture Theatre. They knew that certain standards as applied to the older type of theatres gave reasonably satisfactory results, and it naturally followed in the course of their everyday operations that the same would apply to moving picture theatres.

It is only within the last two or three years that any reliable data has been available to work with which would indicate what the atmospheric conditions should be inside of a building to attain the same comfort that a person feels on a fine June day in the open country. Apparatus was available to maintain any temperature, any relative humidity and produce any air motion, but the right combination was not known. Not until the American Society of Heating and Ventilating Engineers established a Research Laboratory at the U. S. Bureau of Mines, Pittsburgh, and induced the U. S. Department of Public Health Service to take up the investigation of this subject, was any real progress made. This was started nearly seven years ago. The work is now nearing completion, but the whole scope of the problem required nearly five years of constant experimentation and investigation before any definite results were available.

Some years ago Dr. Leonard Hill of London, England, made an investigation of the wet and dry bulb temperatures all over the world. He took particular note of those atmospheric conditions which seemed to be most comfortable. As a result of his observations he found the prevailing wet bulb temperature was somewhere between 54° and 58°, and that the dry bulb temperature must vary, depending on the wind velocity and the occupation of the subject, to attain perfect comfort.

With this as a starting point the Research Laboratory at Pittsburgh persuaded Dr. Sayers of the Department of Public Health Service, Washington, D. C., to take charge of the experiments, to definitely determine the reactions of human beings to varying wet bulb temperatures, dry bulb temperatures, air velocities, when naked, lightly clothed and normally clothed; when at rest, at light work, and when vigorously exercising.

As the greatest demand for refined ventilation is in those buildings where the occupants are at rest, the work so far completed covers that condition quite fully. One or two examples will illustrate how the data obtained may be applied.

Supposing a person normally clothed is exposed to a dry bulb temperature of 71° and a relative humidity of 30%; the wet bulb will be 54°. Again supposing the dry bulb temperature is 60° and the relative humidity is 76%; the wet bulb temperature will be 55.75°. Either of these temperatures will afford about the same degree of comfort in still air.

In the first instance if, instead of still air, the air velocity should be 100 ft., the effect will be the same as though the apparent dry bulb temperature was only 69°; at 200 ft. velocity the apparent temperature will be 68°; at 300 ft. velocity the apparent temperature will be 66°.

In the second case, if the velocity should be 100 ft. the apparent temperature would be 68°; at 200 ft. velocity the apparent temperature would be 65°; at 300 ft. velocity the apparent temperature would be 63°.

If a person was stripped to the waist, under these air motions he would soon shiver as though it was 10° to 15° colder.

These citations are given merely to indicate the scope of the work being done and to impress upon you that real comfort can not be obtained by merely heating or cooling air. There is a relationship existing between the wet and the dry bulb temperatures which must be maintained in a still atmosphere. As soon as an air motion is set up, the relationship changes and it varies more or less as the air motion increases or decreases.

Another important factor that affects the comfort of many persons is odors. To what extent the effect they have on some people is physiological or psychological has not yet been definitely determined. A strong odor of musk in a warm, unventilated room has been known to cause some women to faint, yet others enjoy it. Some people can live and thrive in the midst of conditions that are to others most abhorrent and, perhaps, nauseating.

Odors can always be completely eliminated by passing the air through a properly proportioned air washer. Adding a heater to warm the spray water, the humidity of the air can be increased and by cooling the water the humidity can be lowered. With suitable automatic controlling instruments any desired relative humidity can be obtained that is best suited for the air motion maintained regardless of outside atmospheric weather conditions, in addition to the complete elimination of the odors and the removal of the floating dust and dirt in the air as previously mentioned.

Many owners of theatres fail to realize the value in an air washer. The preservation of the decorations and furnishings will alone make it a good investment in many cities, even if its value as an essential adjunct to the ventilating plant is entirely discounted. But the time is fast approaching when there will be no argument about the necessity of properly humidifying and cooling the air. The theatres that are so equipped will soon become generally known and the public will demand the same comfortable atmospheric conditions in all of them by refusing to patronize the houses which have failed to put in such equipment.

While the building and operation of theatres is a business proposition from the standpoint of the owner or manager, it is a place of recreation and pleasure for those who patronize them, and as the patrons begin to realize it is unnecessary to endure uncomfortable atmospheric conditions they are sure to seek out and favor those places where they are comfortable.

Architectural beauty, pleasing and colorful decorations, comfortable roomy seats and good accoustics have all come about because the public has shown it appreciates such things, but none of them would count for much if the place smelled badly, or the atmosphere was close and stuffy, or if it became too warm, or it was drafty and cold.

While there are now quite a number of theatres equipped with ventilating plants of ample capacity to maintain a reasonable, comfortable, thermometric temperature throughout most of the auditorium, we only know of two buildings in which the designer apparently fully recognized the opposite requirements during the cold and warm weather by arranging for a reversal of the air movement during the two periods. That is, the warm air enters the house through the floor, beneath the seats in the winter and finds an exit mostly through the ceiling. In the summer the cool air is admitted through the ceiling and is largely removed through the floor beneath the seats.

Cold air striking a person shortly after it escapes from the ducts always causes great discomfort and complaint. Hence it must be introduced at a considerable distance from the occupants. On the other hand, the warm air coming into immediate contact with the occupants in cold weather is very agreeable provided the velocity of the air is not excessive.

In both of the theatres referred to, this reversal of air currents is accomplished by shifting two or three dampers. Of course the fans are speeded up to get a larger volume in the summer than is required in the winter, and the velocity can be very much greater owing to the air entering at a distance so remote from the audience.

The question uppermost in your mind is likely "What does it cost to install an efficient ventilating plant such as has been herein described?"

That is a very difficult question to answer with any degree of definiteness, because there are so many variables in the construction and location of the buildings, the climatic conditions prevailing in different parts of this country, the size of the building, its exposure and the type of refrigerating plant used.

It may be stated that it requires approximately from 75 to 100 tons of refrigeration per thousand people, and a complete ventilating plant with refrigeration will cost anywhere from $200.00 to $800.00 per ton refrigeration.

In other words, a house seating 3000 people, with a ventilating plant designed to cool it to 70 degrees when it is 95 degrees outside, recirculating 80% of the air would require about 285 tons capacity. This is based on an initial dewpoint of 40 degrees. With the same dewpoint and outside temperature, if the inside temperature is 85 degrees instead of 70 degrees, it will require about 267 tons of refrigeration, or about 6½% less.

With the same outside temperature and a dewpoint of 50°, to maintain 70° inside will require about 284 tons, and to maintain 85° inside will require only 250 tons capacity. Thus there is only 15% difference in the extremes of refrigeration required in these examples, which are fairly representative of conditions encountered in the summer in this section of the country. It also indicates the possibility of obtaining very comfortable temperatures even when it is impossible to reach an anticipated low dewpoint.

Such a plant would cost from $50,000 to $85,000 complete. This includes blowers, motors, heating surface, humidifying equipment, pumps, ducts, automatic controlling instruments, etc., all installed on foundations and adjusted ready for use.

The next question is the testimony of those who have tried it. The lowest estimate we have obtained from any manager is an average increase of 26¼% in the attendance of patrons during the months of June to August inclusive. The maximum report we received was a statement that the house had always lost money during the hot weather; that they afterward advertised daily the outside and inside temperatures and people actually admitted that they came quite as much to get cooled off as they did to see the show. This may not speak very well for the show, but it indicates whether or not it pays to make such an investment.

In Minneapolis and St. Paul there is a basin of very cold water at depths varying from 400 ft. to 800 ft. This water is supposed to come through a stratification leading from Lake Superior.

The Astor Theatre in St. Paul is so located that it gets a severe exposure from the sun and hot winds blowing in from the prairies.

The attendance at this house fell off to almost nothing in the summer. A cooling system was installed, using artesian water from the basin mentioned. The house not having been built to admit of a highly efficient plant being installed, maximum results could not be obtained, but the conditions are so improved that the manager claims there is hardly any noticeable difference in the attendance, summer or winter.

The State Theatre in Minneapolis is very well known to all theatre owners in the middle west as being about the first theatre wherein a real effort was made to install an up-to-date cooling plant. Cold water is obtained from the same basin above referred to at a depth of about 800 ft. The temperature of the water is 49°. The satisfaction obtained from this installation was so marked that many owners, managers, architects and engineers have visited it from all parts of the country. It is our belief that this plant has has a greater influence on the attitude of theatre owners toward cooling plants than anything that had been done up to that time.

Cold water not being obtainable in most places it is necessary to cool it artificially by a refrigerating plant. This adds greatly to the cost. In fact, it becomes the most expensive unit of the entire system.

Many other instances could be cited than the two referred to, but both being pioneers in that line and still giving a good account of themselves, it seems hardly necessary to mention that about fourteen or more other houses have been since equipped with cooling plants using refrigeration to cool the water.

We hope that out of this discussion you will have been convinced of the coming and certain necessity for cooling theatres; that the problem must receive special treatment by somebody who is conversant with proper relative atmospheric conditions and how to obtain them so that the results will be entirely satisfactory; that the cost, though considerable, is not prohibitive, and in fact that it costs less than many other things that go into theatres from which less returns can be measured on the investment.

In closing, we want to suggest that good, substantial, efficient, dependable apparatus is the cheapest in the end, but that such equipment is incompatible with low initial costs. Anything on which so much dependence is placed is deserving of only the very best equipment on the market. Therefore, place your problem in the most competent hands you know of, and buy only the best equipment. You will then be satisfied and be sure of success from your investment, all other things being equal.

DISCUSSION

Mr. Braun: As Mr. Still says, refrigerated air should not be introduced through the floor. I remember one place where refrigerated air was introduced by means of mushrooms. After the performance it was necessary for the patrons to go through a number of foot exercises to warm up. In how small a theatre would such a refrigeration system be practical from the cost standpoint? Has Mr. Still any ideas for smaller theatres, say a 1500 seat house? How would he take care of getting more air in the summer in the small house?

Mr. Briefer: I understand that about 80% of the air is recirculated. Has anything been done to safeguard the health of the people attending a theatre in which they are recirculating 80% of the air—that is, in connection with purifying the air.

Mr. Still: In the Tivoli Theatre I believe intakes are provided in both the ceiling and the floor with dampers arranged so that the circulation may be reversed. In summer it is admitted overhead and taken out through the floor; in the winter it is reversed. That answers the second question as to how you can get more air into the small theatre in the summer without discomfort. You need air motion in the summer to obtain comfort regardless of the temperature; the greater volume gives you the required air motion. As an apt illustration: in a dead, stagnant atmosphere in hot weather, the moisture given off by the skin is not evaporated, and the blood pressure rises, hence your body temperature rises. That is why you buy disc motor-driven fans to blow air on you in your offices and homes; you feel cool because the moisture from your body is evaporated by air motion, and the body temperature is thus lowered. If you will test your temperature on a hot day you will find it is above normal when the air is extremely hot and stagnant. At Pittsburgh, four physicians that Dr. Sayers sent down from Washington have been experimenting on this problem. These men have subjected themselves to conditions that have almost caused death in order that they might definitely determine these reactions. The body temperature rises above 97.5° when the surrounding air is near that temperature, and continues to rise as the relative humidity increases. If you are surrounded for any length of time by a dry bulb temperature of 97.5° and a wet bulb temperature of 97.5°, you will die. The closer the wet bulb is to the dry bulb reading, the more uncomfortable you are; the farther apart they are, the better you feel. Naturally, there is a point below 50% saturation where you need more heat as shown by the dry bulb thermometer for a given wet bulb temperature, and the dry bulb must go higher as the air motion is increased, due to the evaporation from the skin.

As to the condition of recirculated air: there used to be an old theory that CO_2 is the biggest bugbear to be dealt with. We have more recently found that it is harmless. Too much CO_2 causes us to breathe faster. We now measure the CO_2 simply to determine the efficiency of the distribution of the air. The oxygen in the air is what is needed to support life. We don't require for our physical welfare anything like the volume of air we regularly put into buildings, but we do need the volume so as to get it thoroughly distributed so that it may reach everybody alike.

Due to the experiments and the information gathered at Pittsburgh, engineers in two cities—Detroit and St. Louis—have been induced to build some schools so that the air could be recirculated. Continuous examinations and tests have been made, and it has been found after four years observation that the children are as well off as they are in any of the schools of those cities. In those buildings only 25% of fresh air is used, though 30 cubic feet per pupil per minute is circulated. In St. Louis they also have ozone machines in nearly all the schools in that city—I think they have something like 150 schools so equipped. Ozone has a very peculiar odor, and a strong bactericidal effect. When it is too concentrated, it attacks the mucous membranes of the throat, eyes, and nose, but we are able with an ozone machine in front of an air washer to recirculate the air without any odor resulting, and without the bad effects mentioned. It also has a very decided bactericidal effect on the water, and apparently adds enough oxygen to make up the normal requirements. From a practical standpoint, I believe we can recirculate practically all the air, with a tremendous saving in coal. With proper ventilating equipment in our school buildings using outside air entirely, you might say that for every four pounds of coal, three are burned for ventilation and one for heating, so that by recirculating we can cut this down to one and a half pounds or two pounds.

Mr. Hertner: In speaking about washing the air you said it furnishes some of the oxygen to the air. Is the washing water renewed, or how does it regain oxygen after some is removed?

Mr. Still: There is always a make-up supply to the tank to replace the water evaporated. You thus get nearly as much oxygen without any ozone as if all of the air supply came from outside. What the provisions for ventilation may be makes some difference, of course, but the amount of water evaporated from an air washer will usually put back the amount of oxygen needed. There is from six to eight times as much oxygen in the average air supply as is needed for respiration, and what is consumed comes back by the evaporation of the water sprayed into the air.

Mr. Briefer: You refer to dissolved air in water, I suppose?

Mr. Still: Yes.

THE ARTISTIC UTILIZATION OF LIGHT IN THE PHOTOGRAPHY OF MOTION PICTURES

By Wiard B. Ihnen and D. W. Atwater

THE merit of a motion picture depends absolutely upon its filming. A poor picture, although it may be shown by a skilled projectionist amid beautiful surroundings to the accompaniment of appropriate music, is still a poor picture; a good picture can undoubtedly gain much by an artistic presentation, but no amount of artistry in projection can make a poorly filmed picture any better than it was when it left the studio.

It is in the studio, then, that the worth of a picture is determined, and, as lighting is the very essence of photography, studio lighting has become one of the most important fields of the industry. If the filming of a picture were merely a mechanical process, it would be easy enough by our modern methods of illumination to flood a scene with *enough* light. But rather than being a mechanical process, it is more or less of an art, and the questions involved are not merely the *amount* of light, but the direction and the shading of the light.

Every picture involves its own distinct problems, and the field of studio lighting is practically limitless. The lighting values for each scene must be adapted to it, just as the characters' costumes are. It would be impossible to lay down any fixed rule of thumb for lighting a picture, or to attempt to cover all the possible problems which arise. This paper can take up only a few of the ways in which lighting effects can be employed to create an artistic picture.

Specialization makes efficiency without which the modern world could not exist. Director, art director, cinematographer, whoever assumes the responsibility of lighting a picture should be free of all problems not essentially his, leaving him more time to visualize and concentrate on the problem of making beautiful and imaginative motion pictures which are truly works of art. His scientific (i.e., design and development of equipment) thinking should be done by the engineer.

Aside from development of equipment, the engineer might go a step farther and help work out the proper colors of materials employed in making costumes and settings. Costumes are elaborate and expensive, usually in keeping with each scene and certainly very beautiful. This beauty of color and contrasts of light and dark are many times lost in the picture because the particular combinations of colors and hues do not register in the picture.

We can all remember how movies were made in the early days, practically every scene being taken under a flood of daylight. Studios had great expanses of glass roof and as long as the sun remained bright, pictures could be taken. Let a cloud obscure the sun or a dark day come along and production was at a standstill. Electric lighting has gradually supplanted the daylight pictures until we find a complete reversal of the earlier conditions. Today everything possible is done under artificial light and we find the old glass roof studios painted over in mourning.

FIG. 1.—A stage setting of more than twenty years ago—obviously painted scenery with absolutely no depth or character.

It is, of course, not fair to charge up all the difficulties encountered in lighting a picture to equipment and any plea for improvement should be accompanied by some suggestion of how to go about it. Reviewing, however, the history of the stage as well as motion picture projection it appears quite evident that no artistic advancement can come about in this new medium of expression without first some previous advancement in equipment.

The statement that acting on the stage today is superior to that of 25 years ago has been contradicted and perhaps justly so. The thoughts of limelights along the front edge of the stage and the funny old painted scenery would justify saying that times have changed and stage effects improved. Credit for this admitted improvement must go to the spotlight, arcs, and incandescent lamps. The spotlight had made all the difference between obviously painted canvass flats, and the modern scene where an illusion is created and a mood expressed by the color, change of intensity and direction of light. Figure 1 is a stage still from "The King's Children" made more than 20 years ago. The setting is obviously painted scenery and probably required exceptionally good acting. Compare this with the modern effect Figure 2, a convincing stage still from "Peter Pan."

Fig. 2.—A modern stage scene. Marilyn Miller in Peter Pan—light and shade are employed to make this an artistic and convincing picture.

Figure 3 illustrates the quantity of equipment required, the positioning of which obviously consumed considerable time. These are the tools with which persons responsible for the lighting have to work. The weight of this apparatus is terrific and requires many men to move it. When some of these lights are rolled over compoboard floors so frequently used in sets, they leave deep grooves behind them. It is not simply a matter of pressing a button and turning on the necessary lights. On the contrary it is a complicated procedure. In the first place the camera man, unfortunately, has to do a lot of thinking, which the director already burdened with his own problems, does not like to allow for. He has to consider the construction of the set, then where the action is to take place in the set. This is generally not in one spot but moved from one place to another. Then he has to consider the mood of the scene, i.e., the sort of effects that would emphasize the drama. In addition to these things he has to worry about the shape of the stars nose and sometimes the woman star is showing signs of a double chin—very slightly of course—he must eliminate the crooked nose and other touchy defects by means of light. He hastily forms an impression of how the set should be lighted and shouts instructions to the electricians who roll up their sleeves and start hauling great heavy cables, Figure 4, dragging them

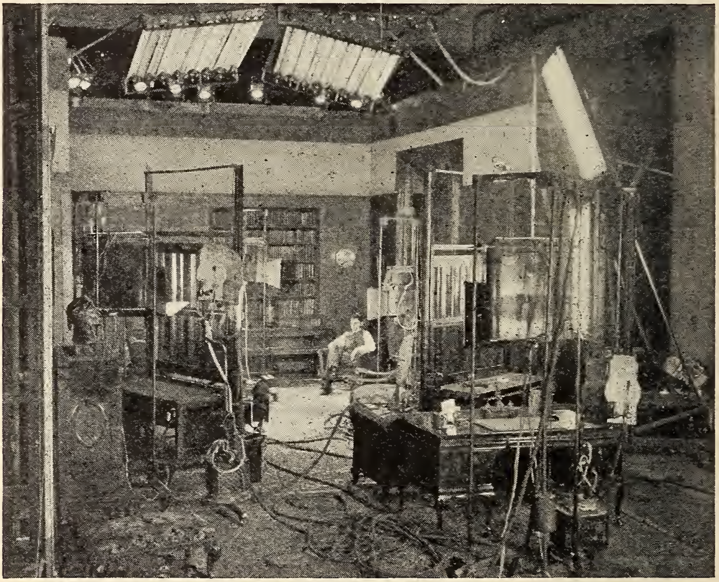

FIG. 3.—Photograph made immediately after a scene was completed, showing the quantity of cumbersome equipment employed.

across expensive rugs and floors just varnished and waxed to look like hardwood. Large sunlight projectors which take a half dozen men to handle have to be hoisted up on platforms previously moved in place.

After a few hectic hours of this, the director has about lost his patience and decides to shoot. He places his actors and rehearses them, then perhaps decides that his crossings do not work well and so he will just change this acting to the other side of the set. This will work more smoothly. That means two hours of work gone for nothing but what can the camera man do? The director wants to shoot.

The camera man must divert the director's attention by fair means or foul until he gets time to change a spotlight or two. But the director cannot be stalled off long and soon yells, "camera, action!" The hero starts to do his stuff.

Frequently when the rushers are viewed in the projection room the next morning, they may look satisfactory, but if a good painter happened to be there he would ask why it was that when the actor walked across the set a great pin wheel (Figure 5) of shadows revolved about his feet on the floor serving to detract attention from the actor. This picture was taken purposely to illustrate the pin wheel effect and the shadows are somewhat exaggerated.

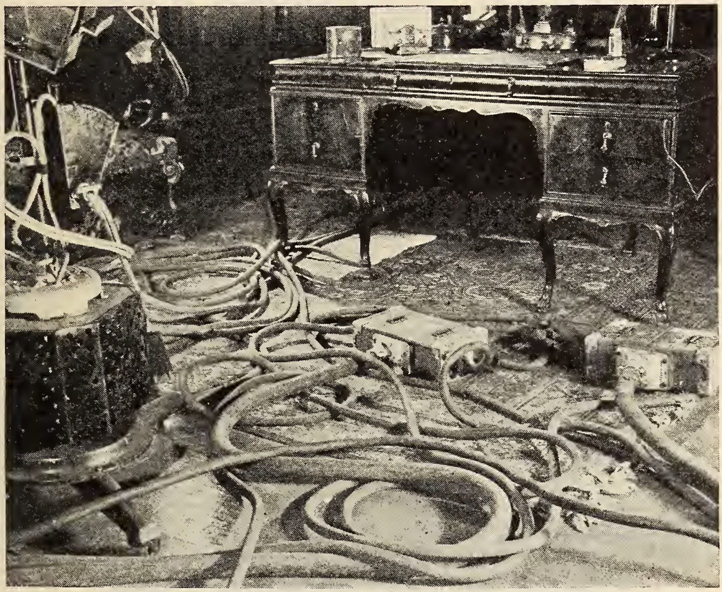

FIG. 4.—Coils of heavy cables with bulky connecting-blocks photographed at the conclusion of a small scene, indicating the considerable time involved in arranging the lighting equipment and the enormous load required.

The best argument for improved facilities is a consideration of the cost of production. Fifty percent of the time consumed in producing a motion picture is used in arranging the lighting and picture costs are based entirely on the time element. The preliminary work of preparing the story and final work of cutting are more or less fixed charges, not dependent so much on the time element. The terrific overhead of stars, production staff and studio makes speed imperative.

It might be well in order to understand some of the problems involved in lighting a set to imagine a simple example such as a 3 wall or U shaped set approximately 12 feet wide. Assume the action to take place "up stage" near the back wall and in one corner. Assume there is no ceiling and naturally no front. Now set up the camera and light up your characters and background—Easy—just put a bunch of broadsides each side of the camera and shoot. The result is a flat picture with no detail, distance or separation between actors and background. Each arc would cast a separate shadow on the opposite wall. The way to improve such a picture would be to add a couple of

FIG. 5.—"Hard light" from spots if not carefully employed will produce deep shadows such as these and thus cause revolving pin wheels about the feet of moving characters.

spotlights overhead directed on the back wall. This might accentuate the floor shadow somewhat, but they are less objectionable than the wall shadows which with such treatment would be eliminated. The spots would throw enough light on the heads and shoulders of the characters, producing a sort of fringe of light around them and partially separate them from the wall.

Figure 6 illustrates three ways of overcoming these difficulties.

The first way, A, would be to move the characters forward and put diffusers on the spotlights. This will eliminate shadows on the walls and floor.

The second way, B, would be to move the characters out along the back wall, away from the corner and move the camera closer. In this picture the actors would appear only against a flat wall and the side walls could be eliminated. It would, however, permit moving lights into the set on each side of the characters.

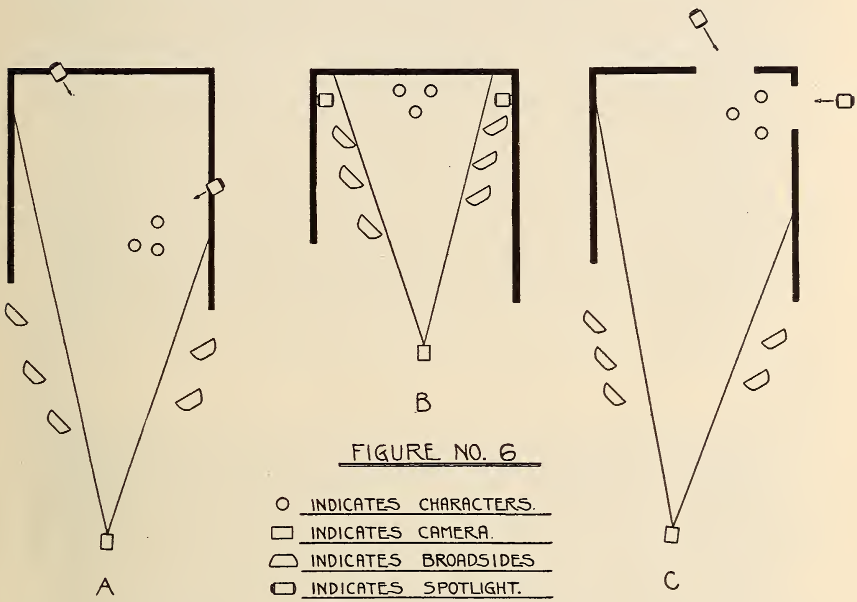

FIGURE NO. 6

The third way, C, would be to eliminate the overhead spots by cutting openings in the walls. These openings would have to be doors, windows or arches whether they belonged there or not.

In other words it is necessary to balance the light from various directions so as to get that exact and beautiful play of light and shade that makes the motion picture a work of art. It is control of these light and dark spots that is so important. These light and dark spots are referred to as values and on their arrangement depends to a large extent the artistic quality of a picture.

Lighting is the very essence of the motion picture. Figuratively it is the palette of the art director and occupies the same relation as pigment does to painting. It is the medium. It might be argued that action is the medium of the movie, but if the analogy of the painting is followed out, action is the subject matter expressed in terms of light. Light should be one of the first thoughts in visualizing a scene. It is just as important as the actor and, in fact, sometimes it takes the place of the actor. It is often possible to heighten the dramatic value of a scene by suggesting the actors with a play of light rather than by actually showing them.

Up to this point "light" has been referred to frequently, always as a desirable and necessary medium. Light reveals the shadow; darkness, or the absence of light reveals the light.

What is seen on the screen of the theatre is a succession of shadows cast by the image on the film in the path of a beam of light. The absence of light is exactly as important as the light. We do not see the light any more than we see the darkness as far as art is concerned. Light by itself we know, if too uniform and diffuse, can completely conceal the shape and contour of an object. It only becomes visible when shade and shadow are allowed to play on its surface.

Darkness generally is considered to be a negative quality but in art it is a positive quality. It is physically easier to control values in painting than is perhaps the case in any other medium. If a dark tone is required, a dark pigment is used, if a light tone is wanted a light pigment is used and so on. Painting with light rays is painting with a more elusive quantity than oil paint.

By going through the same mental process as required in making an oil painting and applying the same general principles of art, it is possible to decide in a particular "shot" where the light tones ought to be and where the dark tones ought to be. All that remains after that is physically to get them there. That is the job which requires so much time and to which there is no formula. With this thought in mind it might be of interest to examine a few stills. The lighting is practically the same as that used for the movies. While these pictures should not be taken as examples of perfection they are all very well done and will serve for the purpose of illustration.

Natural lighting was the aim in the following sets and where this was not accomplished there was generally some mechanical or practical reason preventing it. If these were perfect examples of lighting there would be no point in showing them to a group of engineers, unless it was for reasons of purely personal interest. The fact that they are pretty good, but not perfect by any means, should serve to stimulate interest in eliminating the difficulties involved.

Figure 7 is a long shot of a set representing an upper chamber in an English tavern during the time of Cromwell in Old England. Note that in this room a complete ceiling was constructed, entirely covering the set and not allowing any overhead light. Overhead illumination would be the worst lighting fault that a set of this kind could have. The corner of the room by the pallet bed, being almost completely boxed in, presents a lighting problem similar to that described in discussing the imaginary set in the first part of this paper. Here it will be recalled that difficulty was experienced where action took place in a corner. The lighting used in this "still" (not the same as that used for the motion picture camera) consisted of two

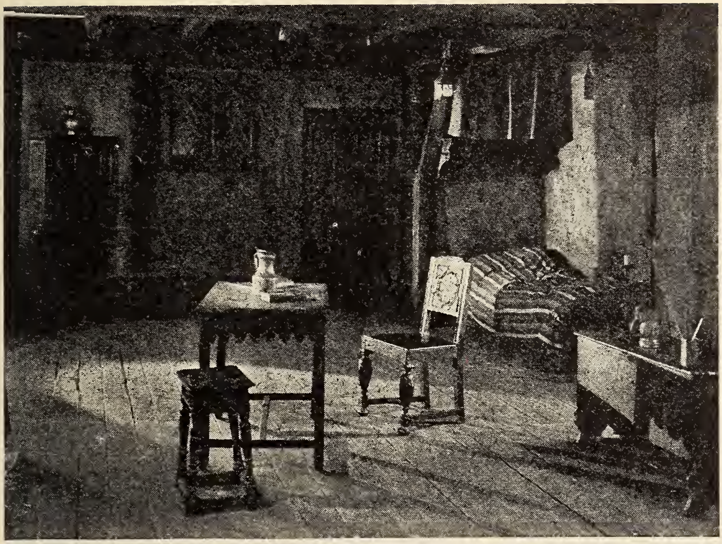

Fig. 7.—The corner of this room, with its low ceiling, presents a difficult lighting problem. Note the ineffectiveness of the lantern and the inconsistency of its shadow on the wall.

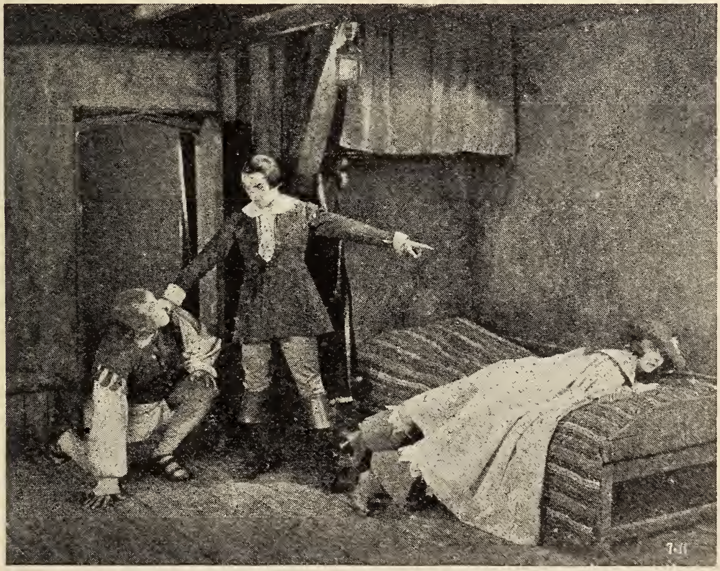

Fig. 8.—A well illuminated set employing camouflage lighting. The curtain shadows are painted, while the highlight on the shoulders of Mr. Barthelmess is produced by a concealed spot.

spotlights whose beams are quite easy to detect, and some Cooper-Hewitt lights on the left side. Note the shadow of the lantern on the wall as well as the absence of light on the curtain which should have fallen on it from the lantern. Also the line of the vertical shadow on the right which unnecessarily repeats the upright timbering in the foreground. This timbering was purposely built in the foreground to add such a dark line. The wall on the right of the bed should have been all light.

Figure 8, is an action "still," showing how the shadow on the curtain was produced by means of black paint and the light below it by white paint. High lights on the bracket and the beam above were painted. The shadow under the shelf was somewhat weakened by too much front light. The light on Mr. Barthelmess, which looks as if it came from the lantern, was produced by a "Baby Spot" hidden above. The balancing light on his head came in through the open door. Note the shadow of the Inkeeper's head across his shoulders; this also comes from the "Baby Spot." The face of the lantern had to be frosted so that it did not become glaring and draw attention from the star's face. Note how the highlight on his shoulder immediately attracts the attention, making the star's face the center of interest.

Figure 9 is a short shot from the "Night Life of New York" a Paramount picture. Note how the spotlight has been used to bring up each of the characters. These highlights on the heads of each of the two men separate them from the dark background at the same time revealing the position of Mr. Kelley's left arm. The dark coat of Miss Gish has been revealed in the same manner.

Figure 10 is the same picture as Figure 9 with the highlights eliminated. Here the dark heads of the men disappear in the background and there is no suggestion of the left arm position. Obviously spotlighting of this kind is necessary. If artistically employed as in Figure 9 it is most pleasing and desirable. On the other hand, this effect and more especially that obtained from back lighting has been over done in the last few years. Despite newspaper stories to the contrary, actors and actresses as a rule do not need artificial halos around their heads to make them acceptable to the public. By a careful study of values, backlight can often be entirely eliminating, to the betterment of the picture.

Figure 11 illustrates an elaborate scene from the recent production "Robin Hood." Light values here have been skillfully employed to make a well balanced composition. The dim illumination above accentuates the height of the scene while shadows and highlights bring out depth and character. Note particularly the pleasing appearance of the brightly lighted doorways which apparently illuminated the set.

Figure 12 is of a small set taking during rehearsal. Note how the lantern light on the floor was painted. The director's shadow on the wall looks as though it is coming from the lantern and is good,

Fig. 9.—Spotlighting is used in this set to separate the characters from the background and to accentuate the predominating features.

Fig. 10.—The value and necessity of highlights are appreciated when this illustration is compared with Figure 9.

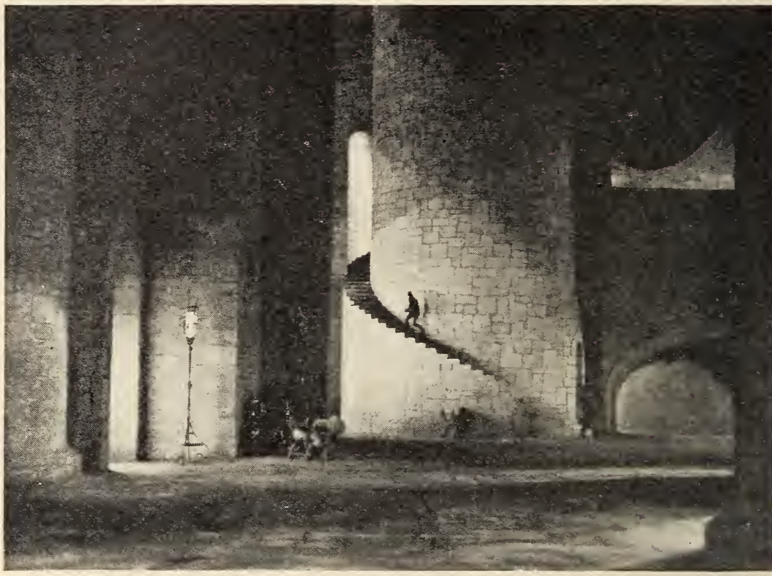

FIG. 11.—An excellent example of artistic utilization of light revealing the magnitude and depth of this elaborate setting.

FIG. 12.—The lantern light on the floor was actually white paint, while the light on the actor and his shadow were produced by a high-intensity spotlight.

but the actor in the corner is casting a shadow on each wall. Fortunately, one is much stronger than the other. The large canvas frame overhead was placed there to prevent any daylight from seeping into the set. Overhead light on this set would have been bad. The studio in which this picture was made is the old Universal studio in Fort Lee, New Jersey, which has a glass roof.

Fig. 13.—Candlelight effect apparently produced by the tallow candle on the table. The actual source was a spotlight, the use of which can be detected by the floor shadows.

The inference to be drawn from all these pictures of interiors is that when the industry has developed to the point where illumination can come from natural sources, motion pictures will be cheaper to make and better to look at. Firelight, light from lamps, and candles are all very difficult to produce. There is no kind of candles now in use in studios that has sufficient light to "pick-up" on the screen. Where they are used near a wall a spotlight is generally thrown against the wall behind them, but the flame is barely visible, and if someone should walk in front of the spotlight the candlelight would

FIG. 14.—Imitation Firelight here was produced by a concealed arc behind the logs and by white paint on the back of the fireplace.

disappear. One trick now being used for candlelight is produced by cutting a hollow paper candle in half lengthwise, and hiding a tiny arc behind it. This throws a pretty good light behind it, with no light at all in front, so that the candle is silhouetted against its own light and, of course, has no flame. When a candle of this sort is carried, the actor has to conceal the wires in his clothes, but there is generally no particular disadvantage in this.

Figure 13—The apparent candlelight is produced from a spotlight on the left. Its use, however, can be detected by the table shadows. This is a picture of Neil Hamilton in "Isn't Life Wonderful," produced by United Artists.

The firelight of Figure 14 is also artificial being produced by a small arc concealed by the logs in the hearth.

Fig. 15.—An outdoor set in which the sun itself furnishes natural and true lights and shades.

Figure 15 is a set produced out-of-doors. This was produced under natural daylight and is taken from "Robin Hood," a United Artists production. Note the crispness and transparency of the shadows. Such a picture could never be produced with electric light. It could be approached but the same values would not be present. By the time sufficient light had been poured into this scene to allow for pick-up the shadows would be entirely washed out or very much reduced in their values.

Everyone has probably noticed or been annoyed, unconsciously perhaps, by seeing a movie scene wherein the sunlight poured in a great window through radiating shadows, so that it was evident that the sun was only eight feet outside of the window or thirty inches in diameter. This fault of artificial sunlight is illustrated in Figure 16.

In addition to the problems encountered in securing proper light direction there are also difficulties in controlling the quantity of light. One method frequently employed consists of using compoboard screens known in the studio as "goboes." These are interposed between the camera and the set to block out light where it is not wanted. They are, however, cumbersome and serve to clutter up the studio. Shadows of any particular character or contour are obtained by placing screens or objects in the path of the spotlight beam. Where tree shadows are wanted, for example, a branch of a real tree is brought in and nailed up in front of the lights.

As the brilliancy of the arc lights are practically constant, various methods must be employed to control their light output. One scheme is to use an iris diaphragm shutter which screens off a certain portion of the total light output. Another method of control-

Fig. 16.—Artificial sunlight is apparent because of the diverging shadows on the wall.

ling illumination is by use of colored filters in front of the arcs. The impression one immediately forms on observing these screens is that they are used to produce a given color, for example, pink over any portion of the set. Their object, however, is to control or dim the illumination. As each color has a different light transmission, carefully selected filters permit the scene to be illuminated to almost any desired intensity.

In a brief and general discussion of this character only isolated and individual problems can, of course, be considered. The various illustrations have been employed to show the possibilities of light in photography of better motion pictures. It is hoped that future developments in lighting equipment will place in the art director's hands a medium for a more flexible, convenient and economical control of light and shade which will make future productions as far superior to our present films, as the pictures of today are superior to those of only a few years ago.

DISCUSSION

Mr. Brown: The use of white paint in fireplaces in order to give the effect of a brilliant source of illumination which is not present seems to be an extremely valuable aid to composition, and I think it will have a very wide application in the future.

THE USE OF COLOR FOR THE EMBELLISHMENT OF THE MOTION PICTURE PROGRAM

By L. M. Townsend* and Lloyd A. Jones**

Communication No. 237 from the Research Laboratory of the Eastman Kodak Co.

"Coloring is the sunshine of art, that clothes poverty in smiles, and renders the prospect of barrenness itself agreeable, while it heightens the interest and doubles the charm of beauty."—Opie.

THE love and appreciation of color is firmly ingrained in the human consciousness. Our oldest written historical records show that color was appreciated and used extensively by the peoples of those early ages. Prehistoric remains dating back centuries before the existence of a written language indicate that the Cro-Magnon men, the first true men (later Paleolithic age, approximately 20,000 B.C.) decorated the walls of the caverns in which they lived with colored paintings. Wells[1] states "It greatly aids us to realize their common humanity that these earliest true men could draw. Both races, it would seen, drew astonishingly well. They were by all standards savages, but they were artistic savages. They drew better than any of their successors down to the beginnings of history. They drew and painted on the cliffs and cave walls that they had wrested from the Neanderthal men. . . . They buried their dead, often with ornaments, weapons, and food; they used a lot of colour in the burial, and evidently painted the body. From that one may infer that they painted their bodies during life. Paint was a big fact in their lives. They were inveterate painters; they used black, brown, red, yellow, and white pigments, and the pigments they used endure to this day in the caves of France and Spain. Of all modern races, none have shown so pictorial a disposition; the nearest approach to it has been among the American Indians." So from the very dawn of civilization color has played an important part in the lives of men. Nor is this to be wondered at since color is an inseparable part of vision. Every visual sensation carries with it its color content, and as stated by Hering, "Our visual world consists essentially of differently presented colors: and objects as seen, that is visual objects, are nothing but colors of different nature and form." This fact has been recognized by many others, among them Clerk Maxwell who states, "All vision is color vision, for it is only by observing differences in color that we distinguish form."

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[1] Outlines of History. McMillan Co., 1923, p. 70-71. See also "History of Art". Elis Faure Co. I (Ancient Art, p. 10-23).

The human race evolving in an environment so colorful as that afforded by nature could not well be indifferent to the beauty and charm of this phenomenon. It seems only natural, therefore, that very early in their evolution, our prehistoric ancestors should strive to imitate in permanent form the transitory colors exhibited by nature. Ever since that remote period color has been used in almost every phase of human activity and the art of combining and assembling colors in pleasing forms has developed to a high state of perfection reaching its pinnacle perhaps in the works of famous painters.

The great difference between color in nature and in the handiwork of the artist is that the latter is largely static, while the former is frequently mobile (dynamic). There is a fascination and charm in the ever-changing color as observed in nature which we can not hope to find in the static production of the artist. Many of the best artistic results are good because the artist has caught a fleeting color effect and fixed it on his canvas. If this is true, how much more interesting and beautiful would be a picture having a mobility of coloring similar to that displayed by nature. The motion picture has made it possible to reproduce mobility of form as characterized by differences in brightness (light and shade), but unfortunately, the photographic process in common use at the present time is not capable of reproducing the chromatic attributes of color, and we are forced to be content with pictures from which these chromatic factors are absent.

In many of the modern motion picture theatres the programs offered include other types of entertainment such as ballet, organ, orchestral, and vocal numbers. The use of colored lighting effects in conjunction with these numbers has already been developed to quite an extent. There seems to be little doubt that an artistically arranged and carefully executed color accompaniment is very satisfying and enhances materially the enjoyment of other visual and auditory sensations. In connection with the production of such color accompaniments used in the Eastman Theatre some new types of color projecting equipment giving dynamic color effects have been developed and it is the object of this paper to describe their construction and use.

The successful use of such color effects as an accompaniment to the orchestral, vocal, and ballet numbers, or even by themselves as a prelude to the feature picture, at once suggests that form of art which has frequently been designated as *color music,* but for which the term *dynamic color* or *mobile color* is more appropriate.

While this paper does not purport to deal specifically with this subject, the authors would like to take this opportunity to express a few thoughts relative thereto. There seems to be no reason, a priori, to assume the impossibility of combining colors in certain spatial and temporal sequences so as to produce an emotional effect. There is little doubt that colors as such do possess a certain emotional value although the correlation is at present not very definite. There is no reason to assume that there is any unique relation between the vibration frequencies of sound and light (color), and hence that there is a possibility of building up a color scale upon the basis of the frequency relations existing in the musical scale. One of the strongest arguments against such a correlation is the marked difference in type between the visual and auditory sense organs; the ear being a receiver of the analytical type, while the eye is synthetic. The ear is able to analyze the stimulus into its component parts while identical visual sensations (colors) may be produced by stimuli differing widely in frequency composition.

Another difficulty encountered in correlating hue (wave-length or frequency of light vibration) with pitch (frequency of sound vibration) is presented by the non-spectral hues, the purples which are mixtures of red and blue and to which it is impossible to assign a dominant wave-length. If, therefore, the radiation in the visible region, 400 mμ to 700 mμ, be considered as analogous to an octave or any part of an octave in music it is difficult to know just what disposal to make of these non-spectral hues without which no color scale can be complete. While it is possible to designate the hue of these red-blue mixtures by stating the dominant wave-length of the hue which is complementary to them, and this subterfuge has been resorted to by some who have attempted to correlate hue with pitch, the arrangement seem highly artificial.

The contention that the failure of the human race to develop an art of dynamic color during its earlier periods of evolution is an indication that there is no possibility of such an art, is wholly unwarranted. The development of an art depends upon the availability of the necessary equipment and materials for producing the required physical stimuli. Satisfactory methods of producing sound were found relatively early in the evolution of the race, and the development of the physical sciences was such as to provide adequate means for building up the art of music. Moreover, each individual was endowed with a pair of vocal cords which at least in some cases, were adequate for the production of musical sounds, although it is unsafe to generalize too far in this direction.

While colored media (pigments, dyes, colored glass, etc.) were discovered and used very early in the history of the race, these afford a means of producing static effects only. Adequate means for the production of dynamic effects became available only when methods of producing light artificially in appreciable quantity were developed, and this accomplishment of science is of very recent date. Previous to the discovery of electricity the human race was dependent for artificial light upon very primitive and inadequate methods. It is rather hard to realize that it is only within the last fifty, or at most one hundred years, that the human race has had available means of producing artificial light in any appreciable quantity. The electric arc was invented by Sir Humphrey Davy in 1800. The first incandescent lamp was made by Edison in 1879 and these were produced commercially for the first time in 1881. Artificial light is, therefore, a relatively new tool in the hands of man, and it is little wonder that he has not as yet completely mastered all of its possible uses, nor under such conditions is it remarkable that an art of dynamic color did not evolve along with the art of music. Nor is it reasonable to expect that a finished art can grow to maturity in a short time, for not only must the fundamental laws be discovered, but the appreciation of such an art is something which must develop gradually by a process of evolution similar to the way in which appreciation of music has developed during the past five or ten thousand years.

There have been many efforts, within relatively recent times, to develop an art of dynamic color. In many cases this effort has not been well directed and attempts have been made to establish a specific connection between music and the art of dynamic color. There is little doubt that such an effort is vain, and we feel that if an art of dynamic color is to be developed it must stand on its own merits as a means of artistic or emotional expression entirely independent of the art of music.

Among the attempts that have been made to develop dynamic color art may be mentioned that of Scriabine[2] in which a color score was played along with the musical production of Prometheus. The work of Mary Hollock Greenwolt[3] is also worthy of note, and more recently Wilfred[4] has developed an instrument, termed by him the clavilux, which is played in a manner similar to the organ and project on the screen many form of changing color. At best only a small beginning has been made, and very much fundamental research work must be done before anything like a finished art can be expected. The increasing attention that is being given to the use of color effects, both static and dynamic in many different fields, indicates a growing appreciation of color in its more abstract forms. This paper makes no pretense of contributing to the theory of the art, but it is thought that the duplex projector using pattern plates of complementary types and compound wedge filters of variable color is a useful addition to the rapidly increasing number of tools available for use in the development of this art.

Color Nomenclature—The terminology of color is at present in a rather chaotic condition, an entirely different meaning frequently being attached to the same word by different individuals. This condition, since it results in misunderstanding and confusion, is undoubtedly one of the causes of retarded progress. Recently the committee working under the auspices of the Optical Society of America has attempted to construct a rational terminology. In their

[2] The Harmonies of Scriabine, London Musical Times, March, 1913, p. 157.

[3] Mary Halloch Greenwolt, Trans. Illuminating Engineering Society, Vol. 16 (1921), p. 110.

[4] Wilfred, Trans. Illuminating Engineering Society, Vol. 17 (1922), p. 8.

report[5] definitions for many of the words used in this field are proposed. We wish to recommend strongly that this report be given careful consideration by all of those interested in the subject of color and its application. Definitions of some of the more important terms as proposed in the report mentioned are quoted below, and an attempt has been made in this paper to adhere as closely as possible to this terminology.

Color—"The general name for all sensations arising from the activities of the retina of the eye and its attached nervous mechanisms, this activity being in nearly every case in the normal individual a specific response to radiant energy of certain wave-lengths and intensity. It may be exemplified by enumeration of characteristic instances such as red, yellow, blue, black, white, gray, etc."

It will be noted that according to this definition black, white, and grays are included as colors. While there is some objection to this it seems on the whole more satisfactory than the opposite course.

The word color is used at present in two distinctly different senses, the one including the gray series, the other excluding them. The extend of usage, so far as can be determined, is about equal for the two meanings. This double usage is obviously undesirable. If the above definition is adopted it will be necessary to use another term to replace the use of *color* in the limited sense.

Chromatic colors—This term is proposed for use in the place of the present limited usage of the word color, and is the general designation for all colors possessing the *hue* attribute.

Achromatic colors—This term may then be used to designate all colors from which the *hue* attribute is absent, that is the grays, black, and white.

Color of an object—As stated above color is defined specifically as a sensation. When the word is used in designating the characteristic of an object it must be kept in mind that it is understood to indicate the sensation produced by the radiation reflected (transmitted or emitted) from the object, and for the sake of definiteness this usage should further be limited to the condition that the object is illuminated by *white* light.

Color of light—Likewise this usage of the word refers to the sensation produced when the radiation in question falls upon the retina, or since this characteristic of light is in practice usually judged by the appearance of objects illuminated thereby, this term should be understood to refer to the sensation produced by the light when reflected from a nonselective, white or gray, surface.

White light—This concept is of fundamental importance for many purposes such as the definition of complementaries and the establishment of the laws of color mixture. In its broadest sense the term must apply to radiation of any spectral composition which

[5] Report of Committee on Colorimetry for 1920-21, J. Optical Society of America; Vol. 6, 1922, p. 527.

will excite a hueless or gray sensation. Since the eye is synthetic in action, the gray sensation may be excited by an infinite number of different spectral energy compositions. For purposes of standardization it is desirable to limit the application of this term to one particular type of distribution. From the standpoint of evolution it seems most rational to consider the radiation from the noonday sun as the adequate stimulus for that sensation which we term white. Since the spectral distribution of this radiation can be almost perfectly matched by a complete radiator operated at a color temperature of approximately 5200° K such radiation may be specified as standard white.

The nature of color, i. e. the sensation produced when radiant energy falls upon the retina, can be completely specified in terms of three fundamental attributes:

(a) Brilliance
(b) Hue
(c) Saturation

(a) "*Brilliance* is that attribute of any color in respect of which it may be classed as equivalent to some member of a series of grays ranging between black and white."

(b) "*Hue* is that attribute of certain colors in respect of which they differ characteristically from the gray of the same brilliance and which permits them to be classed as reddish, yellowish, greenish, or bluish."

(c) "*Saturation* is that attribute of all colors possessing a hue which determines their degree of difference from a gray of the same brilliance."

The color of any object as seen by the eye is in general dependent upon two factors:

(*a*) The *absorbing*, or in the case of self luminous bodies the emitting, characteristics of the object. Since the great majority of natural objects are nonluminous, it is the *selective absorption* that is of interest in most cases.

(b) The *quality*, or *spectral composition* of the incident radiation.

Character of the receiving surface—Since this paper deals with a method of producing colored effects by projection of light onto a surface it will simplify the discussion somewhat to eliminate, as far as possible, the influence of the surface itself. It will therefore be assumed that the surface (screen, curtain, drop, etc.) onto which the light is projected is non-selective, that is white or gray. As a matter of fact such a surface is in general most satisfactory for practical purposes. A surface having marked selective absorption tends to limit the range of hues that can be obtained. For instance, a yellow surface, absorbing the radiation of shorter wave-lengths which evoke the blue sensation, does not reflect blue light, and hence if blue light be projected thereon the surface will appear black. Selectively absorbing curtains or screens may, however, be very useful in special cases in the production of a composition from which it is necessary or desirable to exclude certain hues or to enhance certain hues.

Character of the light source—The spectral composition of the radiation emitted by various artificial sources differs enormously. For practical purposes, however, only the electric arc of some type and the incandescent lamp need be considered. The high efficiency tungsten incandescent lamp operates at a color temperature of approximately 3000° K, while the color temperature of the crater of the ordinary carbon arc may be taken as approximately 4000° K. In the case of the modern high intensity arcs, crater temperatures as high as 5000° K or even greater are obtained. It is evident, therefore, that the color of the arc approaches that of our previously defined standard white. The tungsten lamp, however, is appreciably lower in temperature and if compared directly with standard white appears appreciably yellowish. However, for practical purposes of projection and the production of color effects, all of the sources mentioned may be considered as approximately *white.* The deficiency of the shorter wave-lengths is sometimes a serious disadvantage (especially in the case of the tungsten source) when it is desired to obtain blues and violets of great brilliance and saturation. A non-selectively reflecting surface illuminated with light from any of the sources mentioned above will appear white provided no standard of comparison is present and the term *white light* is frequently used loosely as designating any radiation in which all wave-lengths within the visible region, 400 mμ to 700 mμ, are present in relative proportions markedly different from those of a complete radiator at 5000° K. In the production of color effects by projection of light it is desirable that the equipment shall be capable of projecting light of any desired color. Assuming that the source used is emitting radiation of all wave-lengths within the visible region, the light falling upon the receiving surface can be modified to any desired color by placing between the source and the surface a transmitting material (glass gelatine, etc.) having the proper selective absorption. This absorbs or subtracts certain wave-lengths and permits other wave-lengths to pass through entirely or partially unimpeded and the color thus produced is said to be obtained by a *subtractive* method. Any desired color can be obtained in this way, and with a sufficient number of sources and filters one source could be used for producing each desired color. When we consider, however, that there are approximately 125 perceptibly different hues (including the nonspectral purples); 20 perceptible saturation steps between zero and one hundred per cent saturation; and at least one hundred brilliance steps, making it possible to produce 250,000 different colors, the absurdity of using one source for each color is at once apparent.

Color mixture—It is necessary, therefore, to adopt a method whereby the required colors can be obtained by the mixture of a relatively few components. There are two ways in which color mixing may be accomplished. These methods are usually designated as *additive* and *subtractive.* When pigments or dyes are mixed together in order to form some other color the resultant effect depends upon the laws of subtractive color mixture. When two lights of different colors are projected on the same area of a screen thus producing a third color, the result depends upon the laws of additive mixture. It should not be understood by this that the laws governing color mixture in the case of light and pigments are in any way different; the same fundamental rules apply and depend only upon the manner in which the mixture is made.

Additive mixture—It has been found that all possible colors can be produced by methods of additive mixture when three colors which are termed the additive primaries are used. These are red, green, and blue. The mixture of red and green in this way gives yellow, green with blue gives blue green, and red with blue gives magenta or purple. By varying the proportions in which these three primaries are mixed, any desired hue can be obtained. In order to build up color in this way for use in the theatre it is necessary to have three light sources in front of which are placed the three additive primaries in the form of filters. By controlling the intensity of each source any desired color can be produced on the screen.

Subtractive mixture—The subtractive primaries are magenta (minus green), yellow (minus blue), and blue green (minus red). In order to produce a desired color on the screen filters of the three subtractive primaries are used with a single light source. The minus red used with the minus blue gives green, minus blue with minus green gives red, and minus green with minus red gives blue, and by controlling the thickness or density of the three filters any intermediate hue can be obtained.

Thus by using either the three-color additive, or the three-color subtractive method it is possible to obtain any desired color. In practical work, however, it is rather inconvenient to use three independent sources and for this reason the three-color additive system is not very generally employed. The use of two independent light sources, however, is not open to so great objection and it has proven fairly easy to utilize a two-color additive method. This combined with the three-color subtractive method offers a possibility of producing a very wide range of color effects.

The method devised for producing dynamic color effects with this combination of a two-color additive with three-color subtractive is illustrated by Fig. 1. The apparatus consists essentially of two projectors of the stereopticon type mounted together and so adjusted that they will project two slides in register on the screen. The optical arrangement is shown schematically in the figure, S_1 and S_2 representing the light sources, C_1 and C_2 the condenser lenses, P_1 and P_2 the object slides, L_1 and L_2 the projecting lenses, and R the screen on which the image is formed as indicated at MN. For producing these color effects slides or object plates of two different types are used. Slides which are complementary to each other in both form and

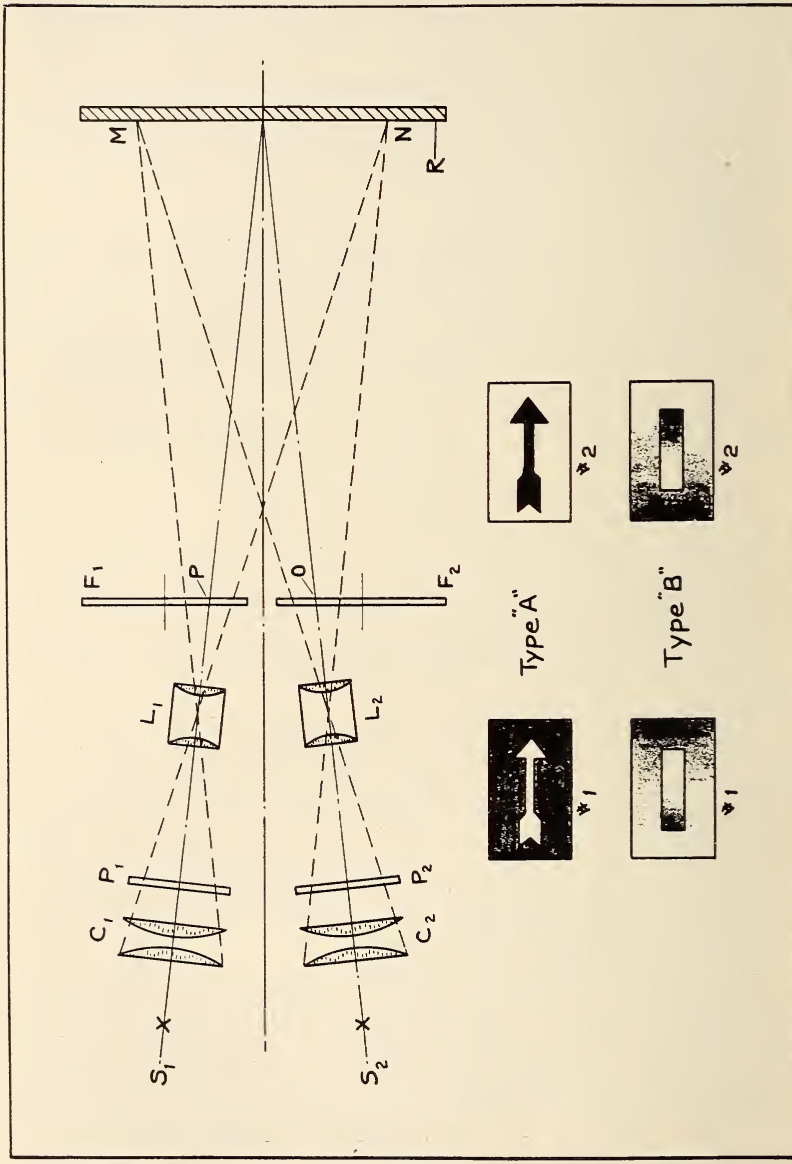

Fig. 1—Diagram showing double projector system with complementary pattern plates.

density are used in both cases, but in type A only two densities, one very high and the other very low, are present on each slide. Thus No. 1 of type A, which may be referred to as the positive member of the pair, consists of an opaque arrow on a transparent background; while No. 2 of this type, which may be referred to as the negative member, consists of the same pattern in which the arrow is transparent and the background opaque. Slides of type B are made up of more than two densities. This is illustrated in the figure; in No. 1 of type B, which again may be referred to as the positive member, the inner rectangle varies continuously in density from one end to the other. This is on a background which also varies continuously in density, but in the opposite direction to that of the small interior rectangle. The other member of this pair, the negative member shown as No. 2 of type B, is the exact complement of No. 1 in both form and density, and if superposed upon No. 1 would produce equality of density over the entire area. Now let us assume that the light sources in the double projector are so adjusted that the screen brightness due to source S_1 is exactly equal to the screen brightness due to the source S_2. Now if the slides shown as type A in the figure be placed in the double projector and projected in perfect register on the screen R, the field will be uniformly illuminated and the pattern will be invisible. If a filter is placed as indicated at F_1 a part of the light will be absorbed, the balance on the screen will be disturbed and the pattern will be visible. Assuming that No. 1 of the pair is placed in the upper projecting system, any filter placed in the position indicated will decrease the screen brightness corresponding to the background area (the transparent portion of slide No. 1) and hence the background will be less bright than the arrow. If the filter F_1 absorbed selectively, the background will then be colored. Now if a filter F_2 be placed in a lower beam having a different selective absorption the arrow will appear of one color while the background will have a different color. In this way a design in two colors can be formed on the screen. The entire background will be uniform in color and the arrow or design also uniform in color. Slides of type B give a somewhat different result when these are placed in the double projector and projected in register with no filters in position and with the sources balanced in intensity, a screen uniform in brightness is again obtained and the pattern is invisible. If filters of different colors be placed in the two beams the pattern becomes visible. The small rectangle will now vary in color from one end to the other, one end being the color as given by the filter F_1, and the other end of the color given by F_2. Between the extremities a graded color effect is obtained depending upon the characteristics of the filters F_1 and F_2. The same is true of the background area except that the color radient is in the opposite direction than that of the small rectangle. The variation in color within the small rectangle is built up by the mixture of color according to the additive principle and the color sequence obtained will depend upon the filters used. Slides for use in this manner are made photo-

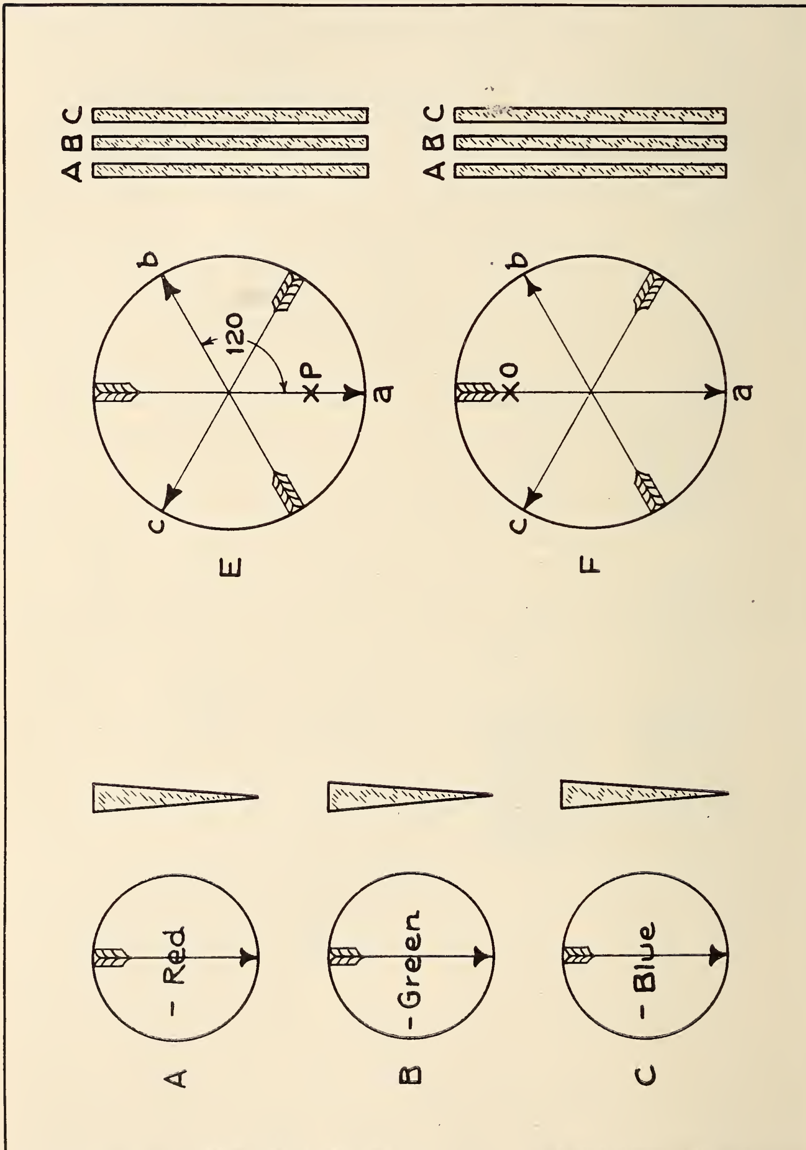

FIG. 2—Diagram showing compound wedge disc filter made up of subtractive primary components.

graphically, one being negative and the other a positive printed by contact therefrom. To obtain perfect balance it is necessary that the negative and positive be carefully matched with regard to density. This condition of balance is fulfilled if the two slides when placed in superposition give a uniform density over the entire area. As a matter of fact, for practical purposes it is not essential that perfect balance be obtained and it is only necessary to fulfill this condition when it is desirable that the pattern be made invisible on the screen at certain

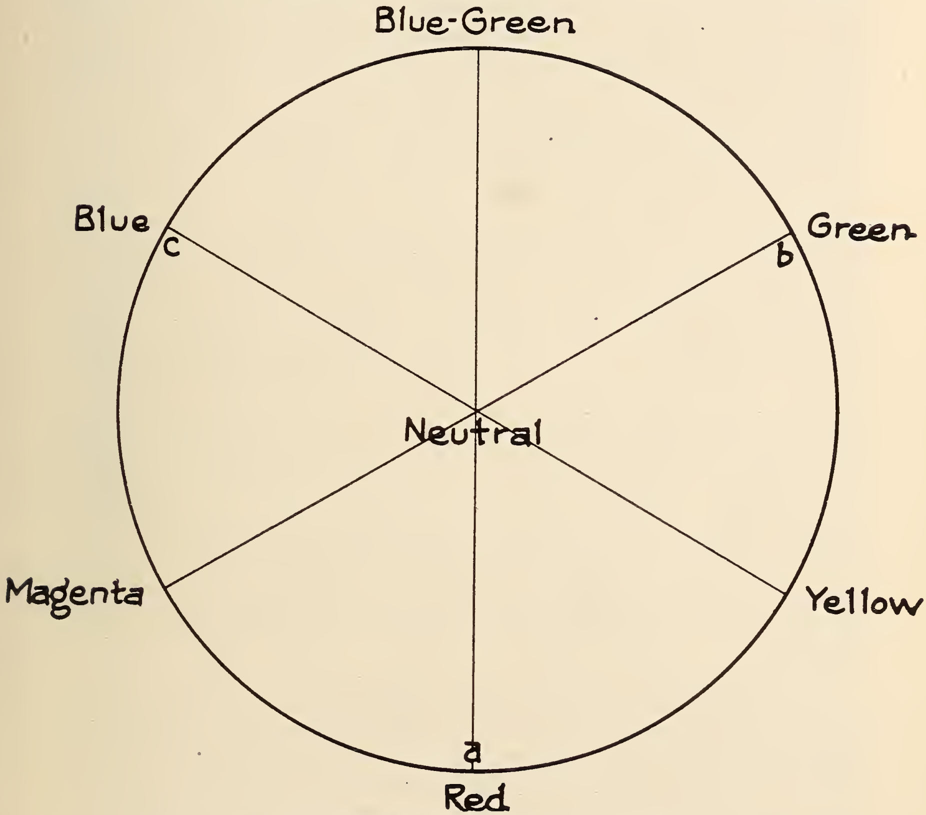

Fig. 3—Diagram showing color distribution in compound filter. Sector filter made up of color gelatines.

points in the cycle of color change. With stationary filters placed at F_1 and F_2 the color effect is static and in order to introduce mobility it is necessary to use at F_1 and F_2 filters which vary from point to point and which can be moved in order to produce a change in the colors on the screen. This is accomplished by use of a compound filter built up of three elements as shown in Fig. 2. For this purpose the subtractive primaries are used and the filters are made in the form of disc wedges. For instance, the disc A is a *minus red* (blue green) filter so made that it is effectively of zero thickness at the point *a*, increasing to a maximum thickness at the opposite end of the diameter. The variation in saturation along the diameter is indicated by the wedge at the right of the circle. B and C indicate the disc wedges of *minus green and minus blue* respectively. The compound filter is then made up by superposing these three as indicated at E and F. In assembling the elements the points *a*, *b*, and *c* are disposed as indicated by the figure and in the finished filters lie at points equally spaced about the circle. These compound filters are then placed in front of the projectors as indicated in Fig. 1, the optical axes passing through the filters at the points indicated as P and O. The compound filter produced in this way gives a result as illustrated by the diagram in Fig. 3. Since the thickness of the minus red wedge is zero at point *a*, it follows that a red filter will be produced at point *a*, and likewise green will lie at point *b*, and blue at point *c*, while in between these points will be found yellow, blue-green, and magenta. All possible hues are therefore found arranged around the periphery of this disc. If the three components of the compound filter are properly balanced with respect to each other, a nonselective area (neutral) will be found at the center of the compound filter. Saturation, therefore, varies along the radius from zero at the center to the maximum at the periphery. It will be noted that complementary colors are found at the opposite ends of any diameter and hence with such compound disc filters are mounted as indicated in Fig. 1, the background color on the screen must be complementary to the color of the pattern. If both discs are then rotated in the same direction and at equal angular velocities this complementary relation must persist, while the hue changes through every possible value during one revolution of the filter. In this way, using slides of type A a pattern of one color on a background of its complementary can be obtained, and by rotating the disc filter every possible combination of complementaries can be obtained.

By using slides of type B more complex effects are produced and in this case we have on the screen at any instant the complete series of colors which can be produced by additive mixture of the color of two filters in all possible proportions. Thus if the compound filters E and F as shown in Fig. 2 be so positioned in front of the projector that blue-green and its complement red are used, the entire series of colors producible by the additive mixture[6] of blue green and red will be produced on the screen. This particular series consists of blue green at one end shading through a series of greens of decreasing saturation until at the midpoint a gray is obtained. After passing the midpoint a series of reds of increasing saturation will be found until at the extreme end the full saturation of the filter itself will give a red of high saturation.

[6] Color Analyses of Two Component Mixtures, L. A. Jones, Physical Review, N. S., Vol. IV, No. 5, Nov. 1914.

By moving the two compound disc filters so that the optical axes pass through points nearer to the center, the saturation factor is decreased until at the center a gray is obtained. In this way any hue of any desired saturation can be obtained. The hue series obtainable by the additive mixture of any pair of complementaries is limited, so, if it is desired to obtain a greater variety of hue, it is only necessary to shift one of the compound disc filters relative to the other. For instance, if the filter F be rotated through 60 degrees from its position as indicated in Fig. 2, the point O is the optical axis of the lower projector and will now fall either on the diameter c or b. Assuming that the rotation is in the clockwise direction, this will be on the diameter c and at a point on the filter which is blue. The upper filter E having retained its position as indicated, will still be acting as a red filter. Under these conditions projection will occur through a pair of additive primaries and the hue series obtainable is entirely different than in the case of a pair of complementaries. Using any pair of additive primaries for additive mixture the entire series of hues lying between the two filters can be obtained in almost constant saturation. Thus for the red and blue filters mentioned above this series will be limited at one end by red, run through the entire range of purples (red blue mixtures), and end at blue. With the disc filters set in this relation to each other synchronous rotation will give a changing series of additive mixtures.

The most fascinating effects are produced by rotating the two filters rather slowly and this is best accomplished by driving them with a small motor through a speed reducing mechanism. The description of the use of this apparatus thus far assumes that the three elements (A, B, and C of Fig. 2) are assembled in a fixed position relative to each other as indicated by the diagram E. Very different series of color changes can be produced by mounting each of the components A, B, and C separately so each can be rotated independently of the other. By means of a suitable mechanism each of these elements can be driven at a different angular velocity. In this way a compound filter which is continually changing can be produced. The sequences of color obtainable in this manner are practically unlimited. No attempt will be made to discuss these in detail as it is quite evident that this general scheme can be used in many ways. Complementary slides made by photographing designs of various types produce, when projected on a suitable curtain, very beautiful effects.

The color and design composition should receive careful consideration from the standpoint of its appropriateness to the music or other number which it is to accompany, or to the picture which it is to introduce.

Dynamic color effects produced with this apparatus have been used with considerable success during the musical prelude or with orchestral numbers. The most satisfactory results have been obtained by projecting these on to a curtain hanging in vertical folds, not a perfectly flat surface.

Very satisfactory results can be obtained by using a filter of the sector type by using colored gelatines or glasses assembled as shown in Fig. 4. It is possible to obtain a fairly good series of colors in dyed gelatines and by choosing, let us say 12 filters having hues spaced uniformly throughout the spectrum and also through the nonspectral

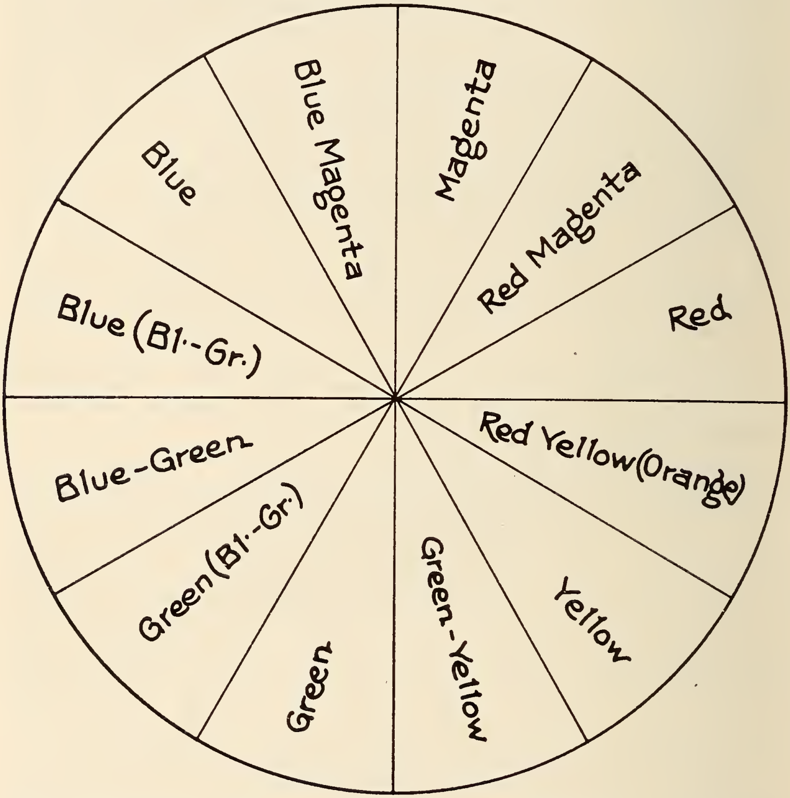

Fig. 4—Illustration of a pair of pattern plates complementary in form and density, of the line type.

region, the purples, a fairly good approximation to the compound wedge filters shown in Fig. 2, can be obtained. In this case, however, no variation in saturation from center to periphery will be obtainable. Such a sector filter mounted close to the projection lens will, when rotated, produce a color change which occurs in a more or less discontinuous series. The transition, of course, is not very abrupt since when the dividing line between two filters is directly in front of the lens, a part of the beam is passing through each of two adjacent filters an additive mixture of the two filter colors is obtained. As a

FIG. 5—Illustrations of a pair of pattern plates complementary in form and density, half-tone type.

matter of fact such sector filters have proven quite satisfactory in practice.

By making compound wedge filters of a size just sufficient to cover the pattern plate, and placing them near to the pattern plates, that is in the focal plane of the projection lens, each projector covers the screen with a variable color. When these are used with pattern plates, as described previously, very fascinating effects are obtained. By properly setting the orientation of the two compound filters relative to each other, form elements immediately adjacent to each other may be projected in complementary colors, and this complementary relation will persist approximately at every point on the screen, but the actual hues and saturations will be variable from point to point.

Further variation may be produced by flooding the entire screen on which the patterns are projected with colored light from a third independent source, such as the usual type of flood light equipped with gelatine or glass color filter. The possibility of using colored screens on which to project the patterns has been mentioned previously and in some cases has proven very effective.

From a careful observation of the dynamic color effects produced by the methods described above we have concluded that their chief fascination lies in the continual change of form and color. Such effects seem to produce a sustained interest which is markedly greater than that which can be obtained with a static composition.

The type of designs which have been used successfully with this duplex method of projecting may be illustrated more definitely by Figs. 5 and 6. Fig. 5 represents a pair of design plates which are complementary to each other in form and in which half-tones are absent. Assuming that No. 1 of this pair is placed in the upper lantern (Fig. 1) with a red filter at F_1 the light areas of this design will be shown on the screen in red. Now with the other member of the pair No. 2 placed in the lower lantern and, let us say, a blue-green filter at F_2, the light areas of this will be shown on the screen in blue-green. By using a filter of variable hue on each projector the background and design can now be made to pass through any desired cycle of hue changes.

In Fig. 6 the design plates shown represent a pair which are complementary in form, but differ from those shown in Fig. 5 in that the design is composed to a certain extent of half-tones. With this pair the design will be reproduced in more than two hues since the additive projection of those areas represented by half-tones will result in colors built up according to the laws of additive color mixture.

By projecting two such design plates slightly out of register with each other a marked impression of plasticity can be produced and in some cases it has been found that more pleasing and satisfactory results are obtained in this way.

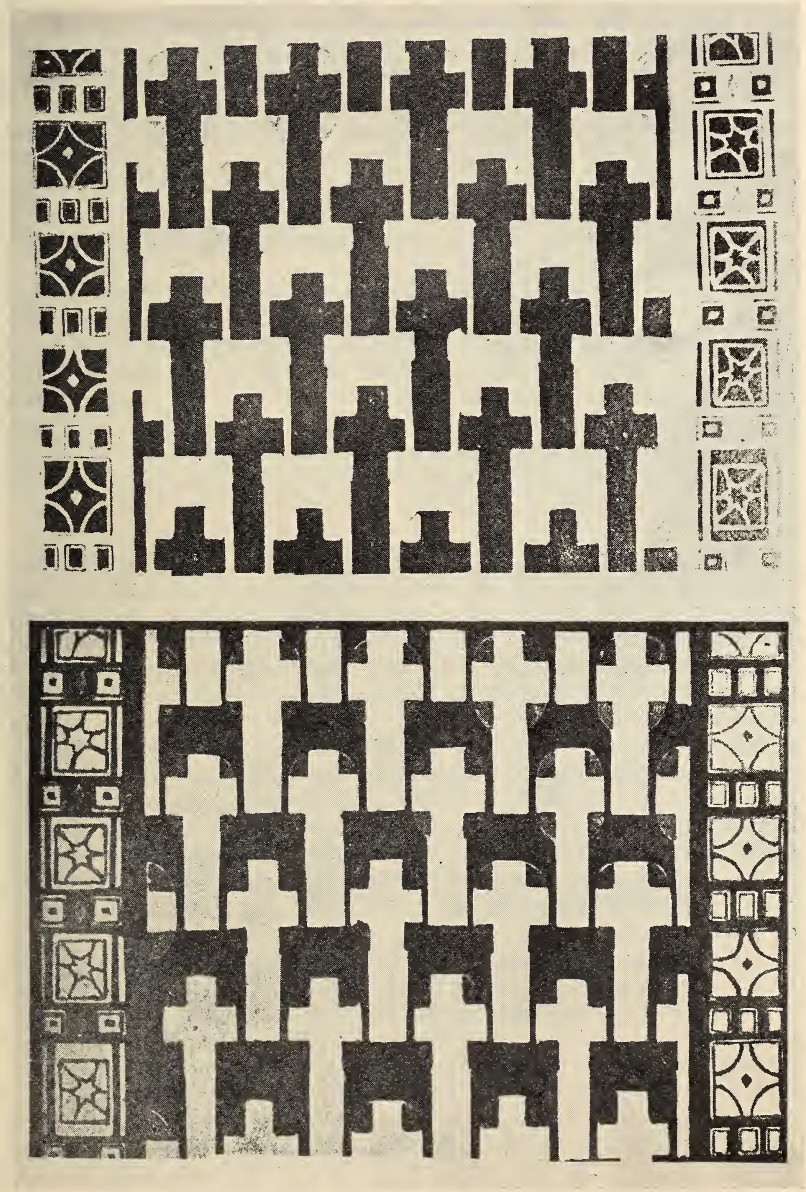

Fig. 6—Diagram showing optical system in improved stereopticon spot and stereopticon flood projectors.

Improved spot and flood lights—The usual form of flood light and spot light consists of an electric arc in front of which is placed a single plano-convex condenser. The size of the spot or the area covered by the flood is governed by the focal length of the condenser lens and the distance between the arc and condenser. Sheets of colored gelatine are used to modify the color of the light as occasion demands. The desirability of keeping something of interest before the eyes of the audience at all times, even while the curtains are closed between different numbers of the motion picture program, has led to the improvement of this type of projector and the construction of a somewhat more elaborate form.

We have chosen to designate these improved spot and flood light units as *stereopticon spot lights* and *stereopticon flood lights.* While there is nothing essentially new in the principle involved in these units they do give results that can not be obtained with the ordinary type of spot and flood light units, and have been found to fill a real need in the motion picture theatre. They have been used extensively in the Eastman Theatre with excellent results. The additional elements which must be added to the ordinary spot and flood are very simple and can be placed in position or removed in a short time.

The arrangement of the component parts is shown diagrammatically in Fig. 7. To the usual flood or spot light unit has been added an optical bed O which is a metallic bar fixed rigidly to the housing of the spot light and providing a means whereby additional lenses, iris diaphragms, etc., can be supported in alignment with the optical axis of the spot light. On this optical bed, O, are mounted two front standards, FS_1 and FS_2. On FS_1 are mounted an iris diaphragm, I_2, a color wheel, CW, and a slot, S_4, suitable for holding color filters. On FS_2 are mounted an iris diaphragm, I_3, and an objective lens, L. In addition to the usual plano-convex condenser, C_1, is added a second plano-convex lens, C_2, making a complete stereopticon with condensing lenses 8 inches in diameter, three iris diaphragms, I_1, I_2, and I_3, a color wheel at CW, slots for holding frames carrying color filters at S_1, S_2, and S_4, and a slot for holding slides or pattern plates at S_3.

For use as an ordinary spot light the condenser C_2 is removed and a condenser of 18 inches focal length and 8 inches in diameter is placed at C_1, the front standards being removed. For use as an ordinary flood light, the condenser at C_1 is changed to one of 13 inches focal length and 8 inches in diameter.

The stereopticon spot light—For use as a stereopticon spot light a condenser of 13 inches focal length is placed at C_1, and one of 18 inches focal length at C_2. The front standards 1 and 2 are placed in position and the arc adjusted at such a distance from the condensers as to form an image of the arc crater on the iris I_2. The opening in the iris I_2 is focused on the stage or object by the lens L. The best results are probably obtained when the focus is not too

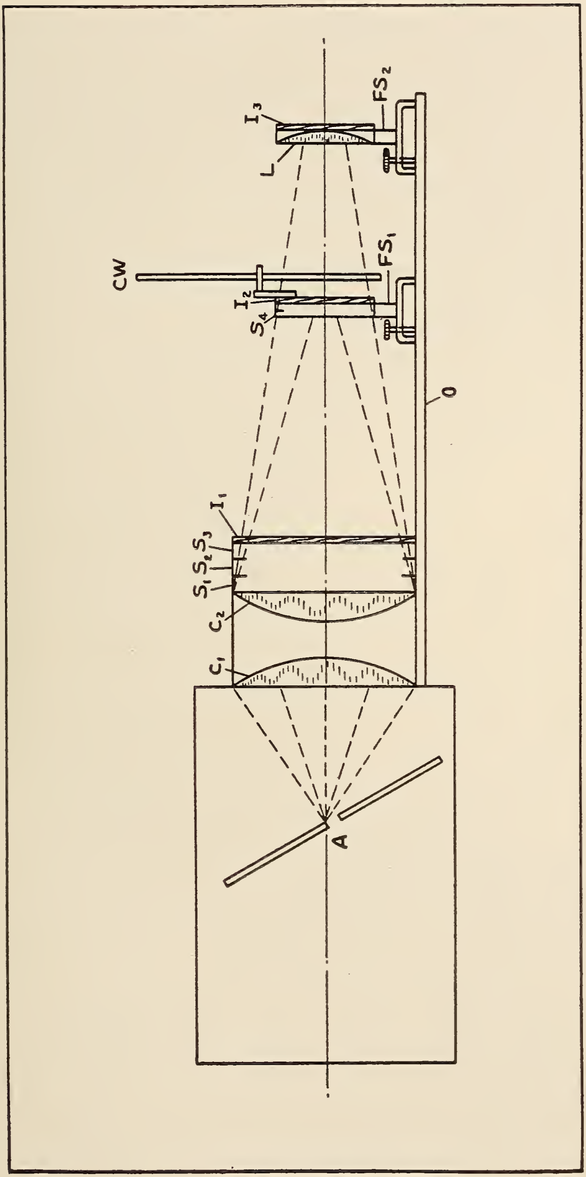

Fig. 7—Illustration showing results obtained with simultaneous use of four stereopticon flood projectors.

sharp, or in other words when the iris is slightly out of focus. The size of spot is governed by opening or closing I_2. The advantage of this type of spot is the elimination of all objectional reflections from the negative carbon tip, and the ability to obtain a perfectly round spot regardless of whether or not the crater is burning perfectly. If designed for special effects a diaphragm stop of any particular shape or design may be placed at S_4, such as triangles, squares, oblongs, or even a shamrock for St. Patrick's day.

The Stereopticon flood light—When using this instrument as a stereopticon flood light the lens L is so adjusted that it will image a slide placed in slot S_3 upon the screen or curtain. The arc is then moved to such a position that an image of the crater is formed approximately upon the lens L. The iris I_2 is fully opened so that the beam may pass through unobstructed. The slides or pattern plates which will be described later are placed in the slot S_3. The front standard, FS_1, is moved to a position much nearer to the iris I_1 than is shown in the figure and the iris I_2 being out of the focal plane, S_3 will be imaged on the curtain very much out of focus and may be used for producing soft blended effects. The iris I_3 is sufficiently far away from the crater image so that an out-of-focus image of this is also formed on the screen and this too may be used for limiting the size of the area covered, and by using two or three of these lanterns together areas of different sizes arranged concentrically or eccentrically may be illuminated.

The color wheel, CW, consists of 18 sectors made up of dyed gelatines chosen so as to represent the entire series of spectral and nonspectral (purples) hues. The projection room at the Eastman Theatre is equipped with 5 projectors of this type. We have been able to obtain good illumination over the entire stage opening, which is 50 feet wide, by using an ordinary arc drawing a current of 60 amperes. The projection distance is 160 feet.

Methods of using stereopticon flood lights—A slide of the same size as the color frames (9½ x 10½ inches) is cut from sheet metal. An opening, approximately 4½ x 5½ inches, to conform to the shape of the stage opening is cut in this. The mask thus formed is placed in the slot S_3 and focused on the stage curtains or hangings. If a sharp outline is objectionable this can be avoided by throwing the image sufficiently out of focus to suit the individual taste or condition. Color frames carrying dyed gelatines are placed in slot S_1 or S_2 or both. By using four of these flood lights simultaneously with the diaphragms, I_1, on each open to different extents, and using four shades of one color an effect similar to that shown in Fig. 8 is obtained. The central area is illuminated by light from all four spots. The zone immediately surrounding this is illuminated by light from three spots, the next zone by light from two of these projectors, and the other zone by light from only one. The central portion is therefore, brilliantly illuminated, while each consecutive surrounding zone decreases in brightness. Obviously a great many variations of

Fig. 8—This was used on the curtains previous to the feature picture.

this effect can be obtained by using two, three, or four different colors in the different projectors.

An altogether different and probably more pleasing effect can be obtained by leaving the iris I_1 of each projector wide open and opening the iris I_3 on each lamp to different extents. This iris is of course out of the focal plane of the projection lens, L, and hence a pleasing blending of one or more colors from light to dark without the appearance of sharp outlines will be obtained. A practically unlimited variety of color blending may be produced by the two arrangements mentioned above, or by using them in combination with the iris diaphragms at different positions and open to different extents.

Another effective method of producing blended color effects is to place small color frames consisting of two or more parts or sections of different color in slot S_4 which is not in the focal plane.

Another method of using the stereopticon flood is to introduce slides or pattern plates in the focal plane, S_3. It is impossible to use glass slides for this purpose on account of breakage by over-heating. It was found possible to reduce the heat to some extent by using A. C. negative carbons as positives. These special carbons contain a small proportion of the materials used in the high intensity carbons and produce a white flame arc similar to the high intensity arc, and is exceptionally good for the projection of color. It is somewhat whiter than the ordinary arc but not as bluish as the high intensity arc. Slides were made on 5 x 7 sheets of Cine Positive film coated on cellulose acetate base. These were mounted on sheet metal frames of the same size as the color frames in which were cut openings of proper shape and size to cover the stage, in the same manner as for use with the plain flood light. Slides made in this way have been applied as follows:

(a) A slide carrying a title of a picture, or a strong scene or incident from the picture itself, or any scene which will indicate the type or locale of the number to follow may be projected over the full stage opening previous to starting and continuing through the introduction and title of the picture number. The intent of this is to assist in the creation of an atmosphere in keeping with the picture. Such a slide can be photographed in black and white and projected in two colors by using a light (high transmission) filter over the slide, and projecting from a second stereopticon flood a different color of lower brightness over the entire curtain or screen. This is illustrated by Fig. 9 which was projected onto the curtains previous to the presentation of "The Sea Hawk."

(b) A further modification of this idea is to project, by means of a third stereopticon, a photograph of the star in the picture to follow, the size being adjusted so that it fits within the blended borders produced on the curtains by the stereopticon flood light units and also fits nicely upon the projection screen when the curtains are parted. The blended border may be colored or in black and white; the latter

FIG. 9—Design used on the curtains as a prelude to the "Sea Hawk."

Fig. 10—Blended effect used for framing photograph of the star in the feature to follow.

Fig. 11—Illustrating the separation of a design into two parts each being projected with light of different color, and the complete design obtained by superposition of the two elements.

FIG. 12—Illustration of slides made by the two-color process.

effect has been used frequently with marked success. In Fig. 10 this idea is illustrated.

(c) A somewhat different method of obtaining a wider variety of colors, while at the same time using a black and white design, is to make two separate slides of the same design placing a part design on one slide and the remainder on the other. The two may then be projected in superposition from two stereopticons using filters of different colors, using a third projector to flood the entire picture with a third color. This idea is illustrated by Fig. 11. One slide is made as shown at A and placed in one stereopticon with a red filter. The other slide is made as shown at B and is placed in the other lantern with a yellow or orange filter. The cat-tails and three butterflies are, therefore, shown in orange while the six butterflies on slide A appear as yellow. The two when projected in register on the curtain produce the complete design as shown at C with the red and yellow butterflies intermingled. By using this idea with filters of variable hue in the two projectors the colors can be changed independently through any desired cycle.

(d) The usual methods of two- and three-color additive projection may also be utilized. Thus colored pictures or designs may be photographed on panchromatic plates using a suitable pair of two-color taking filters. Positives made on acetate base from the negatives thus obtained, when projected in register through suitable two-color additive projection filters (orange-red, and blue-green) give pleasing results. A pair of positives made in this way and suitable for production of two-color additive effects are illustrated in Fig. 12.

(e) Further variation in the effect may be obtained by using the same slides with filters other than the usual two-color projection filters, or by flooding the curtain with a third color. Using three projectors, the three-color additive process of producing color effects may also be employed. It is not necessary, for the production of these color effects that true color rendering be obtained, and frequently the most pleasing result follows rather unfaithful color reproductions of the original. As stated previously, for three-color additive projection, the filters should be red, green, and blue-violet.

In closing we wish to thank Mr. Norman Edwards, art director of the Eastman Theatre for his valuable suggestions and advice relative to the artistic phase of this work, and also Mr. William Hennesy of the Eastman Theatre who has been of great assistance in gathering and producing suitable designs.

May, 1925.

DISCUSSION

Mr. Richardson: I desire to direct the attention of motion picture projectionists to the new complications and possibilities which are constantly cropping up in connection with their work. They must study their job or they will find themselves without one insofar as motion picture projection is concerned. Such things as have just been shown us are coming and projectionists will have to handle them and be able to assist in the intelligent selection of color and design combinations.

Dr. Gage: When my father and I were working up a book on optical projection, we found many references to work—more in England than here—where spectacular effects were obtained by the use of dissolving lanterns. They were not used merely to change from one unrelated slide to another but one picture is dissolved into another similar picture, as for instance a summer and a winter scene of the same landscape. In another spectacular exhibit, a projector was mounted on a wheeled cart behind the screen so that the whole projector was pushed up to the screen, the slide changed, and the projector pulled back. This whole art can be revived for use in conjunction with motion pictures for producing spectacular effects, and we have just seen a demonstration of this.

Dr. Mees: I might point out that the slides with the floodlight on them give an effect exactly equivalent to a tinted film, and it is much better and easier to use a floodlight than to tint the film in most cases. You can get more varied results, there is not the danger of damaging the film by making it brittle. As soon as theaters are fitted with floodlights so that the projectionist can put in the color, it will be a great advantage.

Mr. Townsend: All I desire to say is that anything I have developed has been done by cooperation. I would not have been able to do alone a quarter of what I have at the Eastman theater without the cooperation I received from other sources.

STATIC MARKINGS ON MOTION PICTURE FILM
Their Nature, Cause, and Methods of Prevention

By J. I. Crabtree* and C. E. Ives**

Communication No. 236 from the Research Laboratory of the Eastman Kodak Co.

IN MOTION picture photography the word "static" has a somewhat flexible meaning since it is used as a contraction for both "static electricity" or a "static discharge," and "static markings" produced on a developed emulsion by an electrical discharge at the surface or within the emulsion previous to development.

Although much information has been published on the nature of the markings produced by a spark discharge at the surface of a photographic plate,[1] very few data are available regarding the static markings produced on motion picture film during handling.

In the early days of the motion picture industry static trouble was feared both by camera men and laboratory workers, but as a result of improvements in manufacture, negative film of today has a relatively slight tendency to give static while our knowledge of methods of preventing static on positive film in the laboratory is such that static markings result only from incorrect handling. In spite of this, static markings are occasionally seen on the screen in the present day theatre, especially on new reels, which indicates a need for a better knowledge of the subject on the part of some workers.

It is the purpose of this article to record the experience gained in the Research Laboratory of the Eastman Kodak Company relative to the nature, cause, and methods of preventing static markings during the handling of motion picture film.

The Static Discharge

If a nonconductor of electricity such as glass, sealing wax, hard rubber, or a dry nitrocellulose film is rubbed with an insulated dry substance, which may even be a conductor, the surface of the nonconducting material becomes charged with static electricity. In this sense, the term "static" indicates that the electricity "remains on" the substance.

Precisely how the electricity is produced is not known but in the light of modern knowledge it may be assumed that the friction results in the removal of an electron from the atoms of one of the materials rubbed leaving it positively charged. It is generally stated

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[1] "Figures Produced on Photographic Plates by Electrical Discharges" by U. Yoshida, Memoirs of College of Science of Kyoto Univ., 1916, Vol. 2, p. 105.

that the sign of the charge generated by friction depends on the nature of the material rubbed and of the rubbing substance, although it is possible to charge a glass rod either positively or negatively by rubbing it very slowly or quickly with the same material. A substance may also become charged by virtue of being in close proximity to a second charged body when it is said to be charged by induction, while mere separation of two substances or variation of the distance between them may change their electrical potential.

A static electrical charge is of high potential, though the quantity may be small, and is fairly evenly distributed over the surface of a flat conductor but more or less unevenly in the case of a nonconductor depending on the uniformity of the generation. In other words, on a nonconductor such as film base the charge remains where it was generated unless it is subsequently removed in one of the following ways:

(a) By making the air a conductor by ionization (see later).

(b) By passing a strip of tinsel or some other conducting brush which is "grounded," across the surface.

Since the earth is a good conductor of electricity and is considered electrically neutral, if the surface of a charged body is placed in electrical contact with it a flow of electricity takes place either from the earth to the charged body, or vice versa, until it is at the same potential as the earth when it is said to be discharged. Such a body in electrical connection with the earth is said to be "grounded."

(c) By placing a series of grounded metallic points in proximity with the charged surface.

(d) If the charge reaches a certain critical value and a substance at a lower potential is placed near it, an electric spark jumps across the air gap and the nonconductor becomes more or less discharged over a limited area. Discharges in the manner of "a," "b," and "c" are termed "silent" while "d" is known as a "disruptive" discharge, and is of the nature of lightning which emits heat and light and is capable of performing mechanical work.

Motion picture film consists of a nitrocellulose (or acetyl cellulose) base coated with a gelatine emulsion and unless specially treated, in the dry state both surfaces under suitable conditions will accumulate an electrical charge.

Under certain conditions motion picture film is seen to glow slightly in the dark when rubbed with the hand or when subjected to other friction, but frequently on development no static markings are visible. A distinct spark, however, which is both visible and audible invariably affects the emulsion and produces a latent image of definite pattern.

It is an open question whether static markings are a result of the photographic effect of light rays from the discharge or whether they are a result of the direct effect of the spark on the silver halide grains in the emulsion in which case the markings would be closely related to abrasion marks, or those produced by mechanical stresses. Experience has shown that the speed of the emulsion has not as great an effect on the intensity of the static markings produced by a given discharge as might be expected.

Factors Affecting the Quantity of Static Electricity Produced on Motion Picture Film

In motion picture work, electrical excitation of motion picture film is largely produced by rubbing. The quantity of electricity produced depends upon the following factors:

1. The Electrical Conductivity of the Substances Rubbed

A. The Conductivity of the Film Base

If a good conductor of electricity such as a metal is insulated and subjected to friction, an electrical charge is generated which distributes itself more or less evenly over the surface, depending on its shape, and if the metal is grounded by connecting to the earth, the whole of the charge flows away. In view of this tendency of the electricity to distribute itself over the conductor, it is difficult to generate a charge of sufficiently high potential to produce a disruptive spark on discharging. In the case of a nonconductor the charge remains where it was generated and if grounded at any one spot it is discharged only locally.

Therefore, if the conductivity of a substance is increased it has less tendency to develop a high potential locally, that is, there is a close parallelism between the electrical conductivity of a substance and the propensity for it to give static discharges. This relation is seen in the comparative tendency of a dried film of gelatine emulsion, motion picture negative film base, and ordinary nitrocellulose base, to generate static electricity. The surface electrical conductivity of the materials is roughly in the order given and the tendency to produce static in the inverse order.

Although a strip of comparatively dry gelatine emulsion will generate static, the quantity produced is so slight as compared with that produced under the same conditions on the film base as to be of negligible importance in practice, so that it is usually only necessary to consider the film base.

By special treatment of the film base its conductivity may be increased to such an extent that its tendency to generate static is very much less than the untreated base.

Since gelatine and a gelatine emulsion are much better conductors than film base it would be expected that double coated motion picture positive film such as is used in subtractive color photography, and gelatine backed film such as non-curling roll film would have a much less tendency to generate static than untreated nitrocellulose film base, and this has been found to be the case. The film conductivity can also be increased and its tendency to generate static thereby decreased by increasing the moisture content as described later.

B. The Conductivity of the Rubbing Substance

If the rubbing substance is a good conductor and is grounded, the charge is removed as quickly as it is formed. It is important, therefore, from an anti-static viewpoint, that any substances which come into contact with motion picture film should be good conductors such as metal, while nonconductors such as hard rubber and glass should be avoided. Modern camera and motion picture machinery manufacturers have recognized this fact and are now constructing sprockets, rollers and camera gates as far as possible of metal.[2]

2. The Amount of Friction

In a given apparatus the greater the friction between the film and the parts of the apparatus the greater is the quantity of static liable to be produced. The degree of friction is determined by the roughness of the rubbing surfaces, the pressure applied and the relative speed of travel of the two surfaces. Therefore, in the camera and printer gates, the pressure applied should be a minimum and all parts should be as smooth as possible. In certain camera gates where the emulsion presses against the metal tracks more or less of the film emulsion tends to scrape off and accumulate as a hard mass on the gate, preventing the free travel of the film. In such a case there is a great tendency for static markings to be produced. By slightly lubricating the tracks with oil or grease as described later such gate trouble is avoided and static is eliminated. High speed of movement of the film is also responsible for static trouble when making slow motion pictures in the camera and when printing at an excessively fast rate, though with Eastman negative film, camera static even under such severe conditions is rarely encountered. In the case of printer static either the film should be humidified further or the speed of the printer reduced.

3. The Conductivity of the Air

Dry air is one of the best known insulators of electricity. However, certain substances such as radio-active compounds, a red-hot wire or a flame are capable of ionizing the air and making it a conductor. If a charged body is placed in such a conducting atmosphere it tends to discharge by virtue of neutralization of its charge by the oppositely charged gas molecules and electrons in the ionized air attracted to it. For a similar reason, ionized air tends to prevent the accumulation of a charge on a substance during excitation by friction. The ionizing effect of a flame or a radio-active substance can be demonstrated by placing a charged electroscope close to them when it will be discharged immediately. Some camera workers have utilized the ionizing effect of a flame by fitting a small alcohol lamp below the camera and conducting the products of combustion into the camera chamber. In addition to the ionizing effect of the flame the products

[2] "Static Trouble with the Kinematograph and Means for its Elimination," by A. S. Newman, Phot. Jour., June 1923, p. 262.

of combustion of the alcohol contain water vapor which humidifies the film and renders it a better conductor of electricity.

In the printing trade it is also customary to remove the electrical charge from the sheets of paper travelling through the press by passing them immediately over the surface of a gas flame.

Radio-active compounds are of questionable value in preventing motion picture static because of the expense involved in producing sufficient ionization, while the emanation fogs a photographic emulsion.

Another method of ionizing air is by means of X-Rays. The air in the vicinity of an X-Ray tube is strongly ionized and a charged electroscope placed in the vicinity is immediately discharged. In order to test the anti-static effect of such ionized air an electric fan was arranged so as to blow the air in the vicinity of an X-Ray tube to a spot several feet away in a direction at right angles to the path of the X-Rays, and attempts were made to excite the base side of a strip of motion picture positive film placed in the air current but without success. On cutting off the current from the tube the film was easily excited. This experiment would suggest the possibility of inserting an X-Ray tube in the airducts of a motion picture laboratory, though it is questionable whether the scheme would be practical on account of the large tube currents necessary to produce sufficient ionization, and the danger of fogging sensitive photographic materials by the X-Rays unless carefully screened.

Humidification of the air is a sufficient and practical means of increasing the film conductivity and has proved effective and satisfactory in practice.

The Effect of Humidification on the Propensity of Motion Picture Film to Give Static Markings

Dry air is capable of absorbing or taking up a certain critical quantity of water in the form of water vapor at any particular temperature and atmosphere pressure, when it is said to be saturated. The higher the temperature the greater is the quantity of water vapor which the air is capable of holding, that is, the concentration of water vapor in warm saturated air is greater than in cold air. If warm saturated air is cooled, moisture condenses out leaving the air saturated at the lower temperature.

The percentage of moisture in air at any particular temperature as compared with the quantity which it would hold if it were saturated is termed its relative humidity. Raising the temperature of air, therefore, lowers the relative humidity providing no water is present for the air to absorb, and vice versa.

Relative humidity measurements are usually made by a hygrometer, a suitable form of which consists of a wet and dry bulb thermometer. The bulb of the wet thermometer is surrounded with an absorbent material such as a silk wick which dips into a vessel containing water. The evaporation of this water tends to cool the bulb and since the rate of evaporation depends on the dryness or relative humidity of the air, the difference in reading between the wet and dry thermometers is a measure of the relative humidity of the air. It is important when using a hygrometer to place it in such a position that a representative sample of the air circulates over it. By reference to tables supplied with the instrument the relative humidity is obtained. Some hygrometers rely on the expansion and contraction of a strand of horsehair in dry and moist air but these are not always reliable.

If motion picture film is placed in an atmosphere at any relative humidity there is an exchange of moisture either from the film to the air or vice versa until equilibrium is reached. That is, dry film in a moist atmosphere absorbs water while moist film in a dry atmosphere loses water.

The transfer of moisture either from the air to the film or vice versa requires time and takes place comparatively slowly.

Since the tendency of film to give static markings depends on its conductivity which in turn depends on the absolute quantity of water which it contains, the effect of moist air in affecting the propensity of film to give static depends on

a. The relative humidity and temperature of the air.

b. The time of exposure of the film to the air.

(a) In order to determine the effect of humidification in atmospheres of increasing relative humidity on the propensity of gelatine and film base to generate static electricity, strips of motion picture positive film and sheets of gelatine were exposed to atmospheres of different humidities by placing in humidors containing sulphuric acid of varying concentrations (representing atmospheres of known relative humidity) and stored for 12 hours at temperatures of 50° F., and 110° F., respectively. The strips were then rubbed vigorously with a piece of velvet (the positive film was rubbed on the base side) and tested for electrification by means of an electroscope. The results obtained were as follows:

		Electrification	
Relative Humidity	*Material*	50° F.	110° F.
54%	Gelatine	slight	slight
	M. P. Positive Film	strong	strong
74%	Gelatine	slight	slight
	M. P. Positive Film	slight	slight
82%	Gelatine	nil.	nil.
	M. P. Positive Film	slight	very slight
88%	Gelatine	nil.	nil.
	M. P. Positive Film	very slight	nil.
92%	Gelatine	nil.	nil.
	M. P. Positive Film	nil.	nil.

From these tests it is seen that gelatine ceases to generate an appreciable amount of static electricity when exposed to an atmosphere of about 80% relative humidity for twelve hours, at 50° F.

Although tests were not made with sheets of emulsion stripped from the base, comparative tests made by rubbing gelatine sheets and the emulsion side of motion picture film exposed to the same atmosphere, showed that positive and negative motion picture emulsions have less tendency to generate static electricity than plain gelatine.

The above tests also show that with motion picture negative film the air must have a relative humidity of about 90% at 50° F. and about 85% at 110° F. if it is to entirely prevent the generation of static electricity when the film is exposed to it for a few hours.

Since with air at any constant relative humidity the quantity of water which it contains increases with rise of temperature, film in equilibrium with such air contains a greater quantity of water at higher temperatures. Since the propensity of film to give static markings runs parallel with the absolute quantity of moisture which it contains, it would be expected that at a given relative humidity the propensity of film to give static would decrease with rise of temperature, as was shown by the above experiments.

(b) A dry emulsion or a dry film base absorbs moisture comparatively slowly. Bone dry motion picture film must be humidified for more than 24 hours in an atmosphere at 80% to 90% relative humidity before it absorbs all the moisture it will hold under these conditions. Hence, the condition of the air has very little effect unless the film is exposed to it for a sufficient length of time. Thus, dry motion picture positive film may give static markings even if the air of the printing room is saturated, if the film is not given an opportunity to absorb moïsture. On the other hand, film containing an excess of moisture will not give static markings when immediately placed in dry air.

The fact that motion picture film is usually tightly rolled also hinders the rapid attainment of equilibrium with the atmosphere, but this is advantageous, in case film has to be stored in a dry atmosphere. If conditions are such that static markings are produced on positive film in the laboratory, in order to further humidity the film in the roll it must be stored for several weeks in a moist atmosphere, but not one which is too moist, otherwise the edges of the film will stick together and on unwinding more static will be produced than if the film was handled in its original condition.

Nature and Classification of Static Markings

Static markings produced directly on an emulsion are invariably black, and in the case of a negative, they print as white markings on the positive print. The markings frequently occur at regular intervals owing to the intermittent movement of the film in the camera or printer gate (see Fig. 10), although more often the occurrence is at irregular intervals.

If the friction on the film is local the discharge usually takes place in the same vicinity, but if the friction is evenly distributed over the film surface the discharges occur at irregular intervals and in no particular location. Very frequently the markings are confined to the region of the perforations and occasionally extend inwards from the edges of the film.

With normal development the density of the markings may vary from a just visible deposit to a relatively high density according to the severity of the discharge.

In shape, static markings consist of either dots or irregular lines or a combination of the two.

The appended illustrations are of static markings accumulated over a period of several years and were produced either in the camera or the printer. The exact conditions under which they were produced were not recorded but it was only possible to secure such severe markings by drying out either positive or negative film very thoroughly in a desiccator.

Such well-defined and frequently occurring markings are rarely found in practice, but it was necessary to make the conditions as favorable as possible for their production in order to secure markings suitable for illustration purposes.

The figures merely illustrate the type of markings which may occur under more normal conditions. Although the variety of the markings is possibly not complete it is doubtful if any essentially different types of markings are normally produced in the camera or laboratory.

Static markings may be classified as follows:

1. Small black spots with diffused edges. These markings are very similar to a certain type of moisture spots,[3] or spots caused by chemical dust. Fig. 1 illustrates a large cluster of spots disseminated throughout a fan-shaped marking produced in the camera. This type of marking occurs very rarely.

2. Black spots with branches. In Fig. 2 the black spots have one or two branches while in Fig. 3 several branches radiate from the central dark spot, simulating a spider with outstretched legs.

3. Tree-like markings as shown in Figs. 4 and 5. These are a modification of those shown in Fig. 2 since the tree trunks and branches emanate from a black spot. The branches may also be regarded as sprouting from an imaginary horizontal bar at the base. The markings illustrated in Figs. 2, 4 and 5 were produced in the camera with bone dry negative film and the intermittency of occurrence is clearly seen in Figs. 4 and 5.

4. Fan-shaped markings as illustrated in Figs. 6, 7 and 8. The radii of the fan may be considered as branching out from a point which may possibly be the initial point of discharge. The markings in Fig. 7 consist of an assemblage of fan markings and were produced

[3] "A Study of the Markings on Motion Picture Film Produced by Drops of Water, Condensed Water Vapor, and Abnormal Drying Conditions," by J. I. Crabtree and G. E. Matthews, Trans. Soc. M. P. Eng., Vol. 17, p. 29.

in a step printer. The intermittent occurrence of these is shown in Fig. 11.

In Fig. 6 the lower half of the fan-shaped marking is of much less density than the upper half and not so sharply defined, and is probably a result of either a reflection of the upper discharge, or a secondary weak discharge.

5. Miscellaneous markings. Those shown in Fig. 9 were produced on bone dry negative film in a camera and consist of a conglomeration of dots, branches, and fans.

Static Markings Encountered in Practice and Methods of Their Prevention

When motion picture film leaves the factory it may be reasonably assumed that it is free from latent static since it is handled during manufacture with extreme care and under the most ideal conditions of humidity. Moreover, careful tests are made on the finished perforated film before shipment in order to insure that the film is free from latent static markings which might otherwise appear on the developed film.

During handling, static may be produced either in the camera or in the laboratory when winding the film onto racks, when processing on the developing machine, or during printing as follows:

Camera Static

Negative motion picture film when packed for shipment contains such a quantity of moisture that it is in equilibrium with an atmosphere of 70% to 75% relative humidity, and in this condition, and especially in the case of negative film, unless it is subjected to severe friction, no static trouble need be feared in practice.

In order to determine at what point or points in a camera static is usually generated, a roll of positive motion picture film was thoroughly desiccated over sulphuric acid and then passed rapidly through a camera in the dark. Static discharges were observed at the following points: (a) where the film parted from the spool at a tangent, (b) at the retort traps, (c) in the region of all sprockets even though grounded, (d) at the gate, (e) at the take-up roll.

So-called grounded collectors consisting of tinsel and graphite coated pads were placed against or near the film at two or three places but these had very little effect in preventing the static discharges. On development of the film the quantity of static markings ran parallel with the quantity of discharges observed in the dark.

This experiment demonstrated that static may be produced in the camera at any point where there is friction and especially in the camera gate where the discharges were most severe. It was also concluded that brush collectors are of questionable value, while a grounded metal crank is of little use unless the handle is in electrical connection with other parts of the camera such as the gate and sprockets, which must be good conductors.

Prevention of Camera Static

The only certain method of insuring the absence of static markings is to prevent the generation and accumulation of the static electricity in the first place as follows:

1. By removing all sources of friction. Negative film which shows camera static markings generally also shows bad abrasion marks. Of the various parts of the camera the gate is responsible for most of the abrasion.

When making titles directly onto positive film in the camera the emulsion tends to scrape off onto the metal tracks where it builds up excressences of hardened emulsion which retard the passage of the film and incidentally cause static as a result of the increased friction. By glueing a small strip of oiled chamois on each side of the film track at its upper edge the passage of the film is facilitated and abrasion of the emulsion and the attendant static is prevented.

Film loops which are too long cause the film to rub either against itself or the side of the camera with the possible generation of static.

2. By making all camera parts conductors of electricity. As explained above, when film is rubbed with a conductor such as a metal, a minimum of static is produced especially if the metal is in electrical connection with the rest of the camera or is "grounded." Glass, hard rubber, varnished or lacquered metallic surfaces, silk and velvet should, therefore, be avoided whenever possible in camera construction, while the gate and sprockets and as far as possible every part of the camera should be of metal.

3. By rehumidifying the film. Negative film which is stored for considerable periods in a dry atmosphere loses moisture, but may be rehumidified by rewinding loosely and storing for about 12 hours in a humidor, consisting of an enclosed box containing either a sponge or other absorbent material saturated with water. A simple humidor may be constructed by soldering together two motion picture film cans bottom to bottom, perforating the now common partition and placing saturated blotters in one of the compartments. The loosely wound film should then be placed in the empty compartment and allowed to remain for about 12 hours at 70 to 75° F. The film should not be allowed to remain for too long a period in the humidor, especially at high temperatures (80 to 90° F.), otherwise moisture spots are liable to be produced on the emulsion.[3]

The practice of placing a moistened sponge in the camera is of no value if the film is run through quickly, but if the sponge is allowed to remain in the loaded camera for one or two hours the film has more opportunity to absorb water and may be less liable to develop static markings.

4. By conducting the products of combustion of an alcohol lamp into the camera chamber. Since the products of combustion of alcohol contain water vapor, the lamp has a two-fold effect of humidifying and ionizing the air which as explained above tends to prevent static.

Laboratory Static

In the motion picture laboratory static discharges may occur during the following operations (a) Winding the film on the developing racks, (b) Development on the processing machine (c) Cutting of the negative and (d) Printing.

1. Rack Static.

Film is usually wound on the rack by holding the roll of film in one hand and winding with the other. The slack film is then tightened by pulling on each loop which results in severe friction between the slat and the film base, which may result in static markings.

Static discharges may also occur at the point where the film leaves the roll at a tangent as a result of induction and friction, especially if the film has been humidified excessively causing the convolutions to adhere slightly, while if the roll is gripped at all tightly, friction between the hand and the film or between the convolutions of the film may be sufficient to cause static. The latter difficulty may be overcome by the use of a roll holder illustrated in Fig. 12 during winding. The arm AB is lifted up, the roll placed on core C and the arm AB again lowered. The holder is then grasped by handle H, and by exerting a slight pressure with the thumb at A the film may be fed with a uniform tension and speed.

Static markings produced during winding and tightening may be minimized by humidification of the film before it enters the dark room, and in severe cases by also humidifying the air in the dark room. A suitable relative humidity is from 70% to 80% at 70° to 75° F.

2. Developing Machine Static.

On a processing machine static markings can only be produced up to the point where the film enters the developer, and may be caused by too much tension on the take-off roll, malalignment of the sprockets, or by running the machine at too high a speed. Humidification of the film previous to or during printing, and correction of mechanical defects will prevent such trouble.

3. Electrification of Negative Film in the Cutting Room.

Since electrified film has a powerful attraction for dust particles, it is important to maintain a fairly high humidity in the cutting room in order to minimize the propensity of the electrified film to attract dust. Such humidification also tends to prevent printer static.

4. Printer Static.

The largest proportion of static markings encountered in the laboratory are produced during printing, and especially with step printers. Static is rarely encountered with all-metal continuous printers.

In a step printers the film is subjected to excessive friction during the pull-down movement, especially with shrunken negatives. Static markings may, however, be prevented:–

1. By avoiding friction. All sprockets should be of correct dimensions and in alignment with the take-up roll. If the sprocket teeth are staggered, or if the take-up roll is in malalignment, excessive tension is exerted on one edge of the film. Too much tension should also be avoided at the take-up roll, while the loops should be adjusted to prevent any possibility of the film rubbing against itself or any part of the machine.

The printer should also be correctly "timed," that is, the pressure plate should be released before the pull-down movement commences and should not return in place before the film comes to rest. Although glass is not an ideal material for pressure plate construction in view of its nonconductivity, metal plates are unsatisfactory where a transparent plate is otherwise desired, while glass produces a minimum of scratches on the film. The pressure plate should be renewed whenever the surface becomes roughened.

2. By humidifying the film. When motion picture positive film leaves the factory it is in equilibrium with an atmosphere of 70 to 75% relative humidity, but if the laboratory conditions are favorable for the production of static markings the quantity of moisture which the raw film contains is not sufficient to positively insure the absence of static during processing. It would be dangerous, however, to humidify the film further during manufacture, owing to the danger of the formation of moisture spots when the film is stored.[3] Since a certain lapse of time is necessary for moisture to affect the emulsion, it is possible to humidify film immediately previous to or during processing to an extent which would be dangerous if the film was to be subsequently stored.

3. By humidifying the air in the printing room. If the printers were always in perfect adjustment and not run at too high a speed, a higher relative humidity than 75% at 70° to 75° F. would not be necessary in the printing room. In order to take care of the excessive friction to which the film is liable to be subjected if the printers get out of adjustment it is advisable to maintain the relative humidity at from 80% to 90% at 70° to 75° F. At such a high relative humidity the air feels uncomfortably cool to the worker at temperatures below 68° F. and oppressively warm above 75° F.

The exact relative humidity to be maintained depends on the particular machines used, the condition of the film, the temperature of the air, and time during which the film is exposed to the air before it is subjected to friction. The higher the temperature the lower is the relative humidity necessary to overcome a given tendency for static.

Usually the film is exposed to the air for only a few seconds before reaching the printer gate. This period may be prolonged by looping the film over several idler rollers before it reaches the gate. Such a procedure, however, is usually unnecessary if the negative is humidified as described below.

Methods of humidifying the air supply have been fully described in a previous communication.[4] Since the air in the printing room is at a higher relative humidity than that in any other room, it is necessary to boost the humidity of the air supply locally, and this can be readily accomplished either by means of water spray jets or steam jets. A series of water spray jets operated by compressed air and inserted in the air line serve to immediately change the relative humidity and have the advantage of cooling the air in hot weather. In winter both steam and water sprays are often necessary.

4. By humidifying the negative previous to printing. One contributing factor in the production of printer static is the friction between the gelatine surface of the negative and the emulsion side of the positive film in the gate, and especially during the pull-down period with old, dried out, shrunken negative. This can be largely overcome by humidifying the negative previous to printing by rewinding slowly two or three times in an atmosphere of 80% relative humidity, or by treating the emulsion side of the film with a solution of grain alcohol containing 10% to 20% water. Treatment of the film with this solution would insure that it would not attract dust in the cutting room, while it would assist in the prevention of static markings on positive film in the printer.

Dangers of Over-Humidifying Motion Picture Film

Too much humidification of film is worse than none at all for the following reasons:

a. Moisture spots are liable to be produced if drops of water condense on the emulsion.[3]

b. On winding moist film, the convolutions may adhere locally causing ferrotyping of the emulsion surface by virtue of being in contact with the polished base. On rewinding, the local adhesion of the film may cause more static markings than if the film had not been humidified in the first place.

c. Moistened film is more susceptible to thumb prints and abrasion marks than dry film.

d. Film which is too moist is apt to stick in the printer and may cause a stoppage, tearing of the perforations, or unsteadiness of the picture on the screen. Moist film is also apt to buckle causing lack of contact in the printer with resulting loss of definition.

[4] "The Development of M. P. Film by the Reel and Tank Systems," by J. I. Crabtree, Trans. Soc. M. P. Eng., Vol. 16, p. 163.

Fig. 1—Fan-shaped camera static marking

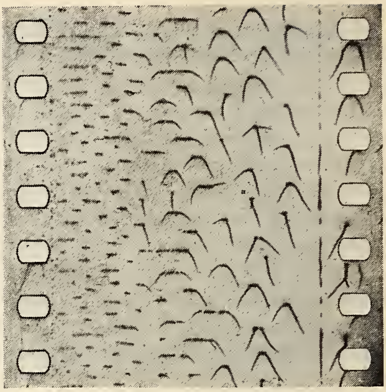


Fig. 2—Black spots and boomerang shaped static markings produced in the camera.

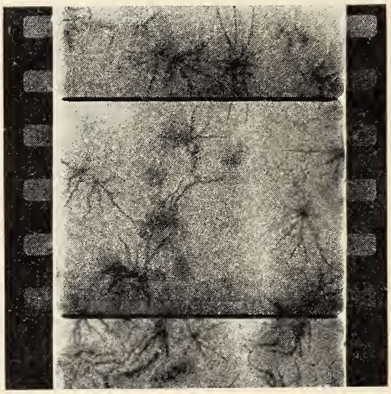


Fig. 3—Spider-like camera static markings.

Fig. 4—Tree-trunk camera static markings.

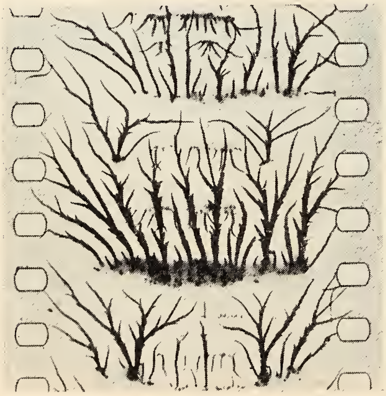


Fig. 5—Camera static markings resembling tree trunks with base line.

Fig. 6—Fan-shaped static marking produced in a step printer.

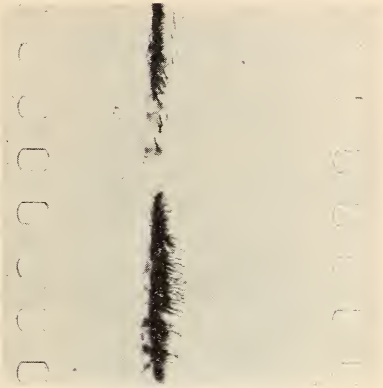


Fig. 7—Printer static markings.

Fig. 8—Fan-shaped static markings sprouting from edge of film.

Fig. 9—A conglomeration of fan-shaped and tree-like static markings produced in the camera.

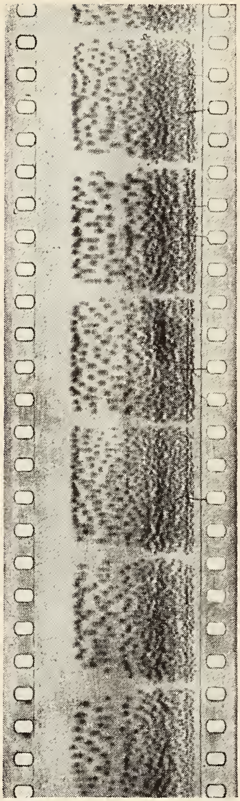


Fig. 10—Illustration showing the intermittency of occurrence of camera static markings.

Fig. 11—Illustration showing the intermittency of occurrence of step printer static markings.

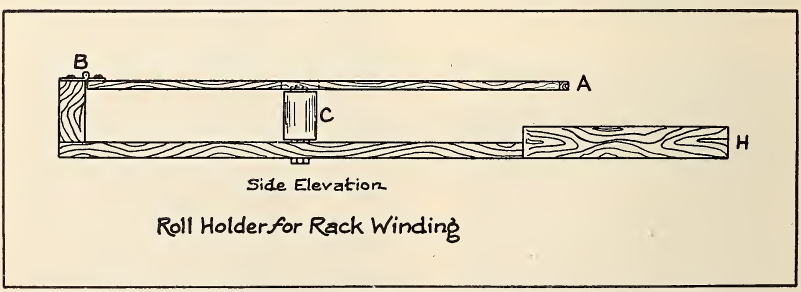


Fig. 12—Roll holder for winding motion picture film onto racks.

DISCUSSION

Mr. Fritts: If we have two spheres near each other at a high potential, the only way a discharge would take place would be by eruption. If the balls were replaced by sharp points, then the discharge does not reach the point of eruption but leaks off as a brush discharge. Would it not be possible to place such points near the film in the camera so that the charge would be carried off by the ionized air surrounding such points?

Mr. Renwick: This paper will be very valuable I am sure to our members for it is of a very practical character.

The friction side of the matter has been stressed however. I do not believe from my observations that the amount of pressure exerted has much to do with the amount of electricity generated. Then, again, it is stated that it is very difficult, even impossible, to produce static by running a motion picture film over a metallic conductor. That is not correct, and as a matter of fact I believe Mr. Crabtree corrects himself a little later when he says that tinfoil was not a preventive of static.

I was a little surprised that he did not mention the subject of contact potentials, nor did he mention the possibility of avoiding static by altering the character of the materials coming into contact.

Dr. Mees: Mr. Crabtree wanted to write a paper intelligible and valuable to operators and motion picture printers. We discussed whether the origin of static electricity should be dealt with. First of all, it is a controversial question; we do not feel it is cleared up from the chemical point of view and we thought that laboratory operators would not be interested in it. They are getting marks on the film and want to know how not to get them, and the paper was designed from this point of view.

With regard to friction, it was not intended to suggest that friction is the cause of static, but intimacy of contact is the cause of friction and also of static.

Mr. Crabtree: About Mr. Fritts' suggestion, all I can say is that we will try it out.

I agree with Mr. Renwick that we can get static by rubbing with a conductor but experiments have shown that the intensity is less with a grounded metallic conductor than with an insulated one under the same conditions. There is no doubt that all-metal cameras have much less tendency to give static than the old type wooden cameras containing hard rubber rollers, velvet pads, and so forth. We have not made specific experiments to show the relative quantity of electricity produced with metal and velvet under the same conditions. Of course, our knowledge of the theory of static is very slight and in making experiments it is very difficult to control accurately all the factors involved. The printed paper is merely a record of the results of practice. Humidification of the film, the elimination of friction and the rapid motion of anything near or against the film tends to eliminate static. By observance of these points we can practically eliminate it. From the standpoint of the laboratory worker and the camera man that is all he needs to know.

Mr. Renwick: I appreciate what Dr. Mees and Mr. Crabtree have said about the value of looking at this thing from the point of view of the practical man but sometimes a paper from that point of view may be misleading. May I suggest that there is no reason why you cannot get very bad static between metals and motion picture film if only you separate them fast enough. If, however, separation takes place very slowly, you get leakage, and that is why the conclusion has been reached that metal conductors in contact with the film give lower potential charges.

AN IMPROVED SECTOR WHEEL FOR HURTER AND DRIFFIELD SENSITOMETRY

By M. Briefer*

Communication from the Photographic Department Atlantic Gelatine Company, Woburn, Mass.

WE FIND in "Investigations on the Theory of the Photographic Process,"[1] that as early as 1840 the sector wheel, a disk with successively increasing angular apertures, was proposed by Claudet. Hurter and Driffield adopted a sector wheel having nine apertures, ranging from 180 degrees for the largest, to 0.703 degrees for the smallest, each succeeding angular aperture from the center being half that of the preceding one (Fig. A). The disk is caused to revolve before a light source usually at one meter distance. A sensitive photographic emulsion, sufficiently exposed behind such a disk, is impressed with nine different light exposures, the ratio of any adjacent pair being as 1 : 2. The radius of this disk, measuring from the center to the circle including the outermost aperture, is about 12 cm. The usual procedure is to expose to a constant light intensity for different times as occasion demands.

One objection to the sector wheel as a time exposure scale, arises from the difficulty in cutting the smaller angles accurately. In order to reduce the error in these small angles, the Bureau of Standards has adopted a disk of about twice the usual diameter, and also increased the radial length of the apertures from 10 to about 13 millimeters. A disk of about these dimensions is in use also, at the Massachusetts Institute of Technology. Another objection is based upon the difference in the photographic effect, between intermittent and continuous exposure, and is known as the failure of the Bunsen-Roscoe "reciprocity law." The failure of intermittent exposures to intergrate, presumably varies with the ratio of exposure time to the time of intermittency; that is, the failure is greater as the intermittent period is increased. Some attempts have been made to avoid intermittency errors, with devices to affect exposures with one complete revolution of the disk; but the mechanical difficulties have been considerable, and besides the "speed" readings so obtained, would be applicable only to the time of exposure used. The rotating disk permits variation of the time of exposure to a constant light intensity, the densities so obtained, being the product of intensity and time. This has proven the most convenient method, and the easiest to standardize.

The sector wheel to be described (Fig. B), is not a radical departure from the conventional type, but a simple modification of it;

* Atlantic Gelatine Co.

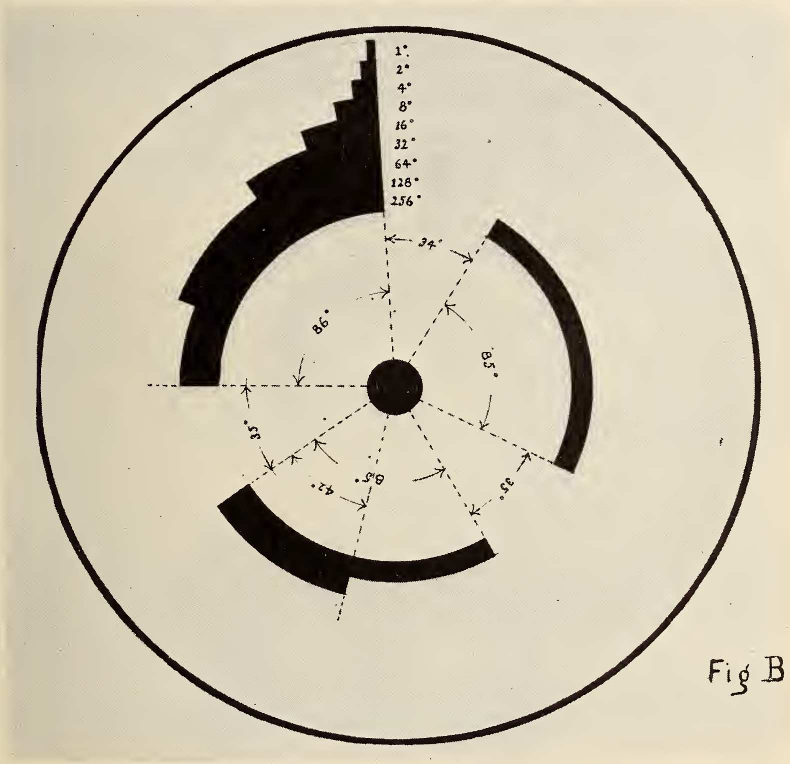
[1] Sheppard and Mees.

yet, two principal objects are attained in the design; first, simplicity in laying out the angles, and secondly, greatly reducing the possibility of error in cutting the apertures. Incidentally, since the intermittent period of one revolution of the disk, is reduced from 50 to 29 per cent, the intermittency error should be correspondingly

"Conventional Sector Wheel"

less. Also, the effective exposure for each revolution is greater by nearly 43 per cent, thus affecting considerable economy of time in doing work.

The diagram shows the plan of the proposed sector wheel, and is self-explanatory. The angles are laid out beginning with one whole degree for the smallest, and ending with 256 degrees for the largest, each angle from the center being twice the preceding. The design is such that there are no fractions of degrees used anywhere. With a little care and some patience, the angles may be laid out to a high degree of accuracy with the aid of a good protractor. In the dimensions given, a radius of 18 cm. is taken for the smallest angle making the aperture approximately 4 by 10 mm. This is about the



''Improved Sector Wheel''

dimensions of the third smallest aperture of the conventional type sector wheel. Obviously, accurate cutting is greatly facilitated. Those without facilities for precision measurements, may cut a good sector wheel of the proposed pattern with ordinary fine tools.

It will be noted that the largest angle (256°) is laid out in three sections; two of 85 degrees, and one of 86 degrees. The second largest angle (128°) is in two sections, 86 and 42 degrees while the three solid sections are 35, 35, and 34 degrees. This slightly unbalanced division of the disk has no effect on the photographic result and is warranted from the fact already noted—doing away with fractions of degrees.

The large disk diameter, (38 cm.) permits a greater radial length for the apertures, but one centimeter each, is quite enough for all practical purposes. Exceeding a total length of nine centimeters at one meter distance from light may make the marginal errors, from the difference in sines, appreciable.

The disk should be mounted on a large hub having three radial spokes to serve as a rigid support. The hub shaft may be run on ball bearings, and the whole carefully balanced for smooth running. Following is a tabulation of relative values.

IMPROVED SECTOR WHEEL
FOR HURTER AND DRIFFIELD SENSITOMETRY

Comparative Values

(A) Conventional Type	(B) Proposed Type
Angles in Degrees	
180.	256.
90.	128.
45.	64.
22.5	32.
11.25	16.
5.625	8.
2.813	4.
1.406	2.
0.703	1.

(A)	(B)
Ratio of Apertures to 360°	
.5	.711
.25	.355
.125	.1775
.0625	.08875
.03125	.044375
.015625	.022188
.007813	.011094
.003907	.005547
.001953	.002773

Effective Exposure	
50%	71.1%

Ratio of Angular Apertures		
1	:	1.428

DISCUSSION

Mr. Renwick: I think that the sector wheel Mr. Briefer proposes has some constructional advantages over the ordinary type but the greatest advance made in sector wheel sensitometers is described by Dr. A. C. Hardy in the February issue of the Journal of the Optical Society of America. In this apparatus, two wheels are made to work together and a series of single exposures covering an extraordinarily long range is possible by this means.

Mr. Briefer: Mr. Hardy's wheel, which is at the Boston Tech, I have seen in operation. It is very ingenious but difficult to build. My object is to promote simplicity and to make it possible for amateurs to construct a sector wheel without difficulty.

THE MANUFACTURE OF TUNGSTEN INCANDESCENT MOTION PICTURE LAMPS

Synopsis

This paper describes the manufacture of Incandescent Motion Picture Lamps and points out some of the manufacturing variables affecting lamp performances.

BY ROBERT S. BURNAP*

INCANDESCENT lamps can be easily described. They consist of a solid filament made hot electrically glowing in a transparent container which contains no filament attacking material. The manufacture of the ordinary incandescent lamps is not so easy to describe because the process involves the handling of a peculiar metal tungsten, the obtaining of gas tight seals for lead wires, the working of glass, and the removal of all oxygen or moisture from the container. The manufacture of lamps for projection or motion picture service is still more exacting for we must concentrate the filament source, reduce bulb sizes, and increase operating temperatures. Design to obtain maximum projected light means a reduced factor of safety as far as manufacture is concerned.

This paper will be limited rather closely to the manufacture of the 900 watt 30 ampere motion picture lamp. This lamp is intended for operation at constant current and is used chiefly for motion picture projection. (Fig. 1.) The filament consists of four parallel coils in series supported from two heavy nickel lead wires. The leadwires conduct the current to the filament from the brass base thru a gas tight seal. The filament is supported by top and bottom anchors so designed as to not cause filament strains during the lamp life. Incidentally, the correct design of the super-structure for the mount involved a problem in structural design where the parts must withstand a 3000° C change of temperature every quarter of an hour and where the filament after many such cycles must show little distortion. The filament is surrounded by an inert gas consisting mostly of argon. The bulb is of hard glass to withstand the high operating temperatures and is made narrow to allow the filament to be placed close to the condensing lens, and high to provide a depositing chamber for the tungsten which evaporates from the filament and is carried upward by the heated gas. Generally the lamp is operated with a concave mirror which is so adjusted that the filament image is meshed with the filament to completely fill the sections between the parallel coils and to present a solid light source to the condensing lens.

The first step in this description of the manufacture is the tungsten filament. Tungsten itself is obtained as ore from China. This ore

* Edison Lamp Works of G. E. Harrison, N. J.

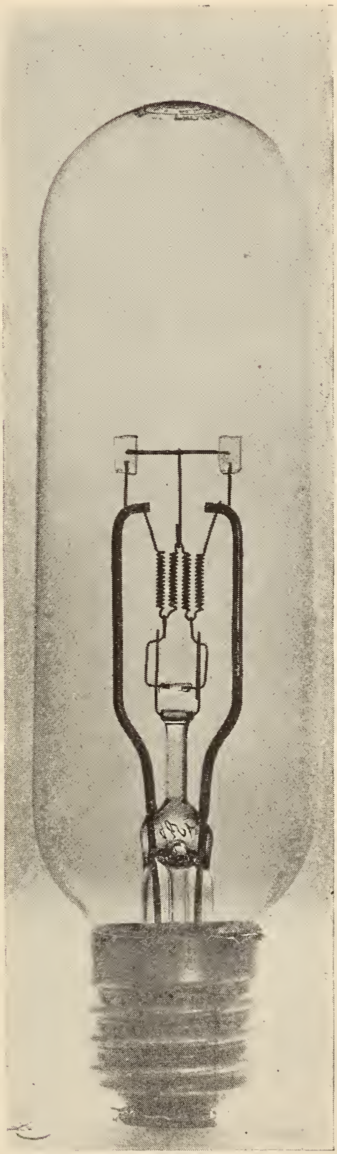


Fig. 1.—900 Watt ampere Lamp for Motion Picture Projection

is known as Wolframite and consists of iron, manganese and tungsten. The ore is treated to obtain pure tungsten in the form of a powder which is pressed into slugs under hydraulic pressure. The slug is heated electrically in hydrogen to sinter the powder and then worked by swaging and drawing to the required size. The handling of tungsten is peculiar in that the metal is never in a molten state and in that working the metal makes it more ductile. Annealing as we ordinarily understand the term for metals makes tungsten brittle.

Since a nontwisting, nonsagging material is required for the filament, the metal is treated and tested for these qualities. After having obtained a satisfactory wire, the wire is coiled on a lathe equipped to space the sections correctly. (Fig. 2.) The mandrel is removed by treat-

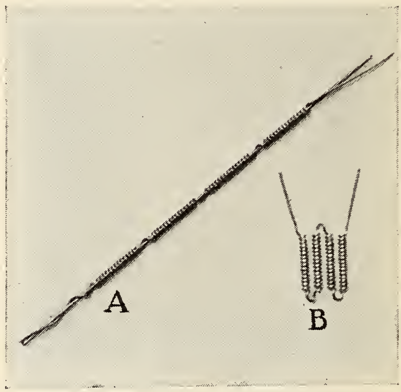


Fig. 2.—A. Coiled Filament on Mandrel; B. Formed Filament

ment in acid. The coiled lengths are fired in hydrogen to clean them and to remove strains and then bent to shape over a heated wire. This is a task requiring skill for the tungsten wire is somewhat brittle and difficult to handle in this large diameter. The loops must be correctly formed to lock with the anchors.

The manufacture of the stem presents difficulties not at first apparent, for this part of the lamp not only supports the finished filament but also forms the seal through which the lead wires pass. The stem consists of a flared glass tube of which the unflared end is pinched about the sealing in wires, the hub cane which supports the bottom anchor guides, and the exhaust tube which ends with a small opening just below the seal pinch. (Fig. 3.) The lead wires consist of three parts, a nickel section which carries the filament, a tungsten section which forms the seal, and a flexible copper strand for attaching to the base. It is not only essential to have a gas tight seal but also to proportion the parts and to fuse the glass so that no strains in the glass are obtained. The actual forming of the stem is done on a rotary spider, carrying heads which align the parts and which pass thru

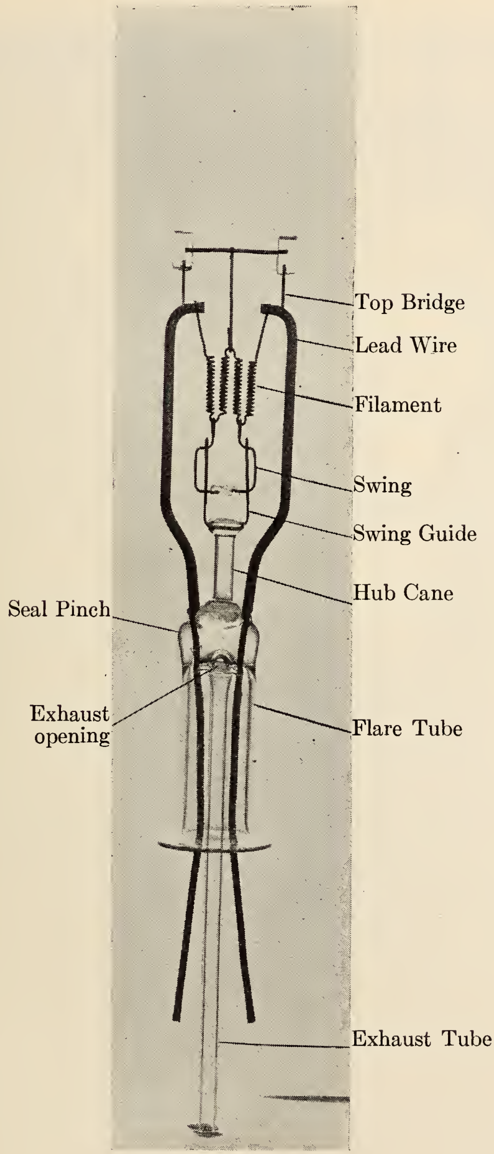


Fig. 3.—900 Watt 30 ampere Mount

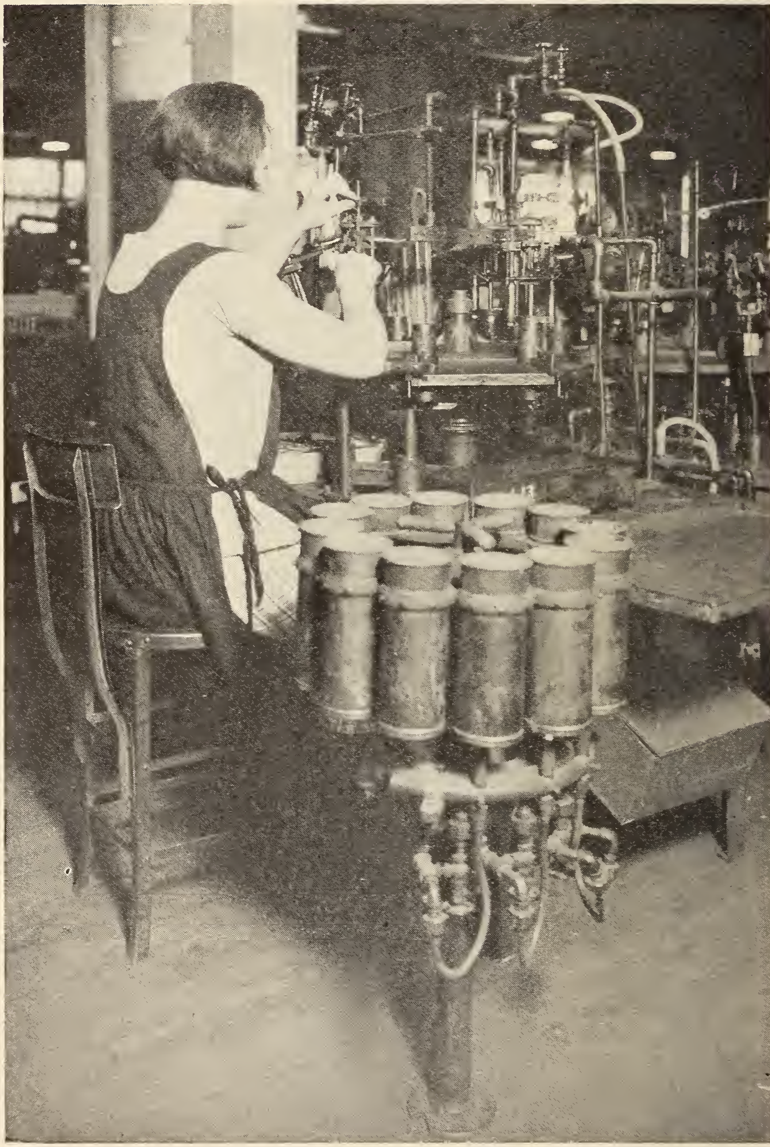


Fig. 4.—Stem Machine

various fires each of which has a certain function to perform in forming the seal. (Fig. 4.) After the glass is heated in an oxygen and gas flame to the correct temperature, two jaws clamp the softened glass firmly to form the seal or pinch about the sealing in wires. The small exhaust hole is formed by a puff of air into the exhaust tube. The air pressure forces an opening thru the side of the softened pinch. This method of making stems results in the elimination of the tip which was so objectionable in the past.

The next operation is the mounting of the filament in the correct position on the lead wires. This is done by an electrical weld made with high current which is automatically timed by a relay. The top bridge and anchors of molybdenum are attached in the same manner. The bottom swing which slides in the vertical guide sections is also attached and carefully adjusted to eliminate possibility of binding. The mount is flashed at full current in a bottle containing hydrogen to relieve any filament strains, and then is cleaned in an electrolytic bath. After cleaning the mount is again flashed and tested for freedom of moving parts.

The skill with which the mounting is done determines to a major degree the quality of the lamp. Ununiform mounting or filament distortion produces a streaked and unsatisfactory screen. The manufacturer is not only concerned with the problem of producing wire which is free from strains, but also with supporting and attaching the filament so that no additional strains are produced. To date no satisfactory mechanical method for mounting the more complicated projection lamp filament types has been developed so that results are dependent on skill by hand. This is a job requiring skill for filament distortion is caused by very minor mounting strains. These strains particularly on the smaller projection lamps set a practical limit to concentration of filament source.

The joining of the flare of the stem to the bulb is done on a machine somewhat similar to the stem machine, and requires oxygen and gas fires due to the hardness of the glass. (Fig. 5).

The removal of the air and moisture and the filling with argon gas is performed on a large rotary machine which carries the lamp thru a heater where the lamp is heated to 500° C. The air is removed by a series of washes with nitrogen gas which simply dilute the air to a negligible quantity. The various ports on which the lamp is placed are automatically connected by means of a rotary valve to the pumps, the nitrogen, and the argon supply lines, as the machine indexes. Constant checks are made on this machine for even a very small leak affects the lamp quality seriously. (Fig. 5).

The lamp is sealed off by fusing the glass exhaust tube while still on the exhaust machine. The lamp is then transferred to the baser who threads the lead wires thru the base which has been previously filled with cement. The lamp base is then heated on a rotary machine to set the cement. (Fig. 5).

After basing the lead wires are electrically arc welded to the base terminals to insure positive connection. The lamp is then tested

Fig. 5.—Group Manufacturing Machine

for accuracy of physical dimensions on a special machine which projects the filament image upon a chart. (Lamps outside the chart diagram limits are rejected). (Fig. 6) After holding for several days to allow glass defects to develop, the lamps are aged at over current, reinspected and packed ready for shipment.

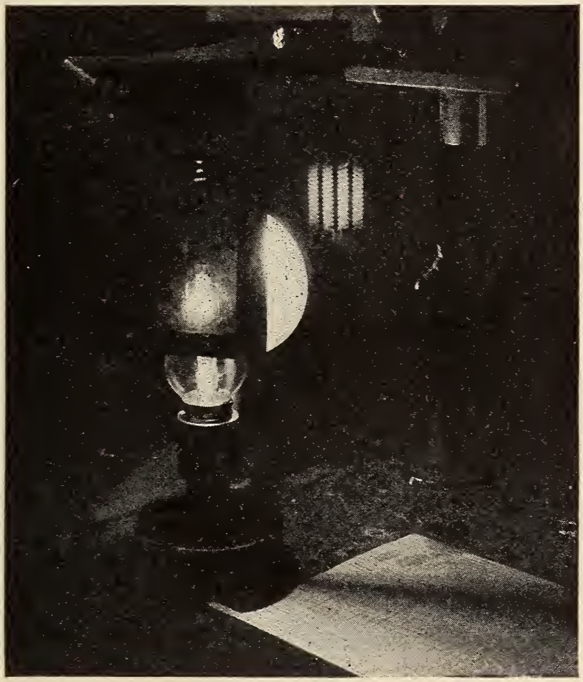


Fig. 6.—Light Center, Axial Alignment, and Source Size Checking Machine

So far very little has been said about the checks which are placed about the product to insure good quality. These checks are very necessary for this is an article where a very small reduction in wire size seriously affects the life of the lamp, where slight variations in materials and methods affect the accuracy of the glass parts, where slight strains in the filament may cause early failures due to short circuit, and where poor exhaust conditions cause early bulb blackening. All of these conditions affect the quality of household lamps, but the more exacting duty of the motion picture lamp or projection lamps emphasizes poor performance when it is obtained. The manufacture of tungsten wire which will always perform the same, the obtaining of perfect exhaust and the manipulation of glass are still far from the state of being exact sciences. This being the case a series of checks on the lamp manufacture is made thruout manufacture from tungsten metal to finished lamp.

In addition to the checks which are a routine of manufacture, all metal is tested for nonsag and nontwist characteristics by making and burning specially constructed lamps. The final product is checked by periodically selecting lamps which are operated under service conditions in the Life Test Department. Here lamps are rated for candlepower and read for screen illumination during life. (Fig. 7)

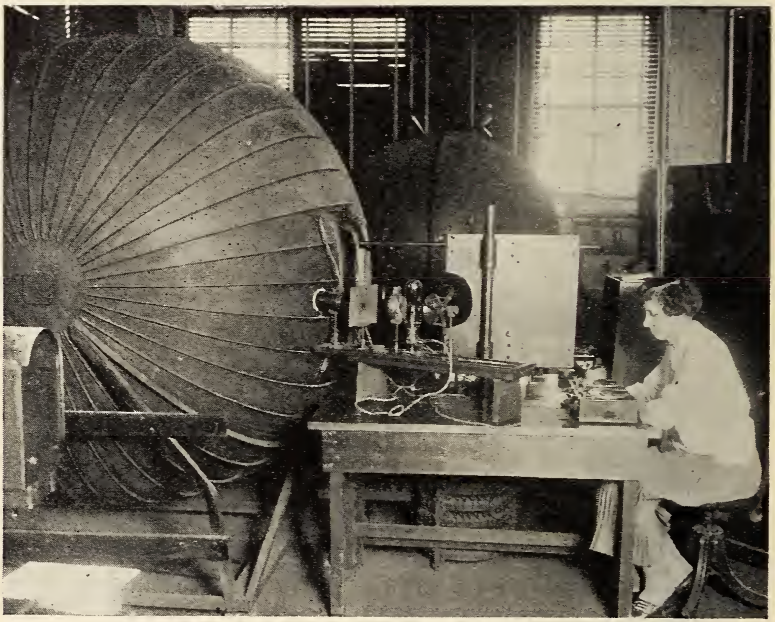


Fig. 7.—Photometer Test

Life tests are made in standard housings under intermittent conditions of burning with accurate current control. (Fig. 8) Another source of lamp performance information is lamps returned from customers. The defects are analyzed and when necessary changes in method of manufacture are made to improve the product.

Just a word on the effect of burning at other than rated voltage. An increase of one per cent in amperes or two per cent in volts reduces the life approximately twenty per cent but gives three per cent greater illumination. An excessive increase in voltage decreases the safety factor against surges in the voltage supply.

Lamps consume watts and as a result get hot. The equipment manufacturer should make all provision possible for getting rid of this heat. Lamps for projection purposes are intentionally made small to help make compact equipment, but the result is to reduce the factor of safety against excess lamp temperature.

This paper has not attempted to cover problems of design which have been met in the development of the incandescent motion picture lamp. It is desirable however to point out that the material tungsten with which we work can not be operated satisfactorily much above 3300° K, and that excessive concentration of the filament defeats its own purpose if it leads to short circuit failures or early burnouts. Progress in any business is limited at best by the average product obtainable under the best practical conditions of manufacture for that period. Fortunately, best practical conditions of manufacture improve, but new designs must keep step with manufacturing skill.

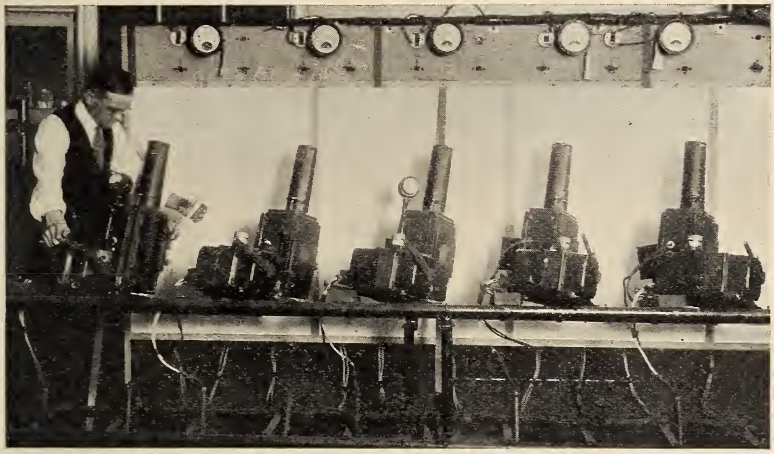


Fig. 8.—Life Test Equipment

The diversity of types of lamps which are required for projection lamp service is a factor which causes production on any one type to be small. At present projection lamps are made in voltages from 6 to 250, in wattages from 15 to 30,000, in tubular, round and pearshape bulbs of various sizes, with different filament constructions, with different light centers, with different bases, with different ratings for life, and with different bulb materials. Manufacturing a few special lamps of a type is expensive because equipment must be changed and adjusted for every order. This changing increases opportunity for error and spoilage in manufacture. Standardization of types is essential for low cost.

The present trend is to distinguish further between the demand for maximum illumination and the demand for longer life on concentrated filament lamps. Round bulb lamps for spot light and commercial installations are to be increased in life. Tubular lamps with monoplane filaments are to have reduced life because this seems the best way to give the customer what he wants in the way of better illumination.

DISCUSSION

Dr. Story: Was I right in understanding that the gas filled lamps were never exhausted but simply rinsed out with the final gas?

Mr. Burnap: The lamps are not completely exhausted; they are partially exhausted and refilled with dry inert gas several times. The process is a rinsing process where the injurious oxygen and water vapor are removed by successive dilutions with dry inert gas. Generally the wash gas is not the same as the final filling gas. Lamps are washed out with nitrogen but are usually filled with argon because argon gives better lamp performance.

The wash process can be used only for gas filled lamps. It is not suitable for vacuum lamps.

A NEW REFLECTOMETER

By Frank Benford*

Synopsis

The theory of illumination between two parallel planes was used by Nutting in the development of his reflectometer, but the deviations of the instrument from the simple theory were so large as to destroy its usefulness. It is an instrument of the greatest simplicity and durability and is ideal where portability is desired. The present reflectometer, which is wedge shaped, is the result of a series of investigations looking to an instrument of good accuracy and at the same time maintaining the extreme simplicity and durability of the older instrument. The theory of illumination by a limited plane is touched on, and some of the details of specular reflection are examined. One form of a wedge reflectometer has been specially designed for direct vision, and has good accuracy for the particular angle of view fixed by the construction of the instrument. The second form of the instrument reads in a manner that is independent of the process of reflection and therefore gives accurate results for all types of diffuse or specular surfaces.

Introduction

THE search for simpler and more accurate photometric instruments has nowhere been more keen than in the particular case of instruments to measure the coefficient of reflection of light reflecting surfaces. There are a number of instruments now available for this purpose, and for laboratory service these seem to be entirely satisfactory, but there still exists a need for an instrument of simpler construction and one having a minimum of auxiliary parts. The Taylor reflectometer and the Karrer reflectometer are both examples of instruments of good precision and well suited for laboratory use and at the same time they have a large degree of portability so that they can be used on "location." The integrating sphere method developed by Mr. Little and the part-sphere method developed by the writer are strictly laboratory methods. The greatest degree of simplicity previously attained was in the Nutting reflectometer, which instrument is unfortunately marred by inherent errors of such size as to render the instrument totally unreliable, for as will be shown later, the indications of the instrument scale are influenced by factors that are in general of an unknown size and therefore it is not possible to correct the readings by a calibration curve.

The instrument herein described has been under development for several years and it has now reached the point where the essential simplicity of the Nutting instrument is retained and the accuracy is apparently of the same order as that of the more complicated laboratory instruments. A brief examination of the theory of reflection is a necessary preliminary to an understanding of the details

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of the instrument, and this is best done by a re-examination of the theory of the Nutting reflectometer, and also a brief consideration of some available test data on various reflecting surfaces.

The Nutting Reflectometer

The Nutting reflectometer is based in theory upon the illumination received by a surface set parallel to a uniformly luminous plane of infinite extent. It can be shown that the illuminated surface receives just as much light per square centimeter as is emitted from each square centimeter of the luminous plane or illuminator. It is assumed that the plane is of uniform brightness from all angles of

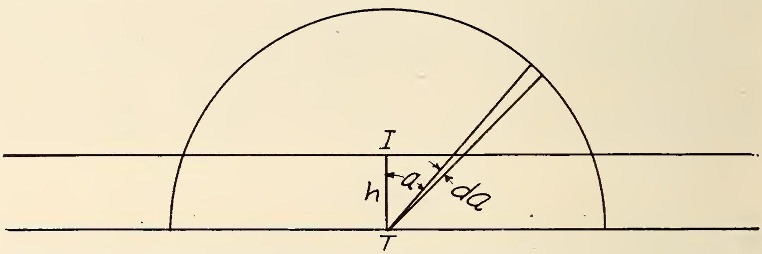

FIG. 1

view, that is, it is a perfect diffuser. In Fig. 1 let us assume that the point I is the central point of an infinite diffusing plane of brightness B candles. The illumination of the test point T is found as follows:

The area of an elemental ring in the illuminator having I as a center is

$$dA = 2\pi h \tan a \frac{h}{\cos^2 a} da$$

The illumination received at T is computed from the inverse square law and the cosine law applied to both surfaces.

$$dE = B \frac{\cos^4 a}{h^2} dA$$

$$E = 2\pi B \int_0^a \cos a \sin a \, da \text{ foot-candles}$$

When $a = 90$ deg., that is, the illuminating plane is infinite in extent

$$E = \pi B \text{ foot-candles}$$

and if the test surface is a diffuser with a coefficient K the intensity B_T of the reflected light is

$$B_T = KB \text{ candles per sq. ft.}$$

It will be noted that the separation, h, of the points I and T does not appear in the equation, showing that the illumination is not dependent upon the distance in this limiting case. For some particular limiting angle a

$$E_a = \pi B \sin^2 a \text{ foot-candles}$$

This equation is of particular interest in connection with the analysis of the Nutting reflectometer as it makes possible a computation of one special case of great practical importance. The new instrument to be described later originated from a study of the older instrument and indeed some of its parts were taken to build up the experimental reflectometer. Therefore some further attention must be paid to the older instrument.

The Nutting reflectometer is composed of a nickel band or ring 7.25 inches in inside diameter and 1.65 inches high. The illuminating plane in this case is a disk 7.25 inches in diameter and separated from the test surface by 1.65 inches. In Fig. 2 the infinite plane is

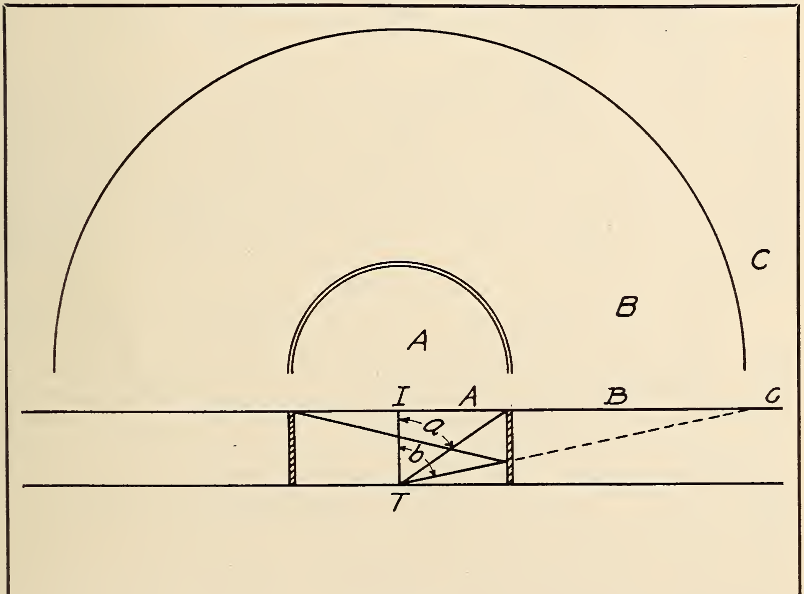

FIG. 2

replaced by a disk A, whose edges viewed from the test point make an angle a with the axis. The walls of the ring being mirrored the disk can be seen reflected in them, and this reflection appears as an annular ring B placed about the disk A. Two reflections give another concentric ring, C, etc. and each ring is less bright by the quantity of light lost on each reflection. Calling the coefficient of the walls w, the illumination at T can be approximated by

$$E = 2\pi B \int_0^a \cos x \sin x dx$$
$$+ 2\pi w B \int_a^b \cos x \sin x dx$$
$$+ 2\pi w^2 B \int_b^c \cos x \sin x dx$$
etc.

This series integrates to

$$E = \pi B\ [\sin^2 a + w\ (\sin^2 b - \sin^2 a) + w^2\ (\sin^2 c - \sin^2 b) + \ldots .]$$

Measurements on the Nutting instrument gave

Coefficient $w = 0.53$
$a = 65°\ 33'$
$b = 81°\ 23'$
$c = 84°\ 48'$

and these substituted in the equation above gives:

$$E = \pi B\ [0.830 + 0.530\ (0.977 - 0.830) + 0.281\ (0.992 - 0.977) + \ldots .]$$
$$= 0.912\pi B\ .$$

This instrument, therefore, has a correction factor of 0.91 for a *perfect diffusing* surface. This factor has been determined by an independent method* to be 0.90 as derived from the Nutting value of 0.88 for the coefficient of reflection of magnesium carbonate and the "part-sphere" value of 0.975 for the same material. The interference of the end of the photometer which is inserted through the ring lowers the illumination at T slightly and the agreement between the computed factor of 0.91 and observed correction factors 0.90 is as good as can be reasonably expected.

A second special surface is a specular reflector which reflects light by the geometrical law "the angle of reflection is equal to the angle of incidence." The Nutting reflectometer is so proportioned that when testing a mirror the entire quantity of light passing through the test side of the photometer field is reflected once from the nickel ring which in this particular instrument was found by test to have a coefficient of 0.53. This is shown in Fig. 3 where a ray is traced from a point I′ (adjacent to the point I of the previous figures) to the ring at R, the specular surface at T and then into the photometer. The brightness of the illuminating plate may be taken as identical at I and I′, but as the point I′ is seen as reflected by the ring at R the apparent brightness will be 0.53 of its real value. Therefore, for *specular surfaces*, the instrument has a correction factor of 0.53. This reveals the weakness of this instrument because a great majority of all surfaces in which we are interested are *mixed surfaces*, reflecting by a process that is a combination of regular reflection and diffusion, and therefore the correction factor lies at some unknown value between 0.90 and 0.53. The probability of large errors in this

* Benford—An Absolute Method for Determining Coefficients of Diffuse Reflection. General Electric Review, January, 1920—page 72.

instrument removes it from consideration as a working tool, and this is so generally recognized that it has fallen into disrepute.

The photometer is of the polarization type and the indicated coefficients for one component of the light is

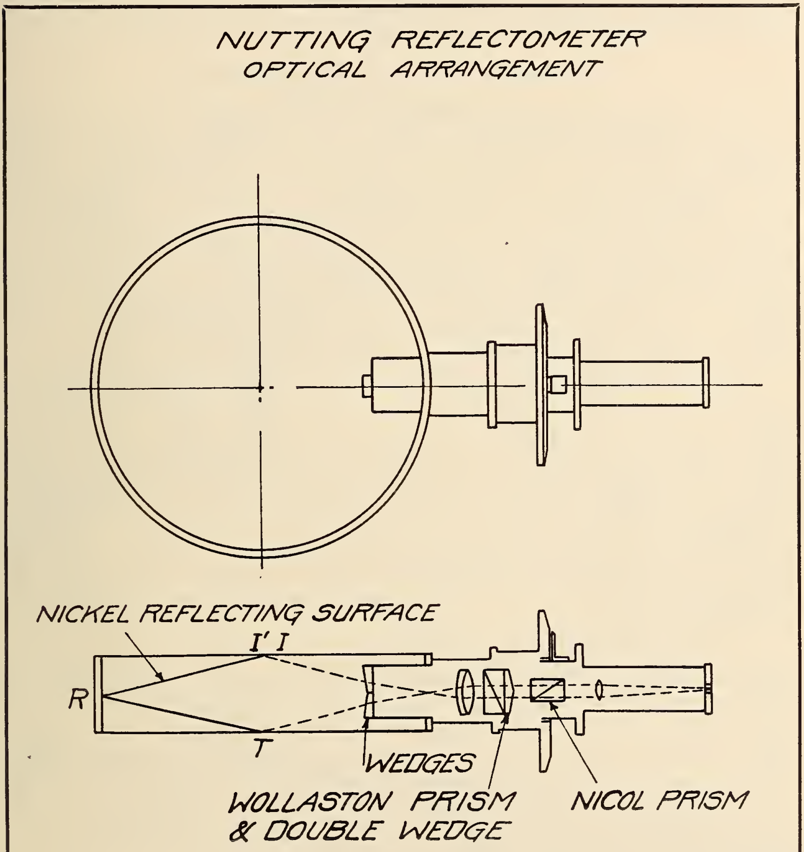

FIG. 3

$$K_1 = \tan^2 s$$

where s is the angle read on the pointer that rotates with one element of the polarizing system. To eliminate the effects of selective polarized reflection which occurs on every surface, the photometer is rotated through 180 degrees and a second photometric balance made, giving

$$K_2 = \cot^2 t$$

where the angle t is read on the same scale as s, but it is over 45 deg. whereas s is always less than 45 deg. The indicated coefficient K is then

$$K = \frac{K_1 + K_2}{2}$$

Direct Vision Type of Wedge Reflectometer

For many of the more ordinary mirror surfaces the laws of reflection are known accurately and in great detail. Thus a single surface of glass with a refractive index of 1.52 reflects 4.25 per cent of the light incident at 90 deg. or normal incidence; at 30 deg. about 5 per cent; at 60 deg. some 9 per cent is reflected and at 90 deg. or grazing incidence, the reflection is complete; that is, 100 per cent. It is thus obvious that we cannot observe a specular surface at one angle and determine its coefficient of reflection. "Coefficient of reflection" ordinarily means the average coefficient without always being specific as to the conditions of illumination or observation.

As an example the glass surface noted above would be found to reflect from 4.25 per cent to 100 per cent when placed horizontally under a uniformly bright sky and the angle of observation varied from 0 deg. to 90 deg. but if a number of angles were observed and then due weight were given to each angle depending on the quantity of light received and reflected at that angle the average coefficient of reflection would be found to be 19 per cent. Viewed at an angle of 71 deg. the reading on the glass would be found to agree with the average, but this particular angle would probably not be correct for any other surface.

A reflectometer, built in the form of a wedge, that is, having a dihedral angle between the diffusing plate and the test surface, is illustrated in Fig. 4. It was found that the "integration" of light was much more complete near the edge of the angle than it was near the back wall, and this has an interesting secondary effect. When the point B on a specular surface is viewed the point A_1 on the diffusing plate is seen by reflection. But the point under direct observation on the diffusing plate was at A and its brightness was somewhat less than that of A_1. Therefore the comparison of the two fields gave a coefficient for the test surface that was higher than the true value. With the photometer drawn back to its limiting position the readings on a specular reflector could be increased several per cent, principally because A and A_1 were more separated. With the photometer advanced so that A and A_1 fell near the edge of the wedge the reading could be brought to within less than one per cent of the computed value.

The calibration curve of Fig. 5 was made with the instrument arranged as for "direct vision"; that is, the test surface itself was viewed in the field. In order to reach the edge of the wedge without using light at angles too close to grazing, the light was received through a pair of reflecting prisms as shown in Fig. 4.

The calibration curve of Fig. 5 was made by observing the surface reflection from one, two, three and four pieces of cover glass. It was found that the instrument read within one per cent in all cases and an additional test on a mirror having a coefficient of 0.81 gave the

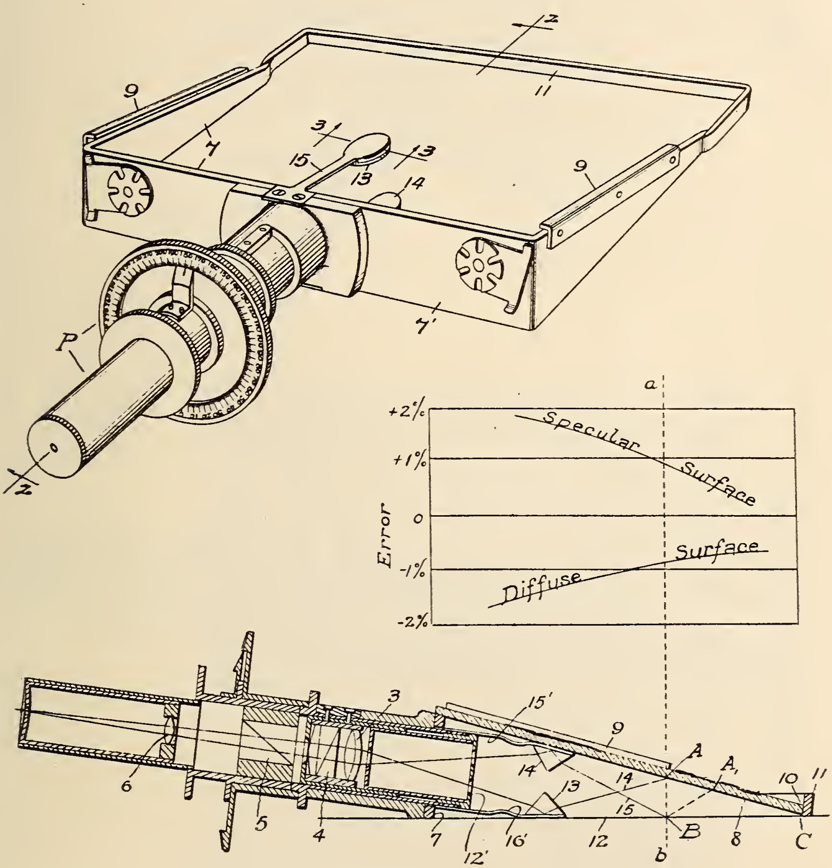

Fig. 4

same size error; the reading on magnesium carbonate was substantially exact. This form of instrument is therefore evidently well suited for a surface that diffuses the light perfectly as does magnesium carbonate but unfortunately such surfaces are rare and furthermore they are not the surfaces in which engineers are most interested.

The great majority of reflecting surfaces act by a mixture of specular and diffuse reflection and it is obvious that if one component only, the diffuse one, can be measured accurately, and the specular component is measured with an unknown degree of error

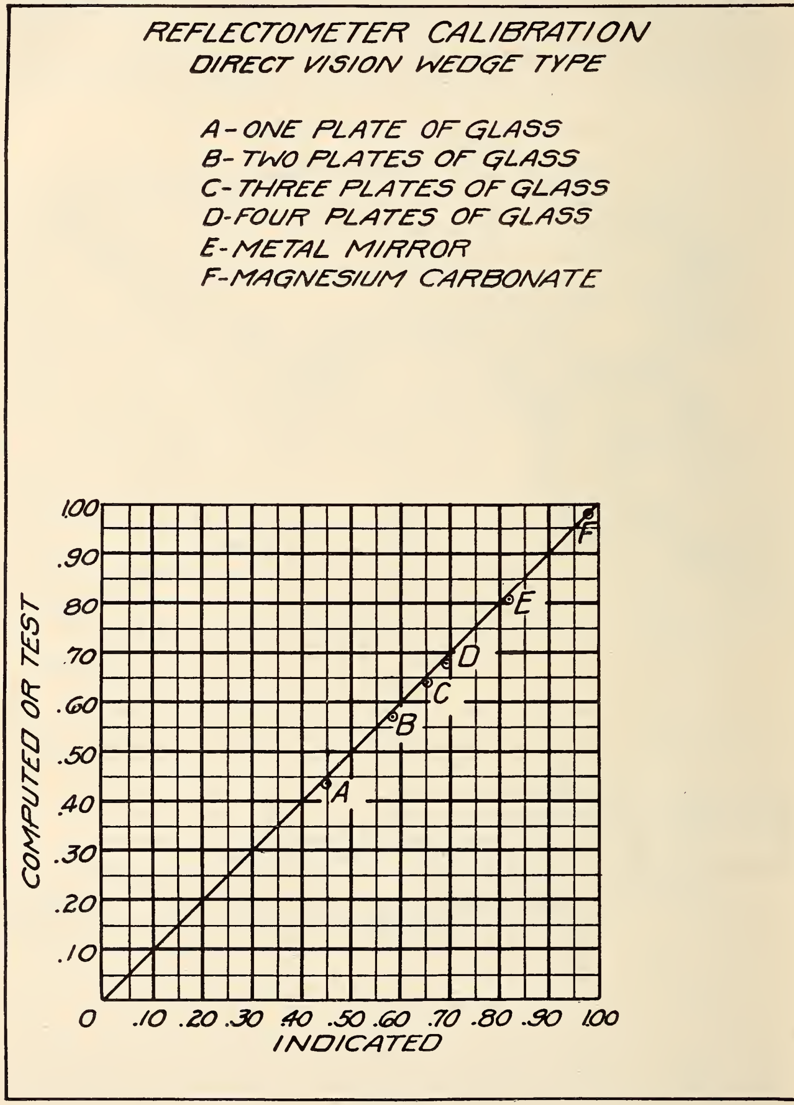

Fig. 5

then the net result will be in error to a degree that is difficult to estimate and the value of all readings is open to suspicion. It was this state of affairs that led to the development of an altered form of this instrument that escapes this limitation. This form of instrument is therefore well suited for mirrors and polished surfaces that are known to have fairly constant coefficients at angles not too close

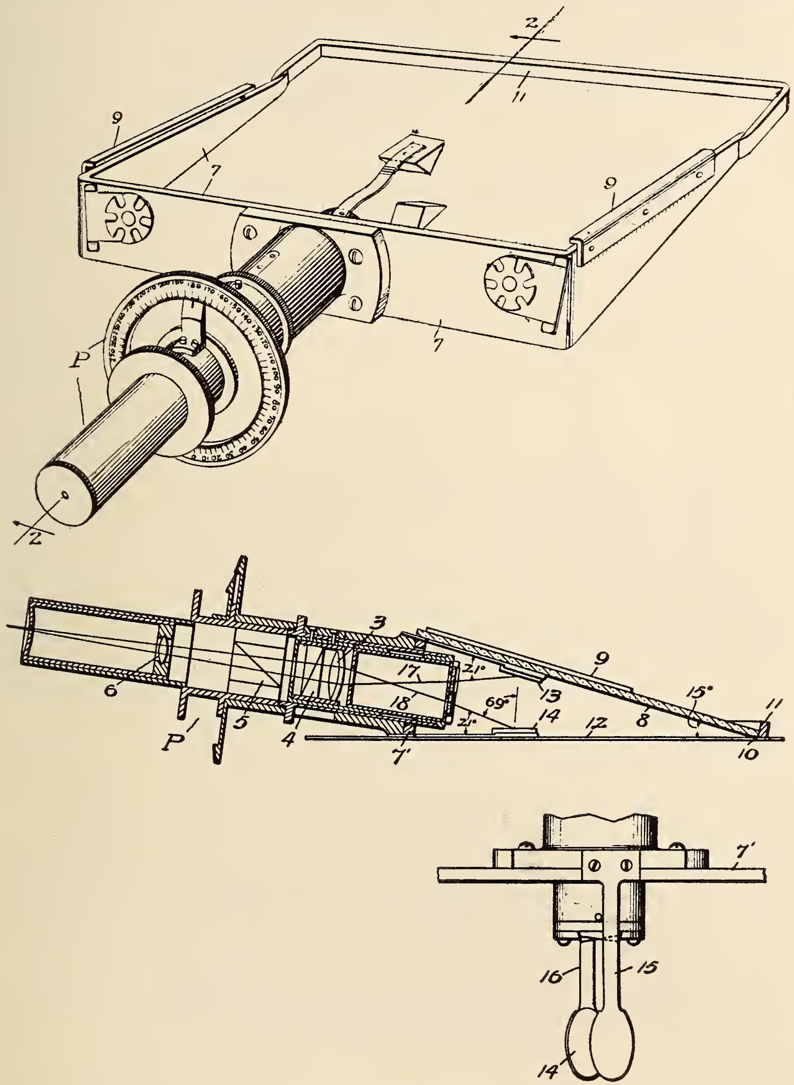

Fig. 6

to the grazing angle, but for measuring those surfaces that require an averaging process another type of instrument is required.

The Target Type of Wedge Reflectometer

In this instrument the idea of a nearly perfect integration of light was abandoned and the first purpose was to establish conditions

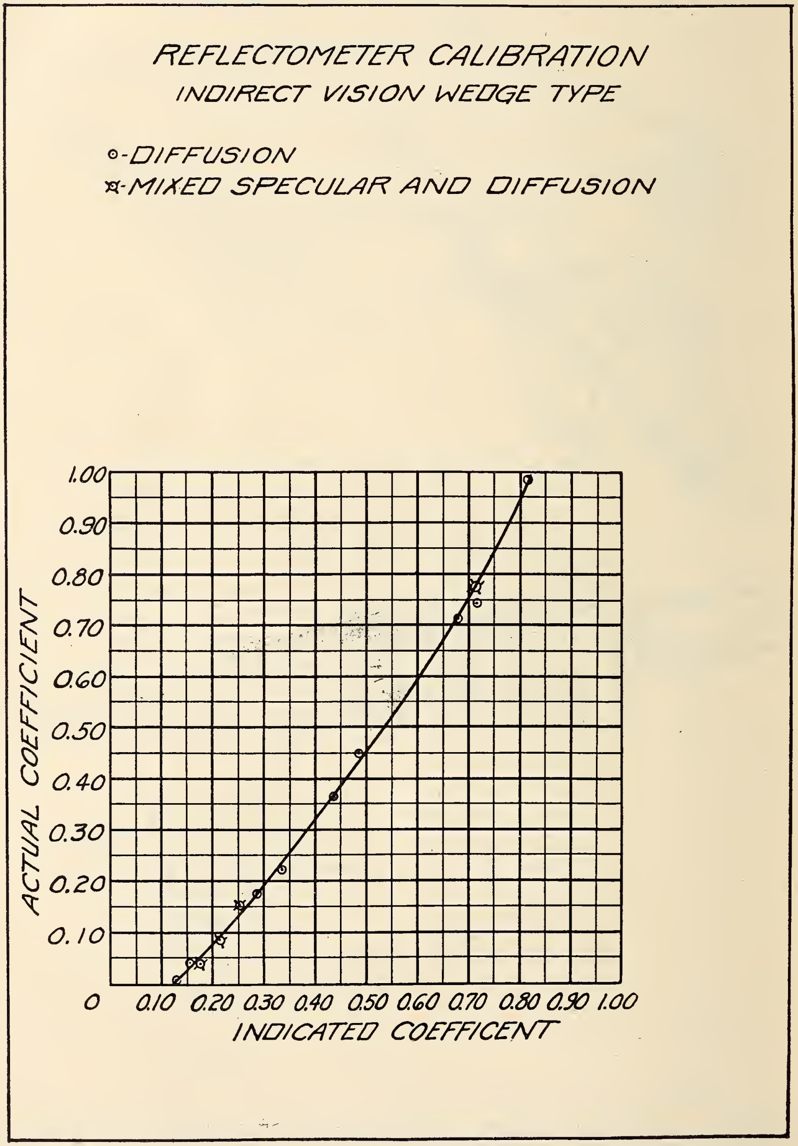

Fig. 7

such that the instrument would give equal readings on equal surfaces absolutely regardless of how they differed in their proportions of specular and diffuse reflection. Also, it is essential to escape dependence upon the coefficient at some particular point on the surface. The obvious way to gain both these conditions is to view targets illuminated by the illuminating plate and the test surface. The instrument now takes the form illustrated in Fig. 6 where the targets, small ovals of rough ground porcelain, are supported on flat springs that press against the two surfaces.

The theory of this instrument has not been completely worked out from the mathematical side and dependence has been placed on thirteen test surfaces, twelve of which have been tested by independent methods at other laboratories. The agreement between laboratories was not all that might be desired; the results obtained by the writer with the Nutting instrument (modified for direct vision) being particularly out of agreement with the others, were not included in finding the averages. The results for each sample are therefore in doubt by about one per cent in all cases, but this accuracy is sufficient for the time being.

The upper point on the curve of Fig. 7 is the reading on magnesium carbonate, and it is probably correct to within one-half per cent; also the lower point is the reading on the interior of a box lined with black felt and here also the error is hardly over one-half per cent. Between these two extremes the other points come fairly close to a smooth curve, but this agreement is not the important fact. The circles represent tests on diffusing surfaces while the stars represent tests on surfaces that have a strong specular action. *There is no indication that the readings of the reflectometer are influenced by the character of the surface,* and this is the optical condition which has been sought by the writer for a number of years.

The target type of wedge reflectometer may be summarized as follows:

(1) Readings independent of specular or diffuse character of test surface.

(2) Readings independent of mottled or uneven character of test surface.

(3) The instrument is complete in itself and requires no auxiliary parts for its operation and is perfectly portable.

(4) It can be made in a form permitting measurements on a wall or other flat surface.

(5) The instrument can be built of materials that do not change with age and therefore it will stay in calibration.

DISCUSSION

Dr. Story: Has a secondary screen been substituted for the prisms?

Mr. Benford: Such targets are used in place of direct vision.

Mr. Renwick: I am very pleased indeed to see an instrument which will give diffuse reflection coefficients so easily. I think it will be of value in determining the reflection coefficients of photographic materials, a matter which has been under discussion recently.

Mr. Summers: Are the results with this instrument comparable with those of the sphere method used by Mr. Little?

Mr. Benford: Yes. I have used Mr. Little's results for calibration as accurate standards to whichto work because they agreed with several other laboratories' results.

COLOR PHOTOGRAPHY PATENTS

By Wm. V. D. Kelley*

DURING a luncheon at which several members of our Society were present, reference was made to a patent, that had recently been issued to me, and one of the party remarked that he was unable to understand the reason for the broad claims that had been allowed. In view of the great number of patents that have issued in this branch of photography, he is interested in knowning what lines of development are still open for improvements by inventors. I am also requested to enlighten the members as to the reason for the apparent similarity in many patients that have issued and if differences exist to point them out where possible.

In the time available for searching patents it has been possible for me to make only a start and if time and health permit, the work will be completed as herein planned.

Not being a patent attorney, nor an authority on patent matters, these comments are necessarily from the point of view of the applicant, who has gathered experience, if not much law.

My conception of a patent in the United States, is any combination of known or unknown elements, that when combined, produce a new result. As you cannot patent an idea, one is confined to the means or machinery or ingredients used in producing the new result. An application usually begins with the words "A new and useful improvement in." Inventions are mainly improvements. And you can see that an improvement may be a very minute change that turns failure into success. This limited demarkation between many patents or applications is quite noticeable in the field of Color Photography.

Sometimes the incident seems of slight importance and the patent is limited in its scope and in its claims, but if this step or incident supplies the solution to the problem, then such a patent is of more value commercially than the one with broad claims. John K. Brachvogel says in the Scientific American: "Now this is well illustrated by the instance of the Sillman-Picard-Ballot patent for a process of oil concentration of ores, which was extremely limited in that it covered merely a specific percentage of the oil used and which was regarded by most patent attorneys as invalid for that reason. Nevertheless, because of the outstanding practical results accomplished by this patented process, the court upheld the patent, with the result that its owners were paid many millions of dollars for the use of the process."

Samuel Cox, of England, English patent No. 15,648 of 1914 patented the idea of producing a blue tone image in a film, then sen-

* Kelley Color Laboratory Inc., Palisade . . . ., N. J.

sitizing the gelatine stratum with bichromate, a light sensitive salt, printing under a positive and finally dyeing the second image with Red dye, using the Pinatype principle. I took out a patent in this country for the same kind of article, wherein the first image was DYE-TONED and the second image produced as Cox describes. (U. S. Pat. No. 1,278,161, Sept. 10, 1918). The difference being that, in the former, a picture was produced by the use of a salt of a metal, while the latter uses the principle of converting the silver image to a mordant and was dye-toned. F. E. Ives, U. S. Pat. No. 1,170,540, Feb. 8th., 1916 also describes a blue tone for the base image and a Pinatype for the second image. This patent to Mr. Ives was applied for July 1, 1914 and while it is the same as the Cox invention, the Cox Patent was not a reference against Ives. The three following patents were co-pending at the Patent Office and it will take a Phildaelphia Lawyer to determine which one of the inventors was the true inventor of certain features which are common to the three patents and there is further doubt as to whether the common features were new to either. One claim from each patent is below:

FOX #1, 166, 125. Dec. 28, 1915.

CLAIM: "A photographic process involving the production of a negative of two images one taken through a red filter and the other through a green filter, imprinting the first mentioned of said images upon transparent or translucent sensitive material, coloring said image bluish green, imprinting the other of said images upon said material in registry with the first image imprinted thereon, and imparting to said second image, by the use of a basic dye, a red color, substantially as set forth."

IVES, #1, 170, 540. Feb. 8, 1916.

CLAIM 12: "A color photograph or color motion picture film comprising a colloid layer upon a suitable carrying base and containing in said layer an insoluble color photographic image, and also in registry therewith an image of soluable dye-stuff of a different color."

FOX, #1, 207, 527. Dec. 5, 1916.

CLAIM 1: "A photographic process comprising the production of two negative images one taken through a green filter and one through a red filter, imprinting one of said images upon light transmitting material, coated with a sensitive emulsion, toning the print to a color complementary to that of the screen through which the corresponding negative was taken, imprinting the other of said images on said material in registry with the first image imprinted thereon, and coloring the second image a color complementary to that of the screen through which its negative was taken, substantially as set forth."

There is a difference in the above patents and this difference may or may not make the particular invention the one that will become of greatest value. Time tells that part of the story. It is probable that the courts will not be called upon to settle the questions that are confusing in these cases. If we follow the work of the inventor we can determine, sometimes, the direction in which he is moving.

The growth in an art in the hands of an individual may be followed from the patent office records. The Examiners are guided, very likely, by their familiarity with pending cases. Take the case of Mr. Ives, as an example.

#1,170,540: Blue tones the first image and resensitizes with bichromate.
#1,207,527: " " " " " " " " iron.
#1,278,668: " " " " " " uses the original silver.
#1,499,930: Same as last.
#1,538,816: Same.

Confusion arises but rarely from having the cases filed in a division other than the one to which it should properly be assigned. I believe the following to be true but have not actually checked the case.

A method for treating strips of films or ribbons was filed in the Photographic Division and the patent granted. Another inventor filed his case in the division that handles papers and the case was apparently handled as a method for treating wall papers and a patent was granted. The Examiner that cared for the first case made sure of the invenion by having the Office send him to the manufacturers plant and examine the device in operation. Years afterward he was unaware that a patent for substantially the same device had been issued in another division of the Office.

The difficulty of understanding some of these color patents may be gathered from these quotations of a report made by a trained patent attorney.

> It is possible to read this claim so as to require the formation and coloring of one image before the other is formed and colored, and if so construed, the B patent would not infringe, and, if not so construed then it is believed that the claim is invalid in view of the article in the B. J. of Photography under date of Jan. 5, 1912.
>
> Claims X and X fall in the same category. That is to say, they are apparently prima facie infringed by B, but are susceptible of a narrower interpretation, in which event B would not infringe, but, if construed broadly they are anticipated by the article above referred to.

Of such details are patents made.

It has been said that all that a patent amounts to is a chance in a law suit. A patent does more than that. It fixes a date. It is an historical record. It is a notice to the World to beware. It may become of great value in the event some incident in the case develops into great commercial value. The inventor files his case, I think, more to establish his dates, than for the immediate protection. Inventions and the filing of Patent Applications usually precede the Commercial development.

We will now make an invention and see how it works.

Start with double coated film. Print an image on each side. The developed images to be negative. The images are bleached in a bath that hardens the gelatine in the vicinity of the silver and leaves the balance of the gelatine softer than the image portions. Fix the film and dry it. Now bathe in a water bath containing Congo Red dye. Dry and pass the side representing the Red negative over a roller that will apply a dilute solution of acid to one side only. The Red dye will turn Green. Dry and project.

Double coated films are old and were described in the Goodwin patent. Use a bleach as described in Capstaff No. 1,315,464 (U. S. 1919) and if Kodak object, then use any one of similar bleaches that give similar results.

The idea of treating two sides to one color and then converting one side to a complementary color is old. It has also been patented by Fox. So you can call it new if you like. It is all the same for the purpose that I have in mind. No one, to my knowledge, has printed prior to two years from this date, the fact that a dye can be used in this conversion scheme. This is the new element in the combination that breathes life into this application. We have a good chance for the patent and if filed it may be granted.

Let us suppose the patent has been granted.

We now have the patent but cannot use it for we may find that there is a dominating patent already issued. If the Fox patent broadly covers the idea of applying the same color to two sides of a film and then altering one of them chemically, to a complementary color, we might be in this position:—Fox could not use our invention and we could not make use of our own invention without permission from Fox or his assigns.

A similar case is that of Ives and Crabtree and the copper mordant cases. Crabtree has the dominating case. Ives covered natural color positives so thoroughly that Crabtree could nor use his invention for making certain kinds of color films while Ives could not make any of the films because of the dominating Crabtree invention. That is the situation as it appears to one standing on the side lines. Actually, the Eastman Company threw the Crabtree invention open to users of their raw stock. It appears that the use of copper ferrocyanide as a mordant was not really new to either of the inventors, the facts having been discovered by Namias and the description buried in some out of the way place.

One or more branches of the art will be discussed and briefed for future meetings. For this first paper I have covered DOUBLE COATED FILMS only and then only those for which patents have issued.

Class I—Double Coated Positives, Div. A

1– Double coated Film. Goodwin Patent No. 610, 861. Sept. 13, 1898.

2– French Pat. Gaumont No. 420,163—Stereoscopic Pictures. Filed Nov. 15, 1909. Granted Nov. 16, 1910.
Published Jan. 24th. 1911.

Invention:–"The toning or dyeing in colors is to be affected on each face in two different colors which may be chosen almost complementary (for example, green and red).

CLAIM:–This invention comprises essentially the use of a film printed on its two sides, each of its faces dyed or toned in different colors, for Kinematographic views in relief.

Hernandez-Mejia claimed that he made his invention prior to Nov. 16th. 1910 effective on that date, which is the date of delivery.

The U. S. Patent Office in their letter of Sept., 1915, withdrew this Gaumont patent as a reference.

3– English Patent No. 24, 534 of 1912. to John E. Thornton. Application filed Oct. 26th. 1912.
Accepted Oct. 23rd. 1913.

Claim 1– In the production of kinematographic color films preparing from a single alternative negative of sectional color pictures two or more negatives of consecutive pictures each negative being of one color and subsequently preparing the final color film for projection substantially as described.

4– U. S. Pat. No. 1,245,822 Nov. 6th. 1917. John E. Thornton. Filed June 7th. 1913.

Corresponds to English 24, 534 of 1912.

Specification says:–

A– Its black image may be toned, one side to an orange-red, the other to a blue-green color.

B– The silver may be removed and replaced by dyes, by one of the well-known substitution methods; or converted into a salt which reacts as a mordant on dyes and precipitates them in situ.

The film is coated or sensitized on both front and back faces, thus producing a duplex film, but between the central celluloid base "b" and one of the sensitized layers "a" (or it may be both if desired) a layer "c" of light obstructing material, such as water soluable dye in gelatine is applied. This color washes out during development, fixing and washing as described in my application filed on the 10th. of April 1913, Serial Number 760,200.

Accuracy of register is secured by the perforations in the films and by the feed devices all being exceedingly accurate, etc.

CLAIM 2:–The herein described method of producing two-color value positive pictures for cinematographic films from a single strip of negative film having the picture negatives of different color values arranged in alternating sequence there on, which comprises printing on one side of a transparent film positive pictures from the picture negatives of one color value, and then printing in register on the opposite side of the transparent film the positive pictures from the picture negative of the other color value, the negative film and positive film being superimposed during said printing operations and the negative film being advanced twice the distance of the positive film between the printing of each picture, and subsequently coloring the pictures on the positive film in the correct color.

5– English No. 9324 of 1912. Filed Apr. 19, 1912. John E. Thornton.

Requires two negatives and light obstructing medium in film.

Claim 1– In the production of Kinematographic color picture films printing simultaneously from two negatives on both sides of a film prepared with an opaque or light obstructing layer between the sensitized layers.

6– U. S. Patent No. 1,250,713 Filed Apr. 10, 1913. Patented Dec. 18, 1917.

John E. Thornton, Inventor.

Corresponds to English 9324 of 1912.

7– U. S. Patent No. 1,174,144. Filed June 21st. 1912. A. Hernandez-Mejia.

Patented March 7th. 1916.

CLAIM 1– The improved process of making a colored photographic transparency, for projection or viewing by direct or reflected light, which consists in simultaneously taking two negatives of the same subject, from the same point, respectively through screens of complementary colors, one of said negatives being directionally reversed with respect to the other printing from one of said negatives upon one side of a single transparent positive film, sensitized on both sides, and from the other of said negatives upon the opposite side of said positive film with the images in register, treating one side of the positive film so that the image thereon will appear in one color and treating the opposite side of said positive so that the corresponding image will appear in a complemetary color.

8—Wm. Frances Fox (Natural Color Company) No. 1,207,527 Filed June 23, 1914.

Patented Dec. 5th, 1916.

"These images are to be precisely superimposed upon the positive stock, either upon one side thereof or one upon each side thereof."

9—U. S. Pat. 1,259,411. Mar. 12th, 1918. Filed July 26th, 1917.
W. V. D. Kelley.

CLAIM 18—"A double coated perforated photographic transparency having a record on each side, each of said records being registered horizontally with a certain perforation as a standard, and vertically with a certain other perforation as a standard, the records on said sides being colored in different colors."

10—U. S. No. 1,278,162. Sept. 10th, 1918. Filed Feb. 8th, 1917. W. V. D. Kelley.

11—U. S. Pat. 1,337,775. Apr. 20th, 1910. Filed July 18th, 1918. W. V. D. Kelley.

#1,166,121	Dec. 28, 1915	Filed	Mar. 11, 1914	W. F. Fox
1,166,122	Dec. 28, 1915	"	May 29, 1914	W. F. Fox
1,187,421	June 13, 1916	"	Dec. 17, 1913	W. F. Fox
1,172,621	Feb. 22, 1916	"	Dec. 3, 1912	T. A. Mills
1,273,457	July 23, 1918	"	Jan. 6, 1917	J. G. Capstaff

Double Coated, Div. B

U. S. No. 1,191,941, July 25th, 1916. Filed Feb. 11th, 1913. Percy D. Brewster.

U. S. No. 1,145,968, July 13th, 1915. Filed July 1, 1913. P. D. Brewster.

DISCUSSION

Dr. Mees: I have long had on my conscience the job of preparing a résume of color photography patents but I know I shall never do it. The task is enormous, searching for each claim and putting them together is a colossal job. I have card indexes to all British and United States patents and will have photostat copies made for Mr. Kelley. They are not complete before 1912 except insofar as the records of the British Journal are complete. In 1907 they published a list of all patents up to that date. I have abstracted all the color photography patents since 1912. I suggest that Mr. Kelley does not give opinions on the validity of patents. That is a matter for the Supreme Court.

President Jones: I think undoubtedly the consensus of opinion is that Mr. Kelley should continue this work on patents for our autumn meeting. I think, Mr. Kelley, you have ample encouragement.

Mr. Kelley: There are many divisions besides the double coated films covered in this first paper such as cameras, printers, etc. Also, I can include many references. I talked to Mr. Wall some time ago, who has a very large collection of data on patents and references, and I am making use of some information that he supplied. He also called my attention to a publication printed by the New York Public Library which contains a list of literature on color photographic subjects only, aside from patents. It is a book of noble proportions and would seem to indicate considerable interest in this subject. I would like to take advantage of the offer made by Dr. Mees to have photostat copies made of the index cards of patents.

Dr. Mees: All right, we will have this done.

REPORT OF THE PAPERS COMMITTEE
May 5, 1925

THE Committee has been fortunate this year in procuring a program of an unusually varied and interesting character, and we are glad to say that there appears to have been greater willingness on the part of those who have been approached to contribute to this convention than on previous occasions. Several very helpful suggestions for papers and authors were sent in by other members of the Society, but we would like to see this made a much more usual practice. As matters now stand, almost the entire burden of securing a satisfactory program rests upon the shoulders of two or three individuals, and it is manifestly impossible for them to know all the people in the motion picture industry who have material suitable for presentation to our Society. There is, therefore, considerable danger of too frequent harvesting of a small corner of the field. For the same reason, it is also highly desirable that the composition of this Committee should, in our opinion, be changed every year.

We have kept a complete record of all those with whom we corresponded. We believe that this practice, if consistently followed, will materially lighten the labors of each succeeding Committee.

In spite of our best endeavors, we were unable to procure manuscripts of more than three of the papers submitted to this convention by the time specified, but we believe that it is a good thing to try to get them, as it undoubtedly has the effect of impressing upon the authors the need for preparing a paper in sufficient time. At the same time the neglect of authors to submit papers involves the risk that papers unsuitable for our Transactions may be submitted at the meeting and so give rise to dissatisfaction and the somewhat unwelcome duty of rejecting such a paper falls upon the Committee subsequently. We believe, however,that the practice which we have been following of notifying authors that papers which have not received the approval of the Papers Committee prior to the meeting will not be published if found unsuitable even though they may have been read before the Society should be strictly adhered to, as only in that way can the Society hope to maintain the quality of its publications at a high level. Fortunately, the occasions on which we have found it necessary to reject papers have been very few.

May we say in conclusion that a great deal more might be done be the authors of papers after the convention to facilitate publication of the Transactions. In only too many cases the author desires to withhold the manuscript for further slight alterations or additions for a period varying from a few days to several weeks, and this inevitably delays the publication of the next issue of the Transactions very seriously. The same remarks apply perhaps in even stronger measure to the correction of discussions and their editing for publication. While the majority of speakers return the slips bearing their remarks with reasonably promptitude, this is by no means always the case and in a few instances serious delay has been caused.

F. F. RENWICK
Chairman.

ANNOUNCEMENT

It is with great regret to all that we learn from Mr. Renwick that he is planning to return to England in the fall. He has, therefore, resigned from the office of Chairman of the Papers Committee. The Society is, however, fortunate in having Mr. J. I. Crabtree accept the office to fill out the unexpired term.

The Society also regrets the resignation of Mr. Nixon as Chairman of the Membership Committee but is again fortunate in having Mr. A. C. Dick in his stead.

NEW MEMBERS

The following additions have been made to the Society Membership.

Brenkert, Karl, M
49 Cortland Ave., Detroit, Mich.

Cook, Otto W. M
Research Lab., Eastman Kodak Co., Rochester, N. Y.

De Vault, Ralph P. M
Acme Motion Picture Projector Co., 1134 W. Austin Ave., Chicago, Ill.

Gray, Arthur H. A
Lancaster Theatre, Lancaster & Causeway Sts., Boston, Mass.

Harrington, Thomas T. A
2233 McKinley Ave., Berkeley, Cal.

Jeffrey, Frederick A. A
North St., Adelaide, South Australia

Miller, Arthur P. A
Rothaker Film Mfg. Co., 1339 Diversey Parkway, Chicago, Ill.

Raess, Henry F.
Warner Research Lab., 461 Eighth Ave. New York City.

Serrurier, Iwan, M
2730 Maiden Lane, Altadena, Cal.

Struble, Cornelius D. M
108 West 18th St., Kansas City, Mo.

Wyckoff, Alvin A
Famous Players Lasky Corp., Astoria, L.I. N. Y.

Transfer from Associate to Active Membership

Alexander, Don M. M, Alexander Film Co., Denver, Col.

CHANGE OF ADDRESS

Braun, Wm. T. M
58 E. Washington St., Chicago, Ill.

Briefer, Michael M
Atlantic Gelatin Co., Woburn, Mass.

Cameron, J. R.
410 Sloan Bldg., Cleveland, Ohio.

Cummings, John S. A
Duplex Motion Picture Industries, Harris St. & Sherman Ave., Long Island City, N. Y.

Hubbard, Wm. C. M
111 W. 5th St., Plainfield, N. J.

Hutchinson, Wm. M.
Box 576 Sherman, California.

McAuley, J. E. M
McAuley Mfg. Co., 552 W. Adams St., Chicago, Ill.

McGinnis, F. J. A
Box 541, Palm Beach, Fla.

Murphy, E. F.
Palisade Film Lab., Linwood Ave., Fort Lee, N. J.

Porter, E. M. M
352 Argle Rd., Brooklyn, N. Y.

Ransdell, Russel R.
5408 Pasex Boulevard, Kansas City, Missouri.

Raven, A. L. M
Raven Screen Co., 1476 Broadway, New York, N. Y.

Roseman, Earl W.
City Club of New York, 55 West 44th St., New York City.

Sloman, Chibi M.
East 3000 Woodbridge St. Detroit, Michigan

Victor, A. F. M
242 W. 55th St., New York City.

TRANSACTIONS

OF THE

SOCIETY OF MOTION PICTURE ENGINEERS

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TRANSACTIONS

OF THE

SOCIETY OF MOTION PICTURE ENGINEERS

Number Twenty-two

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SCHENECTADY, N. Y.

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1924-1925

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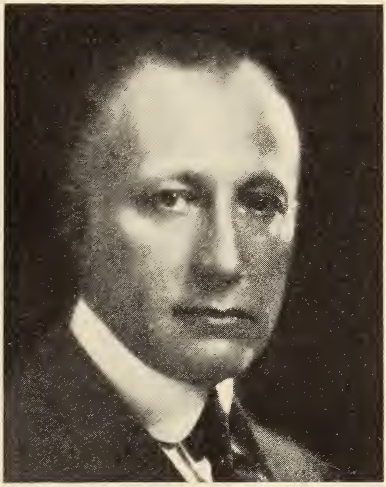
Urban-Kineto Corporation,
Irvington-on-Hudson, New York

INTRODUCTION

By Adolph Zukor*

IT SEEMS to me that the work of the motion picture engineers is significant of the change which has taken place in the picture industry in the last few years.

In its early days the motion picture industry was a battlefield. The leaders of the industry were perforce absorbed in the industrial problems which this rapidly growing business presented daily. They were pioneers and had to fight the pioneer's battles. However, the solution of these problems and the gradual solidification of the industry have now made it possible for everybody concerned in its growth to devote his attention more and more to the great essential—the improvement of pictures themselves.



Adolph Zukor

And there has been great improvement. Never have the studios turned out such a consistently high grade product. Proud as we are of this improvement, we are equally proud of the fact that it has come entirely from within the industry. Our specialists, our technical men, our leaders both in the artistic and industrial development of the business, have been evolved directly out of the motion picture ranks. We in the picture business have been favored with a great deal of advice from people outside our business, but despite this almost universal desire to advise us, we have been obliged to depend upon ourselves for the development of men and means of improving our position.

Thus, the technical advances in direction have been made by men who have grown up in the studio. Most of our great stars and leading

* President, Famous Players-Lasky Corporation.

players have received their training in pictures, alone. And now we have the author coming to our studios to learn the craft of picture writing.

Time was—and not so long ago—when a theatrical producer would not sell a play for picture purposes, when authors of reputation would not consent to have their writings screened. In a few swift years all that has been changed. Playwrights and novelists realize today the great advantages that accrue from having their plays translated into pictures. Many of them have even gone beyond that; they are entering the studios and are learning how motion pictures are made and then are writing their stories directly for the screen.

The result of this change of heart on the part of authors is that the screen has at its command today practically every novel, story or play of importance, in addition to the output of original stories written by men who have studied the technique of picture making.

Of significance, too, is the definite effort being made to train people who can assume leadership in the various phases of this big business. For instance, in our own studio on Long Island, we have a class of twenty young men and women who are being taught the fundamentals of screen acting. These young people have been chosen after an exhaustive search throughout the country and represent the finest type of American youth. They will be given a course of six months' intensive instruction under conditions that no beginner in this business has ever before experienced. We are training young men in the business of selling these pictures and have already had three classes from which have been graduated young men who have found important places in our own sales organization. Before this magazine is published we shall have opened another school—for the training of theatre managers. These young men will be taught the most modern methods of presenting motion pictures to the public, so that the efforts of the people in the studio will reach the great multitude of motion picture theatres under the best advantages.

So, you will see from all this that the leaders of the motion picture industry are alive to the possibilities of its future and are preparing man power to carry on the art and business of the motion picture to even greater heights. We have built a solid foundation, both financial and artistic, and this foundation is no less solid because it has been built through years of great stress and turmoil. Now we must erect the superstructure, and we have prepared for that task by developing the men and women who can do it.

STUDENT PSYCHOLOGY
AND
MOTION PITURES IN EDUCATION

By M. Briefer*

You must be cautioned in one respect. This study is neither technical nor academic—it is much too simple and prosaic for such ambitious designation. But, then, the subject is with the beginnings of intellect, and also, let us say, with a comparatively new form of education. By the very nature of these things, we are led into elementary forms.

In this outline, student psychology and educational motion pictures are considered not in specific terms, but rather in the broad application of the principles involved. The state of mind, its more appealing phases and general functions; the mental attitude of teacher toward student, and the place motion photography may hold in the educational field are presented in the narrative, rather than academic form. The discussion is predicated on the proposition that race progress is a mass movement with leaders and followers—a procession made up of rank and file marching together toward some goal not yet understood. The state of civilization as a whole, or that of any group or tribe, is generally not greater than the average of the individuals composing it. This immutable law of average is a wise provision, for while it exacts a price for the benefits of social intercourse, it delivers, in turn, ripe experience and priceless mental and spiritual gifts.

Psychoanalysis has been practiced, in one form or another, from the moment mind became conscious of the existence of mind. To the modern psychologist, the study is a fascinating romance, and though still sparsely explored, it, like other branches of science, is slowly unfolding under pressure of intelligent research. The mechanics of the mental process is simple enough. We know it to be the storage place for information; that it is capable of registering impressions subject to association and recall. Registration, storage, association, and recall sum up the practical operations of the mind. We can produce, mechanically, imitations of three of these four functions namely, registration, storage and recall, as in the phonograph record. The trouble begins with the association function, and is further complicated by the personal equation.

* Powers Film Products, Incorporated, Rochester, New York.

The mind at birth is virtually a blank; so, to all intents and purposes, it is a clean slate upon which the world will write a life history, environment, trace a course, and shape a destiny. Every child is a dependent; subject to the vicissitudes of chance. The sublime theory of equal rights and equal opportunities is throttled in the very beginning. So it is, that by the time the child reaches school age, it is charged with many impressions, not attributable to choice; these may or may not serve as good foundations upon which to build. But whatever the impressions, it is a mistake to think of them as fixed or permanent. On the contrary, they are very transient and may, by suitable means, be easily displaced if necessary. Impressions become fixed, more or less, only after the faculty of association has become strongly developed, and this faculty does not really begin to mature until the student is well advanced in school life. This is a happy circumstance, which the wise educator studies carefully, and takes advantage of at every favorable opportunity. With a little patience, we may realize the psychical difference between transient and fixed impressions from the following hypothetical experiment.

I take two disks, each about nine inches in diameter. One is colored red, the other blue. I say to the child, "This disk is painted with a color and it is called red. This other disk is also painted with a color and it is called blue. If I mix the two colors beforehand, half and half, and paint with the mixture a third disk, the color will be violet." I have, as you perceive, given two correct impressions and one incorrect. But the child accepts all three impressions with equal confidence; it cannot mix colors in the brain; it does not try to reason the matter; it simply accepts the ideas provisionally. The red and blue impressions are *truths*, which the child will verify and fix permanently later on; but not until it has seen red and blue mixed, will it associate the two colors as combining to produce *purple*. The red and blue impressions, in the experiment, are primary sensations which fact, however, has nothing to do with their being primary colors. The mixture of the two colors gives rise to a new sensation in which the component parts lose their individuality. If, instead of colors, we take two patterns, a circle and a triangle for example, and superpose them, we simply create a new design the component parts of which are as clearly individual as before. These examples are symbolic of the way in which ideas are built up in the brain. Fusion creates mental reactions with the development of new compositions. Combination is expressive of the association of ideas. Nature plays a simple harmony. In all her works, the same law applies. Chemical substances react to form bodies differing from their component parts, and physical combinations, resulting in her splendid architecture. As the chemist and physicist perform their miracles of analysis and synthesis, so the psychologist, by means of the same general formulae, directs his research into that mysterious complex, the human mind.

But I have led you away from our transient impressions. By a wise provision of the intellect, the most important matters of the mind remain transient for the longest time, and far into the evening of life they persist. In scientific thought, they have come to be known as theories. In ordinary language, the idea is expressed as conservatism. The fact that students are thus "open minded" would make their education a simple and sure process amenable to any well-ordered plan, were it not for a very disturbing element. In fact, your own impressions of what has been said so far must be, at least in part, in a very transient state; for with respect to the virgin field, which the mind presents at birth, only the half truth has been told.

Within the span of one lifetime is experienced, in rapid succession, the entire development of the human race. We meet it at birth with the dawn of mind; but back of that, in the profound mysterious prenatal state, we pass through even that remote period when all life was aquatic life with the earth still unprepared to receive it. This is the uncertain element; this period over which no human power except the parent has control. Thus, the mind dawns upon the world already armed with primal instincts and it is with them we have to reckon most profoundly, for whatever be the sensations or impressions that stimulate these primal instincts, they are, unfortunately, not of the transient variety.

When a child is frightened into obedience or for whatever cause, when it is threatened with punishment for reasons it cannot understand, the instinct of self-preservation is powerfully excited. Fear and self-defense are the reacting elements. Cowardice and evasion are the reactions, and the quality and sum of the consequences are in proportion to the degree and frequency of the excitations. These early impressions are almost always permanent and strongly influence each step in the subsequent training of the individual. Only an overpowering counter excitement can make a coward brave, or a liar truthful; wherein lies the hope of reformation and restoration through suggestive psychology.

We cannot attempt a discussion of the effects of heredity on human development except to say, that the specialists in that branch of study attach an importance to it entirely unwarranted by experience. Heredity effects are insignificant as compared with the effects produced by the state of mind, the environment, the physical condition and general conduct of the prospective parent. Some day, it will be considered wise and expedient to require a compulsory report of expectancy, and attendance of special classes so that the education of children will begin at the beginning, and not at the parting of the ways. It is fair to assume that motion photography will have its full share in this form of education. Meanwhile, we must find how best to meet the needs of the moment.

Credit is due to the pioneers in the field of educational motion pictures. It is admittedly a difficult task; but much experimental work and many disappointments may be avoided by taking a careful inventory of the material with which we have to do. This amounts to an analysis of the student mind, the teacher's treatment of it, the kind and type of motion pictures used and the manner of their presentation. Naturally, these elements apply relatively to all forms of education; with motion pictures, however, they seem of much greater importance. In this connection, attention is directed to the splendid paper, "The Use of Motion Pictures in Education" by Mr. F. N. Freeman, read before this society, and published in number twenty of the TRANSACTIONS. Of special note also, is Mr. Rowland Rogers' breezy, statistical contribution, "Pedagogical Motion Pictures" published in number fourteen, S.M.P.E. TRANSACTIONS. These men have analyzed the subject from many practical and psychological angles, in a really noteworthy manner.

It is axiomatic that the most important attributes of the mind are the powers of concentration and imagination The first tends to fix independent impressions and store them in orderly manner for ready reference; the second, to relate and combine them in the form of complete and appropriate mental images. Concentration is concerned simply with the immediate present; imagination with antiquity and the remote future and with all that may bridge these extremes. There is no limit to the imagination. It is the seat of discovery and invention, of inspiration, culture, faith and spiritual being. You scientists and engineers know that theories are but mental images built from fragments of material stored in the subconscious, and the psychologist tells us that a criminal act is the result of a deranged mental system, or a partial or total lack of imagination, or it may be uncontrolled imagination, run wild. A serious crime against society is seldom, if ever, committed when the mind is able to fully realize the consequences of the act. It seems highly important, therefore, to guard the gates of entry to the subconscious, for the conduct of the individual rests with this—he can make use only of that which is stored there. Civilization is teaching humanity a sense of its responsibility. Its tolerance has a wider scope. It embraces a broader vision. We have begun to question the wisdom of censuring too strongly the weak and mentally inefficient. Rather do we look to the system of education, the environment, or what not, for the material these conditions have put at its disposal. It is, or should be, the business of motion photography to properly develop the powers of concentration and imagination, and direct reason into normal channels.

Psychology is not an exact science in the sense of being able to apply to it fixed laws or axioms. The complexity of the mental process does not permit of the strict isolation of its separate functions. The whole subject of mind study is a matter of careful deduction, but the science has so far progressed that we may lay down certain broad principles and arrive at a reasonably satisfactory classification. This is necessary if we are to adapt a course of study to the formative mentality, for the student, in his early period of mental digestion, may be led far afield in a direction wholly unsuspected, simply because his conceptional powers have not been truly appraised.

The foundation of knowledge is undoubtedly laid down during the first eighteen or twenty years, which time may be fairly divided into three distinct periods of about seven years each. During the best part of the first seven years the child is obsessed with intense curiosity. There appears little imagination. The child is essentially cruel and selfish. These qualities are clearly indicated from its treatment of small animals, its destructive tendencies, its desire to possess everything within reach and its anger when crossed. Everyone will probably subscribe to these terms except the mother. In the new brain cells, it will be remembered, is stored the age-old fundamental principle of self-preservation. Clearly this new human being, new at least to our understanding, must be carefully reared during these critical years. The child must be taught confidence; in a measure also, self-sacrifice; its demands should be satisfied with sound examples and, above all, it should find truth in everything it absorbs from its elders. Curiosity being the child's predominant mental phase, it cannot associate ideas effectively, and we thus find it necessary to formulate studies based upon abstract impressions, the best of which are those which amuse and please and impose no mental strain. In some such way as this, the very important quality, that of good nature, is developed.

The second period of seven years is more hopeful if our child has already had the right beginning. Here we find growing the seeds we have sown. Curiosity, while still a prime factor, is tempered with a striking ability to associate ideas. We begin to note the power of the mind for deduction. The early impressions, conceived in the abstract, are pieced together with the exercise of reason. The student displays a sense of mental balance and co-ordination. As a matter of fact, this is the real formative period of mental development; the preparatory stage; the most impressionable, and undoubtedly, the one in which the die is cast.

Students between the ages of about seven and fourteen are real problems. They are neither here nor there, as it were; they do not seem to fit altogether into the scheme of life as their elders understand it. We fondle and make foolish talk with babies, and we argue and attempt to reason with the older students, and find in both circumstances some measure of satisfaction; but with these of the second period we seem at a loss; and all because we make no real effort to live with them in their world. We expect these children to abide with us in our mental sphere, one which they have not yet perceived—do not in the least understand—while declining to share with them a mental state through which we have already voyaged and from which we have taken out full measure of experience.

A common mistake of some educators lies in their expectation that these young students be contemplative; that they show respect and deference to a degree commensurate with the dignity and authority of the office of instructor, and clearly indicate their disappointment when these expectations are not fully realized. Indeed, it is more than a mistake, for any display of impatience and distemper on the part of the teacher before these students destroys their faith and provokes an unwholesome state of resentment. There is no more effective method of sowing the seeds of hatred.

Respect and admiration, like love and affection, are emotions. They cannot be taught as a language is taught. They cannot be commanded as a right or as a reward; neither may they be invoked by coercion. They rise spontaneously in response to the right kind of conduct and performance. They are not conferred upon individuals, as such, but upon their deeds and ideals. When students show disrespect, it is invariable because their emotions have not been stimulated by the right attitude. Educators and parents alike have need to pocket their false pride, and strive to win, rather than command, these emotions.

Motion photography is well adapted to this class of students. It should present happy and amusing situations, combining health education and simple truths. The morals should not obtrude themselves as deliberate lessons, but rather appeal as natural consequences of a set of conditions. Morals, truths, justice and consideration may be best taught as part of comedy and laughter, for these are, or should be, the child's happy, carefree years. These students should not be preached to, for such a course only leads to silent opposition. They will not accept, gracefully, the negative principle of teaching, expressed by the admonition, "don't"; in fact, we carry with us, through life, a strong resentment to any form of prohibition which, after all, is but the challenge of human nature to interference with natural experiments in evolution. Perhaps, when the first worm ventured forth out of the soft ooze upon the freshly-formed earth crust, its mother worm said, "Don't go out there child, its dangerous!" And perhaps the baby worm replied in effect, "Mind your own business, mother dear, this is my experiment."

The student of the second period is a large responsibility. It is rounding the first real milestone of life—the critical stage of sex appreciation, a flame which may cleanse or consume. It is strange how tenaciously we cling to our antipathy with respect to the biological facts of life, permitting our children to discover for themselves, in any old way, matters relating to the most vital and profound decree of nature. Without condoning the grossly obscene, it is safe to say that the so-called immoral plays and immoral pictures are doing more to banish evil than all the professional reform elements combined. Motion pictures do not attempt to smother truth; they reveal it. Truth can never be immoral except as a state of mind. What is today a cautious whisper, tomorrow becomes a topic of intelligent discourse. Motion photography has done much already to reveal the truth about human conduct and sex relations. With special direction and efficient organization, an important study course can be developed, doing for the young that which their parents should, but don't.

There is, perhaps, no more interesting state of mind than that found in the average student of the third period. At least the possibilities are inviting. The susceptibility of this class to suggestion is very noticeable: at the same time it is very keen to detect sham and insincerity, and whether we teach with pictures or textbooks, or both, it is important how the instructor deports himself before this body of students, for it is a critical body, naturally inclined to question. Curiosity has changed to inquisitiveness. The peculiar interest which attaches to these students rests with the fact that they represent the age which will pass judgment upon our accomplishments, as we pass judgment upon those of past generations. It is that posterity of which we strive to merit approval, and all our hopes for the future are bound up in its success. Each teacher will make the task easier for the next and help himself also if he will just shed his years, enter into the spirit of youth, and be as much a part of the student body as the students themselves.

Motion photography has the advantage of being impersonal. It never tires, never loses its poise. What it wishes to say can be well debated beforehand, and if perchance, it develops shortcomings and requires revision, there is no personal reflection involved, no feelings hurt, no serious loss of prestige.

All knowledge is acquired and made of permanent value by repetition. Perhaps one of the most difficult things to do is to construct a picture that will bear repeated screening and still hold the interest of the student. An inviting possibility is to provide a number of brief texts enabling the instructor to emphasize beforehand some special feature of the picture for each showing, subordinating the others as completely as possible by suggestion. A picture will thus display a fresh element with each exhibition, and so fix the separate parts, first independently, and later as a complete whole. To show how such a plan would work out, a growing plant may serve as an example.

It will help to improve the interest, faith, and appreciation of students if they are made familiar with the fundamentals governing the production of motion pictures. They should know, as far as possible, the true relation of motion photography to natural phenomenon. The mystery of acceleration and retardation of motion, its apparent, not real, continuity upon the screen together with other essentials, should be carefully explained, lest speculation be aroused at the expense of attention. On this assumption we may proceed to project the growing plant for study. If now, the instructor will stress the apparent rapid growth of the plant in the picture, with its slow rate in nature, the suggestion will fix the student mind on the physical development of the plant while the imagination plays with the marvel of speeding up nature's slow motion—condensing, as it were, the passing of time, correspondingly increasing the rate of movement in space; a simple illustration of the relativity of time and velocity. The lesson has impressed the form of the plant during its various stages of development in a striking manner, and the student has probably accepted the suggestion, and missed the other details. Speeding up and slowing down motion furnishes an infinite variety of possibilities. The picture may be shown again, this time emphasizing the remarkable development of the large arteries which, as in the human system, provide the means for circulating the chlorophyl, the plant blood, through the plant body. The student is again compelled, by suggestion, to focus attention on a particular phase of plant structure, and while the earlier lesson of plant growth and its physical form will be mentally followed through this second screening, the main attention will be for the new idea; in fact, the two lessons will fuse. Plant structure, the dimensions relative to other plants, the blossoms, the fruit or flower, each in turn can, by proper suggestion, be made as separate and distinct a study as is to be found in any text book, and infinitely more interesting.

The example given above represents the idea, not necessarily the procedure. Mathematics will yield to the magic of the camera, especially in dealing with geometric forms. From the simple figures, the complex may be built up developing the problem graphically. Reversing the film, and the system is analyzed while again resolved into its simple elements. Botany, zoology, biology, much of chemistry and physics, many phases of engineering, mechanical operations and industrial process may be advantageously presented in a manner similar to the one described. In medicine and surgery, the records with motion photography are invaluable.

In planning educational pictures the manner of showing them will, of course, be taken into account. Explanatory titles, if used at all, should not be painfully exact. The effect is enormously heightened when the right elements are left to the imagination. Details are wearying. The mind wishes to be left alone to work out its own images, each one in its own particular way, and, as far as possible, this freedom should be encouraged. Given the fundamentals, with just sufficient detail to illuminate them, the mind will "see" and remember, the more clearly, because it is called upon to exercise the appropriate function.

The faculty to observe, and the power to concentrate go hand in hand. Educators have long known that, as a general rule, the intelligence, and hence the class standing of students, varies as their power of concentration. When a number of people witness an exciting event, it is rarely that two descriptions of it are alike in every particular. Frequently, they differ in the most grotesque manner. The fact is so well recognized that it may be dismissed with the mere mention of it; yet all co-ordinate thinking depends upon the accuracy of observation, which, in turn, is a function of concentration.

It may at first appear that concentration predicates oblivion to all surroundings except the subject under immediate attention. This is not strictly so unless we associate concentration with absent mindedness, as in the case of the old professor, slowly homeward bound, thoughtfully pondering a deep problem, who meets his own son with this greeting, "Hello George! how's your father?" One may be deeply engrossed with a particular matter, and yet be alive and alert, or, one may easily concentrate on a number of subjects in very rapid succession. My wife, for example, apparently just glances at another woman, and later gives me a most minute description of her costume, from the shape and colors of her hat, to the design of her shoes. However, omitting any further reference to the filial complex, it is to be noted that what we call observation cannot stand alone. Merely to observe means nothing. To fix the thing observed, complete in every detail, is the basis of memory and the foundation of experience. Children first learning to read piece words together by laboriously studying each letter. In the course of time, they learn to read the words complete, paying little attention to the individual letters. Stenographers learn to write and read complete phrases—at least, they learn to write them. It is by no means uncommon to find people able to read at once whole sentences. It is said of the late Theodore Roosevelt that he read at a glance complete paragraphs. One newspaper had it as a complete magazine page and I have since been expecting to hear that he read a whole book at a glance without ever opening the cover. We do not term reading an act of observation, but, whether we observe word pictures or the real thing, the mental mechanism functions alike, except as we read the imagination has a little more work to do. Many people cannot remember what they have read, but they are the same who cannot recall what they have observed. Thus, we note that observation and concentration have no value except as they are associated in memory; so that it is well worth while to study the reactions to different methods of memory training; nor, must we forget the danger of developing a encyclopedic mind; a memory at the expense of reasoning power. One thing seems certain; except with the very young, successful teaching must rest with definite association of ideas, each new phase linked with something pertinent that has already been mastered. Association is better than absent-minded concentration. Detached subjects are soon forgotten. Those who "crammed" for examinations will have no quarrel with this statement.

I should feel now about in the position of the preacher, when, after the service was over, one of the parishioners remarked to another, "That was a good sermon, brother," "Yes," came the reply, "but he passed up so many good places to stop." I cannot resist the temptation in closing to make one appeal for simplicity. We have no right to burden those who come after us with unnecessary and useless labor in their effort to acquire an education. Before we have gone very far with educational motion pictures, we may well ponder the question of teaching through the path of least resistance and by means of the simplest terms. It is bad enough to struggle with long tons and short tons, pounds, ounces, grains, scruples, pennyweights; avoirdupois, apothecary, and troy weights; pints, quarts and gallons (although pints and quarts belong rather to a secret language now) inches, rods, feet and what not; a ship travels so many knots and a railway train so many miles, while a horse is so many hands high, and a man so many feet tall. The whole mess is too many fathoms deep. All that is, indeed, bad enough without being obliged to rummage through the ashes of dead languages to find what science has to say of its great achievements. If it were not for the popular interpretations given by newspapers and periodicals, the patient labor of scientific investigators, throughout the world, would be about 90 per cent good for nothing so far as service to mankind is concerned. Such is the history and fate of the stupendous volumes, conceived in impossible language, vainly appealing to be liberated from their cobwebbed prisons, in remote corners of places where such books usually hibernate. Ten simple numerals will one day solve the riddle of the universe, and Brisbane says of the metric system that all the hard work there is in the use of it is to shift the decimal point about. Twenty-six simple letters are made to express every possible human emotion. Mathematics express every fact of natural laws; language expresses the whole of spiritual life. Why should we not make use of these two powerful instruments in the simplest and easiest way?

The ideal of education is, finally, the seeking after truth—to find the real purpose of life and to teach it. "We know not from whence we came, nor whither we go" nor, if we live but once, or whether our civilization is yet in the stage of short memory, to ripen and grow with the years, to remember the yesterdays—that our consciousness will, with the passing of time, come to know that a life is but as a day—to lay down the task and rest awhile, to reawaken with the dawn of another era. Whatever may be our belief, it is significant that within the heart of man, within the very core of his being, is an involuntary urge to do and to dare; to strive and to suffer; to hope and to pray for a posterity of which he has no conscious knowledge to ever have a part; yet, the urge persists, expressing in unmistakable language, man's destiny and fellowship with all that has ever been and will ever continue to be. In this task which is set before us, let there be truth in all things; in science, in ethics, in religion. "As we face the light, the shadows fall behind." Let us bring to these growing children the love of being; not the threat of retribution. Let us teach them to feel that their life is linked with the pleasure of work and service through all time, and that their less fortunate brothers will always have their chance; that what we call death does not close the door forever to redemption. One life is not enough to merit the heavenly bliss held out to us in theology, and I like it not that hell is the alternative. We no longer torture the product of man's mind as for witchcraft; neither shall we oppress with fear.

Man is the greatest miracle we know,
All elements combining from his birth,
With water, air and fire, and parts of earth
Blending in perfect harmony to grow.
He claims a kinship also with the sky,
His heart is made of star-dust, and his dreams,
Are shreds of moonlight, purest silver beams
Falling from out that shining glow so high.
Where then is born our widsom and our love,
Our faith for sacrifice, our hopes so fair?
Surely in some planet far above
The northern star that lights the midnight air.
Man is a part of all things that may be
One with the earth and sky, the stars and sea.

MURIAL BREWSTER

INFRA-RED PHOTOGRAPHY IN MOTION PICTURE WORK

J. A. Ball*

Photographs by infra-red light were first made some years ago by Professor R. W. Wood, of Johns Hopkins University. He noted that the most striking features of these pictures were that blue skies were rendered very dark, whereas green foliage was rendered very light. Photographs by infra-red light with these characteristics have remained more or less of a scientific curiosity every since. In Professor Wood's day the available photographic sensitivity in the infra-red was very low and the required exposure very long; furthermore, no one had pointed out a practical use for this effect. More recently Haller has announced an infra-red sensitizer which gives considerably increased speed and this, in combination with the Technicolor film sensitizing technique, has made possible a film sensitized in the infra-red which can be produced uniformly and economically in any quantity, large or small, and of sufficient speed to allow of good exposures in motion picture work.

I am not aware that anyone has previously noted that these characteristics of infra-red photography—namely, to make blue sky dark and to make green foliage light—are just what are needed to make moonlight effects without the aid of artificial light. Such effects are of considerable importance in motion picture work.

An approach to such effects can be made by taking scenes with visible red light, as, for example, a panchromatic film and an "A" filter and, in fact, such effects are commonly used nowadays. But the effects obtained by the use of infra-red light are far superior. To be sure a panchromatic film and a red filter make a blue sky somewhat dark, but there is no brightening of the foliage; in fact, the foliage also is darkened. In using infra-red light, however, the sky is made still darker and the foliage is made quite bright, greatly enhancing the effect of a scene illuminated by a bright moon. This latter effect may perhaps find its explanation in the fact that the sensitivity of the eye, when adapted to moonlight intensities, has its maximum shifted towards the blue-green. Probably for the very same

* Technicolor Motion Picture Corporation, Hollywood, California.

fundamental reason it has become customary to print up scenes for night effects with a blue-green or blue tint over all. When all these effects are combined, that is to say, when an infra red photograph is printed up with a moonlight tint, the effect is very striking.

Some lantern slides have been prepared with clippings from motion picture film prepared in this way. In each lantern slide is shown the scene photographed in the ordinary way, side by side

(a) Film sensitized in the ordinary way

(b) Film sensitized for improved light

with the same identical scene photographed at the same time by infra-red light. In these slides both types of scenes have a blue tint in order that in this case the comparisons shall show only the night effect created by the infra-red photography. Another slide has no comparative scene beside it, but is of interest in that it is a clipping from a scene taken for a recent production using film sensitized in the infra-red. The stars in the sky were, of course, double-exposed in.

A number of scenes in various productions have been photographed recently on this film.

The lantern slides will demonstrate not only the general night effect, but will further show the enhanced cloud effects that can be obtained by infra-red photography. This in itself adds to the moonlight effect, because it makes white clouds stand out brilliantly just as they do on a bright moonlight night. In addition to that it is a valuable effect in itself, for oftentimes clouds are found against a hazy blue sky where the ordinary methods of correction are not powerful enough. The most extreme effects can then be obtained by infra-red photography.

Besides the effects shown in these slides, there should be a number of other effects obtainable by infra-red photography. For example, water is a powerful absorber of infra-red rays and the blue color of a large body of water is perhaps attributable to a powerful absorption which has its maximum in the infra-red. Night scenes on the water should be very effective where the blue and green tones of the water go dark, together with the sky, leaving reflections from wave tops, white caps, sails of a boat, etc., standing out just as they do in the moonlight.

The writer hopes at some future time to show some examples of this and other effects to supplement the examples shown herewith.

DISCUSSION

Dr. Mees: I am glad that Mr. Ball has made pictures by infrared light; I tried to do it about three years ago and failed. I thought that if I could take pictures at wave-length 750, the pictures would be of the type shown and give the moonlight effect. I tried to sensitize some film with kryptocyanine and got it fast enough to get still pictures by infra-red light, but I could not get enough sensitiveness in my film for motion pictures. The material sensitizes very strongly indeed, but at the point of maximum sensitiveness there are tremendous absorption bands due to the earth's atmosphere. Evidently Mr. Ball has succeeded where I failed—I could not get better than three pictures a second at f / 4.5. I imagine he has sensitized more efficiently. I wish he had told us how he did it but perhaps that is a trade secret.

Dr. Story: I should like to emphasize one point that Mr. Ball would probably have brought out more strongly if he had been here to describe the stereopticon slides. Photographing by infra-red light does lower the value of the sky with respect to most other parts of the picture, since the sky diffuses to the camera relatively little of the light of longer wave-lengths. This lowering of the sky value gives, as the paper brings out, the general effect of moonlight. The point I wish to emphasize is that not only is the average value of the rest of the picture raised relatively to the sky, but that the objects themselves in general appear quite different.

When photographing with infra-red the light from a blue sky has but little effect on the film, that is, all the *effective* illumination comes directly from the sun, or the light source is concentrated at one point. It occurs to me that this concentration of light source is the essential difference between moonlight and sunlight. The striking lack of half-tones in these stereopticon slides made from the infra-red negatives would seem to furnish strong evidence for the belief that the effect of moonlight is produced largely by apparent contrast rather than by apparent intensity. I say "apparent" because the distribution of energy in the spectrum of the moon may be such as to give the sky the same relative energy value as a clear sky by sunlight. If this were true there might still be a greater apparent contrast by moonlight due to its lower intensity. The half-tones might be too low in energy to affect the retina appreciably and so would be indistinguishable from the shadows.

It would be interesting to have some further information on these points.

Mr. Palmer: Can some one tell us what kind of filter you use in photographing with infra-red light?

Dr. Mees: It doesn't matter, because the kryptocyanine has all its sensitiveness in the extreme red. If you cut out the blue with a yellow filter or a red filter such as "Tricolor Red," the picture will be taken not by visible red light but by the extreme red. Any strong yellow filter will do.

INCANDESCENT TUNGSTEN LAMP INSTALLATION FOR ILLUMINATING COLOR MOTION PICTURE STUDIO*

By Loyd A. Jones **

The requirements of the illuminating equipment for use in studios where color motion pictures are to be made, are somewhat different than in the case of black and white work. The mercury vapor source, used so extensively in motion picture studios where black and white work is done, is practically useless for color work. The spectrum of this source is of the discontinuous or bright line type, and there are broad spectral regions in which no radiation is emitted. The satisfactory rendering of colored objects illuminated by this source is, therefore, quite hopeless.

Electric arcs, especially the improved type such as the high intensity and white flame, are extremely efficient and produce light of very satisfactory quality. The illumination given is not as constant as is desirable, since all processes of color photography are especially sensitive to variations in exposure. They must be recarboned at frequent intervals and require attention during operation. For the general lighting, especially where it is desirable to support and manipulate the units from an overhead structure, they offer many inconveniences.

Tungsten incandescent lamps, even when operated at the highest practicable temperatures, are relatively inefficient. There is a relatively high proportion of radiation in the infra-red region thus giving rise to an uncomfortably high temperature when the required illumination levels are reached. They give very constant illumination when operated at constant voltage, are clean and extremely convenient to manipulate.

When it was decided to equip a color studio at the Eastman Theatre and School of Music, the question of the most suitable type of light source for color photography was given careful consideration, and after preliminary experimental work by Mr. J. G. Capstaff of

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** Physicist Research Laboratory, Eastman Kodak Co., Rochester, N. Y.

this laboratory, who is in charge of the research work on color photography, it was decided to adopt the incandescent lamp as offering the most advantages with the fewest objections.

Best size of unit.—During the experimental and development work done on the Kodachrome process for producing motion pictures in color, which has been in progress for several years, Mr. Capstaff has had extensive experience in using various types of tungsten incandescent lamps. Among these may be mentioned the thousand watt unit of the usual commercial type and a special 30 volt, 150-watt lamp of the locomotive headlight type. Lamps of the latter type were operated in groups of three connected in series. Such a group can be conveniently operated on a 110-volt line with a resistance, or in case of alternating current with a transformer, the best results being obtained by operating these at about 10 or 15 per cent above their rated voltage during the actual taking of the picture. They stood up very well under such over voltage conditions. They were used for the most part on relatively small sets and for this kind of work are as satisfactory as any type of lamp that has thus far been used. When plans were begun for equiping a larger studio, however, it seemed desirable to adopt a somewhat larger unit in order that the number of units required should not be excessive. It was thought that a smaller number of relatively large lamps would be much more convenient to manipulate in arranging the lighting of the sets and probably would produce a somewhat better quality of lighting from the standpoint of distribution.

Tests were made using 1,000-, 3,000-, 5,000-, and 10,000-watt units, some of which were made especially for us by the Harrison Lamp Works of the General Electric Company, and we wish to acknowledge our indebtedness to Mr. L. C. Porter and his staff of engineers for their assistance and co-operation. The 3,000-watt unit was finally chosen as most nearly fulfilling all requirements, although from certain standpoints a somewhat larger unit seemed desirable. The 3,000-watt unit was obtained in a P.S. 52 bulb, mogul screw base, 110 volt rating on a basis of a normal 800-hour life.

Operating voltage.—In order to obtain a higher photographic intensity these lamps during the actual taking of the picture are operated at 120 volts, this being 9 per cent over voltage which gives a 35 per cent increase in photographic candle power. During make ready they are operated at 100 volts which is a 9 per cent under voltage. The life at the 9 per cent over volatge is estimated to be approximately 250 hours, and since the actual taking time is relatively short, a life of 250 hours should be fairly satisfactory.

The reflector.—In order to utilize the greatest possible proportion of emitted flux it is obvious that some type of reflector must be used in order to concentrate the light on the desired areas. No commercial reflector suitable for use with these 3,000-watt lamps and fulfilling the requirements was found on the market, so it became necessary to design and construct one for our particular needs. Polished metallic reflectors of elliptical, parabolic, and spherical types were considered and a few preliminary trials made. No material of this type was

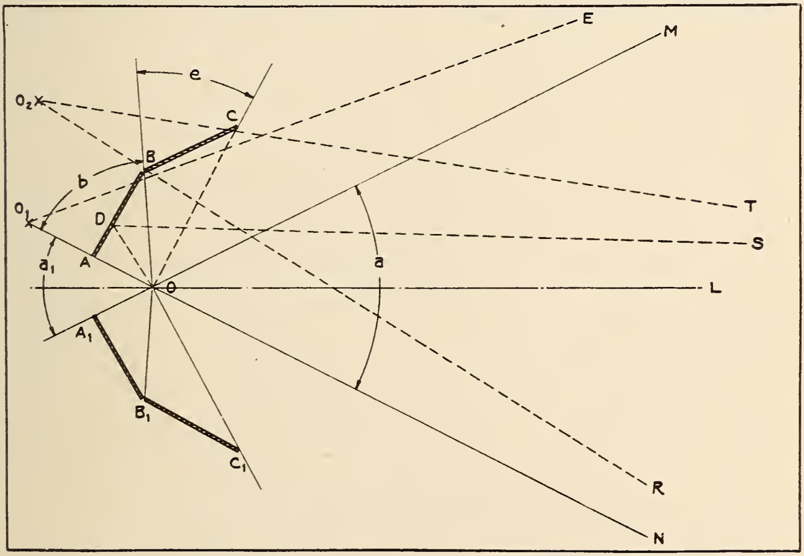


Fig. 1. Diagram showing position of reflecting elements

found which would retain high polish when subjected to the temperatures obtained with these high wattage units, nor could the desired distribution of light be obtained with reflectors of these types. In collaboration with Mr. Capstaff, who had given this matter of the reflector careful attention, a reflector of the polyhedral type was designed and constructed which gave high efficiency and fairly satisfactory performance. This is of such shape that with the source at a distance of 12 feet from a surface an area approximately 12 feet in diameter is illuminated with a fair degree of uniformity. The reflecting surfaces are plain glass mirrors protected on the back with a heat-resisting coating. These were manufactured for us by the

Bausch and Lomb Optical Company, and thus far have stood up very well at the temperatures reached in operation. The geometrical arrangement of the reflecting surfaces is illustrated in Fig. 1 which represents a section through the optical axis of the reflector.

The point O designates the position of the light source and the angle a, 52°, is the angle subtended at the light source by a line 12 feet long passing through and perpendicular to the optical axis at a distance 12 feet from the source. All of the light flux emitted within the angle a falls directly upon the area to be illuminated. The angle a_1 represents the space required for the opening in the reflector through which the stem of the lamp bulb projects. Sufficient clearance around the stem of the lamp bulb is allowed for adequate ventilation of the unit. This angle is very nearly equal to the angle a and is shown in the figure. It should be understood, however, that this diagram is not drawn precisely to scale and is merely given for purposes of illustration. Having determined the space required for mounting of the lamp and ventilation, the angle a_1 is laid out accordingly, and then measuring from the boundary of this angle the angle b is laid off, this being approximately equal to the angle a; as a matter of fact it is necessary to make b somewhat larger than a in order to allow for the finite size of the filament assembly. The reflecting element AB is so placed that it reflects all of the flux emitted within the angle b back onto the area included within the angle a. The bisector of the angle b is incident on the reflecting element AB at point D, and is reflected along the line DS which when extended intersects the axis of the reflector, OL, at a distance of 12 feet from the source. The limiting ray OB is reflected along the line BE as indicated and intersects the line OM, also in the plane, at a distance of 12 feet from the source. The reflected image of the light source due to this reflecting element lies at O_1. All of the light flux emitted within the annular angle b is therefore reflected so as to fall within the prescribed limits. The second zone of reflecting elements BC and B_1C_1 subtends the angle e which is equal approximately to one half a, and is placed as shown. The limiting ray OB is reflected along the line BR which intersects the line ON in the plane at a distance of 12 feet from the light source, while the other limiting ray OC is reflected along the line CT and intersects the axis of the reflector OL at a distance of 12 feet from the source O. Thus one half of the field is illuminated by the light thus reflected. The reflecting element B_1C_1 placed symmetrically with respect to BC covers the opposite half of the field. It is obvious that a greater amount of the light flux could be thrown onto the desired area by making the element *BC* longer. This, however, results in a reflector which is excessively large, thus increasing the weight and inconvenience of mounting and handling. The figure shows only a cross section through the optical axis of the reflector and a plan view is shown in Fig.2. It will be noted that this is octagonal in form and each zone of reflecting elements consists of eight plane mirrors (trapezoidal in shape) making a total of sixteen plane reflecting elements in the entire unit. The image of the light source formed by the element *BC* lies at the point O_2. If the eye be placed on the optical axis looking into the reflector sixteen images of the filament may be seen. For points ourside of the axis a smaller

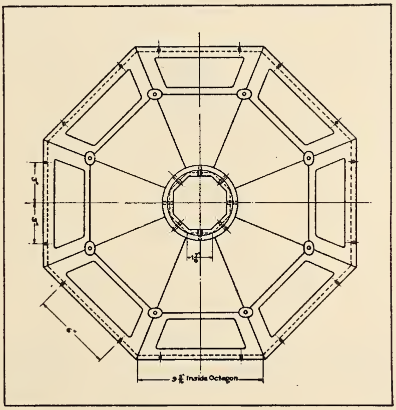


Fig. 2. Plan view of the octagonal reflector shell

number will be visible due to the limiting boundaries of the various elements. Measurements show that the illumination at a point lying on the 12-ft. plane, and also on the axis of the reflector, is approximately eight times as great as the illumination given by the source without the reflector. The illumination over the 12-ft. circle is not entirely uniform but is fairly satisfactory and when several such reflectors are grouped together, the inequalities of illumination can be sufficiently equalized for practical purposes. The first reflectors of this type were built by using a shell formed of sheet metal. The lamp socket being held in position by a cast aluminum yoke fitted to the collar of the reflector, some space was allowed so as to provide a passage for the heated air around the stem of the lamp. These units were used and found to be satisfactory from the standpoint of illumination. The reflector shells, however, were not sufficiently rigid, and it seemed advisable to adopt a more solid type of construction in order to minimize danger of breaking the glass mirrors. A pattern was therefore made and a solid shell of cast aluminum was thus obtained for carrying the reflecting elements. This is illustrated in Fig. 2 which shows the octagonal form of this reflector.

Since these units are designed to be used largely with the reflector pointing downward, the heated air tends to accumulate within the reflector, the ventilation by convection alone did not seem to be adequate and it was considered advisable in the improved models to provide forced ventilation. This was done by placing over the collar

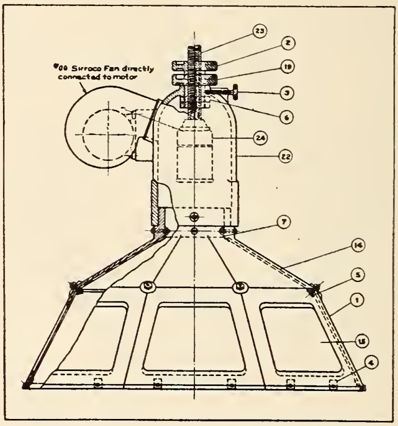


Fig. 3. Elevation showing assembled reflector unit with Ventilating blower and lamp socket

of the shell carrying the reflector an aluminum cap as shown at 22 in Fig. 3. To one side of this cap is attached a number OO Sirocco fan directly connected to a small A. C. motor. The method of attachment is shown in Fig 3. The stream of air from the blower enters the cap tangentially and directed downward so that there is a tendency to form a circulatory motion within the shell and the reflector. In this way the hot air is swept out and the lamp bulb and reflecting elements adequately ventilated. The mogul socket is mounted inside of the cap on a threaded stem which extends through the top of the cap and is held in position by the nuts 2 and 19. This provides a method of adjusting the light source in the reflector to the proper position. The set screw 3 serves to fasten the stem in position when the required adjustments have been made. The motor driving the fan is connected in parallel with the lamp and is rated at 110 volts, thus during make ready and rehearsal the motor runs at a relatively low speed while during taking, when the over voltage is impressed on the lamps, the motor is also subjected to an over voltage and operates at high speed thus giving a greater volume of air when most needed.

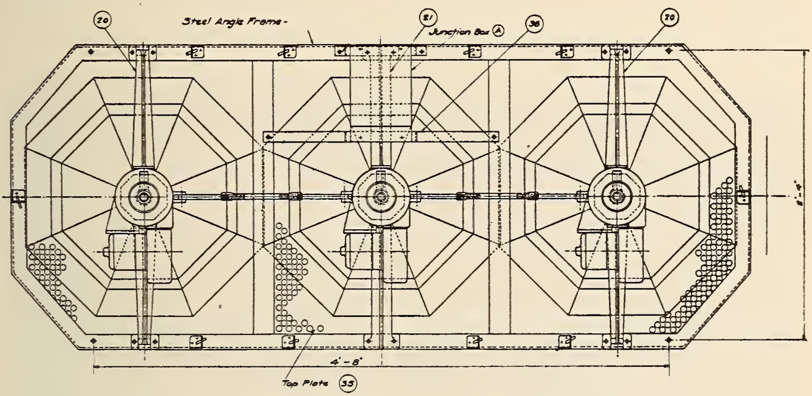


Fig. 4. Plan view showing method of mounting three units on frame

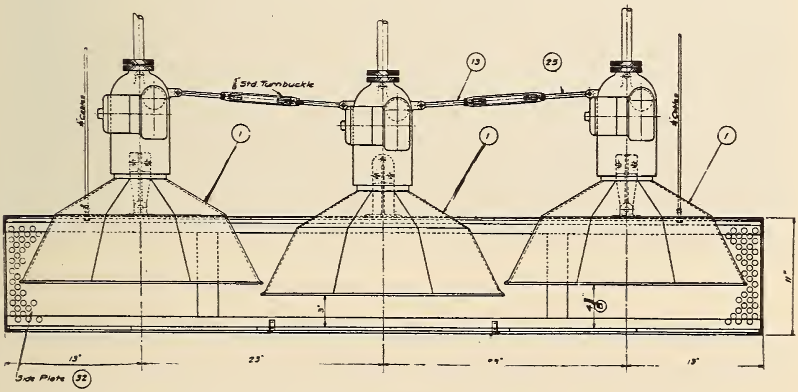


Fig. 5. Elevation showing assembly of triple unit

Mounting of the reflector units.—In order to facilitate the handling of the lamps in the studio three reflectors are mounted together on a single frame and are handled as a single unit. This was considered advisable since a fairly large number of lamps are required to illuminate a set of large size and the manipulation of a large number of single 3,000 watt units would be much more complicated than in groups of three. From the standpoint of flexibility and distribution it was not considered advisable to group more than three lamps on one fixture. The method of assembling these reflectors on the frames is shown in Fig. 4, which is a plan view of the assembly, and in Fig. 5, which is a side elevation. The framework is formed of electrically welded angle iron. The central unit is mounted in a fixed position relative to the framework while the two end units are mounted in

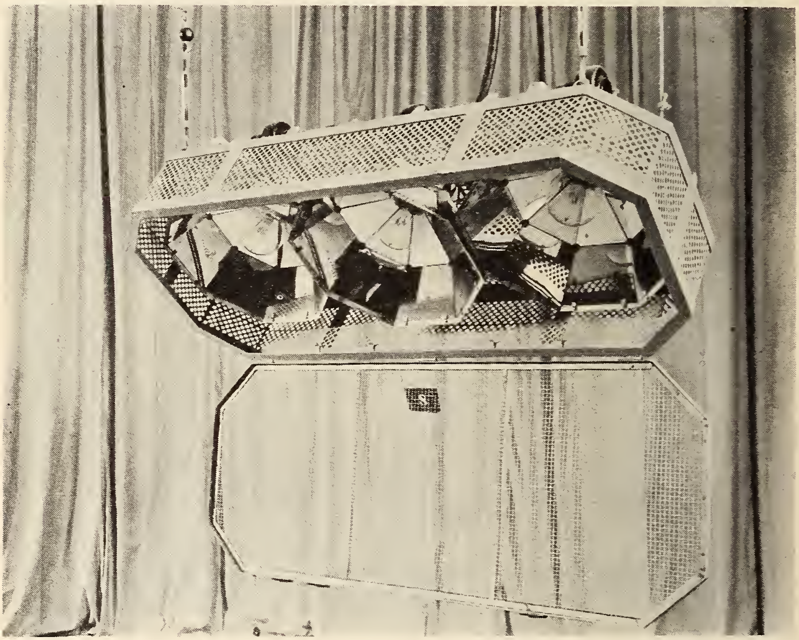


Fig. 6. Photograph showing front view of complete triple unit

such a way that they may be tilted with respect to the framework. Connection is made between the central element and the outer ones by means of the right and left hand threaded rods, 13 and 25, attached to bosses on the reflector cap, and turn buckles as shown in the figure. By adjusting these turn buckles the inclination of the optical axes of the outer reflectors can be adjusted so as to converge or diverge the illumination as desired. The frame carrying the three units is 28 in. wide by 72 in. long and 11 in. deep. The sides and top are covered with perforated sheet metal while the front of the framework is covered with half inch square woven wire netting mounted on a frame hinged to the front of the main framework. This is used in order to prevent pieces of glass resulting from accidental breakage of a reflector or bulb from falling on persons working below the units. The corners of the frame are truncated as shown so that the unit may be turned with less danger of interference with other units in its vicinity. This complete assembly is carried by four steel cables, 1 / 4 in. in diameter, attached one at each corner of the frame work.

Fig. 7. Photograph showing rear view of triple unit

These cables go to the hoist which will be described later. Photographs which give a more definite idea of these triple units are shown in Figs. 6 and 7. The cable is attached to the framework through a turn buckle which is used for leveling the unit after it has been hung. A strain insulator is also used as protection against short circuit. The cable carrying the electric current enters the junction box which can be clearly seen in Fig. 7, and from this leads are carried to the individual lamps. Connections to the three motors are also made to this junction box in which is located a suitable fuse on the motor line.

A small pilot lamp is mounted at the side of the junction box which indicated at all times whether or not the motor circuits are complete.

Method of handling the units.—Since the room in which this installation is made is a part of the ballet school and is at times used

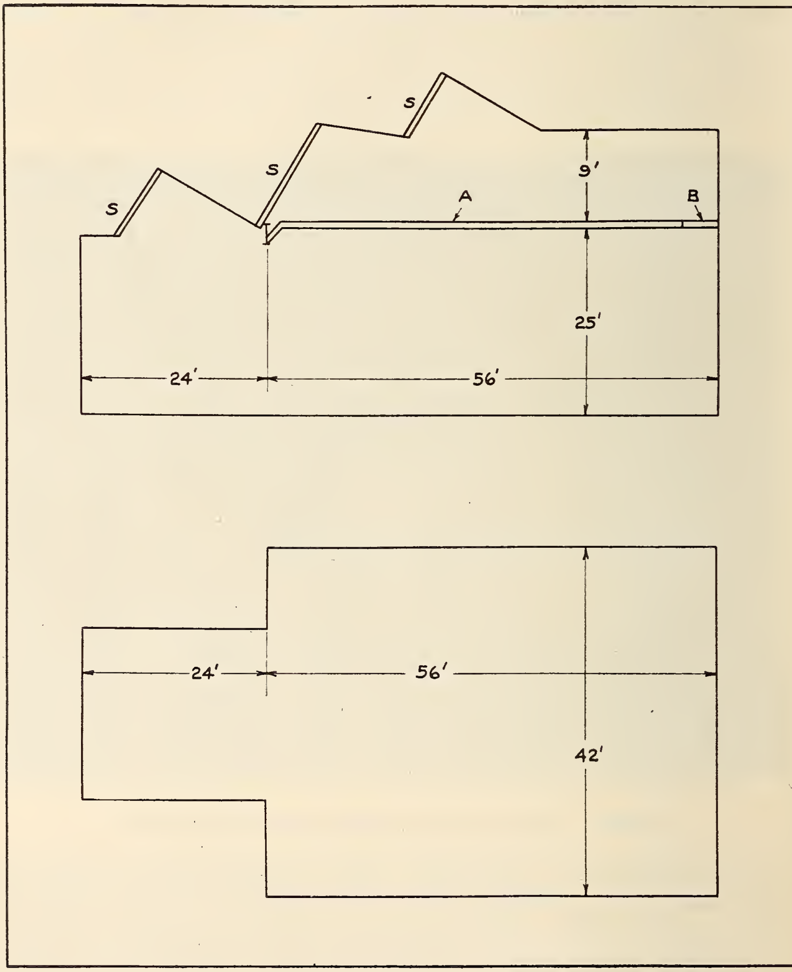


Fig. 8. Diagram showing dimensions of studio and position of gridiron

as a classroom, it was necessary to adopt a method of handling the lighting equipment which would interfere as little as possible with the use of the floor space for ballet purposes. It was highly desirable, therefore, to adopt some overhead system of electrical distribution and of handling the light units, thus preventing the obstruction of floor space with electrical cables and lamp supports.

Before deciding upon the method of mounting and handling the lighting equipment, Mr. C. A. Livingston, Superintendent of Buildings, Eastman Theatre and School of Music, and the author visited several of the motion picture studios in and around New York in order to familiarize ourselves with the equipment in use for black and white work. After carefully weighing the advantages and disadvantages of the various systems examined a method commonly called the "gridiron" distribution system similar to that used in the studios of the Famous Players-Lasky Corporation in Long Island City* was adopted. This was designed to meet the requirements of our particular work and was installed under the supervision of Mr. Livingston. The author at this point wishes to acknowledge his indebtedness to Mr. Livingston not only for the work mentioned above but for his assistance in the design of all of the other structural features installed in the studios, and for his very efficient supervision of the work of installing this equipment.

In Fig. 8 is shown diagramatically a side elevation and floor plan of the studio. The structural steel gridiron was installed as indicated at *A*, the distance above the studio floor being 25 ft. This gridiron is approximately 56 ft. long by 42 ft. wide. Six longitudinal slots 8 in. wide and formed by standard 8 in. channel iron extend the entire length of the gridiron. The hoists carrying the units shown in Figs. 6 and 7 are mounted on carriages which travel back and forth along these slots.

The structural details of the combined hoist and carriage are shown in Fig. 9. The drawing at the right hand side of the figure is a vertical transverse cross section. *AA* indicate the 8 in. channel iron which form the sides of the slot. On top of these channel irons are mounted the angles *BB* and the vertical elements of these angles form the track on which the carriage operates. The slatted floor of the gridiron, which is formed of inverted channel iron, is indicated at *CC*. The carriage and hoist is supported on the grooved wheels *DD*. The bed plate of the carriage is indicated at *E*. This is a casting which is circular in plan and is supported by the channel irons forming the bed of the carriage. *F* is another casting, circular in plan, which

* Jac. R Manheimer. Design of Power Plant and Electrical Distribution in Large Studios. Trans. of S.M.P.E. No. 11, p. 93.

rests upon rollers carried by the bed plate *E*. The element *F* is therefore free to rotate about a vertical axis. The steel tube *K*, perpendicular to the plane of the circular plate *F* and passing through its center, extends downward through the slot. This tube is firmly attached to the plate *F* by the central bearing as shown. Upon the rotating bed plate *F* are mounted the hoist drums *H*. These are shown more clearly in the drawing at the left hand side of the figure which is a side elevation. These drums are carried on bearings mounted directly on the plate *F*, and are actuated by means of worms, *J*, and worm wheels, *I*, which are mounted directly upon the axes of the

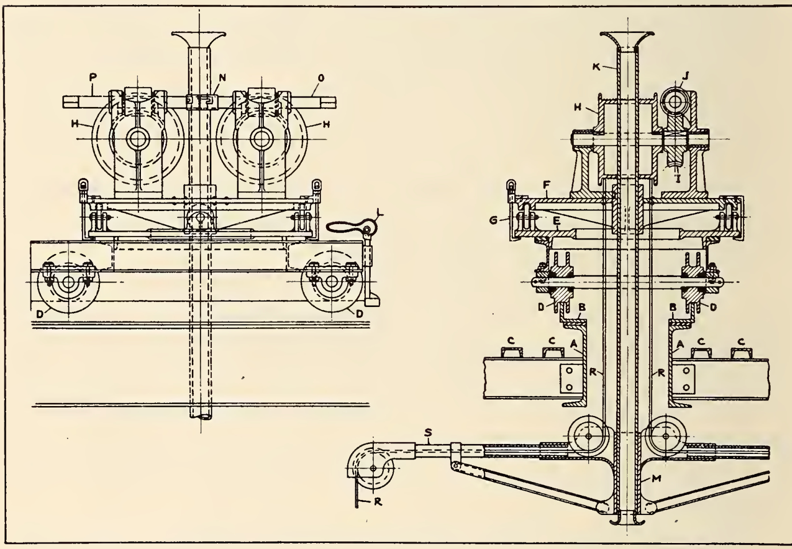


Fig. 9. Drawing showing constructional details of hoist and carriage

drums. The worm *J* is driven by means of a handle attached to the end of the shaft on which it is mounted. It will be noted that there are two hoist drums each driven by its own worm and worm wheel. The two shafts, on which the worms are mounted, are in exact alignment with each other and by means of the sliding lock sleeve *N* can be rigidly connected to each other, and under these conditions operate as a single shaft. Thus a handle attached either to *O* or *P* will actuate both hoist drums. If the sliding lock *N* is removed, then the two shafts *O* and *P* can be operated independently. Quarter-inch steel cables wound upon the hoisting drum *HH* extend downward through the slot and are spread out of the four corners of the frame on which are mounted the three reflectors (see Figs. 6 and 7). These cables, which are designated as *RR* in the figure, after passing through the slot are given horizontal spread by means of two sheaves, one mounted directly under the slot, and one at the end of the arm *S*. Four arms such as are shown by *S*, which together form the diagonals of the rectangle equal in dimensions to the frame of the triple unit, are carried by a heavy casting firmly mounted on the lower end of the tube *K*, and are given strength by the bracing as shown. This assembly, diagonal arms, sheaves, braces, etc.,is termed the "spider." It is evident now that all elements carried upon the bed plate *F* are free to rotate with *F*, and in this way any desired orientation of the illuminating unit can be obtained. The lock *G* served to prevent relative motion between *E* and *F*, while the clamp, *L* engaging the flange of the channel iron track serves to lock the entire carriage into position as desired. The electrical cable supplying current to the unit passes down through the tube *K*. Each hoist drum is grooved, right and left hand, and serves to take up two cables. The two cables from one hoist drum are attached to the front edge of the triple unit and the two from the other drum are attached to the rear edge. By locking the elements *O* and *P* together by means of the sleeve *N*, the two hoist drums operate in synchronism and all four cables are taken up equally, thus raising and lowering the unit without any change in its angle of inclination. If, however, the lock sleeve *N* is removed, then the operation of *O* will either raise or lower the front of the unit, thus changing its angle of inclination relative to the floor of the studio. All possible required adjustments of the unit are therefore, provided for. By moving the carriage back and forth along the track the unit can be shifted longitudinally with respect to the studio. By rotating the element *F* any desired orientation can be obtained, and by operating the hoist drums either simultaneously or differentially any desired height and inclination of the unit can be obtained. A photograph, which perhaps contains a more definite idea of this hoist and carriage, is shown in Fig. 10.

This unit was constructed according to our design by the Peter Clark Company of New York City. Patents have been applied for to cover all of the novel features of the carriage and hoist, as well as the triple unit reflector assembly.

Eighteen of these hoists are provided and under normal operating conditions three are located in each of the six gridiron slots. In order to provide for the necessity of concentrating a greater number of units at one side of the studio, a transfer track and carriage is provided at one end of the studio. This consists of a pair of rails, mounted about three feet above the gridiron level and extending across the studio, that is, perpendicular to the direction of the slots. From this hangs a carriage or cradle which can be moved into position in line with any one of the gridiron slots, and onto this the carriage and hoist can be rolled. The transfer carriage can then be moved into position in front of any other of the gridiron slots and the hoist in this way transferred laterally across the studio.

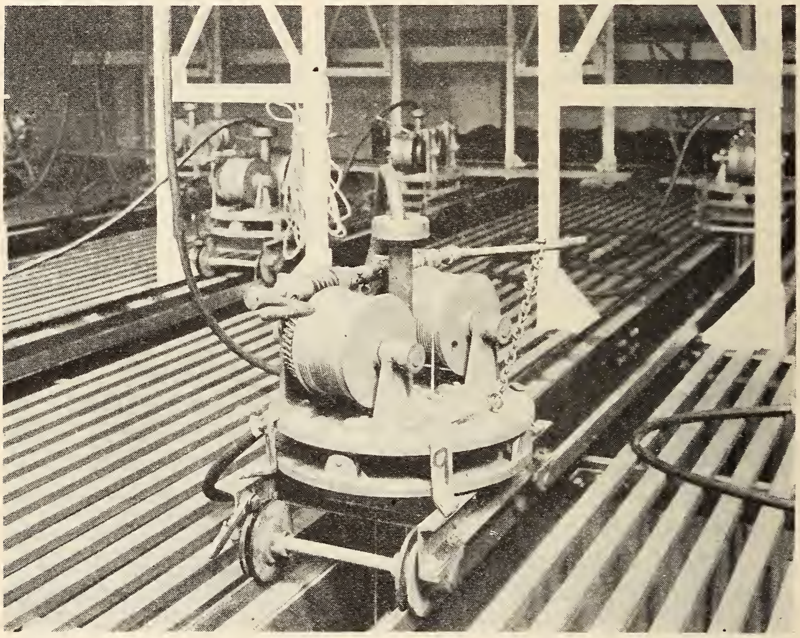


Fig. 10. Photograph of the hoist and carriage in position on gridiron

Side balconies.—Two narrow balconies are provided on each of the studio side walls extending practically the entire length of the studio. One of these is approximately 8 feet above the studio floor and the other about 15 feet. Guard railings are erected at the front edge of each of these balconies and in the guard railing posts are located sockets into which arc or tungsten spotting units can be set. These balconies provide locations from which to operate spot lights for side lighting effects. The electrical supply for the operation of the various sources will be discussed in a later section.

The flying bridge.—It was considered desirable to provide also some means of operating spot lights for use in producing back lighting effects. There were objections to building a permanent equipment for this on the end wall of the studio, and hence a movable structure referred to as the *flying bridge* was installed. Immediately beneath the gridiron along each side of the studio were mounted heavy I-beams which serve as tracks to support small movable carriages to which are attached one-ton chain hoists. A narrow platform approximately 30 in. wide and 42 ft. long was constructed of trussed structural steel, the ends of this platform being supported by the chain hoists. Sockets for setting spots are provided, and outlet pockets for the supply of electrical energy are mounted directly on the flying bridge. The two carriages operating on the side I-beams are linked together by a steel cable carried completely around the room and supported at the corners by sheaves. An endless chain hanging over a grooved pulley is mounted at one corner of the room, and serves to operate the cable. In this way one man can move the bridge back and forth to any desired position in the studio. The height of the bridge above the studio floor can be adjusted by the chain hoists which support the ends.

Electrical equipment.—The tungsten lamp equipment is operated from an alternating current supply. The feeders are three-phase, three-wire, 240-volt, 800-ampere, or 332-kv-a capacity. Since it is desired to operate the tungsten lamps at two different voltages, one of which is below the nominal rating of 110 volts and one above, it was necessary to install compensators to give the required voltage control. For this purpose three compensators of 50-kv-a unbalanced load capacity, each provided with taps for a neutral wire and for 100 and 120 volts on each side of the neutral, are used. Three feeder taps are also provided so that adjustment can be made for variations in line voltage. The switchboard is the dead front type in three sections, one section per phase. A double throw switch is provided for each triple lamp unit with an interlocking master lever for each five units. The double throw switches are connected to the 100- and 120-volt leads to the compensators so that when the switch handle is thrown down the potential applied to the lamps is 100 volts, and when the switch handle is thrown upward this potential is raised to 120 volts. By using the interlocking master lever the voltage on five units can be changed from low to high simultaneously. The electrical energy is distributed to the gridiron in three conduits which are mounted approximately 7 feet above the floor of the gridiron, one conduit being placed midway between each pair of gridiron slots. Each conduit contains five circuits, each one of which goes directly to one of the double throw switches on the board. Each of the triple units is fed by a No. 2-guage, 2-wire stage cable, terminating above the gridiron in a 150-ampere Anderson plug. Flush receptacles for these plugs are enclosed in steel boxes and point downward so as to be dust proof. These receptacles are mounted directly in line with

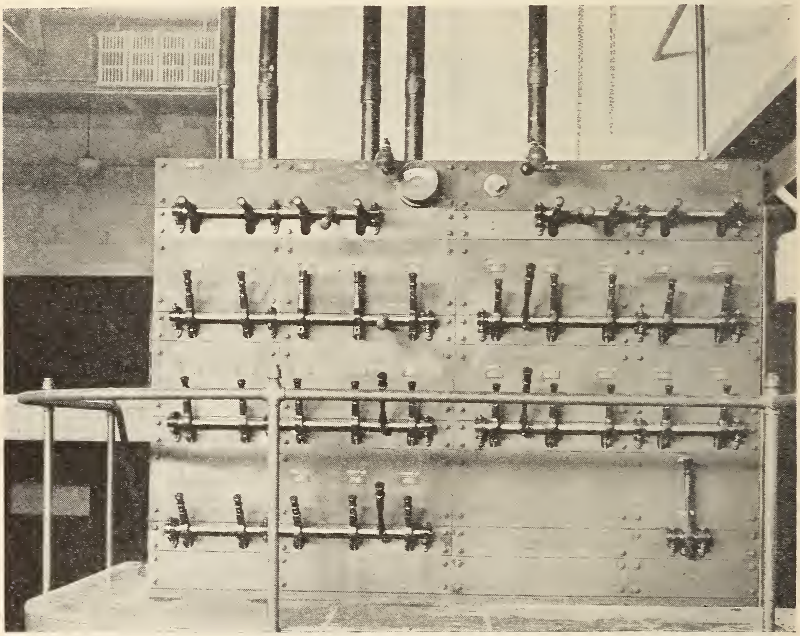


Fig. 11. Photograph of switchboard

the conduits and hence are in easy reach of a man of ordinary height. Three receptacles are connected to each circuit at different points along the length of the studio. This was necessary in order to avoid the necessity of having extremely long cables attached to the units. One group of outlets is placed at about the center (longitudinally) of the studio and the other groups at about 25 feet to the front and to the rear of the central group. Of course only one unit (three 3,000-watt lamps) can be operated on each circuit, and care must be taken not to plug two units into two of the receptacles connected onto the same circuit. The electrical equipment, therefore, provides for the simultaneous operation of fifteen units, (45-3,000-watt lamps) from the gridiron circuits. In order to provide for the operaton of tungsten spots, side light, and footlight units, ten additional circuits of the same capacity are provided, four outlets being provided on each wall of the studio and two on the end wall. These circuits terminate in individual switches on the board, each group of five being operated by the interlocking levers. The wall pockets are so located that

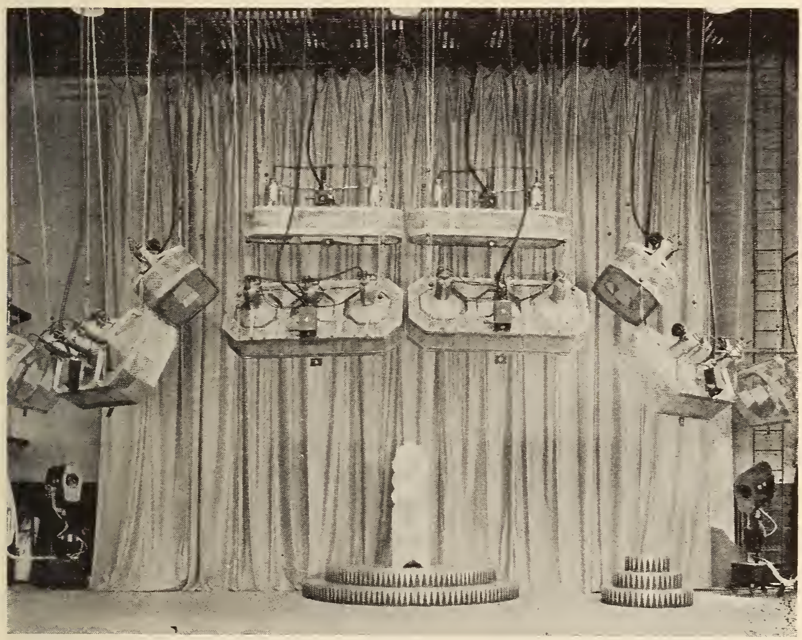


Fig. 12. Photograph showing sample set in the studio with lighting unit in place

connection can be conveniently made for the operation of units operated either on the movable floor stands or on either the lower or upper side balconies.

It was considered advisable to provide also for the use of some arcs for spotting purposes. Eight D.C. circuits were therefore provided, each having the capicity of 150 amperes. Three outlet pockets for these circuits are mounted on each wall of the studio and two on the rear end wall. In Fig 11 is shown a photograph of the switchboard. The eight switches across the top of the board control the eight arc circuits. The ten switches on the right hand panel control the A.C. wall circuits and the fifteen switches on the left hand panel the gridiron circuits. Switches, outlet pockets, and the lighting units hanging from the gridiron are all numbered in order to facilitate the operation of the equipment.

The switchboard, distribution, and transformer equipment were designed in accordance with our requirements by Mr. Frederick A. Mott, electrical engineer and manager of the construction department

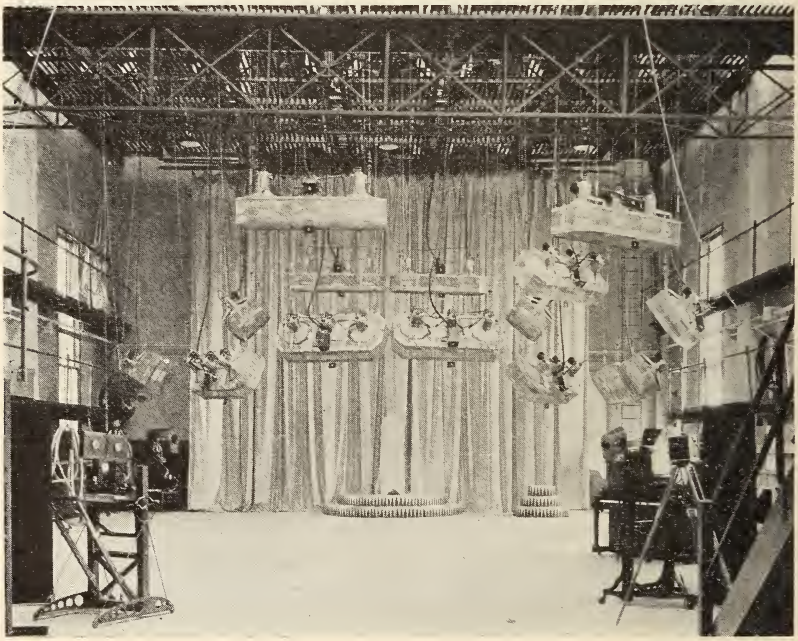


Fig. 13. Photograph showing the complete studio with gridiron, triple units, side balconies, etc.

of the Wheeler Green Electric Company, and was installed by that concern. We are indebted to Mr. Mott for the technical details relative to the electrical equipment.

In Figs. 12 and 13 are shown photographs of the interior of the studio with the units in position. Fig. 12 shows a fairly close view of a set with nine of the units in position. Fig. 13 is a more general view of the interior showing all of the units, some of which are in position for illuminating a set, and the others not being placed for use. In the upper part of the photograph may be seen the gridiron and in the extreme foreground at the top is the flying bridge, which in this case is not in use and is drawn as near as possible to the gridiron in order to be out of the way. The side balconies may also be seen in this view. The 75-ampere high intensity portable arc units may also be seen on their floor stands. These have been used to some extent for spotting purposes. The results thus far are not entirely satisfactory but sufficient tests for a definite decision have not yet been made. At the present time spot lights using 10-kilowatt-tungsten incandescent lamps are in the process of construction. Preliminary results that have been made with tungsten spot light using the 10 and 30-kilowatt lamps indicate that these will be more satisfactory than arc spots, the chief reason for the superiority being in the quality (color) of the illumination afforded and the size of spot obtainable.

No attempt will be made at this time to give a complete analysis of the illumination levels and distribution obtained with these units. A few values, however, may be of interest. With one of the triple units at a distance of 12 feet above the studio floor and pointing directly downward, that is with the axes of the reflectors perpendicular to the floor, an illumination of 1,500 foot candles was obtained directly below the central unit. The value was obtained with the lamps operating at the high voltage, 120 volts. The illumination over a rectangular area 10 x 14 feet directly below the unit was fairly uniform and had an average value of approximately 1,200 candles. The illumination obtained at high voltage is 70 per cent greater than that at low voltage which is in satisfactory agreement with the theoretical value for this ratio.

The efficiency of the system for the purpose for which it was designed may be illustrated by a statement of the conditions under which fully exposed color pictures can be made. Using the two-color camera, with the lenses set at approximately f/3.5 and a shutter opening of 180°, the fifteen units are sufficient to illuminate a 40-ft. set so that fully exposed negatives can be obtained at normal taking speed, sixteen pictures per second. For smaller sets the number of units required is of course proportionately less.

Some tests have also been made to determine the efficiency of this system for the making of black and white pictures. Using a camera equipped with a lens operated at f/3.5 and shutter opening of 180°, fully exposed negatives were obtained on a 20-ft. set with three units, taking speed being normal. We consider that this compares favorably with the illuminating systems at present in use in commercial studios. With this number of units the heat is not at all objectionable, nor is the glare difficult to face. By using lamps of the same type in photographic blue bulbs the glare factor could be practically eliminated and we feel that such an equipment of tungsten lamps can be used advantageously for black and white work. So far as we are aware this is the first tungsten lamp installation of any magnitude which has been tried for motion picture work, and while it has been in operation a relatively short time the results thus far obtained lead us to believe this type of illumination compares favorably with others at present in use for black and white work; and for color work we feel that it is the best that can be obtained.

DISCUSSION

Mr. Benford: Could Mr. Jones tell us the operating temperature of the filaments during the taking period.

Mr. Davidson: In the smaller units did you try using the lamps in series instead of rheostating each lamp? We have done this satisfactorily.

Also did you use clear globe lamps or blue lights?

Mr. Kelley: We have experimented with the Cooper-Hewitt, which we have used in combination with tungsten. Our impression is that where you have gold or yellow, it is better to use Cooper-Hewitt combined with the other light. It seems to bring out these colors and make them sparkle.

President Jones: We haven't as yet measured the operating temperature. The lamps are so designed that when operated at 110 volts, the efficiency is approximately the same as the ordinary commercial thousand-watt lamp. During actual taking, they are subjected to an over-voltage of 9 per cent. I do not know just what the operating temperature would be under such conditions.

Mr. Burnap: It is somewhere between 3,100 and 3,200 Kelvin.

President Jones: In using the small low voltage unit, they were used on the 110 volt line, three lamps being connected in series. We are using clear bulb lamps for color photography since the longer wave-lengths, which are cut off by the blue bulbs, are required. For black and white work, there is little doubt that the blue bulb lamps would be almost as efficient photographically, but for color work, the use of blue glass would lower the efficiency enormously.

Mr. Davidson: Did you use any blue to cut down the excess red in the tungsten?

President Jones: No. All of the radiation of longer wavelengths, red, orange, yellow, etc., are useful for color work. The mercury vapor lamps have been found entirely unsatisfactory for general color work. It is possible that under certain special conditions they would give fairly satisfactory results but in most cases, the color rendering with the mercury vapor lamp is very poor. Some materials such as colored fabrics may have very narrow spectral reflection characteristics. In case such reflection band comes at the point on the spectrum where there is no radiation in the light from the mercury vapor source the material would be rendered as very dark. In general the mercury vapor light is not satisfactory.

Mr. Kelley: You have more red in the tungstens than is needed. Some recent pictures were made using a combination of arc lights, and Cooper-Hewitts and the results were excellent We recently fitted up a cartoon outfit for color photography consisting of two clear bulb tungsten lamps and two U-shape Cooper-Hewitts. This mixture of lamps gave all the colors on a color card in their correct shades.

President Jones: I misunderstood Mr. Kelley's first statement and thought he implied that the Cooper-Hewitt source was used alone.

Mr. Kelley: Oh, no! That is impossible.

President Jones: It is probable that a mixture of tungsten and mercury vapor light could be used with good results for color work. In building this installation, however, we wished to have the units of uniform type. While Mr. Kelley's point may be well taken, I consider it better not to have two distinct types of units to deal with.

MACHINE DEVELOPMENT OF NEGATIVE AND POSITIVE MOTION PICTURE FILM

By Alfred B. Hitchins*

A great deal has been written, during the past two or three years, on the subject of machine development, but the discussion and description of the various methods in use have been confined entirely to the machine development of positive film. There seems to be a strong feeling against the development of negative in any kind of machine and rule of thumb methods of developer manipulation are in force generally. There seems to be a lingering doubt about submitting a valuable negative to machine development, yet exhaustive series of experimental test runs have proved that, in both theory and practice, properly controlled mechanical development is the most satisfactory method.

When Hurter and Driffield published their splendid researches on the theory of photo-chemical action and established beyond doubt that exposure and not developer manipulation governed the photographic result, they proved once and for all the utter futility of trying to make the developer do that which can only be done by light. Whatever light action or exposure has done in forming the latent image is unalterable, whether it be too much or too little, and no amount of juggling the developer will ever compensate for it—we cannot alter the impression due to light. If the negative is under-exposed and we force it, nothing more than light has impressed can be developed in the shadows. All that happens is that the high lights are clogged up or over-developed and the result is soot and whitewash. We have simply increased the contrast and have not created or conferred any detail that was not registered to begin with.

In the case of over-exposure, if the negative is developed for a shorter time than usual, the result is flatness. In either case we have gained nothing by monkeying with the developing time, and it is equally true that varying the constituents or proportions of the constituents of the developer will not help.

It is true that different emulsions or brands of film have different development velocities, or, in other words, the time of development necessary to gain a given degree of density and contrast varies with different makes. But, given a well-balanced developing formula,

* Technical Director of Duplex Motion Picture Industries, Inc.

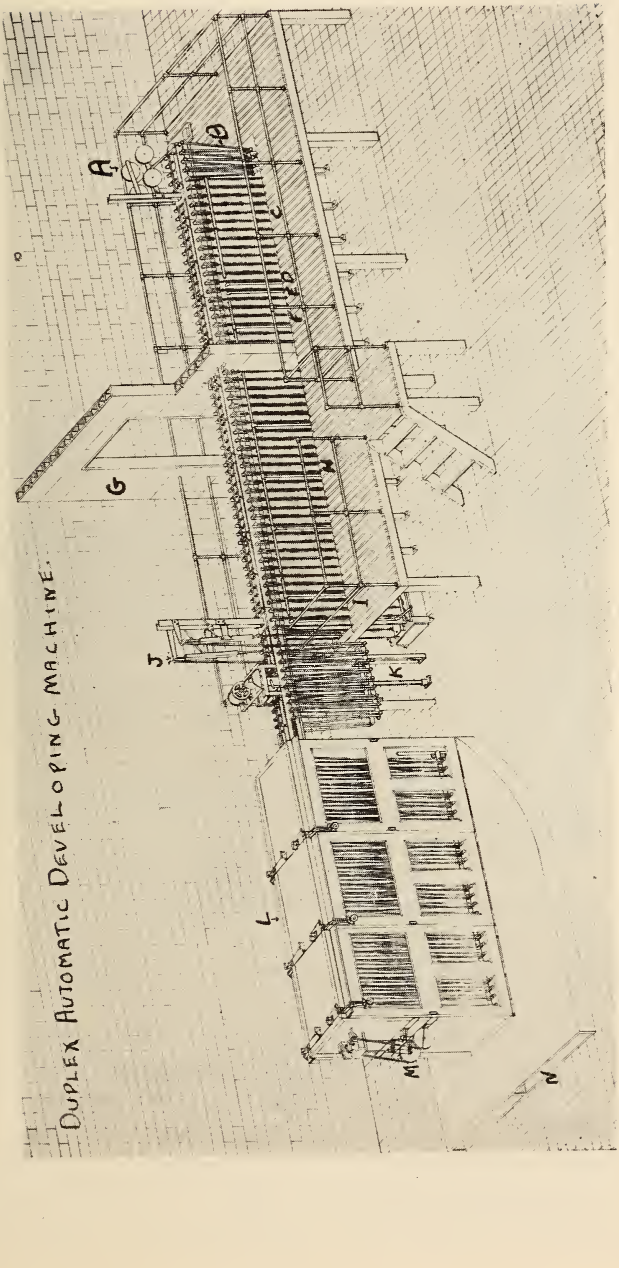


Fig. 1. Duplex Automatic Developing Machine

properly controlled time and temperature methods will give the best average results from any exposure. Control of time and temperature are the essence of a well designed developing machine and the less manual handling and examination the film has the better the results will be. A careful, unbiased observation of comparative tests of controlled development versus developer manipulation will prove the scientific method to be both theoretically and practically sound. No one understands lighting and exposure better than the high grade cameramen, 99 per cent of whom are fine photographers in every sense of the word and well know that properly controlled light conditions and exposure are the governing factors in the faithful reproduction of the tone values of the original subject. Having taken advantage of all their skill in impressing a well balanced latent image on the film is it not logical and sensible to develop the negative under conditions that are controllable and constant instead of submitting a thing of such value to the haphazard conditions and uncertainties of the rack and tank method?

There is perhaps a justifiable pride of craft in the manual development of negatives. The earnest worker likes to feel that he himself can make the negative of supreme quality, but the cold scientific fact remains that he cannot materialy alter what has been definitely effected by light. And when it comes to a consideration of cleanliness, uniformity, lowered cost, and increased production of better average quality, then there is no comparison between machine and manual methods, it is all in favor of the machine.

There is nothing radical in advocating machine development of negatives, it is the logical and certain method of producing the largest output of uniformly good quality for the least expenditure of time and money. Twenty years ago the skilled portrait photographer would have laughed at the idea of taking his day's negatives and putting them in a developing solution at a definite temperature and then forgetting them for twenty minutes. He believed in dish development, personal examination and thought he could by developer manipulation make up for inaccuracy of exposure. Today the photographer knows better and realizes that time and temperature properly harnessed will produce for him the best negatives his exposures will yield.

The germ of successful machine development is time and temperature. Time is controlled by the speed of the machine, by the number of tubes that the film is put through, and this not only applies to developing but to the check bath, rinse, fixing, tinting and washing. Temperature is controlled by thermostatic regulators which maintain the developing solution at proper operating temperature.

The machine development of positive film calls for no special remarks for it is rapidly becoming the accepted practice and most of the big laboratories are equipped with developing machines of one form or another.

A long experience with machine development methods seems to point to some form of what is known as the "straight line" machine as being the most efficient and flexible type. One of the most up-to-date machines of this nature will be described; it embodies improvements that are the result of years of experience in developing machine design.

The complete machine is shown in the illustration and the important parts are lettered to aid in description. The machine is duplex in principle, that is to say, film is processed on both sides of the machine at one operation. The speed of the machine ranges from 15 to 30 feet per minute, giving, when both sides are in operation, 30 to 60 feet production per minute. When used for negative development it is run at 15 feet per minute and for positive 30 feet per minute. One motor drive of one-fourth horse power operates both sides of the machine.

A. The take-off reels. Two are provided on each side of the machine, so that a second roll can always be in readiness to splice on to the end of the roll in process, making the operation continuous.

B. Compensating elevator. The film is led on to this from the take off reel. The elevator has a latitude of 3 minutes, that is to say, when it is full it will feed the machine for that time, allowing plenty of time for the splicing on of the second roll.

C. The developing tubes. These are made of heavy walled Pyrex glass. The film is led into them from the elevator over sprocket and idler rolls and is held in the tubes by weighting down with Pyrex glass bobbins. There are twelve developing tubes and the rate of passage through each tube is 30 seconds when the machine is run at 30 feet per minute and 1 minute when run at 15 feet per minute. According to the number of tubes that are put in use the times of development can be varied from 30 seconds to 6 minutes when running 30 feet per minute and from 1 minute to 12 minutes when running at 15 feet per minute. Further modification of development times can be accomplished by the length of the loop of film in each tube, the figures given above being for the maximum loop. The developing solution is kept in a storage tank and is pumped to the tubes and recirculated. During recirculation the solution passes through a chamber that is provided with coils, thermostatically controlled, and is automatically maintained at the chosen working temperature. To take care of evaporation and the gradual exhaustion of the solution, fresh developer is added continuously at a given point in amounts in keeping with the machine speed and other conditions.

D. The check bath tube, to arrest development.

E. The rinse bath tube.

F. The fixing tubes, six of them, allowing the time of fixing to be varied from 30 seconds to 3 minutes when running at 30 feet per minute and from 1 minute to 6 minutes when running at 15 feet per minute. The fixing solution is also recirculated and the combination of moving film and circulating hypo materially increases the efficiency of fixing; positive film is completely fixed in 2½ minutes and negative in 5 minutes. The hypo bath is kept up to full strength and hardening properties by suitable additions at intervals.

G. A tile wall dividing the dark room operations from those that can be carried out in the light. From the fixing tubes the film passes through a light trap in the wall into the washing tubes.

H. Washing tubes, twenty-four in all, giving washing times ranging from 30 seconds to 12 minutes when running at 30 feet per minute and from 1 minute to 24 minutes when running at 15 feet per minute. The wash water is circulated and changed very rapidly through these tubes and tests show that all hypo is removed in 10 minutes.

I. Tinting tubes, five of them, and an additional rinse tube.

J. Air jets, blowing on the film on both sides and removing all surface moisture and drops. After passing through these air jets the film contains only retained moisture and so all drying and tear marks are avoided.

K. A compensating elevator, with a time latitude of 5 minutes. Under normal running conditions the elevator is kept about three-fourths full. The time latitude is sufficient to allow of starting and stopping, changing speeds and for taking care of any break that might occur in the drying cabinets.

L. The drying cabinets, divided into three compartments each side, each loop of film is on an individual compensating elevator which is connected through an electrical circuit to an alarm system so that in case of over filling, breaks, or other conditions a lamp on the compartment housing lights up as a warning and the necessary splicing or changes in speed transmission can be attended to. The time of passage through the dryers is on an average 28 minutes. All air is conditioned and circulated. The fact that the film is continually moving in a sinuous manner during drying is an advantage, film so dried will remain more flexible throughout its life and will behave better in the projector than film which is stationary during drying.

M. The take up reels, for receiving the film as it leaves the dryers.

N. The air intake, connected with the air conditioning system, the air having first been washed, then heated to tempertaure and properly humidified. The drying air is very important and there is no doubt that drying conditions have a marked effect on the life of the finished film. It is poor practice to completely dry out film and chance it coming back to something like proper moisture conditions. Film should be dried under known conditions of temperature and humidity as determined by its life, its continued flexibility and lack of brittleness.

Each of these machines are provided with suitable decking and railing so that all parts are readily accessible. All tubes are fitted with pet cocks for draining and cleaning. The use of Pyrex glass tubes throughout is a great advantage over the old lead or wood tanks. They are easier to keep clean and as the interiors are visible there is no excuse for letting them get dirty. Also the glass tubes do not break up under the action of the various solutions or become soaked up and incrusted with chemicals as happens in the case of lead or wood tanks.

The advantages of machine development are many. There is practically no manual handling, and fewer finger marks, scratches and tears. There are no spots of unequal density such as occur at the tops and bottoms of racks; no silver stains or air bells, and, last but not least, there is the saving of labor. With this machine four men can turn out the work that would require twenty-five men using the older methods, and the product will be cleaner, better, and more uniform.

Taking into consideration the average range of exposures and subjects that come in from the cameramen, machine development of negatives gives a better net result than can be obtained by any method of so-called development control.

In view of the different behavior of the various makes of film, so far as their development speed, time taken to arrive at a chosen contrast, and density, test strips are made under correct time and temperature conditions and, this having been found, the machine is set at the proper speed to accomplish the desired results automatically.

The negative emulsions of the present day are wonderful products; they have sufficient latitude in exposure and are suitable in every way to yield the best average quality with machine development.

DISCUSSION

Dr. Gage: I should like to ask the speaker if this machine differs from machines for developing positives.

Dr. Hitchins: The only difference is speed. When developing positive it is run at 30 feet per minute and when developing negative, requiring longer times, it is run 15 feet a minute.

Mr. Richardson: I should like to ask what granulation is due to? Is it due to the developing process? You can notice it in the front seats and I think the attention of the Society should be directed to the elimination of this evil.

Dr. Hitchins: Mr. Jones in his paper a few meetings ago described all the things that tend to produce these effects. One influence is exposure and the effect is further increased by injudicious developing.

Mr. Crabtree: Do you have much trouble with breakage of the tubes? I should like to have information as to the exact method of circulation in the tubes to maintain the composition of the developer constant and whether you have any data with regard to the volume of renewal developer required per foot of film. Also have you information on the suitability of various materials for constructing sprockets.

With regard to the development of negative film on the machine, it is interesting to know that negatives are being actually developed commercially, and I agree that in the case of the average negative exposed in the studio, the latitude of the film and the uniformity of exposure is such that good results can be obtained. In the case of negatives exposed on short scenes of widely varying brightness contrast, I don't think it is practical to use a machine. The object in negative development is to get all the scenes so that they are of uniform density contrast, or of such density contrast that when the positive prints are all developed for the same time, the desired screen contrast is secured.

In ordinary photographic work, the professional photographer can compensate for lack of correct contrast of his negatives by using printing papers of varying contrast. In motion picture work, since positive film is available in only one degree of contrast, in order to vary the contrast of the print from any particular negative, it is necessary to vary the time of development of the positive which is very undesirable.

Let me repeat that it is desirable to so develop the negative that correct positive prints from all the scenes are obtainable by a constant time of development of the positive film. In case the negative consists of a number of scenes exposed on subjects of widely varying brightness contrast, the only way to secure this end is to develop each scene separately. If the negative consists of only one scene, or of scenes of subjects having the same brightness contrast, then machine development is satisfactory.

Of course, on most machines it is possible to vary the time of development from scene to scene providing the scenes are not too short, but with a scene of say 2 or 3 feet in length, it is almost impossible to give this, say, 9 minutes development when the scenes on each side of it require, say, 4 minutes.

Dr. Hitchins: We have found that even with short scenes the latitude is sufficient to make machine development possible. It is being done every day. The metal used around the machine and on the sprockets is monel. The various details are given in the written paper, and I do not need to go into it now. Breakage of the tubes is very rare. The machine feeds easily and smoothly, and I do not think there are more than one or two breaks on an eight hour shift.

Mr. Briefer: I am inclined to agree with Mr. Crabtree as to the necessity of handling separately the many small scenes taken under different lighting conditions and of different pictoral composition. The ultimate requisite is to provide negatives capable of producing a band of positive prints of quite even density throughout. If, as Dr. Hitchins says, machine development will accomplish this result, the method is desirable. My own opinion is in doubt.

Dr. Hitchins: I am sorry to have to disagree with good friends, but I know that on a production basis, the plan is workable. Timing is simple and the printer has nothing to worry about. Varying densities are taken care of by automatic light changes on the printer.

A MUSEUM OF MOTION PICTURE HISTORY

By T. K. Peters

It may seem presumptious for me to write this plea for a museum, when there are others in the Society who are far better fitted to take up the task, as for instance, Mr. Jenkins, who has made a beginning in this direction by placing in the Smithsonian Institution some of his first apparatus. But as no one else has stepped forward to do so, I have been endeavoring to gather material for the project. I feel as though I were stealing Mr. Jenkins' thunder, but in a measure he has brought this condition about, for it was due to my perusal of his book, *Animated Pictures* which I purchased in 1897, that I became fired with the ambition to also make Chronophotographic pictures, or in other and more modern language become a "movie" man.

Seriously though, I want to present to the Society a subject that should be of vital interest to everyone engaged in the industry; the formation of an historical section of the Society and the establishment of a museum of historical material giving the observer a chance to visualize the early stages of the art. Every time I see an old bit of machinery or an old negative, my mind travels back through a long list of incident and scenes connected with the early history of animated pictures. Therefore, I must ask your pardon if I digress a moment from the subject of the museum proper, in order that you, too, may see a few of those scenes and realize just what a museum of the kind would mean to us, who are still in the industry today and who saw its yesterdays. For, like many of you who will be present at this meeting, I have lived motion picture history while others have written of it.

In my boyhood days here in California I had a photographer friend who knew Muybridge in San Francisco, and he often regaled me with stories of the eccentric old Englishman. Then, as I grew older after passing my early youth in Mexico, I became conscious that my great work in life was to be a rival to Hermann or Keller. Being of the mechanical turn of mind, I decided to begin making my apparatus, and with that end in view I purchased a book called *Magic and Stage Illusions* and started out to become a magician. Unfortunately, while able to make the apparatus, I failed deplorably in presenting it, so was forced into the minor role of assistant on the stage, but leading man in the work shop; in other words, I had the pleasure of seeing someone else present the illusions which I built.

In this capacity I joined forces with two Hindu magicians and toured the Eastern States and from there we went to England and on to the Continent. We separated in Paris owing to a lack of agreement on the part of the partner regarding the affections of a young French girl. Left to my own devices, I wandered around Paris until one day I stumbled upon a friend I had known in California, a Frenchman, who had returned home and was then engaged with a concern making animated views.

I understood at once what he meant, for my book on magic and stage illusions contained an account of the new wonder, and, pursuing my studies further, I had purchased a book written by Francis Jenkins of Washington which contained a complete description and being interested in amature photography I felt that I was competent to follow the new profession. With this idea I went to the studio where my friend was engaged and had an interview with the manager, to whom I unfolded my desire. He was cordial and sympathetic but was unable to help me at the moment, but suggested, when I told him that I had had experience as a photographer, that I try and get a camera and make some film which he would buy if it was good. I went to the largest dealer in photographic goods, a man named Thibault, and purchased a camera which had just been constructed by a young man named Charpentier, which the Lumieres had taken up and were using. Armed with this I went on my own, getting views which I sold to the Pathes and to Daddy Paul of London. Both of these firms were making kinetoscopes in imitation of the Edison product which had become the rage all over Europe. As yet we had no projected pictures in common use, and our negatives were made for the kinetoscope and in fifty foot lengths. My particular product was scenic views entirely, such thrilling views being recorded as "Boat Traveling up the Seine," "Train Leaving the Station," "Breaking Waves," "Rough Sea in the English Channel," etc.

My camera when first purchased had sprockets made to the Lumiere standard, that is, they had but four teeth as the film used Lumieres had but one perforation per picture. I had this changed to the Edison standard which was fast becoming fixed as the universal perforation for film, due to the fact that Edison sold more kinetoscopes than his competitors and they were more busy supplying film for his machines than their own.

I returned to California in 1900, which I regretted as soon as I arrived, for I found that there was no business there in the making of animated views, so I laid my camera aside and went back to stage illusions, scenery and magic apparatus. I kept in touch with activities in the East however, through a friend, and occasionally received such thrilling news as the fact that nickleodeons were being opened up daily and the craze was spreading like wild fire. The Eden Musee and several other houses were running pictures regularly, and they had gotten out a small outfit that could be put in a trunk, and gave a dazzling light with oxygen and lime pastilles. I nearly fell for the purchase of one of these outfits, in fact I wrote to Lubin and received a catalogue describing his NEW TWENTIETH CENTURY MARVEL LIFE MOTION PICTURE MACHINE in such glowing terms that I was on the point of ordering one when I received a letter from my friend (Daddy Paley) telling me of a new stunt that was going to be all the rage. The idea was to erect an imitation railroad coach in a penny arcade to which an admission fee was to be charged, your ticket to be taken by a uniformed conductor as you entered the car. When the car was full the conductor would shout "All Aboard," you would hear the hiss of air brakes, the wheels would begin to revolve, the coach swayed this way and that, and then before your eyes opened up a vista of track and you were off down it traveling through strange lands, over hill and dale, through tunnels, over bridges and through streets of foreign cities. I fell for this idea and taking my camera I started out to do a little traveling myself, so that others might travel vicariously via the medium of my pictures.

I embarked for the Orient and for the next two years I sweated in the tropics, dried out in the Deccan, and hit most of the high spots from Tokio to Ceylon. I arrived home in San Francisco in time for the big event of April, 1906, and saw my entire two years work, my camera, and everything I had go up in smoke in fifteen minutes. For the next three years I operated in theatres or ran my own in Los Angeles and San Francisco, and unsuccessfully endeavored to get some company to come out to California to make pictures. At last Colonel Selig came out to stay, although the Biograph Company had come out for a few months the previous year. Then the Bison studio was opened, the second one in Los Angeles, and the race was on.

A month or so after the Bison Company arrived I joined them and from that time on I have been continuously employed in the industry in one capacity or another. In 1909 we were making one thousand foot pictures, turning out an average of two such pictures a week. We had a thoroughly modern studio on the site where the Max Sennett studio now stands in Edendale. The office and the laboratory were across the street. The studio proper consisted of a three room unplastered bungalow, two of the rooms being reserved for ladies and one for the gentlemen for dressing rooms. Behind the house the stage stretched away into the distance for twenty-five feet. Our lighting system was rated at 190,000 candle power, being the sun, the stage was screened and the light diffused by means of a canopy of bleached muslin, and on cloudy days our life was made a torment by shouts to "Put up the canopy—take down the canopy," whereat all hands would join in and grab the sheet.

Our settings were gorgeous, for we possessed two entire interiors consisting in all of about twenty canvas flats, including center door fancy and doors and windows. It kept us busy repainting those sets in preparation for the next week's work. As film was an important item, and as no well regulated story that had been brought up properly could have more than one thousand feet, our director, Charlie French, would take out his stop-watch and time carefully each rehearsal. If a scene ran over in action the fifteen or twenty seconds allotted to it, the script would have to be re-written right on the spot. This was no great matter, however, as it seldom ever exceeded one typewritten page, something like the following:

Scene 1. Jim discovered. (5 feet)

Scene 2. Comes down to camera. (5 feet)

Scene 3. Canyon stream, Marjorie discovered. (6 feet)

etc., etc., etc.

We were, of course, perforce, limited to two interiors in one reel and so the story had to center around those two or bust.

Up to about 1902 the longest pictures were not over 500 feet, and they rarely reached this figure. About 1902, however, a picture appeared called *The Astronomer's Dream* in the unprecedented length of 1200 feet, but long after that date the popular picture was from fifty to one hundred and fifty feet.

In looking over some old film catalogues of that date I find such interesting subjects as:

> *Hurry up.* 50 feet
> "Here is one to fool you," the catalogue says. "As the characters disappear in the air, you sit and wonder how it happened. By no visible aid they jump over a fifteen-foot wall and appear to go through the same maneuvers, much to your surprise and amusement."

Another super-feature of that date was this one. Will somebody please page Mr. Ford Sterling, or Max Sennett.

> "*The Inexhaustible Cab.* 90 feet.
> This is a remarkable picture! A hack drives up to the curb on a prominent street and a clown jumps out. He proceeds to fill the hack by notifying the passers-by to get in. Thirty-two persons enter the carriage built to hold but four, but none are seen to get out."

About 1905, as my records show, we had such thrillers as *The Nihilists* in seven magnificent sensational scenes! In length 841 feet it was produced by the Mutoscope and Biograph Company, which had abandoned its early standard of 2-¾ inches in width and was following the popular fashion using Edison standard. We also had an anticipation of the Volstead reaction in a film called *The Moonshiners*, 960 feet long. Then, too, appeared the first Westerns, *Kit Carsons*, 775 feet long, and *Indians and Cowboys* in six scenes, 590 feet long. Gloria Swanson's prototype harrowed us with the struggles of the poor working girl in a picture called *Annie's Love Story* in seven pitiful scenes as follows:

> Scene 1. Betrayed!
> Scene 2. From Work to Pleasure
> Scene 3. Abandoned!
> Scene 4. Dying of Hunger!
> Scene 5. Letter to the Parents
> Scene 6. Terrible Expiation
> Scene 7. In the Hospital

Annie croaked in the last scene and there was not a dry eye in the house.

Our thrillers were represented by the *Life of an American Fireman*, 425 feet, seven scenes of daring gamble with death from smoke and flames; then the *Great Train Robbery* in fourteen scenes, 740 feet long. No thriller made since has caused the cold chills to run down my spine as did the last scene in that memorable drama. It was the first close-up! A life size view of Barnes, the outlaw chief—

his face stamped with determination and showing his heartless nature —appeared on the screen. Suddenly he lifted a pistol and, pointing it at the audience, fired point blank! The excitement was intense; strong men paled and frail women fainted. Everyone in the audience ducked his head and was glad when it was over, but my, what a thriller it was! Then came the chase picture, an English production called the *Daylight Burglary.* Costume pictures such as *Marie Antoinette*; magic pictures which anticipated all our double exposure of a later day; microscopic pictures such as *The Drop of Water,* made in 1899, the negative of which is still in my possession, and many others.

So you see, I have truly lived motion pictures, and being a collector, (my wife says that one of my ancestors must have been a junk man) I have gradually accumulated a lot of material bearing on the early history of cinematography, and I suppose others have done the same. What I propose now is that we pool these exhibits and add to them while we are able to get the material and thus form the first Motion Picture Museum. During the last few years I have spent a great deal of time finding out where old machines and film were available and collecting data regarding early cameras and projectors prior to 1896. In 1920, assisted by two other persons, I spent nearly six months in going through, page by page, every specification for letters patent since 1860, picking out every patent that related to motion pictures and making a list of them for reference. These will prove invaluable in reconstructing old models. I hope to see a museum established and have tentatively envisioned the following sections:

Section A. History and Historical Models

This would contain originals or models of the following machines:

Plateau's Zoetrope, Thaumatropes of various patterns.

Brown's Lantern of 1860 with Geneva movement and "Pross" shutter (This type of shutter is in use at the present day.)

Heyl's Phasmatrope, Muybridge's cameras and Zoopraxinoscope

Donisthorpe's Kinesigraph, Demeny's Photoscope

Marey's Camera and Projector, Le Prince's sixteen Lens Camera

Levison's Patent, Ancheutz's Tachyscope

Jenkins' Phantoscope, Edison's Kinetoscope

Lubin's Cineograph, Selig's Polyscope

Edison's Exhibition and Universal Models

Spoor's Kinodrome, Powers' Model No. 1

LeRoy's Acmegraph, the Viascope, the Optigraph
Schneider's Mirror Vitae
The Motiograph and Edengraph, etc., etc.
Modern machines of both American and foreign make
Models of all types of intermittent motions mounted on boards and so arranged that they may be operated by hand for study.
Cameras from Muybridges down to date
Illuminants, such as oil lamps, gas lamps, lime lights, alcohol lamps, oxylith outfit, early arc lamps, modern arcs and modern Mazdas.
Laboratory machinery, past and present
Developing outfits, printing machines, and perforators

Section B. History of Film

Early attempts at making film
Paper negatives
Glass plate motion pictures
Gelatine negatives
Early Eastman, Carbutt and Lumiere film
Film manufacturing machinery
Early film standards, Edison, Biograph
Demeny and Lumiere standards

Section C. Historic film-making epochs

The first motion pictures on glass plates
The first pictures with paper negatives
The first celluloid film pictures
Early fifty footers
The first 500-foot picture
The first 1000-foot picture
The first two-reel picture
The first three-reel picture
The first five-reel picture
The first chase picture
The first comedy
The first melodrama
The first western
The first trick picture
The first microscopic picture
The first scenic
The first close-up
The first fade-out and fade-in

Great films marking important steps in the art, such as *Civilization*, *Dante's Inferno* (Cines), *Birth of a Nation*, *The Golden Wedding*, etc., etc.

Films depicting historical events since the advent of the motion picture as a recorder of history.

Educational film and records of great exploring expeditions

Section D. Bibliography and Patents

Catalogues of early day apparatus

Early posters

Photographs of old time companies

Stills from old pictures

Clippings relating to the industry

Trade papers, the *Film Index*, the *Slide Review*, the *Motion Picture World*, the *Motion Picture News*, the *Kinematograph and Lantern Weekly*, the *Property Gazette*, the *Cine Journal* and all foreign papers.

Books and papers containing references to motion pictures

Statistical data in regard to the industry

Patent specifications, United States, England, France, Italy, and Germany

Files and TRANSACTIONS of the Society

Technical papers and reports

Yearbooks and directories

Research material, such as books on costume,

Furniture, manners, and customs, antiques, etc., etc.

Section E. Studio Construction

Models in minature of every studio marking a step in advance of the art.

Photos and data regarding studio construction and equipment

Section F. Motion Pictures other than Standard

Models and examples of plate motion pictures, continuous, motion picture apparatus, miniature movies such as Ernemann's, the Cinescope, etc., paper pictures, the spirograph, disc machines, Pathescope, Ciné-Kodak and other narrow width gauge films and apparatus, Widescope and other wider than standard devices, Picturol and other film stereopticons, film targets, paper book films, mutoscopes, talking picture devices, etc., etc.

Many other exhibits will suggest themselves to you, but in the main, this is a brief outline of what might be accomplished to preserve to posterity many things now daily being lost to history. I present the idea to the Society for its earnest consideration as a body or as individuals, with the hope that in the near future it may be a realization.

DISCUSSION

Dr. Mees: There is a numerical statement in the paper which I think should be corrected before it is published. He says the sun has an intensity of 196,000 candle power. I have just made a rough calculation and figure that it is about a hundred billion quintillion.

With regard to this paper, I think it is useful to have a list of what should be in a museum. Film manufacturing machinery would take up a good deal of room; in fact, it would not seem altogether possible, and I am afraid that we will come back to the stumbling block of all human desires—expense.

Mr. Richardson: I think these things should be gathered as soon as can be, and I think it is the duty of the Society to collect them. I think if the matter were broached a good fund could be collected, a committee appointed, and these things put in a museum. I have things which I should be glad to turn in.

Mr. Porter: Some time ago, the Society had a Historical Committee, and they made a start in a manner in which I think this thing might be handled. They collected things relating to the past history of the art, and turned them over to the Smithsonian Institution. Probably they could not accept such a large collection as Mr. Peters suggests, but I think a Historical Committee under the guidance of the Society could collect such things and vouch for their authenticity and that the Institution would accept the material, and I don't know where it could be better preserved than in Washington.

President Jones: It seems to me that some action or recommendation should be made at this time. I should like to entertain a motion.

Mr. Porter: I suggest that the Society appoint a Historical Committee of the Society of Motion Picture Engineers.

Motion carried to appoint a Historical Committee of the Society.

WHAT HAPPENED IN THE BEGINNING

By F. H. Richardson*

When one seeks to delve into the history of the motion picture industry during the period we usually refer to as "formative"—the space of time during which the inventions upon which the future success of the industry would be based were in process of discovery—one is immediately confronted with many apparently conflicting claims.

When the writer undertook the preparation of this paper, he had nothing more in mind than the showing to you, by means of projected stereopticon slides, certain old pictures in his possession, together with some samples of old films and the relation of certain historic facts then in his possession.

When the time came for serious consideration of the matter, however, certain things came to the fore in mental vision which very greatly altered the plans. One by one the pioneers of the early days are slipping out into ghostland, and few indeed have left any consistent written record of their achievements in the industry. William T. Rock, Sigmund Lubin, Nicholas Power, Edward Earl, Frank Cannock, and others have passed into the Eternal Shades, and in every case, so far as I know, we must now depend upon bits of information picked up here and there for the very incomplete record we have of their doings in those early days around which so much interest centers.

We still have with us, however, some men who were pioneers on the very frontier of the industry, and it seemed to me to be of real importance to secure from them a personal, written statement of their activities in those days, for while we hope and trust they may be with us for many years, still, who may say when the Grim Reaper will speak the word which all humanity must obey at the last?

With this thought in mind I have approached Thomas A. Edison, George Eastman, Thomas Armat and C. Francis Jenkins, each of whom has been kind enough to drift back in memory into the past and set forth for the records of this Society their own personal recollections, supported in many instances by records, official or otherwise, as to their own individual activities during the period when the motion picture industry was in the process of changing from a peep-hole affair into the life size motion picture which we know today.

* *Motion Picture World*, New York City.

I have also been able to induce Mr. Albert E. Smith, President of the Vitagraph Company of America, to set down for us a record of his own activities in the early days, Mr. Smith and Mr. J. Stuart Blackton having been the original incorporators of the Vitagraph, which was, so far as I know, (though I do not make it as a statement of known fact), the first producing corporation outside of the Edison Company, and certainly the only producing company of them all, including the Edison Company, which started in the very early days, has endured through the years and is today still producing motion pictures. Also, it was the Vitagraph Company which created the very first "Star," who was Miss Florence Turner, long known as the "Vitagraph Girl."

The statements of all these various gentlemen are in the form of letters prepared and signed by them personally; hence, there can be no question as to their genuineness, or that they contain anything not personally written and approved by them. For reasons you can readily understand, I desire to retain the originals of these letters in my possession, when the records of the Society have been completed so far as they are concerned. I would therefore suggest, if I may, that these letters be incorporated into our proceedings in the form of cuts made from the originals.

I also take the liberty of most respectfully suggesting to this honorable body that a committee be appointed by its President to examine into and, so far as possible, reconcile any conflicting claims as between the various early inventors, most of which are, I believe, more apparent than real.

First, I will present the statement of Mr. Thomas A. Edison, who says:

Cable Address "Edison, New York"

From the Laboratory
of
THOMAS A. EDISON

Orange, N. J.
January 24, 1925

Mr. F. H. Richardson,
516 Fifth Avenue,
New York, N. Y.

Dear Mr. Richardson:

In accordance with your request I will give you a brief account of my work in the development of the motion picture, with the hope that it will be filed in the proceedings of the Society, so as to constitute a permanent record.

One of my early notes on the subject made shortly after the kinetoscope was invented, not later than 1890, was the following:

> "In the year 1887 the idea occurred to me that it was possible to devise an instrument which should do for the eye what the phonograph does for the ear, and that by a combination of the two all motion and sound could be recorded and reproduced simultaneously. This idea, the germ of which came from a little toy called the zoetrope and the work of Muybridge, Marey, and others, has now been accomplished so that every change of facial expression can be recorded and reproduced life size. The kineto scope is only a small model illustrating the present stage of the progress, but with each succeeding month new possibilities are brought into view.
>
> "I believe that in coming years, by my own work and that of Muybridge, Marey and others who will doubtless enter the field, grand opera can be given at the Metropolitan Opera House at New York without any change from the original and with artists and musicians long since dead."

I knew, of course, that both Muybridge and Marey had been able by photography to produce the *illusion of motion* by first securing instantaneous photographs of a *single cycle of movement* and indefinitely repeating the same and that they had actually employed projectors by which the moving image would be shown on a screen. The work of these two pioneers was essentially scientific and in no sense utilitarian; they were interested only in *analyzing* movement and not in creating a source of entertainment. Their pictures were taken on plates and therefore were limited in number, so that a continued exhibition necessitated the constant repetition of a single cycle of movement. Furthermore, with both Muybridge and Marey, the photographic images were located *centrally* on the plates and for this reason when projected on the screen the image of the subject remained stationary with its arms or legs in motion. It was because of this limitation that, with the early pictures of Muybridge and Marey, it was not possible to utilize a distinctive background and therefore the pictures were taken before a screen of uniform color.

When I first turned my mind to the subject in 1887, it was with the thought of creating a new art. I was not interested in analyzing motion because that had been done with brilliant success by Muybridge and Marey before me. Just as with the phonograph which makes a permanent record of an indefinite number of successive sounds, I wanted to make a permanent record of an indefinite number of successive phases of movement, doing for the eye what the phonograph had done for the ear. This meant the photographing instantaneously of a scene *as viewed by the eye* and involved the following problems:

1. The pictures had to be taken from a single point of view and not from a changing point of view as with Muybridge and Marey. In other words, the camera should not move with respect to the background but the moving object or objects should move with respect to the camera—exactly the reverse of what had been done before. And taking the pictures from a single point of view meant the use of a single lens.

2. The pictures had to be taken at a sufficiently rapid rate to give a smooth and uniform reproduction without jerking; that is to say, the displacement between the succeeding photographs had to be made very small. With my early pictures the rate at which they were taken varied from 40 to 50 per second. This gave a smooth and beautiful reproduction even though the movements photographed were quite rapid. With the modern art this rate has been reduced to

about 16 per second, solely in order to prolong the exhibition. Therefore sudden and rapid movements are avoided.

3. The reproduction of the photographs either by direct view or by projection on a screen, had to be so effected that the interval between successive images would be less than one-seventh of a second. This was a purely physiological limitation made necessary to take advantage of the phenomenon of persistence of vision as had been done for many years with the zoetrope and toys of that character.

4. Since my conception involved the thought of permanently recording and reproducing a scene *of indefinite duration*, the use of disks or wheels on which to carry the pictures, as had been proposed by Muybridge and Marey, was impossible. A carrier of indefinite length was required and my conception included taking the photographs on and reproducing the positive prints from a *tape* of light, tough, flexible material, such as a narrow celluloid film. In this particular development I was very materially assisted by the intelligent and hearty cooperation of Mr. George Eastman of Rochester, New York. At the time the invention was being developed by me, it was the accepted belief that the size of the grains of a photographic emulsion bore a definite relation to its sensitiveness and that a very high speed film must necessarily be one with very large grains. If this belief had been true it would have been difficult to secure satisfactory results, especially if the photographs were enlarged on the screen. However, I did not believe it was true, and thanks to the skill of Mr. Eastman and his assistants, I was able to obtain from them for my experimental work and later for commercial use, an extremely sensitive film of very fine grain.

With the problems above stated before me, I took up my experimental work late in 1887 or early in 1888. As a preliminary and to test out the feasibility of my ideas, the first photographs were made on a cylinder (somewhat resembling a phonograph record) turning continuously, the pictures being of small or almost microscopic size and being arranged in a continuous spiral line on the cylinder. A positive print of the photographs was then made and placed upon the cylinder which, upon being again rotated, gave a reproduction of the original scene by illuminating each picture as it passed the eye by means of an electric spark. This was a purely tentative experiment and was eminently successful, a perfect reproduction of the object in motion background and all being secured.

I immediately perceived that my original conception of 1887 was entirely feasible and that it was possible to make a permanent record of a continuous scene just as it had been possible to make a permanent record of a continuous musical selection.

But the first experimental apparatus was obviously impracticable not only because the pictures were too small but also because the duration was limited by the length of the spiral path. The pictures were small because with the first experimental apparatus the sensitive surface moved continuously; to have made them larger would have meant inevitable blurring. I concluded, therefore, that in order to make larger pictures so as to secure sharp impressions it would be necessary to move the sensitive surface intermittently many times per second, thereby permitting the exposure to be made when the surface was stationary.

Turning then to my original thought of using a continuous film, I first employed a film of a width of one half inch but found that the pictures were still too small for satisfactory reproduction especially if enlarged by projection on a screen. I then experimented with photographs one inch wide by three-quarters of an inch high. These dimensions were adopted by me in 1889 and remain today the standard of the art.

The problem then arose as to the mechanical possibilities of feeding such a film intermittently past the field of a camera lens many times per second with the assurance that the film would be stationary at the instant of exposure and not shaking and vibrating to blur the image, and with the further assurance of such accuracy that the succeeding photographs would be exactly superposed one upon the other in reproduction. Various methods and schemes were experimented with for thus feeding the film and I concluded to adopt the scheme of using sprocket holes or perforations outside the photographs in order to permit the film to be engaged accurately by the feeding devices and to be moved always precisely the same distance in making the successive photographs. In forming the sprocket holes in the film I first used only a single line at one side but finding this unsatisfactory, I utilized two lines of sprocket holes spaced so as to provide four holes for each picture which also has been and now is the present standard of the art.

Very many forms of start and stop mechanism were tried and by the summer of 1889 a satisfactory arrangement was adopted by me and was embodied in an actual full size camera by means of which the first motion pictures were taken on a celluloid film. These pictures were made in the summer of 1889; they were exactly like the present pictures except that they were taken at a considerably higher speed. In the latter respect they were actually superior to the present practice of the art, because the reproduction was smoother and less jerky.

Having by a long course of experiments thus made my first successful camera in the summer of 1889, I applied for a patent on it on August 24, 1891, and the patent thereon issued August 31, 1897, No. 589,168. This patent with its several reissues was recognized by the early manufacturers as the fundamental patent in the art and royalties under it were paid to me by the American manufacturers of films until its expiration in 1914.

My first camera constructed by me in 1889 and covered by this patent disclosed the following features which have always been utilized in the art:

1. A single lens.
2. A long celluloid film carrying a sensitive surface and having two rows of sprocket holes.
3. A reel from which the film is unwound and a second reel on which the film is wound after exposure.
4. Mechanism having a minimum inertia for moving the section of the film between the two reels intermittently past the lens many times per second, the film being stopped and brought to rest at each exposure.
5. A shutter coordinated with the feed mechanism to expose the film during the periods of rest.

The following quotation from my patent (written in the year 1891) may be of interest to you:

> "The purpose I have in view is to produce pictures representing objects in motion throughout an extended period of time which may be utilized to exhibit a scene including such moving objects in a perfect and natural manner, by means of a suitable exhibiting apparatus.

> "In carrying out my invention I employ an apparatus for effecting by photography a representation suitable for reproduction of a scene including a moving object or objects comprising a means, such as a single camera, for intermittently projecting at such rapid rate as to result in persistence of vision, images of successive positions of the object or objects in motion as observed from a fixed and single point of view, a sensitized tape like film, and a means for so moving the film as to cause the successive images to be received thereon separately and in single-line sequence."

The invention by me of this camera was in my opinion the egg of Columbus. By its means I had been able to secure as early as the summer of 1889 motion pictures on a long celluloid film representing exactly a scene as it would be observed by the eye with all of its details both as to background and as to objects moving with respect to the background. No such film had ever before been secured. No such camera for feeding a film intermittently and making exposures during the periods of rest had ever before been made or suggested.

After making my camera, the question then was, how shall the pictures be reproduced? It was obvious that they could be viewed directly throught a suitable magnifying lens or that they could be projected on a screen as had been done by Muybridge and Marey in their classical work on the analysis of motion.

The most fruitful field immediately before me was the exhibition of the pictures by direct observation rather than by projection, because in the year 1890 and for some time afterwards a very popular form of entertainment in this country was the so called slot parlor where phonographs were installed, arranged to be operated by coin-controlled mechanism. It therefore occurred to me to start out with a device by which the motion pictures could be made use of in the many hundreds of slot parlors which were then doing a flourishing business in the United States. This resulted in the development of the peep hole kinetoscope in which the film was moved continuously by a coin started electric motor passing a magnifying lens of about two diameters; the picture was illuminated by an electric light below it and was observed through a slit in a shutter which exposed the picture when substantially in the optical axis of the lens. This gave an entirely satisfactory reproduction and anyone who remembers the old peep hole kinetoscope will I think agree with me that the results secured were remarkably clear and natural. Several thousands of these first kinetoscopes were made and distributed throughout the country in the years following 1890 and many of them were exhibited at the World's Fair in Chicago in 1893. Hundreds of films were made from 1890 and even earlier, for which purpose the first motion picture studio was erected, known as the "Black Maria."

I had always had in mind the projection of motion pictures on a screen even before the completion of my first successful camera in 1889. As a matter of fact, it was our practice from the very first to test the character and quality of films by projecting them on a screen by equipping the kinetoscope with a more powerful light and with a projecting lens.

Of course such a device would not have been suited for the public exhibition of pictures by projection owing to the insufficient light. For this purpose I saw that the successful projector should be based upon the principle of my camera wherein the periods of rest greatly exceeded the periods of motion of the film, thus giving the opportunity for much greater illumination, or in other words making it possible to very greatly prolong the shutter opening. But in the early days there was no demand for a projector; there were no motion picture theatres and even after projectors were made by me their introduction was slow. The competitive struggle between the motion picture theatre and the penny arcade lasted, as you will remember, for a good many years.

In the year 1895 I had reached the conclusion, largely as the result of urging on the part of my agents, Messrs. Raff and Gammon, to design and manufacture a projector based upon the principal of my camera, feeding the film intermittently so as to secure satisfactory illumination. This work was well under way when early in the year 1896, Mr. Thomas Armat of Washington, D. C. brought to my attention a projector which he had invented and which he had exhibited in the previous Fall at the Cotton States Exposition at Atlanta. That exhibition, by the way, although technically successful, was a commercial failure. Any public interest in the possibility of motion picture projection was still dormant. Mr. Armat had worked out the details of the mechanism quite ingeniously and I concluded that the intermittent device which he had developed was more satisfactory than the one upon which I was working. I therefore arranged with him to use his type of projector, which was thereupon put on the market in 1896 as the Edison Vitascope and that machine (later known as the Edison Projecting Kinetoscope) was with various modifications and refinements manufactured and marketed by me for many years thereafter.

The foregoing comprises the essential facts in connection with my invention and development of the motion picture art. Of course much of the success of the motion picture as we now know it has been due to many factors, such as the skill and artistic ability of the directors, the technical skill of the camera men, the exhibition value of the scenarios, the genius of the actors, and the business judgment and courage of the manufacturers, distributors and exhibitors.

But from a purely mechanical and technical standpoint the motion picture art was created when my camera was completed in the summer of 1889. That device made it possible for the first time to secure a permanent photographic record of a scene including movement—something never before accomplished—and that device also was the basis of and disclosed the principle used with the modern projector. In the latter respect it disclosed the two reels for storing and taking up the film after exposure, it disclosed intermittent mechanism for feeding the film step by step past the lens, it disclosed the feature of relatively long periods of rest with correspondingly short periods of motion, and it disclosed the shutter for exposing the film during the periods of rest. In a broad sense all that was necessary to convert the camera into a projector was to use a suitable source of illumination for the film and to enlarge the shutter opening to secure the maximum lighting effect.

Yours very truly,
(*Signed*) Thomas A. Edison

You will observe that Mr. Edison not only has covered the ground very thoroughly, but also he has cited certain official records in support of his statements. I am very sure there will be no shadow of a doubt in the minds of any of us but that Mr. Edison has set forth only that which he believes to be the even and exact truth with regard to things not directly supported by corroborative evidence.

I have myself examined many records not incorporated in this paper, all of which corroborate what Mr. Edison has said. More than this I do not feel it right and proper to say, since, as I have stated there are some apparently conflicting claims, which I again respectfully suggest that this Society take steps to try to harmonize.

I next present for your consideration a statement by Mr. Thomas Armat, of Washington, District of Columbia. You will observe that the statements of Messrs. Edison and Armat agree throughout. There seems to be, so far as I am able to see, no conflict of claims with regard to the application of the old, well-known star and cam type of intermittent movement to the motion picture projector, in this country at least, but there was a bitter legal fight some years ago as to who invented what is known as the "Latham Loop," which is so very vital to intermittent projection.

The only serious controversy existing today, so far as my understanding goes, is with regard to who first projected life size motion pictures to a screen as we have them today, and it is this matter which I have suggested that this Society, through a committee, attempt to settle. I have other correspondence from Mr. Edison, Mr. Jenkins and Mr. Armat, together with certain items of evidence, which I will be glad to turn over to such a committee.

Mr. Thomas Armat says:

THOS. ARMAT
1870 Wyoming Ave.

GRAYSTONE
KLINGLE ROAD
Washington, D. C
April 4th, 1925.

Mr. F. H. Richardson.
516 Fifth Ave.
New York, N.Y.

Dear Mr. Richardson:

I have your letter of recent date and have delayed answering it in order to get copies of certain patents which I am now mailing you under separate cover.

These patents are Nos. 578,185 and 673,992 issued to me, and No. 586,953 issued to C. F. Jenkins and myself.

I am very glad indeed that you are taking the trouble to get at the facts in regard to the moving picture projecting machines covered by these patents, so many mis-statements concerning them having been published by uninformed, or misinformed, writers on moving picture history.

My patent No. 673,992, applied for on February 19th, 1896, covers the "Vitascope," and is no doubt the projector referred to by Mr. Edison, in his letter to you, as having been invented by me.

No. 673,992. Patented May 14, 1901.

T. ARMAT.

VITASCOPE.

(Application filed Feb. 19, 1896.)

(No Model.) 3 Sheets—Sheet 2

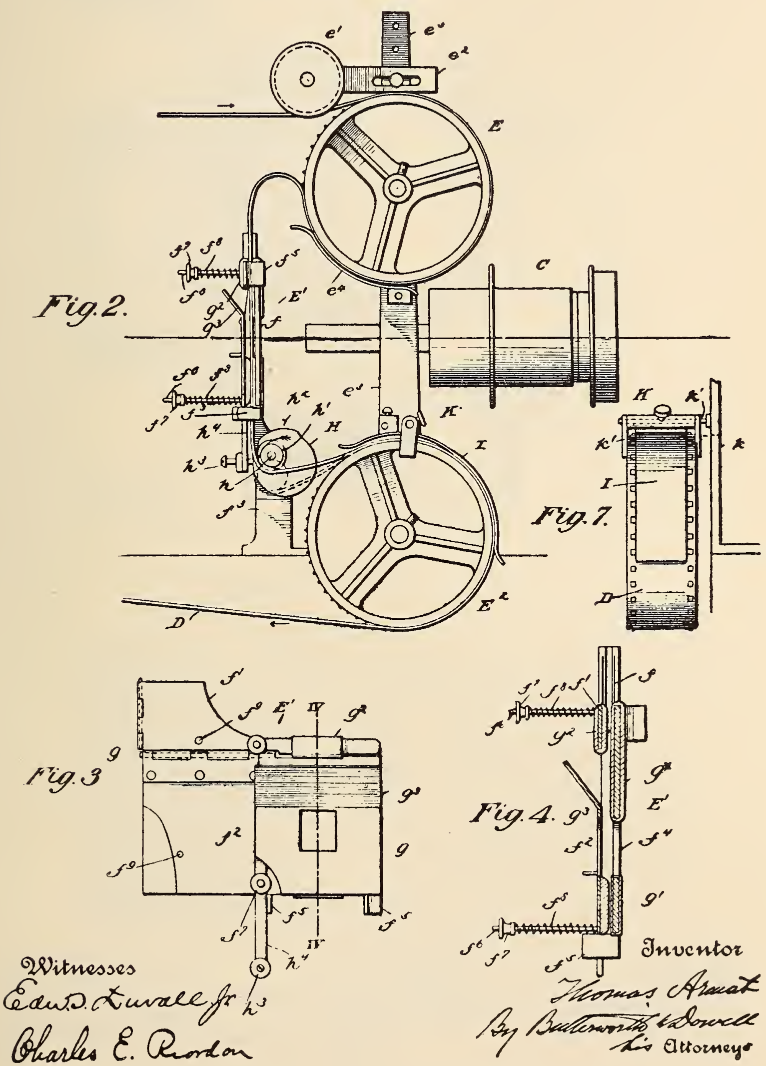


Fig. 1. Sheet No. 2 of U. S. Patent No. 673992.

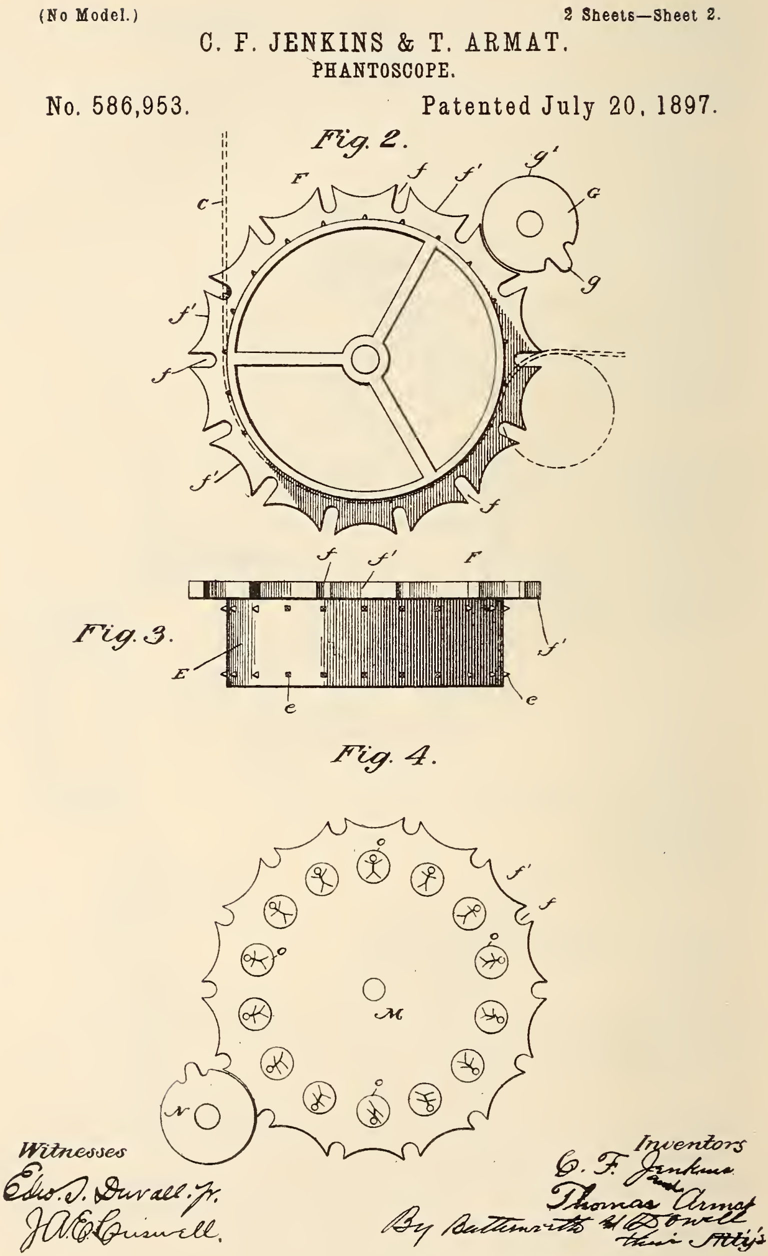


Fig. 2. Sheet No. 2 of U. S. Patent No. 586953.

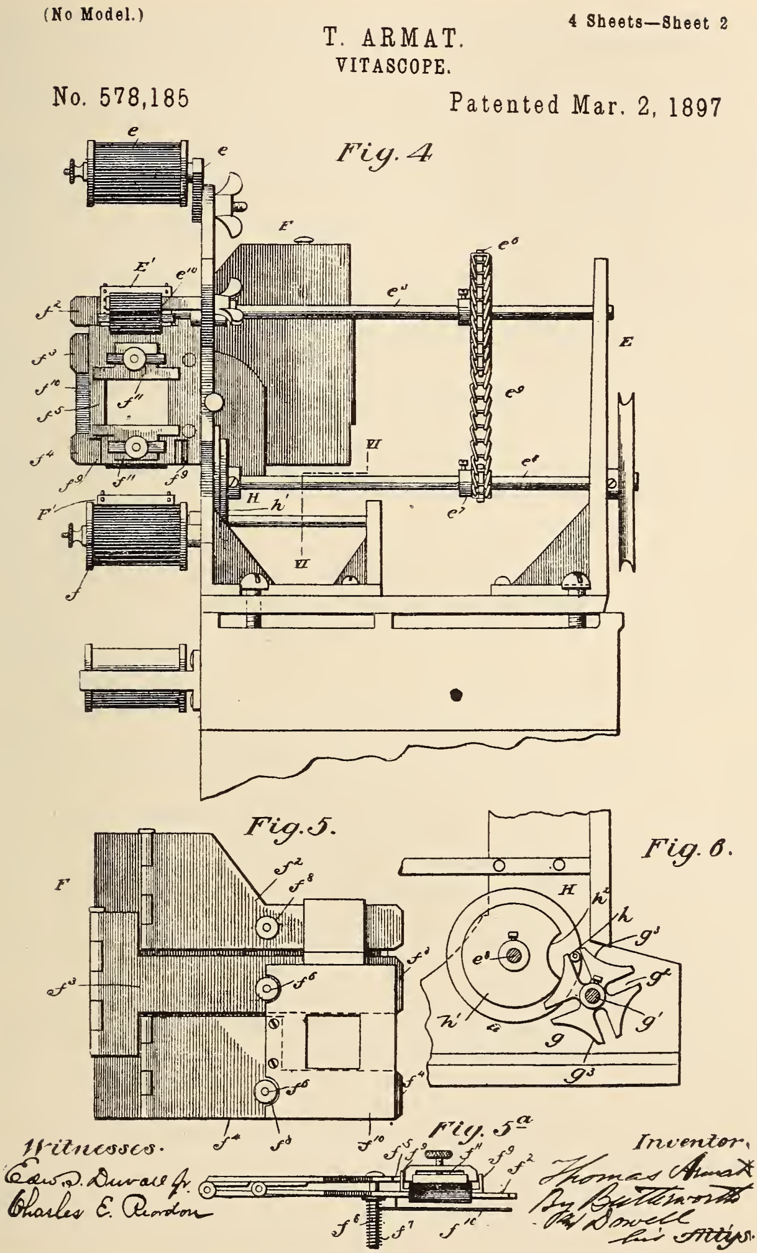


FIG. 3. Sheet No. 2 of U. S. Patent No. 578185.

This patent although applied for in February 1896 did not issue until May 1901 for the reason that it was involved in a long Patent Office Interference proceeding. This is a proceeding for defining an invention and deciding who invented it. There were four claimants to this invention in this Interference to wit: Thomas Armat, Herman Casler, E. H. Amet and Woodville Latham. The applications were filed in the order named. The taking of testimony in such cases follows the rules laid down in courts of law and is very thorough. After taking volumes of testimony the case was decided in my favor by the Examiners-in-Chief, the Commissioner of Patents and finally, on appeal by Latham, by the Court of Appeals of the District of Columbia. The invention involved in this case was that of the "slack" or "loop" forming means in a projecting machines as set forth in claim 2 of my said patent 673,992.

Some fifteen years after my machines covered by this patent were made and extensively exhibited and long after this Interference had been decided in my favor, certain claims were set up to the effect that a projecting machine of this character and covered by this patent had been made prior to the dates claimed by any of the parties to this Interference. It is sufficient to say that all such claims are absurd and untrue and were based upon false or mistaken testimony.

Patent No. 586,953 was applied for by C. F. Jenkins and myself on August 28th, 1895. The invention covered by this patent was the result of a series of experiments carried on under my direction after certain ideas of Mr. Jenkins had been tried out and proved to be valueless. These experiments extended over a period of about three months, from April to August 1895. The first and only place the machine of this patent was ever exhibited was in my office in this city in the month of August 1895. This was also the first exhibition anywhere of a machine embodying the principle covered by the claims of this patent. The machine was a mechanical failure and commercially valueless for the reason that in it we attempted to give a rapid intermittent movement to a large and heavy kinetoscope sprocket. The claims of this patent however, if they could be sustained, had a certain strategic value in connection with my later and successful projecting machines. The claims covered broadly the principle of giving, in a projecting machine, an intermittent movement to the moving picture film so that each picture on the film was given a relatively long period of exposure, as set forth in detail in the claims. This patent was also involved in a Patent Office Interference proceeding. I have recently had occasion to go quite fully into the facts in this Interference and will be glad to go over them with you, but will not take the time now to do so.

My patent No. 578,185 covers the so-called Geneva star type of intermittent movement as applied to moving picture machines. The claims are broad enough, as you will see, to cover this and all similar types of intermittent movements. The intermittent movement mechanism has been frequently referred to as the "heart" of the moving picture projector. This Geneva type of intermittent movement as you doubtless know, superseded all other forms soon after it was introduced in the fall of 1896, or thereabouts, and continues to be almost universally used up to the present time.

After I had produced a satisfactory projecting machine in the fall of 1895, it of course became necessary to secure an adequate supply of moving picture films for use thereon. All films I had used for experimental purposes in 1895 were Edison films secured from the Columbia Phonograph Company who had an Edison Kinetoscope parlor in Washington. They, in turn, secured them from Messrs. Raff and Gammon of New York, who were exclusive agents for Mr. Edison.

In December 1895 I started negotiations with Messrs. Raff and Gammon and shortly thereafter entered into a contract with them under the terms of which they were to supply Edison films for use on the "Vitascope" the name I had given the projector described in my patent No. 673,992, and the Edison Manufacturing Company were to obtain a certain number of these projectors from a model I gave them.

Raff and Gammon wanted to use the Edison name in connection with their exploitation of the Vitascope, for obvious commercial reasons and for the additional reason that they wanted to be assured of a continued supply of Edison films. Edison kinetoscope films were the only moving picture films obtainable anywhere in the world at that date. Mr. Edison had produced his kinetoscope and had pending patents covering his camera and the product of the camera, the moving picture film itself. The moving picture film has been held by the Patent Office and the Courts to be an essential element in the moving picture exhibiting machine. I have frequently stated that, in my opinion, when Mr. Edison produced his camera and film he did far and away more than anyone else ever did before or since, in the way of moving picture invention.

Recently certain misinformed writers on moving picture history have credited certain individuals, whose activities commenced years after Mr. Edison had produced his camera, his film and his kinetoscope, with having "invented" or "discovered" moving pictures.

To set up such a claim from twenty-five to thirty years after the inventions covered by the patents I have referred to were made is of course absurd, as an intelligent search of the Patent Office records would disclose.

The moving picture art, like many others, has been a matter of evolution in which many people have had a part, some directly and some indirectly. Inventors and manufacturers in the art of instantaneous photography which had to be brought to a high state of perfection before moving pictures as we know them today became a possibility, as well as manufacturers of celluloid strips for carrying the highly sensitive emulsion for taking the pictures, all had an important part in the development of moving pictures, so that no one person can properly claim to have invented or discovered moving pictures.

I have never set up any special claims for myself one way or the other but I feel that I can justly claim to have done my full share of what Mr. Edison left to be done in the way of developing or inventing moving pictures, and, in the matter of projecting machines, I think perhaps that the patents I have referred to may entitle me to claim that I did more than anyone else in the way of inventing the first successful moving picture projecting machine.

Prior to the advent of such a machine the moving picture film was confined to the very narrow field of the peep-hole or direct view machine, where the pictures about the size of a postage stamp, were seen through a lens that magnified them but very slightly.

The patents whose numbers I have given were the first ones covering the essentials of the projecting machine, the machine that throws the pictures upon the screen.

The foregoing, I believe, answers all of your questions.

Yours very truly,

(*Signed*) THOMAS ARMAT

You will observe that the Jenkins and Armat patent was, as we all now know, not practicable. The "Vitascope," invented by Mr. Armat and patented by him March 2, 1897, has the regulation star and cam movement, which, somewhat to my surprise, is a one-pin movement. This was later changed by Mr. Edison to a two-pin. It was the change of the Edison two-pin movement into a one-pin which constituted Mr. Nicholas Power's first big improvement to the Edison projector.

The "Vitascope" as designed by Mr. Armat was intended to handle a continuous band of film over a "spool bank." This was the way Mr. Edison first used it. Apparently there is no means provided for cutting the light off the screen while the film is in motion over the aperture, which presumably was one of the improvements added by Mr. Edison. Also, I see no apparent method for effecting a framing of the film, though probably there was some method employed to accomplish this important and very necessary function.

In the year 1901 Mr. Armat patented an improved form of the "Vitascope," but what finally became of it I do not know.

I next present for your consideration the letter and two photographs sent by Mr. C. Francis Jenkins, in response to my request for data.

C. Francis Jenkins
Frank H. Edmonds
Lewis M. Thayer

JENKINS LABORATORIES
1819 Connecticut Ave.
Washington, D. C.

January 8th, 1925

Mr. F. H. Richardson,
646 West 158th Street,
New York, N. Y.

Dear Mr. Richardson:

I am enclosing the two photographs you asked for, (1) an early portrait, and (2) a photograph of my *first projection machine*, the type now used in every theatre the world over.

This machine was built in 1893, and repeatedly exhibited in 1893 and 1894, and is the projector referred to in "The Photographic Times" for July 6, 1894 which I am quite sure you can find in any of the large public libraries in New York City, I know I found it recently in the National Library here.

In the Baltimore, (Maryland) "Sun", of October 2, 1895, appeared an account of the construction of three copies of this machine for the Atlanta Cotton States Exposition of that year.

These machines were installed in a building, especially built therefor by my financier, Mr. Thomas Armat, the *first motion picture theatre* ever built exclusively for the purpose, the admission charged being 25c. Notices of this "marvelous exhibition" appeared in the Atlanta papers, and copied rather extensively elsewhere.

That winter the original machine of which the Atlanta machines were copies, was exhibited before the Franklin Institute (Philadelphia), and after the taking of much testimony for and against the claim that I was the inventor, the Elliott Cresson gold medal was awarded by the Institute to me.

It may interest you to know that within a few weeks, that is, before the next S.M.P.E. meeting, we expect to give public exhibitions of motion pictures, and performances from living subjects, transmitted by radio from our studio to private homes here in the city, a perfection of the present apparatus of daily demonstrations in our laboratory here.

Sincerely yours,

CFJ/sla (*Signed*) JENKINS

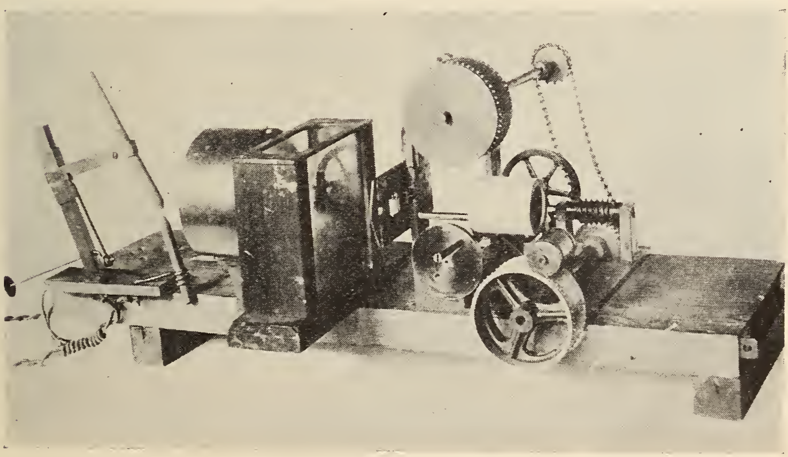


FIG. 4. The Phantoscope. Invented by Mr. Jenkins and used in 1893-94.

You will observe that both projectors shown have the well known "beater" type of intermittent movement. You will also observe that the first mechanism (Fig. 4) apparently has no means for shutting the light off the screen while the film is in movement. There is no lamp house at all, and what seems to be a cell, which probably was filled with alum water to absorb a portion of the heat, is in front of the condenser. There is an upper sprocket, and a lower sprocket, driven by a worm gear, the upper sprocket being chain driven from the shaft of the lower one. These sprockets are apparently about three inches in diameter, and of a width to take film of approximately, if not exactly, the present width and perforation. Mr. Jenkins' claim is that this projector was made and used by him to project life size motion pictures in 1893 and 1894. The means for driving the mechanism is not apparent.

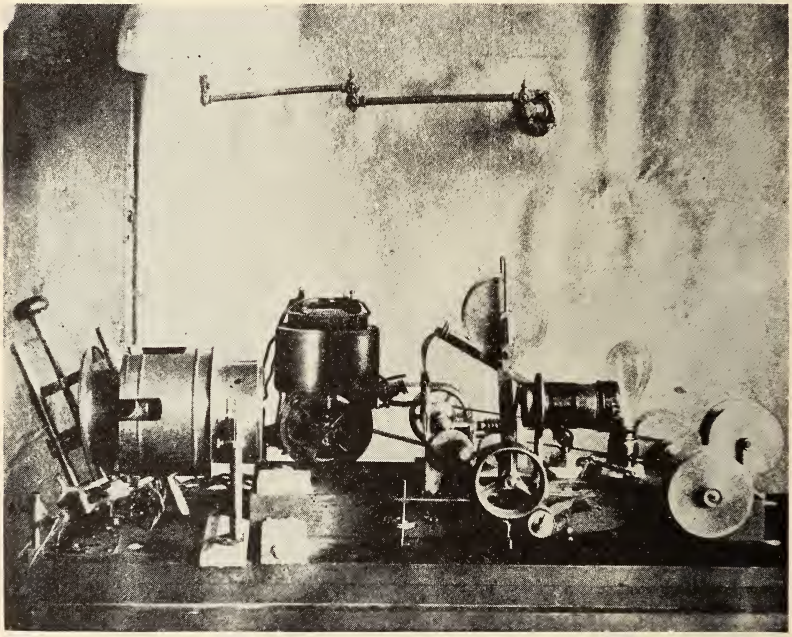


Fig. 5. The "Atlanta Exhibition" machine. One of three copies of the Phantoscope taken to the Atlanta Cotton States Exposition.

The second picture (Fig. 5) is of the "Phantoscope," which is the projector Mr. Jenkins advises was made for use at the Atlanta Exposition. Apparently it is of the same general type, but an improvement on the one shown in the first illustration. There seems to be no upper sprocket shown. The cell in front of the condenser in the first projector is absent in this one. There is some attempt at inclosing the arc, though the lamp itself is still outside.

The next statement is in the form of a letter from Mr. George Eastman to the author of this paper. I am very sure you will be deeply interested in what it contains. Mr. Eastman has, at my request, personally prepared it with intent that it become a part of the records of this Society, and as such a permanent, official record of his activities in the matter of discovering flexible film and its application to motion pictures. Mr. Eastman says:

EASTMAN KODAK COMPANY
Rochester, N. Y.

March 18th, 1925

Mr. F. H. Richardson,
New York City,
Dear Mr. Richardson:

In reply to your letter of March 2nd, addressed to our Mr. Blair, asking for a statement in regard to my connection with motion picture film, to be made a part of the records of the Society of Motion Picture Engineers, I am writing this letter.

I have read Mr. Edison's statement of January 24th and am in full accord with the reference which he makes to me.

About the year 1883 or 1884, in connection with William H. Walker, I engaged in an effort to create a system of film photography. Mr. Walker was a skilled mechanic and had had some experience in manufacturing cameras. I was engaged in the manufacture of dry plates and had had experience in the making and handling of photographic emulsions, as well as some mechanical experience.

On looking over the ground we found that there were three things necessary to be accomplished:

1st. To find a suitable flexible support to take the place of glass.
2nd. To devise a method of applying emulsion to it, and
3rd. To create a practical mechanism for exposing the sensitive flexible support in the camera.

Walker and I worked together on the mechanical problems, while I tried to work out the photographic and chemical side of the enterprise. The broad idea, of course, was not new. An exposing mechanism, called a "roll holder," for sensitized paper had been made as early as 1854, the year that I was born. Warnerke, in about 1875, made a roll holder and a film, the latter consisting of paper coated with collodion emulsion. The image was stripped direct from the paper after exposure and development. His attempt to create a system of film photography was a failure and the field had been practically abandoned at the time Walker and I began. We soon worked out a practical roll holder. A machine for coating paper in bands 8 or 10 ft. in length, for the carbon process, was in existence. We devised a machine for coating paper continuously. I invented a film, known as "Eastman Stripping Film"; filed an application for patent on March 7, 1884, and the patent was issued October 14, 1884. This completed a practical system of film photography. A company, The Eastman Dry Plate and Film Company, was formed and the enterprise started in 1885. It was successful from the start but the use of the film was hampered by the necessity of sending it to the Company for development because the development and finishing of the negatives was too complicated for the amateur, or even the dealer, to accomplish. The film consisted of a strip of paper first coated with soluble gelatine and afterwards with the sensitive emulsion. After the film had been exposed in the roll holder it was developed and then squeegeed down on to a glass plate which had previously been coated with a thin solution of rubber. This held it in a rigid position while the paper was dissolved off by hot water, leaving a very thin image on the glass plate. This had to be reenforced by a sheet of moistened gelatine. When dry the reenforced image could then be pulled off from the glass plate. This produced a negative which was very similar to the film of the present day. There were other objections to this process beside the complications. For instance: The time required to dry the gelatine sheet used for the backing; and the fact that the image sometimes was affected by the grain of the paper offsetting. It was quite obvious that what was needed to make a perfect substitute for the glass plate process was a substance which had the properties of glass except its rigidity and fragility. Transparent celluloid had already been used as a substitute for glass in making single negatives but no way was known of producing it in sheets thin enough and long enough to use in a roll holder. After we got started with the stripping film I made many experiments to produce long sheets of transparent material, using cellulose nitrate "soluble cotton", which is the chief constituent of celluloid. I used the only solvents known in photography at that time, namely grain alcohol and ether. A mixture of these solvents would only dissolve about 10 per cent of its weight of the cellulose nitrate and this solution, when coated on glass, gave too thin a film to be of any use. I tried building up a thicker film by using successive coatings of this solution (known as "collodion") and rubber but I could not get a thick enough film to be practical. In the meantime, failing to succeed in producing this ideal support, I began to experiment in replacing the sheets of gelatine used for backing the stripping film with a varnish to overcome the objection of the slow drying. One day a young assistant whom I had assigned to this job came to me with a bottle of varnish and a glass plate bearing a stripping film negative which had been varnished and partially stripped from the plate. He said he had found just what we were looking for. I asked him what the varnish was composed of and he said: "Wood alcohol and soluble cotton." It was very thick, like separated honey. I saw at once that it was the solution which I had been looking for to make film base and immediately began to devise apparatus for producing film by drying the varnish on long strips of plate glass. We at once fitted up a small factory with tables 100 ft. long, having glass tops of the longest sheets of plate glass we could find, with the joints cemented together, and began to make the first practical transparent film in rolls that was ever put on the market. This was in August, 1889.

While we were engaged in fitting up this factory I received a call from a representative of Mr. Edison's who told me of Mr. Edison's experiments in motion pictures and how necessary it was for him to have some of this film. The idea of making pictures to depict objects in motion was entirely new to me but of course I was much interested in the project and did my best to furnish him film as near to his specifications regarding fineness of grain and thickness as possible. As far as I know the film we furnished him then, and from time to time later, was satisfactory. In the years during which the motion picture industry has been developing we have made many improvements in the way of fineness of grain, photographic quality, and uniformity, but the film made today is substantially the same as the first film furnished Mr. Edison.

So far as I can recollect all the experimental film that was furnished Mr. Edison was negative film. Special film for printing positives was not made until about 1895.

The new film was a success for amateur purposes from the moment it was offered to the public. The use of film has superseded glass plates for amateur use for many years past; and of late years has been replacing them for all professional uses as well.

The support, instead of being made on glass tables as at first, is now cast on the surface of great nickel plated wheels which run continuously night and day, week in and week out. One of these wheels, of which we have upwards of fifty, produces 25 times as much as the whole of our first factory. The base is turned over to the sensitizing department in rolls 41 inches wide and 2,000 feet long and is so accurately made that it does not vary over one-four thousandth of an inch in thickness. Of course only a part of this product is for motion pictures.

Yours very truly,
(*Signed*) George Eastman

It is understood that the above statement will be incorporated in the records of your Society as an unaltered whole.

The last personal statement I shall present is one by Mr. Albert E. Smith, President of the Vitagraph, and one of the two men who originally formed that company in March, 1897. Unfortunately, when I saw Mr. Smith he was about ready to leave for the west coast, and could only take time to dictate a very brief statement.

The information about the "Idoloscope" is interesting, also, you will note that Mr. Charles Webster, whose photograph I will show you later, and who was the projectionist the second night Thomas A. Edison saw motion pictures in their present form, was one of the firm known as the International Film Company.

I think but few of us knew that William T. Rock did not join the Vitagraph until two years after it was organized. I know I always had the idea myself that it was he who organized the company.

The thing called by Mr. Smith the "setting device," was what we now know as a "framer." Mr. Smith's explanation of its invention was that the film would "creep up" out of frame in the friction type of projector, and the framer was designed to overcome that fault, or to neutralize it, rather.

Mr. Smith says:

ALBERT E. SMITH, President

THE VITAGRAPH COMPANY
OF AMERICA
EXECUTIVE OFFICES
E. 15th St. & Locust Ave.
BROOKLYN, NEW YORK

April 13th, 1925,

Mr. F. H. Richardson,
646 West 158th Street,
New York, N. Y.

Dear Mr. Richardson:

The following statement covers dates of happenings of early items of interest in the history of the Vitagraph Company, which I trust will be of use to you:

The Idoloscope was brought out in 1896. It was a special machine, using a special film, in the camera of which the film ran continuously and in which the film was rendered optically stationary, by the aid of a slot in a 360° shutter.

The film was first projected with a machine in which the film ran continuously, but later was projected with the aid of a Pitman or Beater movement which Beater movement was later incorporated in the camera.

The film and apparatus of the old Idoloscope Corporation was purchased by Mr. J. Stuart Blackton and Mr. Albert E. Smith in the early part of 1897.

The International Film Co. was owned by Messrs. Webster and Kuhn. They operated from 1896 to 1898.

The Vitagraph was organized by Mr. J. Stuart Blackton and Mr. Albert E. Smith in March, 1897.

Mr. William T. Rock joined Vitagraph in the summer of 1899.

Vitagraph's first projector was built by Mr. Albert E. Smith in 1896. It had an intermittent friction movement, and the setting device that was incorporated in all later Vitagraph machines and was copied on all Edison projectoscopes and was imitated by most other projectors, was the same setting device that was devised on the original Vitagraph projector in 1896. The non-flicker shutter was devised by Mr. Albert E. Smith, and used on Vitagraph machines in 1898.

The first pictures by electric light were taken in 1899 by Mr. J. Stuart Blackton and Mr. Albert E. Smith, at the old Manhattan Theatre in New York, which was loaned for the occasion by William A. Brady. Upon demonstrating the success of photographing by electric light, Mr. Brady then contracted with Mr. Blackton and Mr. Smith, to photograph pictures of the Fitzsimmons-Jeffries Fight at the Coney Island Sporting Club, in 1899.

Unfortunately, the cylinder head of the engine of the special plant, which was installed at Coney Island to furnish the current for this operation, blew out at the start of the fight, and therefore, the entire fight was never photographed.

The enlargement over Mr. Rock's desk in the photograph showing the early Vitagraph Office, is an enlargement of one of the moving pictures taken of the Fitzsimmons-Jeffries Fight.

The first picture was made by Mr. J. Stuart Blackton and Mr. Albert E. Smith on the roof of the Morton Building, No. 140 Nassau Street, in the fall of

1897. It was a short comedy picture, about 45 feet in length, and was called "The Burglar on the Roof."

The average length of pictures at this period, ran from 40 to 75 feet.

The early pictures of the Vitagraph Company were either topical, that is, scenes of every-day occurrence, comedy, or magical pictures—the magical pictures being what were known as the "stop-motion" variety, that is to say, the action would be carried to a certain point, where the director would call "stop." Everyone then would hold the position that they happened to be in at the moment. Some change would then be made in the development of the action, that is to say, a character's coat might be taken off and laid on the floor, and when this action was carried out, the director would give the word "go." The camera would start to grind, the characters would start further business, until they again received the word "stop," when some other change would be made.

When the negative was finally cut and edited, the effect of this particular business would be that, during the course of the action, one of the character's coats would suddenly fly off onto the floor.

All the magical effects were instantaneous happenings, produced somewhat after this fashion and along these lines.

The first "stop-motion" picture of this nature produced by Vitagraph, which made a big hit throughout the country ,was a "Visit to the Spiritualist," in which all kinds of mysterious things happened, the same being brought about by the above described method.

The foregoing relates to pictures taken prior to 1900.

The first animated cartoon was made by Mr. J. Stuart Blackton and Mr. Albert E. Smith, in the year 1903.

The first director engaged by Vitagraph was Mr. G. M. Anderson, who joined the Vitagraph forces in 1904. He later became the partner of Mr. George K. Spoor in the Essanay Film Producing Company, Chicago.

Florence Turner was the first Vitagraph star, and I believe the first film star. She joined Vitagraph in 1905, becoming popularly known as "The Vitagraph Girl."

Very truly yours,
A. E. Smith, *President*

I shall now show you various pictures, some of which are my own property and some of which have been loaned to me. Many of them are very valuable, because of the fact that no known duplicates exist. Mr. William Reed, Motion Picture Projectionist at Atlantic City, New Jersey, is owner of some of the most rare and interesting ones.

Let me say that Mr. George Eastman and Mr. Thomas A. Edison are two of the great men on earth—men whose names and whose works will live so long as the history of our time shall last.

Both Mr. Edison and Mr. Eastman were pioneers in the very forefront of the motion picture industry. Both Mr. Eastman and Mr. Edison have told you the story of what they did in the early days. It would be presumptuous for me to dilate upon the tremendous influence these two gentlemen have had upon the perfection of the thing which has come to be the most widely patronized and the most keenly enjoyed form of public amusement the world has ever known.

Next I present (Fig. 6) to you a gentleman who needs no introduction to the Society of Motion Picture Engineers, because C. Francis Jenkins was chiefly instrumental in bringing about its formation and in literally nursing it through its first years of life.

Fig. 6. Mr. C. Francis Jenkins.

Had C. Francis Jenkins done no other thing for or in the motion picture industry than to form this Society, surely that one act would be quite sufficient to write his name upon the Roll of Honor of the industry as a man who did really worthwhile things.

The next picture (Fig. 7) is that of William T. Rock, one of the pioneers in both the production and exhibition end of the motion picture industry. It was he, who, together with his partner, Mr. Wainwright and William Reed, projectionist, opened Vitascope Hall, corner of Canal Street and Exchange Place, New Orleans, Louisiana, in June, 1896, which was the first theatre used strictly and exclusively for the exhibition of motion pictures of which I have been able to discover tangible evidence—any evidence other than the personal statements of various individuals, which same I have invariably found to be more or less contradictory. I shall present to you a photograph of this theatre and of its programme before I have finished.

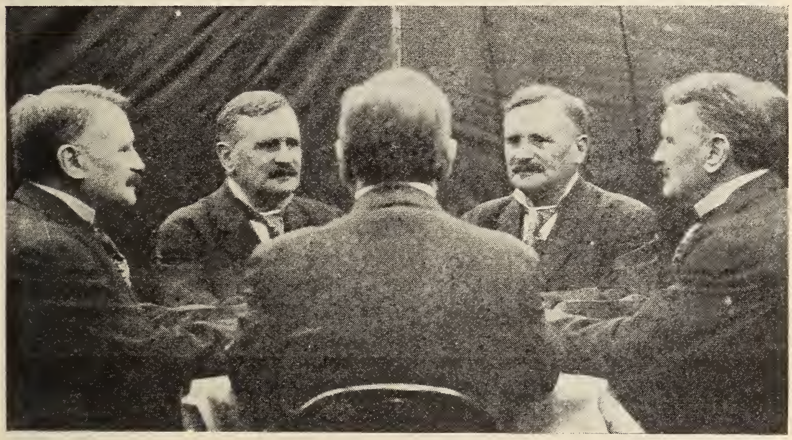


Fig. 7. The late William T. Rock, President of the Vitagraph Company of America from the time it was organized until his death some years ago. Mr. Rock and his partner, Mr. Wainright, opened the Motion Picture theatre in New Orleans, in the year 1896, which was the first theatre, of which visible evidence still remains, devoted exclusively to motion pictures. Mr. Rock was, during his lifetime, one of the most widely known men in all the motion picture industry of that day.

Mr. Rock, who was popularly known throughout the industry of that day as "Pop" Rock, joined the Vitagraph Company in its early days (1899) and, up to the time of his death a few years since, was its president. He was in many ways a picturesque character, an excellent business man, and very capable in the matter of forming correct judgment as to the amusement value of various things. He loved diamonds, his collection of them being famed throughout the entire industry of that day. The picture selected is somewhat in the nature of a "freak," but it nevertheless is a most excellent likeness of Mr. Rock, as the writer remembers him. It was taken during the last years of his life.

The next picture (Fig. 8) is that of William Reed (left) and Charles Webster (right). It was Charles Webster who acted as projectionist on the second evening that Thomas Edison witnessed the projection of life size pictures on a screen by means of Mr. Armat's "Vitascope" projector. On the first evening Mr. Armat himself projected the pictures. That was the first time Mr. Edison ever saw

Fig. 8. Mr. William Reed (left) and Mr. Charles Webster (right).

motion pictures projected to a screen at full life size, though at that time he was himself working on a projector designed to do that very thing.

William Reed was the man who left a position with Messrs. Raff and Gammon where he was "keeping tab" on Edison peep-hole Kinetoscopes in Boston and vicinity, and went with Messrs. Rock and Wainwright to New Orleans, Louisiana, in the spring of 1896, where he acted as motion picture projectionist, using an Armat "Vitascope," which same had then been taken over by Mr. Edison.

After having filled an engagement in a New Orleans park, Messrs. Rock and Wainwright opened "Vitascope Hall," as will be hereinafter set forth.

Mr. Reed was the guest of this Society at its Atlantic City dinner, in May, 1923. He has requested that I convey to you his felicitations and earnest good wishes. He has projected motion pictures continuously from the time he started in New Orleans in 1896 up to the present time. He is today projectionist at the new Palace Theatre in Atlantic City, New Jersey.

While it cannot be said that Mr. Reed was the first man to project motion pictures, he was, nevertheless, the projectionist in the

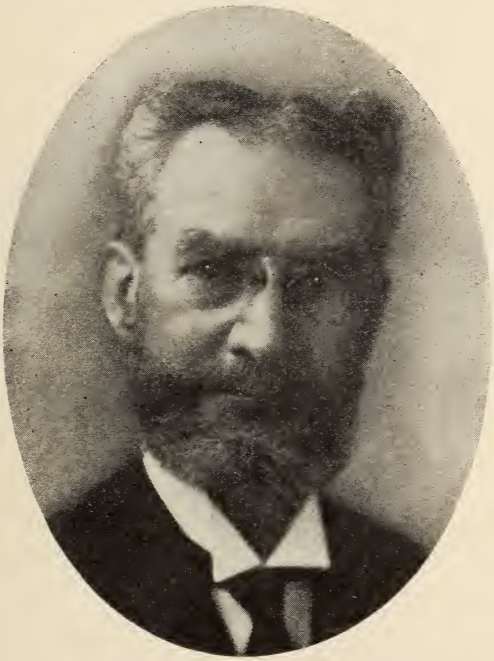


Fig. 9. Mr. Nicholas Power.

first strictly motion picture theatre of which we have printed, authentic record, and certainly his record entitles him to be hailed as the Dean of Motion Picture Projectionists.

Nicholas Power has passed to that bourne whence no traveler ever returns, into the shadows of which so many of the pioneers of the industry have already entered. Next to Mr. Edison himself Mr. Power was the first man to manufacture motion picture projectors on a commercial scale for use in the United States of America and Canadian America. In fact, so far as I have been able to find out, for some time after Mr. Power himself began manufacturing projectors the Edison Company was his only rival in that field. Certain it is, that the Edison Company and Mr. Power were the only ones who put out any considerable number of projectors in the very early days of the industry.

Just how Mr. Power, who I have been told, was a dabbler in real estate dealings before he took up projection, first came to take up projection I have not been able to ascertain. His family refused to

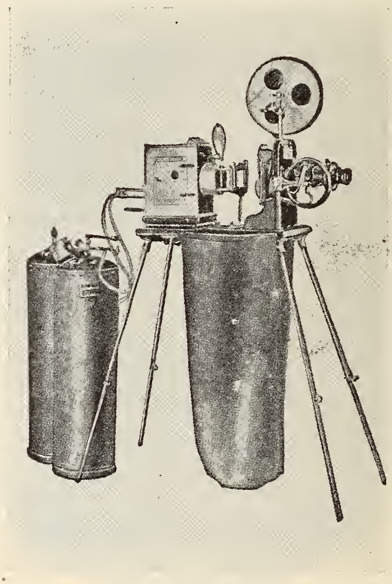


Fig. 10. The Power's Peerless Projector.

give any information on the subject. Either in the fall of 1896 or the spring of 1897 he was acting as projectionist at the Koster and Bial Music Hall, on Twenty-Third Street, near Sixth Avenue, New York City. Afterwards he was projecting pictures at a vaudeville theatre in Brooklyn. The story is that one day when he took down the intermittent movement of his Edison projector, he was unable to get it back in time for the evening show, had a go-round with the theatre manager and quit—either voluntarily or "by request."

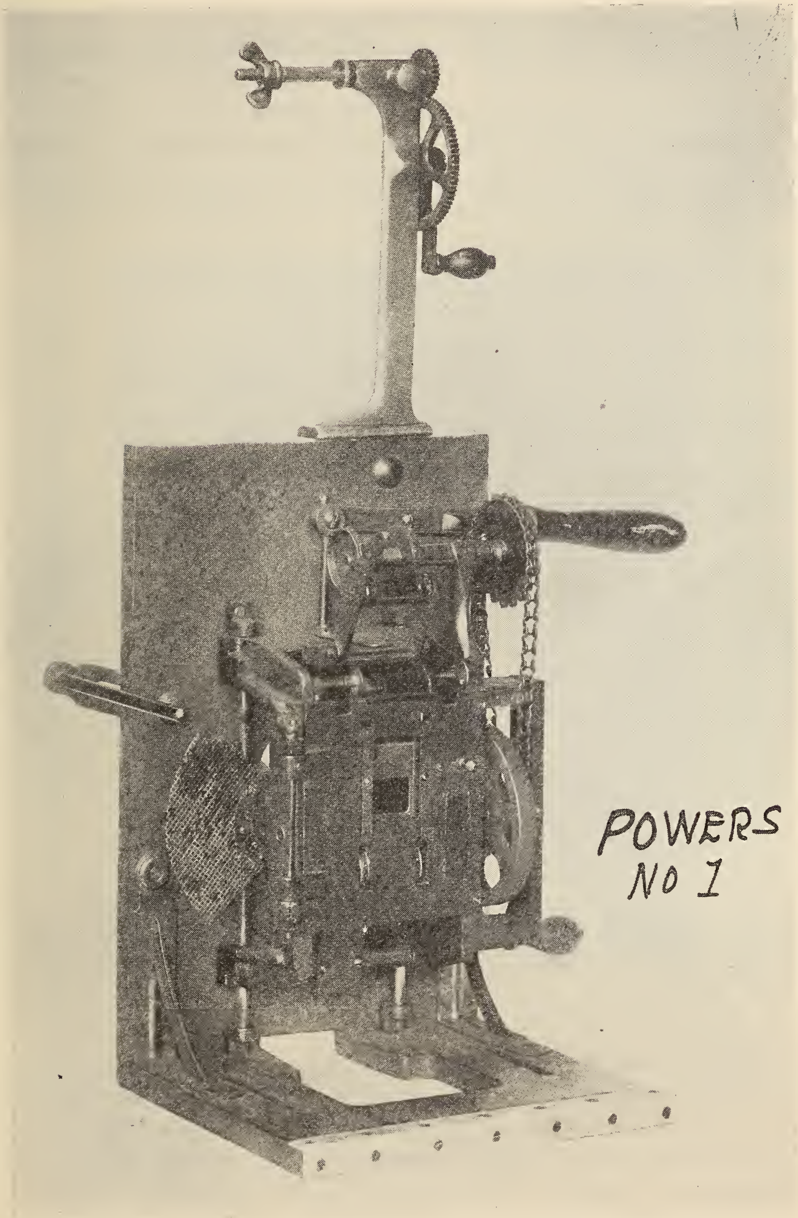


Fig. 11. The Power's No. 1.

Shortly thereafter he leased a room on the third floor, 117 Nassau Street, where he started a repair shop for Edison projectors. Soon he conceived the idea of making changes in the mechanism of the projectors. I am told that his first improvement was the changing of the then two-pin Edison Geneva movement to a one-pin. He then added other changes and improvements of his own, and soon came out with what he called the Power's Peerless Projector, very few of

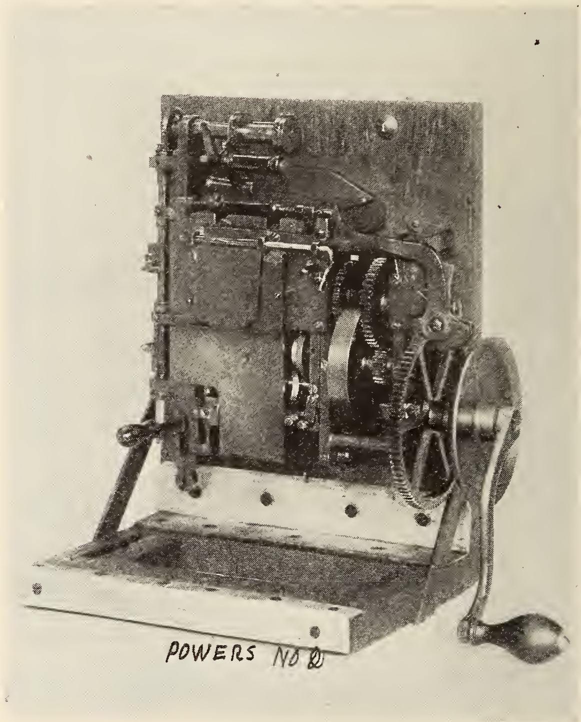


Fig. 12. The Power's No. 2.

which were actually made and sold. In the accompanying picture, (Fig. 10), notice the sack for catching the film after projection. This is a very genuine relic of the distant past of motion picturedom. I very much doubt if there is another picture of this projector in existence.

Shortly after the advent of the "Power's Peerless," which must have come out some time in either 1897 or 1898, Mr. Power brought out his "Power's No. 1" projector, which was followed by the No. 2, No. 3, No. 4 and No. 5 models, all of which appeared between 1897 or 1898 and 1907, in which latter year the No. 5 appeared, it being the first approach to a really high grade projector mechanism in general use up to that time, except that the Motiograph had appeared shortly before, and George K. Spoor, of the Essanay Producing

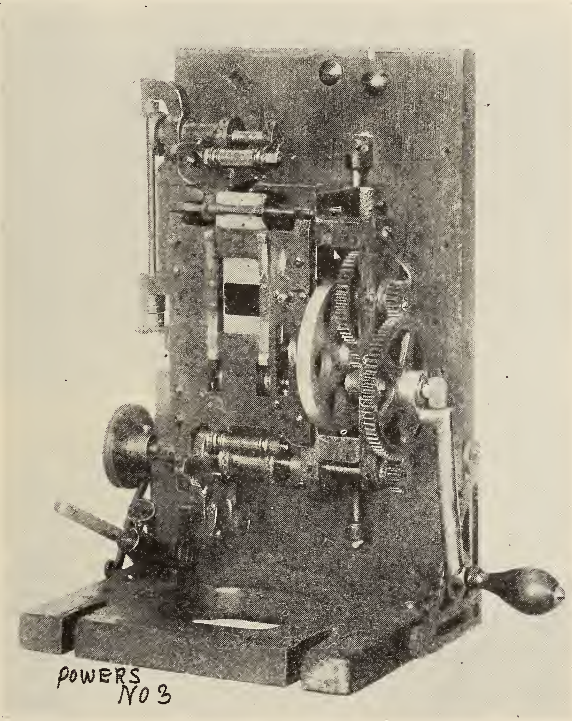


FIG. 13. The Power's No. 3.

Company had put out a limited number of "Kinedrome" projectors, which were distinctly high grade mechanisms, as also were the motiographs.

During the first ten years of the industry, or up to about 1907, the only projectors having anything like a general use were the Edison, the Power, the Vitagraph, the Lubin, the Selig and (around Chicago, Illinois, only) the Motiograph, the Spoor Kinedrome and

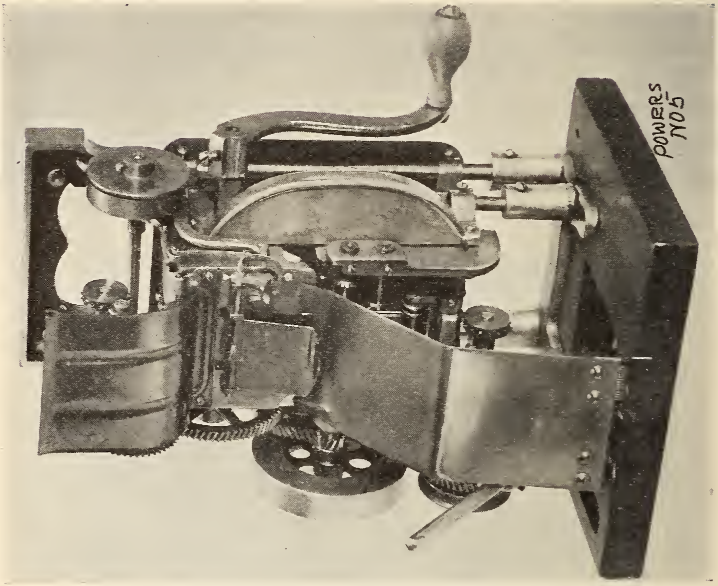


Fig. 15. The Power's No. 5

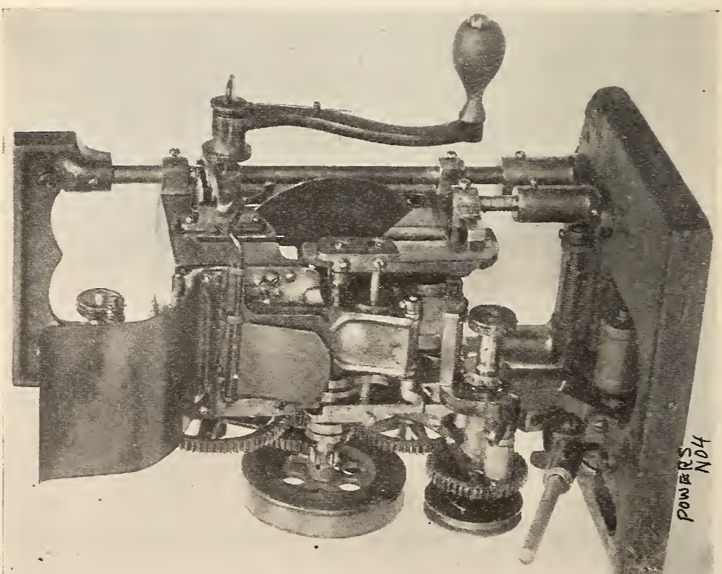


Fig. 14. The Power's No. 4.

a claw-movement projector made by a man named Pink, called the "Viascope." I have been unable to ascertain the exact dates at which these various projectors appeared. Except for the Powers and the Motiograph (The Simplex did not come into the field until about 1911) they have all entirely disappeared, though being permitted to rummage through the "morgue" of the Nicholas Power Company, examples of several of their mechanisms were discovered, covered with the dust and grime of many years. Through the kindness of the

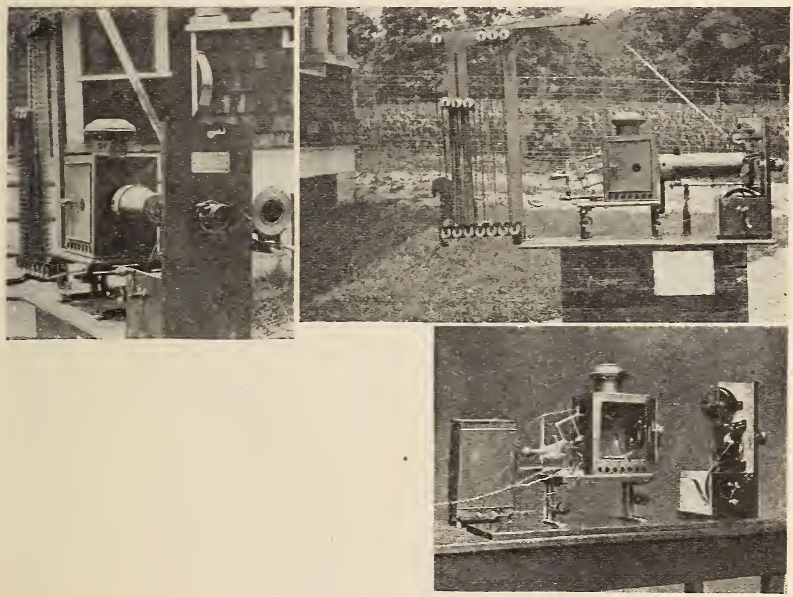


Fig. 16. The Edison Spoolbank projector. In one, the film is in a roll. The reels were supplied with the outfit. In the other are two views of the Edison Spoolbank Projector. Note the diminutive size lamp house and how the film runs in a continuous band over the banks of spools.

Power's Company I secured photographs of these mechanisms, which will, I am sure, interest you. I will show them to you a little later.

I show you (Fig. 16) the famous Edison "spoolbank projector," of which you doubtless all have heard, and many have wished to see. The photograph of this relic came into my possession as technical editor of the *Moving Picture World* some years ago. By looking closely you may be able to trace the path of the film, which was in the form

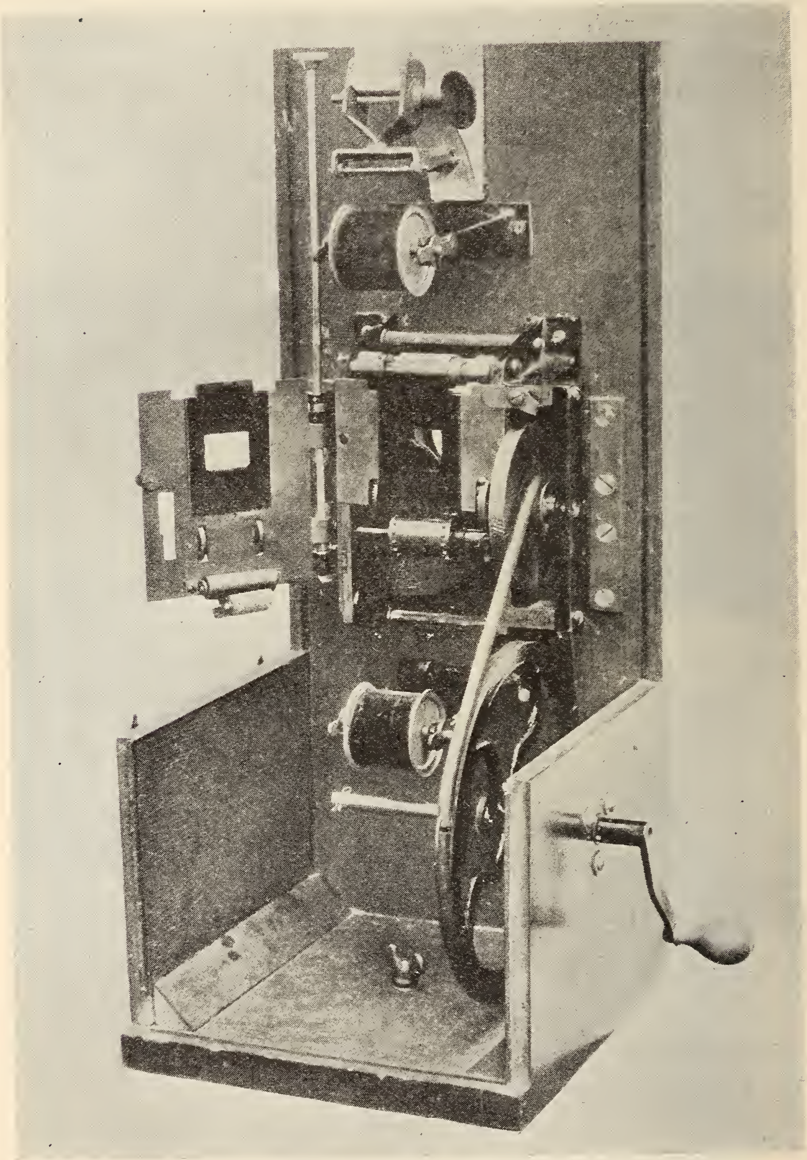


Fig. 17. The Edison Spoolbank Mechanism.

of an endless band. The "spoolbank" was merely a device to permit of using a band of film having greater length than could be used without it. The two upper views are two views of the same projector, while the lower one shows it, minus the spoolbank and fitted to use an upper reel, which same you may see is merely a core, or hub, with four projecting spokes on either side, to hold the film roll in position.

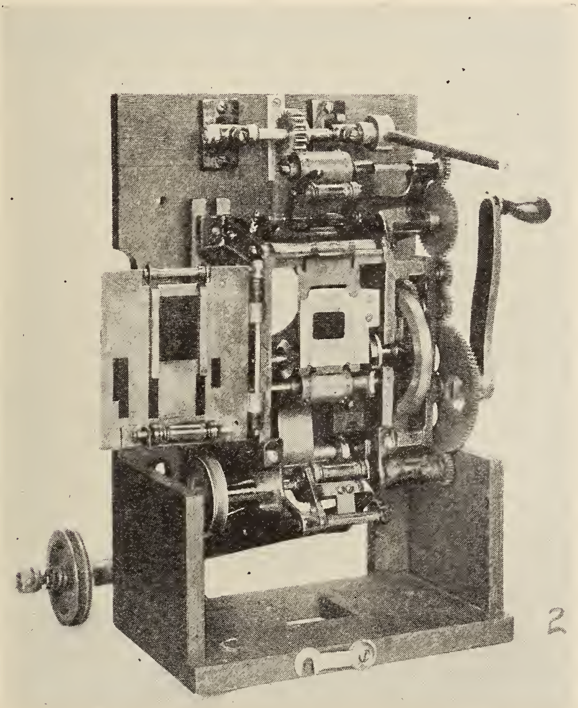


FIG. 18. The Edison "Exhibition Model" projector.

Notice the diminutive lamp house, and that the lamp mechanism was located entirely outside of it, only the long, flimsy carbon arms extending into its interior. Notice also how the lamp house sets up on a stand to bring the condenser in line with the projector aperture. The rheostat is, you will observe, well encased in a sheet metal cover.

In Fig. 17 you see the mechanism of the Edison spoolbank projector. It is the same general style, with its wooden frame, to which Mr. Edison clung, with slight variations, for many years—until about 1907.

In Fig. 18 you see Mr. Edison's final perfected projector. Very soon after it was finished, and before it was placed on the market, Mr. Edison decided to abandon the making of motion picture projectors, which he did, so that the "Super" never actually came on the market at all.

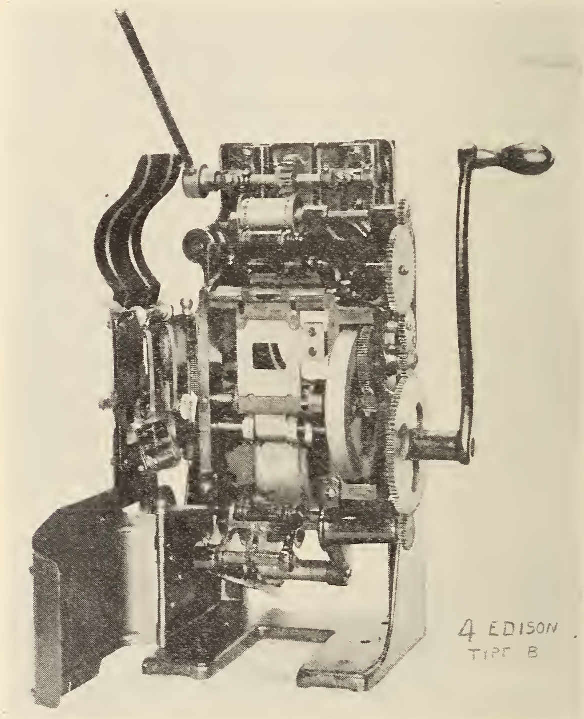


FIG. 19. The Edison "Model B" Projector.

The only model of projectors Mr. Edison ever placed on the market was the Edison "Exhibition Model," of which many thousands were sold. It had, as you may see, a wooden frame. It had an "inside shutter," the interrupter blade of which was perforated.

The Model B came out about 1907 or 1908. It had a metal frame, but aside from that change and several improvements, it clung closely to the old Edison style of projector.

Motiograph Early Models

I present to you (Fig. 20) a picture of the Model No. 1A Motiograph, its predecessors the No. 1, No. 2 and No. 3 Optograph and

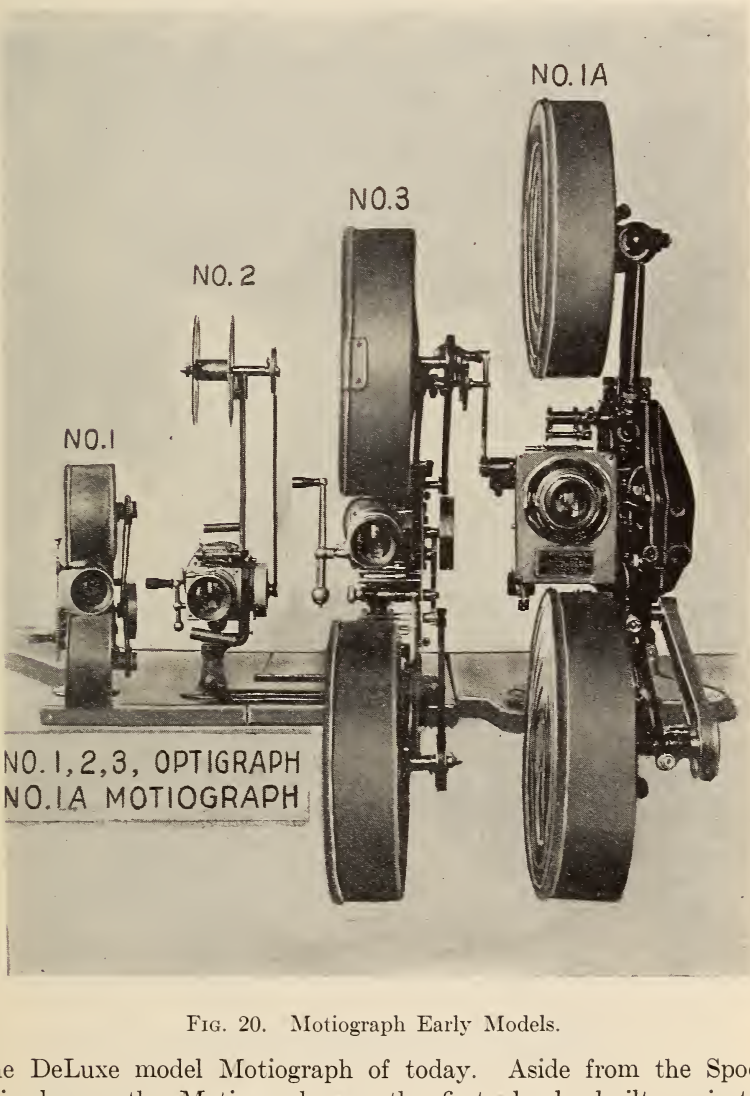


Fig. 20. Motiograph Early Models.

the DeLuxe model Motiograph of today. Aside from the Spoor Kinedrome, the Motiograph was the first closely built projector mechanism given us. It was the invention of Mr. A. C. Roebuck, a

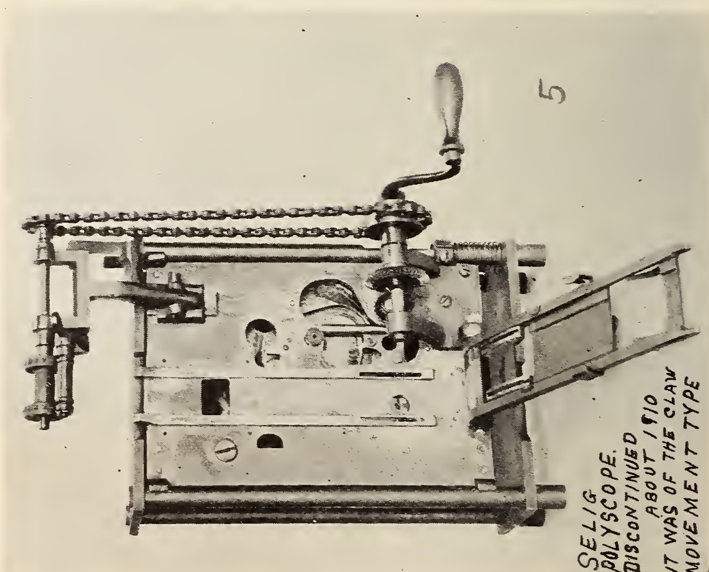


Fig. 21. Selig Projector Mechanism.

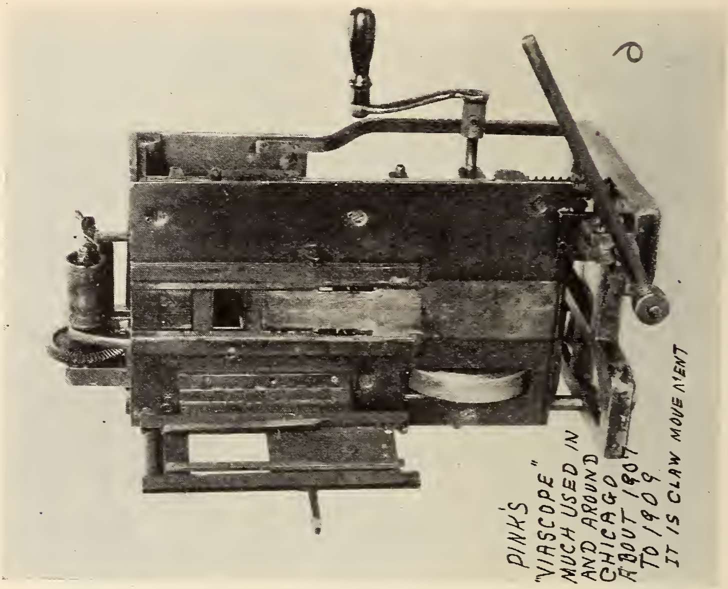


Fig. 22. Pink's Viascope.

member of the Society of Motion Picture Engineers, and a man we all know well. What you may not have known, however, is that he was the original Roebuck of Sears, Roebuck & Co., the famous mail order house.

Fig. 21 is of the old Selig projector mechanism. Observe the small crank and the chain upper sprocket drive. It had a claw movement, commonly termed, at that time, a "finger feed." It was great on ripping out the divisions between sprocket holes.

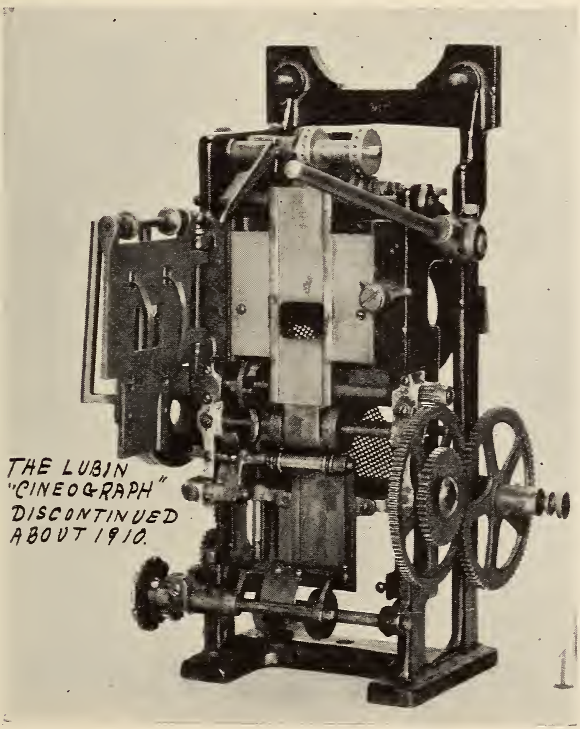


Fig. 23. The "Lubin Cineograph," discontinued about 1910.

In Fig. 22 is shown another claw movement projector mechanism, which was very popular in and about Chicago, Illinois, about 1907 and 1908. It was roughly built, but gave results considered very good in that day.

Lubin Projector

In Fig. 23 is shown the projector mechanism put out by Siegmund Lubin. It disappeared finally about 1912. It was crudely constructed and never very successful, though at one time rather widely used in the city of Philadelphia and territory immediately adjacent thereto, also it was used somewhat in other eastern territory.

A Stranger

This picture (Fig. 24) is made from a photograph which has been in my possession for a long while. Evidently it is an early type, and I have suspected it was one of Mr. Power's first efforts toward chang-

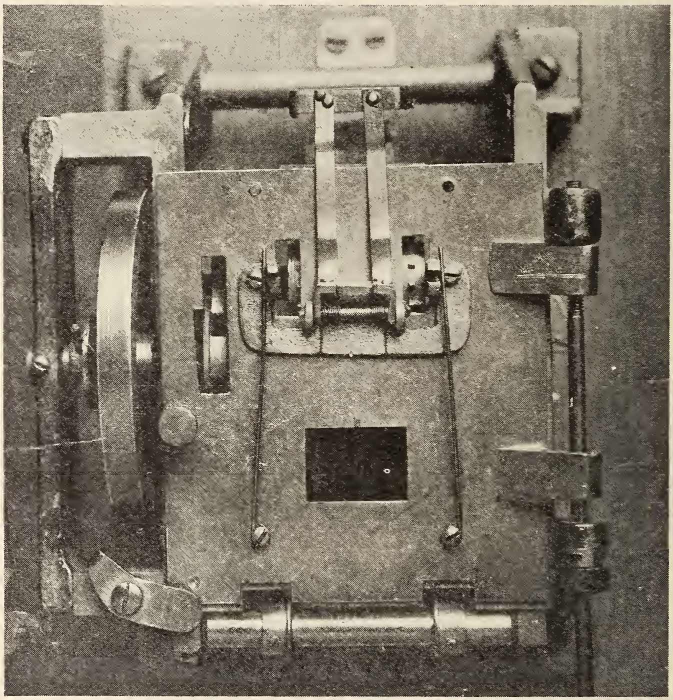


Fig. 24. A Stranger.

ing and improving the Edison projector. Note the framing device which raises the gate bodily a short distance by means of a slow-acting screw.

Amet Magniscope

This picture (Fig. 25) is of the Amet Magniscope, a projector invented by a man named Amet, who now is located in Mobile, Alabama. At the time he evolved this mechanism he lived near

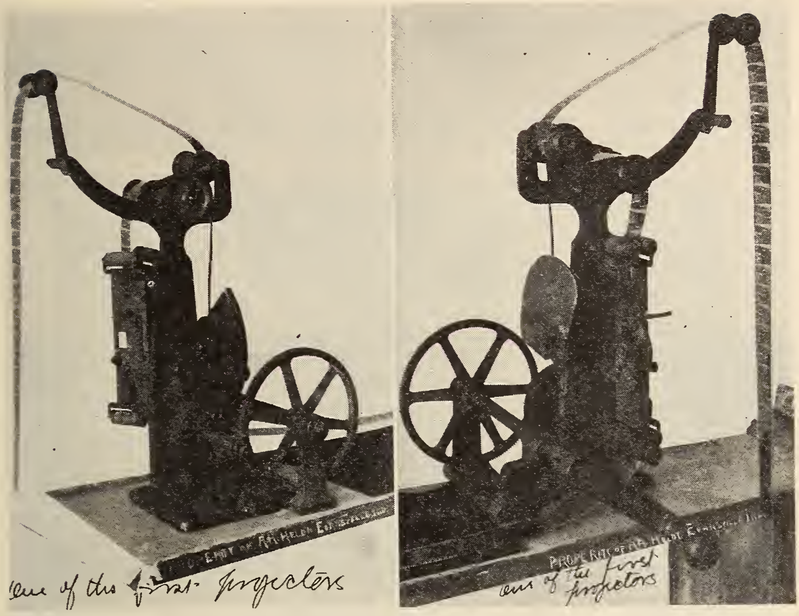


Fig. 25. The Amet Magniscope.

Fig. 26. Old Films.

Chicago, Illinois. Its intermittent movement was of the clutch trip type, hence, enormously noisy and quite impractical. It projected nine pictures per turn of the crank. The picture is only of interest as showing one of the early efforts to evolve motion picture projectors.

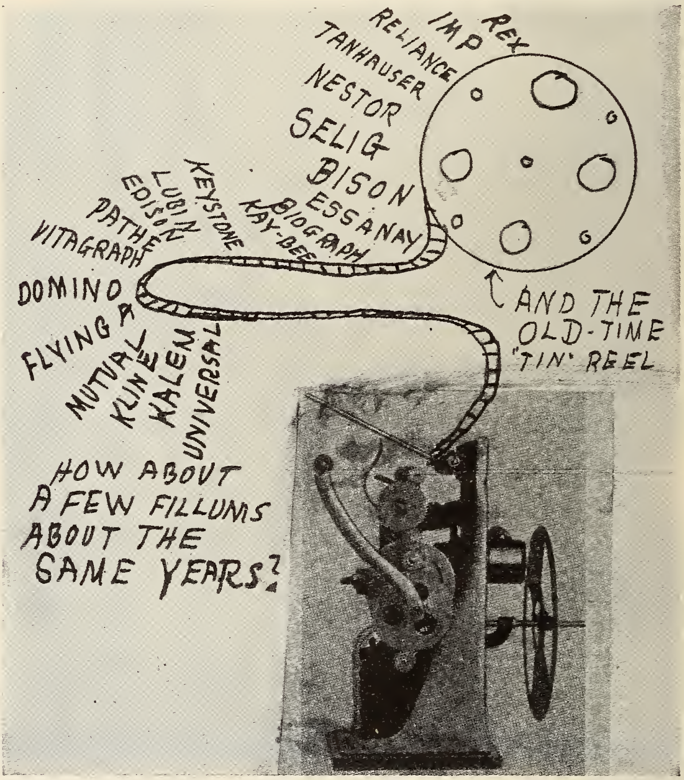


Fig. 27. Old Type Films.

Here is a projector mechanism which was considered one of the best and most popular no longer ago than 1912. Thousands of them were then in use. How many of you can name it? I had the engraver remove the name plate in making the engraving.

Old Type Film

I show you in Fig. 26 some of the early types of film. I have lost the data connected with the one to the right. Note the wide spacing between the pictures and the round, queerly placed sprocket holes. The Veriscope film and projector were made especially to "take" the Fitzsimmons-Jefferies prize fight. It was, so far as I know, never used for anything else.

Old Films

Some months since I published a picture of an Edison Model B mechanism, asking how many projectionists could identify it. One man sent the drawing shown in Fig. 27 in addition to the picture of the mechanism. It is distinctly interesting. I venture many of you had almost entirely forgotten some of these one-time popular films.

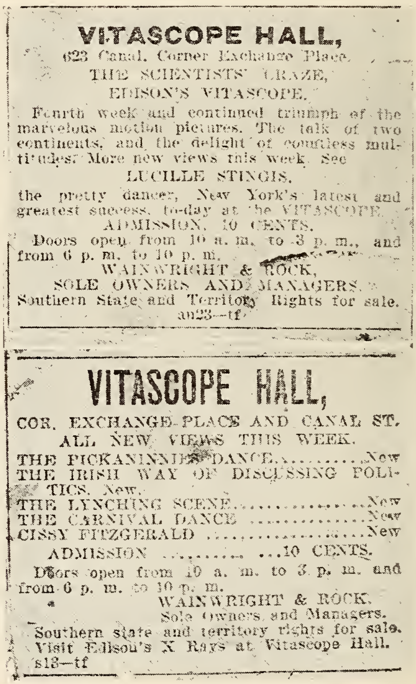
Fig. 28. Vitascope Hall.

Vitascope Hall

I now present a photograph of "Vitascope Hall," opened by Messrs. Rock and Wainwright as a strictly motion picture theatre, in June 1896. Its location was the corner of Canal Street and Exchange Place, New Orleans, Louisiana. They showed, among other things, the "May Irwin Kiss," "Waves of Dover," also a lot of short scenic stuff. Admission was ten cents. For ten cents additional patrons were permitted to peek into the "projection room" and for another ten cents they were presented with one frame of old film.

The projector used was the Armat Vitascope, then being produced by Thomas A. Edison, and, for business reasons, called the "Edison Vitascope." That last is on the authority of projectionist, Reed, who had it direct from Mr. Rock, who himself purchased the projector.

The theatre was a store room fitted with a screen, wooden chairs, an enclosure for the projector, a ticket booth and a name—Vitascope



VITASCOPE HALL,

623 Canal, Corner Exchange Place.

THE SCIENTISTS' CRAZE,

EDISON'S VITASCOPE.

Fourth week and continued triumph of the marvelous motion pictures. The talk of two continents, and the delight of countless multitudes. More new views this week. See

LUCILLE STINGIS,

the pretty dancer, New York's latest and greatest success, to-day at the VITASCOPE.

ADMISSION, 10 CENTS.

Doors open from 10 a. m. to 3 p. m., and from 6 p. m. to 10 p. m.

WAINWRIGHT & ROCK,

SOLE OWNERS AND MANAGERS.

Southern State and Territory Rights for sale.

au23—tf

VITASCOPE HALL,

COR. EXCHANGE PLACE AND CANAL ST.

ALL NEW VIEWS THIS WEEK.

THE PICKANINNIES DANCE..........New

THE IRISH WAY OF DISCUSSING POLITICS. New.

THE LYNCHING SCENE..............New

THE CARNIVAL DANCE..............New

CISSY FITZGERALD..................New

ADMISSION ....10 CENTS.

Doors open from 10 a. m. to 3 p. m. and from 6 p. m. to 10 p. m.

WAINWRIGHT & ROCK,

Sole Owners and Managers.

Southern state and territory rights for sale.

Visit Edison's X Rays at Vitascope Hall.

s18—tf

FIG. 29. Vitascope Hall Program.

From the Bill of the Theater at 623 Canal Street, New Orleans, La., in the fall of 1896, of which you have been shown a photograph. Take note of the admission price, also the reference to "Edison's Vitascope" and "Edison's X-Rays."

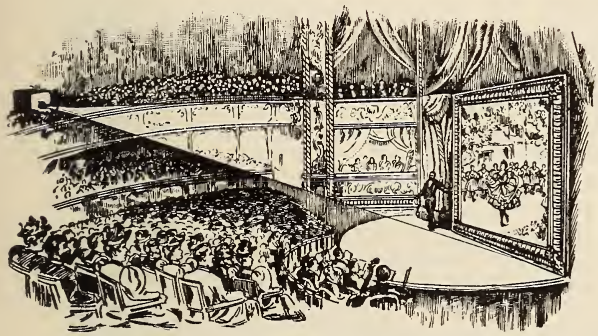
Hall. It seated about four hundred people. In the photograph you see its operators, Messrs. Rock and Wainwright, standing in front, together with its projectionist, William Reed. Mr. Rock is at the extreme right, with Mr. Wainright next to him. Mr. Reed is at the extreme left. The names of the others are unknown. You will observe that "Li Hung Chang" was the bill on the day the photograph was taken.

Vitascope Hall Program

Here, gentlemen, is the printed program of that little theatre of far-off days. Doors open 10 to 3 and 6 to 10.

Letter of Raff and Gammon

Messrs. Raff and Gammon, whose office was in the Postal Telegraph Building, 253 Broadway, New York City, were agents for the Edison Phonograph, and sole agents for the Edison peep-hole



Raff & Gammon

(ORGANIZERS OF THE KINETOSCOPE CO.)

EXCLUSIVE CONTROL OF THE
LATEST MARVEL

The Vitascope

SOLE AGENTS FOR THE
EDISON KINETOSCOPE
IN THE UNITED STATES AND CANADA
THE EDISON PHONOGRAPH

PHONOGRAPH AND KINETOSCOPE SUPPLIES,
ELECTRIC DESIGNS, ETC

Postal Telegraph Building, 253 Broadway
Removed to 43 W. 28th St.
New York,

Vitascope opened Keiths Theatre
May 4th — Boston, Mass

N. C. R.
Harry Brooks, Esq.,
2995 Washington St.
Roxbury, Mass.

Dear Sir:-

Replying to your postal card of the 5th inst., we beg to say that the right to Massachusetts has been sold, and if you wish to exhibit in that state, you will have to address the purchaser, Mr. P. W. Kiefaber, 419 New Market St., Philadelphia, Pa.

Would be glad to sell you the right to any state remaining open, but they are nearly all taken, and you should act promptly if you wish to secure such a right.

Very truly yours,

FIG. 30. Letter from Raff and Gammon.

This letter was written May 9, 1896, just about the time Mr. Edison had the Vitascope projectors ready for the market in considerable numbers. The note in ink was presumably made by Mr. Brooks. This letter is especially interesting as showing the avidity with which state rights were taken up.

kinetoscope. It was this firm who were responsible for Mr. Armat's invention being called to the attention of Mr. Edison. They heard of it, Mr. Gammon went to Washington and witnessed its performance, was so impressed with its apparent possibilities, even in its then very crude form, that he hastened to lay the matter before Mr. Edison, and plans were laid for a demonstration of the projector at the Edison laboratories. Evidently the demonstration was satisfactory, for arrangements were entered into immediately between Mr. Armat and Mr. Edison to build the projectors at the Edison plant. Due to the commercial value of Mr. Edison's name, it was decided it would be best to use it in connection with the projector, which thus became the "Edison Vitascope."

Fig. 31. The Black Maria.

Soon after this Messrs. Koster and Bial, who operated two music halls, one on West Twenty-Third Street, New York City, and one at Broadway and Thirty-Fourth Street, where the Macy Department Store now stands, booked the "act" (life size motion pictures) for their Thirty-Fourth Street house, paying the sum of five hundred dollars per week therefor. I might add that as soon as Oscar Hamerstine saw the "act" he offered one thousand dollars a week for it, but his offer was refused because Messrs. Koster and Bial had it under contract. Keith also tried to secure it for his Fourteenth Street Theatre, but failed for the same reason, whereupon he at once proceeded to import Lumiere cinematographs, which arrived in July, 1896, together with men to act as projectionists. Mr. F. Keith had an Edison Vitascope in his Boston, Providence and Philadelphia theatres early in May, 1896.

The first show at Koster and Bial's consisted in "Anabella in the Butterfly Dance," "Shooting the Chutes at Coney Island," and the "Waves of Dover," the latter being a surf picture made by a man named Paul, in London, England. James H. White and P. L. Waters, were projectionists on the night the "act" opened at Koster and Bials.

Fig. 32. The Vitagraph Office.

The Black Maria

In Fig. 31 is shown a photograph of what was the first strictly motion picture development plant in the entire world. It was a frame structure covered with black tar paper, and the Edison force quickly christened it the "Black Maria," which name clung to it and has been passed down to us as history. It was the building erected to develop motion picture films for use in the Edison peep-hole kinetoscope, but was used for a time to develop films for use with the Vitascope.

Mr. Edison still has the negative of this picture, from which he was kind enough to permit the making of a print for this paper. I feel that I cannot too strongly stress the advisability and desirability of this society, possibly acting in conjunction with others identified with the industry, devising some method by means of which such relics of early days may be collected and preserved in as nearly as may be a permanent way, for the benefit of posterity. I am sure that even so comparatively short a while as one hundred years from now such things will have value beyond all computation.

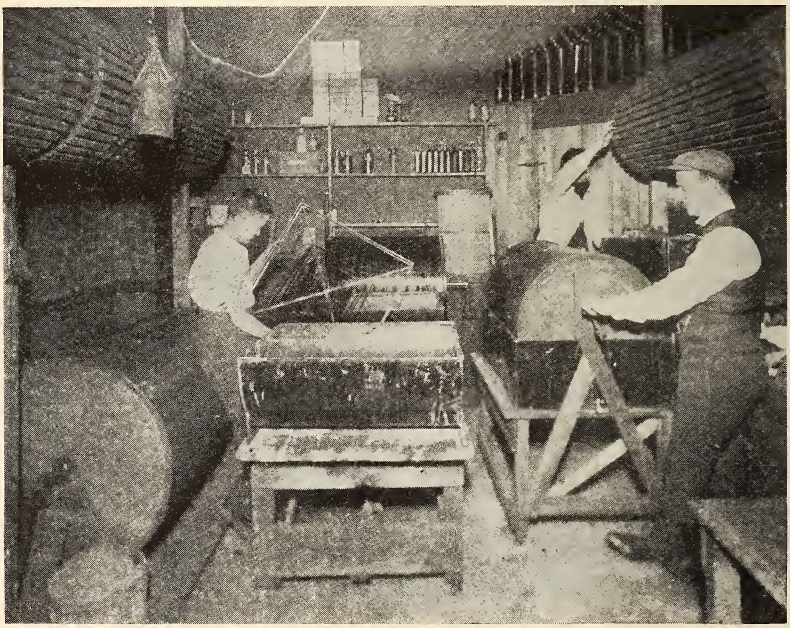


Fig. 33. The Vitagraph Development Plant in 1897. Contrast it with those of today.

Next I present (Fig. 32) two photographs, one of the office of the Vitagraph Company of America in its early days and one of the first development plant of the same company, the latter picture was taken in 1897.

In the first picture the late Mr. William T. Rock, then president of the Vitagraph Company, is seen seated at his desk at the left. Over his desk is an enlargement of one frame of the Fitzsimmons-Jefferies prize fight, taken by the company. At the right is J. Stuart Blackton, and in the center Alfred E. Smith, who became president of the Vitagraph Company after the demise of Mr. Rock. This office was at 116 Nassau Street, New York City.

It is most interesting to contrast the little plant shown in Fig. 33 with the motion picture development plants of today.

DISCUSSION

Mr. Jenkins: I suggest that Mr. Richardson's alleged facts should be substantiated by citations where evidence may be found to support his allegations, i.e., public documents, records, publications, *ex-parte* statements, oaths, etc.

I believe no one denies that my name is associated in some way with the period of transition from peep-hole machines to life-size picture projection.

An analysis of motion picture apparatus discloses that the only new essential over old apparatus was the adoption of *means for getting long illumination of the film at the exposure aperture of the projecting machine.* That was my contribution, and that is why the shutters were left off my early machines (Fig. 34), lantern slides of some of which were shown us by Mr. Richardson (see Figs. 4 and 5).

No projection of well-illuminated, life size motion pictures had been attained before the time I refer to, and no machine has been made since without this feature. This is conceded by the parties whose letters were read by Mr. Richardson. And as both Mr. Armat's and Mr. Edison's letters say that Edison got his projector from Mr. Armat and put his name to it in order to get more money out of the public, it would seem to be only a question of evidence of invention as between Mr. Armat and myself.

You doubtless noted yesterday that in Mr. Armat's letter he says he changed the name of his projector to the "Edison Projectoscope" or "Edison Kinetoscope" (from the original name Phantoscope).

Now "Phantoscope" is the fanciful name I had given all my motion picture apparatus.

If you will look up the *Photographic Times* of July 6, 1894, which can be consulted in any of the larger public libraries, you will find that this name "Phantoscope" was applied to my machines, with descriptions and accounts of exhibitions of them, months before I ever met Mr. Armat.

Many friends saw these exhibitions, and their affidavits and testimony can be found in suit Equity No. 5/167, U. S. Circuit Court, Southern District of New York. There also can be found the affidavit and testimony of the workman who made several of these machines for me, including the construction of the "1893-94 Phantoscope," the construction of which was paid for by J. P. Freeman.

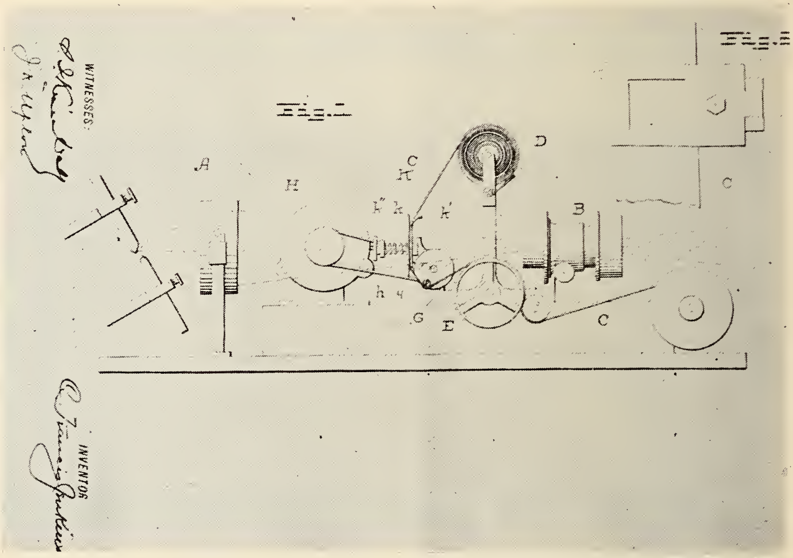


FIG. 34. The Jenkins Sole Application which was put in interference with the Armat-Jenkins joint application.

Mr. Armat, after investigating a machine of mine which projected motion pictures, believed he saw how he could make some money out of it as a promoter, as is explained in the preamble of our contract signed March 25, 1895, which reads as follows:

"This agreement, made and entered into this 25th day of March, 1895, in duplicate, by and between C. Francis Jenkins, of Washington, D. C., party of the first part; and Thomas Armat, of Washington, D. C., party of the second part, witnesseth, that—

Whereas, the party of the first part has filed application for letters patent of the U. S. for a certain invention of his known as the 'Phantoscope', and also for letters patent on certain new methods of photography, it is agreed that—

First: For and in consideration of One Dollar and the immediate construction and subsequent public exhibition and proper promotion by the party of the second part * * * "

You notice he admits that the Phantoscope is my invention, and he proposes to make, exhibit and properly promote my "Phantoscope."

Under this contract, three copies of my 1894 machine were made and taken to Atlanta, Georgia, for exhibition at the Cotton States Exposition. Mr. Armat called in a reporter to write up the trip, and his account appeared in the *Baltimore Sun*, October 2, 1895. The article refers to the machine which would be used, as "the Phantoscope, the invention of a Washington stenographer."

MR. EDISON OUTDONE

PHANTOSCOPE MORE WONDERFUL THAN HIS KINETOSCOPE

LIFE-SIZE FIGURES SHOWN

THE REMARKABLE INVENTION OF A WASHINGTON STENOGRAPHER

It will be shown for the First Time at the Atlanta Exposition, Where it May Reproduce All the Details of a Mexican Bull-Fight Without Fear of Interference by Mr. Ballou- It May Also Figure Largely at the Corbett-Fitzsimmons Prize-Fight at Dallas.

(Special dispatch to the *Baltimore Sun*)

Washington, October 2, 1895.

Mr. Armat was not, until much later, interested in claiming that he *invented* the machine, so he continued to give out news stories, even during my absence from Atlanta, about "The Phantoscope," for example, in the *Atlanta Journal* of October 15, 1895, and October 21, 1895, in which the exhibition of the machine continues to be referred to as the "Phantoscope."

Soon after Mr. Armat's return to Washington, he took one of the machines to New York, and there on the second floor of the Postal Telegraph Building, he exhibited it to Edison and his associates in December, 1895, as Mr. Armat explains in his testimony in the Armat-Latham-Castler suit.

About the same time I made another copy of the original 1894 Phantoscope machine and exhibited it before the Franklin Institute, Philadelphia. The invention was referred to the Committee on Science and the Arts for report. In due course, this committee recommended the award of the Elliott Cresson gold medal, their highest honor. This recommendation was published for three months in the *Journal* of the Institute, and Mr. Armat protested the proposed honor. His protest was dismissed. I quote from the report.

"Mr. Armat declined to submit testimony to substantiate his claims to inventorship, the protest is made up chiefly of aspersions upon the character of Mr. Jenkins, which matters are not relevant to the question. No allusion is made in said (Jenkins-Armat) agreement to any inventions made or contemplated by Mr. Armat. An interference was declared in the Patent Office to

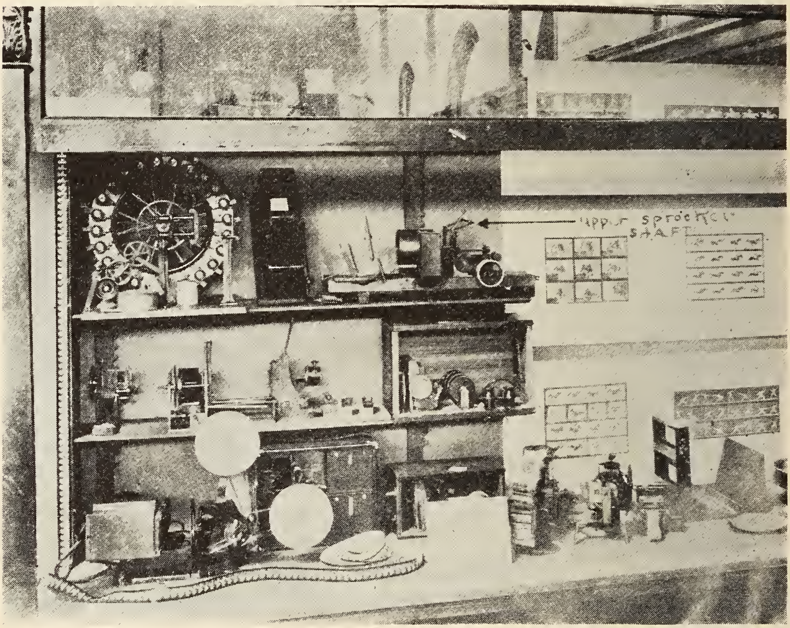


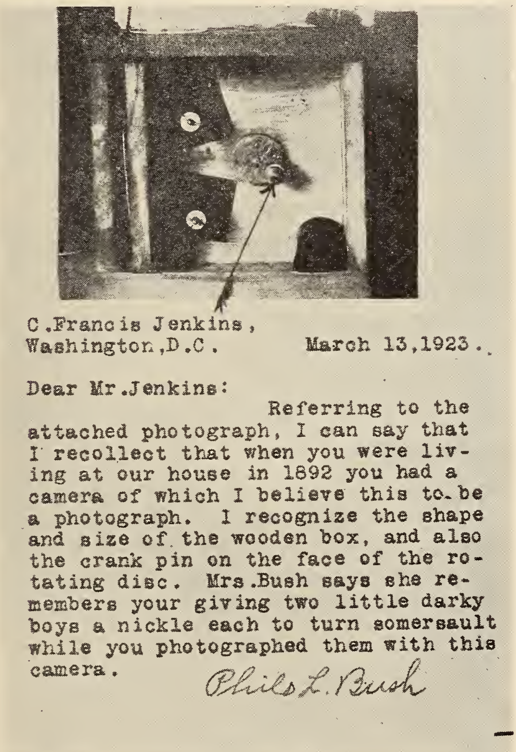
FIG. 35. A part of the exhibit of apparatus built and used by Mr. Jenkins in the development of motion pictures.

settle the question of inventorship. After Mr. Jenkins' testimony was given, Mr. Armat declined to maintain his claim as inventor by giving testimony before the Patent Office, but he, at that stage of the case, bought for a cash consideration, all of Mr. Jenkins interests in the Phantoscope, and had Mr. Jenkins withdraw his application, which made the way clear for the allowance of the joint patent (Jenkins-Armat No. 586,953)." Fig. 2.

So the Elliott Cresson award was made; and thirteen years later a second, the John Scott Medal was given me, perhaps to confirm their earlier judgment. I quote from that award.

"Eighteen years ago the applicant exhibited a commercial motion picture projecting machine which he termed the 'Phantoscope'. This was recognized by the Institute and subsequently proved to be the first successful form of projecting machine for the production of life-size motion pictures from a narrow strip of film containing successive phases of motion."

After signing a contract with Edison, Armat asked the Court to stop me from making, using, selling, or exhibiting my machine, or



C.Francis Jenkins,
Washington,D.C.   March 13,1923.

Dear Mr.Jenkins:
Referring to the attached photograph, I can say that I recollect that when you were living at our house in 1892 you had a camera of which I believe this to be a photograph. I recognize the shape and size of the wooden box, and also the crank pin on the face of the rotating disc. Mrs.Bush says she remembers your giving two little darky boys a nickle each to turn somersault while you photographed them with this camera.

Philo L. Bush

Fig. 36. One of the first cameras built by Jenkins. It has a crank pin for giving the film an intermittent movement behind the lens, later called the "Beater Type."

publishing any description of it. But Judge Hagner dismissed the suit in my favor, from which decision I quote. (In Equity No. 17, 416, D. C. Docket 40).

"Its statements (Photographic Times filed by plaintiff Armat) would seem to be of value to defendant Jenkins, inasmuch as it showed his attention had been directed to this subject at a period in advance of any intercourse between Armat and himself, and long before the date complainants attach to the alleged inventions of Thomas Armat. The injunction is denied."

I might say that all the evidence referred to by me this morning and much more has been collected and bound, in three copies, one of which can be found on deposit in the Franklin Institute. This evidence was gotten together at the request of the National Museum, at considerable labor and cost, and delivered to Dr. Charles D. Walcott, Director, but later, on inquiry, I was told the evidence could not be examined as the museum could not consider controversial subjects. May I add that much of the old apparatus I made and used in developing motion pictures had been in the National Museum for twenty-eight years, unchallenged, and can still be found there on exhibit.

As to Edison's invention of anything original connected with motion pictures, the United States Supreme Court decided he had not invented anything which had not already been disclosed by others. The decision appears in U. S. Supreme Court Record Vol. 243, U. S. 502, 61 L Ed. 871; Vol. 235, Fed. 398; Vol. 232, Fed. 363; Vol. 231, Fed. 701; and many others.

Quoting from C. C. A. 2nd Ckt. March 10, 1902—Fed. 114, page 926, the court said:

"The photographic reproductions of moving objects, the production from the negatives of a series of pictures, representing the successive stages of motion, and the presentation of them by an exhibiting apparatus to the eye of the spectator in such rapid sequence as to blend them together and give the effect of a single picture in which the objects are moving, had been accomplished long before Mr. Edison entered the field."

CONTROL OF SERIES ARC GENERATOR SETS

By J. H. Hertner*

There have been a number of papers presented before the Society relative to the direct current motion picture arc and the use of various types of motor generator sets for the production of such current. In several of these papers the relative advantages of the multiple and series systems are compared. A quite complete description of the multiple arc and the principal requirements of its successful design appeared in one of these papers. A brief outline of the design of the series arc machine might likewise be of interest.

The Usual Design of Shunt Wound Generators

Beginning with a generator of the usual design, unless some method is provided of increasing the magnetic strength of its fields, the effect of added ampere load is to cause the voltage produced to decrease and in a shunt wound machine this effect is so marked as to make the generator almost useless where a uniform voltage pressure is desired. A machine of this kind with the brushes set at the neutral point even if lightly loaded will immediately begin to lose voltage unless some means of continuous regulation of field strength is provided. This is due to several causes.

First, the losses in the armature and brushes must be subtracted from the voltage generated and this will cause a voltage loss proportionate to the load. Second, the armature, excited, becomes a magnet at right angles to the poles; its effect is to strengthen the trailing pole tips and to weaken the leading tips. Owing, however, to the fact that the permeability of iron is not constant, the net effect is to weaken the resultant field strength which decreases the voltage produced. Third, the field winding being now less strongly energized, the poles become weaker, producing less excitation so that the total effect is cumulative. A point is reached, where, if it is attempted to allow more current to flow by lowering the resistance of the load circuit, the voltage generated decreases so rapidly that the current remains constant over quite a voltage range and finally beyond this point the current will actually decrease as its path becomes less and less resistant.

* The Hertner Electric Company, Cleveland, Ohio.

Under ordinary conditions of design the current will not attain the critical point of constancy until the load has reached a value which is far in excess of what the machine can safely carry continuously, Fig. 1, hence means must be adopted to hasten this condition in order to have the current remain substantially constant over the entire working range of the generator. There are several ways of accomplishing this.

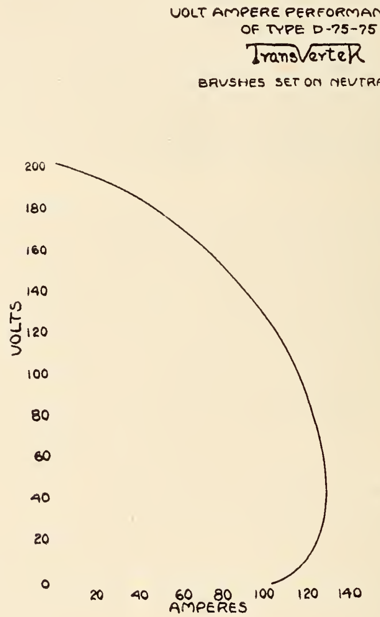


FIG. 1

Constant Current with Reversed Series

If the load current is carried around the field poles in a direction contrary to that of the shunt circuit, a demagnetizing effect is produced that is proportional to the load itself and which is zero at no load. This will carry the volt-ampere curve from the postion shown in Fig. 1 to that shown in Fig. 2. It may be remarked here that the effect of these reversed series turns is naturally but slight near the lower parts of the curve where the current is low.

Constant Current with Armature Reaction

A second method of control is available. Looking again at Fig. 1 where, as already explained, the effect of the load circuit is to cause the armature to become a magnet at right angles with the field, suppose the brushes are moved in the direcion of rotation, the magnetism produced by the armature will oppose the field in the same measure as the brushes have passed the neutral point and this component is in effect the same as if the load current passed around the field poles opposite in direction to that of the shunt, as already explained. By proper rocking, the volt ampere curve becomes the same as if the demagnetizing effect were produced by the use of the series field, and shown in Fig. 2.

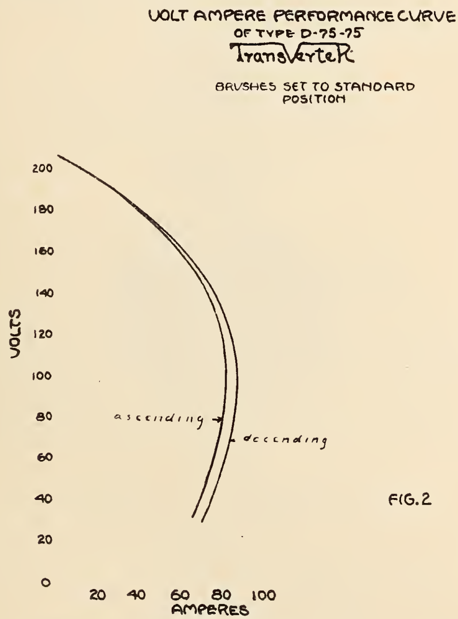


FIG. 2

Fig. 3 represents the magnetic lines as produced by the shunt field and with the brushes in neutral before any current is drawn from the generator. The arrow *a* indicates the direction and magnitude of this field. It will be noted that its distribution is substantially uniform. Fig. 4 shows the effect of a load in the armature. A cross field indicated by *b* is produced, giving with *a* resultant *c* shown, and with the distortion shown in Fig. 5.

Rocking the brushes as shown in Fig. 6 breaks up the armature magneto motive force into two components one of which *d* opposes the shunt magneto motive force *a* and has the effect of a reversed series field producing a resultant *e* of less magnitude than *c* already shown, and a distortion as pictured in Fig. 7.

To run two arcs in series requires about 120 volts and if the machine is to operate at 55 to 60 volts and again at 110 to 120 volts,

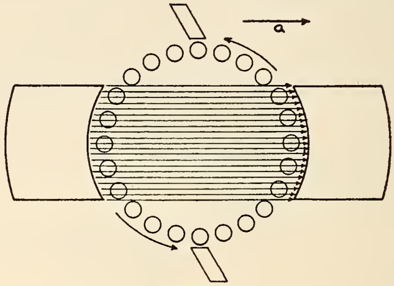


FIG. 3
SHUNT FIELD NORMAL, NO LOAD

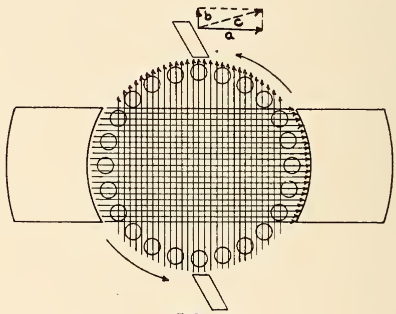


FIG. 4
SHUNT FIELD NORMAL, WITH LOAD

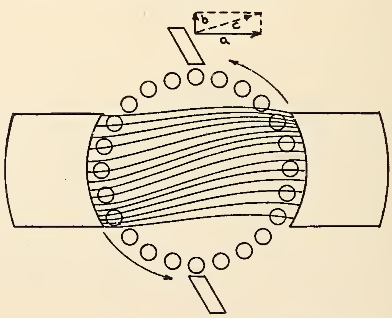


FIG. 5.—RESULTANT OF FIELDS SHOWN IN FIG. 4

it is evident that on open circuit the voltage must be in the neighborhood of 200. Such a machine on a single arc at 60 volts is running on a very weak field and likely to spark so that it becomes advisable to use interpole coils.

Compound Winding Versus Armature Reaction

With the compound wound machine the governing action to retain constancy of current must come from the series fields and as

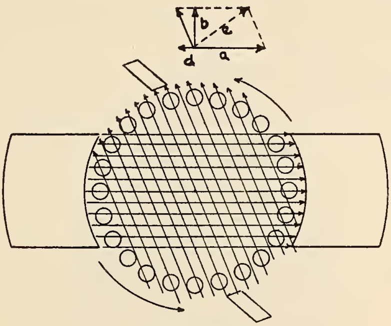


FIG. 6

SHUNT FIELD WITH LOAD AND NORMAL BRUSH SETTING.

they are located on the poles, the flux throughout the entire magnetic circuit must change to comply with the new condition. The flux for two arcs or 120 volts is substantially twice what it is on 60 volts. If the opposing force is in the armature itself, the field structure does

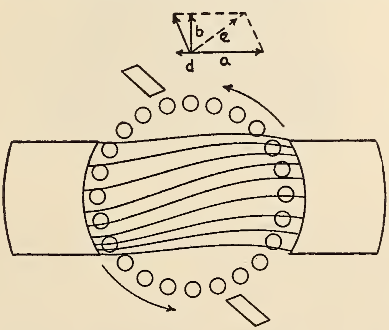


FIG. 7.—RESULTANT OF FIELDS WITH LOAD AND NORMAL BRUSH SETTING OF FIG. 6.

not enter into consideration to the same extent as it does with the reversed series field since a leakage flux is developed that need not travel through the field structure which ordinarily is not laminated and which introduces an element of sluggishness into the action. In the case of rapid fluctuations of the arc resistance there must be an instantaneous adjustment of magnetic flux and voltage if there are to be no current fluctuations. The control effected by means of armature reaction appears to have eliminated the current surges present in the compound generator on the high intensity arc.

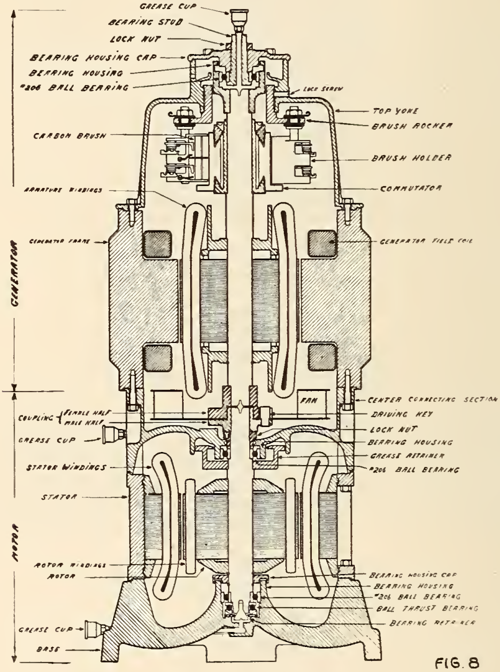


FIG. 8

Behavior of the Arc

It has been argued against the series generator that it is difficult to start the first arc in that it must be touched and pulled quickly. It has been found, however, that after a few attempts no difficulty will be experienced from this source. A very easy way of starting the arc is to bring the carbons together lightly with the short circuiting switch closed, next open the switch, a current will flow which is only a fraction of the full load current and a pressure of a few volts will be developed. If now the carbons are separated a trifle, the machine will build up full voltage and if the carbons are then touched the arc will follow without difficulty. The foregoing procedure eliminates the uncertainty of bringing the carbons together for an instant from an uncertain distance apart separating them promptly enough so as not to demagnetize the generator and only far enough as so to draw, and not to extinguish, the arc.

Starting the second arc on a series generator is, if anything, easier than with the multiple machine. If the carbons are touched together and the short-circuiting switch opened a short time before the arc is drawn, and full load current will pass between the carbons

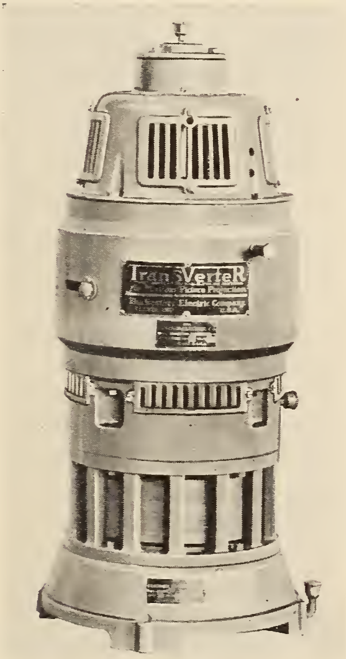


Fig. 9.

with about a 5-volt drop furnishing enough energy to bring them to a red heat so that on separating them, the arc will follow quietly without the necessity of warming up the tips while the arc is burning.

The curve of performance of the series arc machine on increasing voltage does not follow the curve on decreasing voltage. This, of course, is due to the retentivity of the iron. To get the nearest to a constant current performance on one and two arcs the descending curve or the one of amperes and decreasing voltage should be used in which case after the second arc has been struck going back to the single arc will cause no change in current value.

Fig. 8 shows such a close coupled motor generator of this type in section. In this unit the motor is below with the generator above, all ball bearing mounted. Fig. 9 is the same machine externally.

The exact handling of either the series or multiple generator is sometimes a matter of the personal taste of the projectionist. There are those who desire the nearest approach to unvarying current from two to one and one to two arcs and who will keep their arc lengths adjusted to very close limits. When using a multiple arc machine, many prefer a generator somewhat over compounded so that the points of single and double arc current are at about the same voltage. This, in spite of the fact that on open circuit the voltage will be considerably lower than on load. It might appear that this would lead to some difficulty inasmuch as when the arc length increases the current would drop off more rapidly because even on constant arc length the voltage drop across an arc is greater as the current decreases. With a lower voltage generated on light load, this effect would be more pronounced. But it must be remembered that the ballast drop decreases at the same time in proportion to the current decrease and that the performance curve is convex so that the effect of drop in generated voltage is slight until a point is reached where the current is considerably below normal so that the open circuit voltage can be somewhat lower than the full load voltage without any appreciably undesirable effect. The wide use of automatic control has also largely eliminated the possibility of a loss of the arc on account of too infrequent adjustments.

DISCUSSION

Mr. Kunzmann: Our laboratory tests are mostly conducted on 110-volt D.C. circuits, and we have found that the most satisfactory operation with low intensity carbon arcs starts at 52 volts with 30 amperes and with every 10 amperes increase we increase the voltage by 2 at the arc. Do you find this to apply also?

Mr. Hertner: On heavier currents you want higher voltage across the carbons for the best results. On the reflector type arc we can run at slightly lower voltage than on the higher amperes. You can run from 50 to 55 volts on the reflector arc with 30 amperes and on 125 amperes about 65 volts.

Mr. Kunzmann: On the reflector arc operation, we find when you get away from 55 volts at the arc, you get unsatisfactory arc operation, with the result that a quarter inch arc length cannot be maintained; hence an unstable arc.

Mr. Richardson: I have observed that the necessary voltage of the arc within rather narrow limits changes with the composition of the carbon. Does the arc stream or the gas stream vary with the composition of the carbon?

Mr. Kunzmann: It depends on the chemical used in the core of the carbon.

Mr. Richardson: I have discovered in projecting pictures that there was a difference in the quality of the light from different generators. Did you ever hear of such a thing, and if you did, do you know the reason for it?

Mr. Hertner: Were those experiments made with different carbons on the same generator? All generators give you a constant current. If you take a curve of the current stream you would not find any appreciable variation due to the generator itself, so I cannot understand how different generators could be responsible for the condition.

Mr. Ruben: I can substantiate Mr. Richardson's statements. I also have projected for many years and have always thought that 50 or 75 amperes was 50 or 75 amperes, but I have found with the same current values, carbons, projectors, and projectionist, the same room, screen, and lenses, there was a variation in the quality of the light with different motor generator sets. Some will produce a blue light and some a yellow light. Salesmen of different generator sets have used this as a sales argument. One claims blue light is better and the other claims that yellow light is better.

Mr. Briefer: In connection with that point, I should like to ask if the quality of the light continued with the same conditions or if it varied as the carbons were used.

Mr. Palmer: I have observed the same thing under different conditions. The arc lights burning in a studio from a studio generator of small size give a different kind of light from that which they emit when used on a large central station system, you get more light than if a small generator were used, which I attributed to the fact that on a large system you are operating off a system with machines running in parallel and there is no hum in the arc due to commutation of the small machine.

Mr. Kunzmann: I should like to ask if the observations which Mr. Richardson and Mr. Ruben speak of were made on a white screen or with film projected on the screen.

Mr. Richardson: The difference was even apparent at the spot.

Mr. Kunzmann: You can effect a considerable change in the condensing system; also a noticeable change in color and candle-power due to condenser discoloration.

Mr. Richardson: We had two generators. They were the same size and make, and there was a decided and pronounced difference when we had to change from one to the other. After that it attracted my attention so much that I talked with other men and made experiments in other places and found it was true.

Mr. Hertner: I was going to suggest that it would have been an excellent chance for Mr. Richardson to change carbons, and I think this would have solved the problem.

Mr. Richardson: That was done a couple cf times. We changed in the middle of a train and the quality of the light was entirely different.

Mr. Hertner: Did you carry the same individual carbons over to the other machine?

Mr. Richardson: It was the same machine, nothing was changed.

Mr. Powrie: I have recently discovered some local variations in the carbons of a projection lamp we have been using. There was a change in the character of the carbon that produced quite a marked variation in the quality of the light. I think local variations in the carbon has much to do with the fluctuation of the light.

Mr. Ruben: I want it more thoroughly understood. A certain theatre has a generator manufactured by Mr. Hertner, and one of another make. Whenever Mr. Hertner's is used, the light is more brilliant. The amperage is the same and the conditions are the same, but there is no question Mr. Hertner's gives more brilliance, it is whiter and has more life.

Mr. Kunzmann: The mirror arc carbons referred to have a neutral core, but with high intensity carbons, the light emitted comes from the gas ball from the core. Unless there is some chemical spilled over a neutral cored shell the effect referred to in my opinion would not be noticeable providing all tests were made under the same conditions.

Mr. Kroesen: I would be interested in knowing if a comparison has been made between the mercury arc rectifier and other sources of current supply, and what the operating results at the carbon electrodes are. I am under the impression that a rectifier is the more desirable insofar as the quality of light on the screen is concerned.

Dr. Gage: In answer to Mr. Kroesen's inquiry, quite a while ago we made some tests that were published in the *Electrical World* comparing the candle power of the same amperage using the rectifier and using direct current. We found apparently a very slightly less candle power as indicated by a direct current meter when we used the mercury arc rectifier. The question that Mr. Palmer brought up may be the clue to a proper method of inquiry. We have a series of machines supplying an arc with the same number of amperes, as indicated by a direct current meter, and if there is a difference in light, it would be attributable to an alternating current superposed on the direct current, which is indicated by a commutator hum. It would be interesting to get some data on this disputed point.

Mr. Richardson: How can you superpose direct current on alternating current with a motor generator set?

Dr. Gage: I mean commutator hum.

Mr. Richardson: You mean the variation in the rectification of the current.

Mr. Hertner: In motor generators, there is no definable difference in the direct current. I don't think the variation would be sufficient to make a difference, but on a mercury arc rectifier, there would be an appreciable difference depending on how you measure the current. If you get an average in amperes with one and a square root mean on the other, it might show up a difference.

Mr. Ruben: I have noticed the effect is more pronounced, that is, the quality is better with constant current type generators than with the constant voltage type, which gives a yellower light. It may be that the open circuit voltage on a constant current type is much higher with the other. For probably the same reason I have noticed in an arc produced with a commercial direct current at 220 volts stepped down through a rheostat the light is much better and stronger than from a 110-volt circuit, and I thought that possibly it is so much brighter due to the higher original voltage impressed.

Mr. Hertner: That suggests a possible explanation. When you run a multiple machine, unless you keep the arc length about right, you will lose your current and the projectionist will watch this and automatically set his arc shorter. On the series machine, this does not hold true, as on most of these machines it will increase. This means that it is quite possible that the arc is allowed to run long, which produces whiter light.

Mr. Kunzmann: I also have observed this.

Mr. Manheimer: I know there is such a thing as the counter e.m.f. of an arc and perhaps this would explain the difficulty.

Mr. Kunzmann: I might add that I have been present at light demonstrations where twenty or thirty people have been present for determining an increase or decrease of light, and in the majority of cases, 15 to 20 per cent differences of light could not be detected with the unaided eye by those present.

Mr. Richardson: That is true, but you will admit that while the eye is not sensitive to an increase or a decrease, it is sensitive to differences in quality.

REPORT OF STANDARDS AND NOMENCLATURE COMMITTEE AND DISCUSSION THEREON

Introduction

GENTLEMEN:

Your Committee has been diligently corresponding regarding the various problems assigned to it at the last convention. We also spent one day in New York, discussing the work, and have had a meeting here at Schenectady, the results of which we offer for your consideration.

Review

You will recall that at Chicago, you gave final acceptance to a standard observation port 16 in. square, with its center located 5 ft. 3 in. above the floor, based on a zero projection angle. The center of the port to be lowered one inch for each degree drop in angle of projection.

You also accepted, after the required six months' consideration, a standard maximum cutting width for standard positive film of 35 mm. or 1.378 in.

Standards Up For Final Adoption

The following matters were thoroughly discussed and accepted at the Chicago convention. They have now stood unchallenged for the required six months' period. We, therefore, recommend that you give them your final approval at this time.

The question of the form of perforation for 35 mm. film was again discussed at Chicago. It was stated that several different forms would be tried out during the coming year; therefore, the matter of standardizing should be held in abeyance pending the results of such tests. Your Committee has not secured any further data in this connection. If anyone has any authentic information on these new forms, we hope he will present it now.

Your Committee has been in touch with the English, French and German Societies, and are advised by Mr. L. Lobel of the French organization that they have agreed to the same form and dimensions of perforation for positive film which we have recommended, i.e., a rectangular hole 1.98 x 2.79 mm. with rounded corners. (Fig. A, p. 238, No. 18 TRANSACTIONS). There seems, however, to be some feeling on the part of Pathé that his perforation, 3 mm. long x 2 mm. high, having straight top and bottom edges, but ends formed by the arc of a circle, and joined to the top and bottom by rounded corners, is better, and this may be standardized also. For negative film, they also have accepted our practice of perforations 1.85 x 2.79 mm. with rounded ends. (Fig. A, p. 238, No. 18 TRANSACTIONS).

As the use and value of other forms of perforations than the rectangular with rounded corners for 35 mm. positive film, proposed at the Roscoe meeting a year ago, (as shown in Fig. A, p. 238, No. 18 TRANSACTIONS), seems doubtful, and as the foreign practice seems to be going also to the same perforation, your Committee recommends that you now accept for final standardization this form of perforation.

At our last convention, your Standards Committee stuck to their guns and again recommended the same dimensions for camera and printer apertures as proposed at Roscoe a year ago, i.e., that the black border is desirable, and to obtain it we recommended the following aperture sizes:

Camera: .700 in. high x .925 in. wide; .035 in. radius corners
Printer: .757 in. high x 1.000 in. wide; 3/64 in. radius corners
Projector: (already standardized as .725 in. high x .950 in. wide; square corners.)

The camera aperture corners may be either square or rounded, but the projector aperture corners must be square.

This recommendation has now stood for the required six months, and we recommend that you give it your final approval at this time.

At our last convention, we gave you a demonstration of projector speeds, and recommended as standard practice 80 ft. per minute, with a maximum of 85 ft.; and a minimum of 75 ft. We now suggest that you give this your final approval.

At the Chicago convention, the Committee's recommendation that we standardize 2-25/32 in. as the external diameter of the barrels of No. 2 size projection lenses was accepted. We now suggest that you give this your final approval.

DISCUSSION

PRESIDENT JONES: I will call for discussion on this section of the report.

DR. MEES: In view of the fact that at the beginning of July the International Congress of Photography will deal with these matters in their Cinematograph section, it might be well for the Society to withhold its decision until the report is received from the International Congress. If we settle the matter now, we should have some difficulty in going back on our decision, if, after the International Congress, it seems desirable to change it.

Mr. Porter: I will read a telegram on that matter which I have just received:

London, England, May 19, 1925: British Standards Committee plead perforation shape remain. Congratulate your society on adoption width films and aperture sizes. Agree number two lens barrel. Suggest number one size 2—1/32. British delegates to Paris will be pleased to meet your delegates in London prior to Congress. Brooke Wilkinson.

Dr. Story: The suggestion has been made in one of the later paragraphs of the tentative report now submitted that as some of our members are going to Paris, that they would be able to represent us very easily there, and I think it would be courteous for us to leave as many of these matters open as we can until afrer that international meeting.

Mr. Davidson: To avoid adopting a standard we may not be able to keep, I move that action on that part of the report referring to standards down to "Nomenclature" be postponed until the autumn meeting.

Motion seconded and duly passed.

Mr. Porter: We are now down to "Nomenclature." The following nomenclature was adopted at Chicago and is before you now for further disposition.

Retake: The action of photographing scenes, or the negative resultant therefrom, when the negative or negatives previously obtained are unsatisfactory.

Scene: A division of the story showing continuous action in the same locale or set, and taken from the same point of view.

Film Gate: A movable element which, when in operating position holds the film in register against the aperture plate.

Cooling Plate: A shield or baffle composed of one or more plates mounted between the light source and the mechanism, and usually attached to the latter but spaced therefrom, to prevent overheating the mechanism.

Dr. Mees: I move that it be adopted. Motion seconded.

Dr. Story: I have understood from men in the laboratories that the definition in the Report of "scene" is incorrect. They say a scene is not necessarily taken from the same point of view, and in many of the later productions the camera has been moved around during the action without the scene being considered changed.

Mr. Renwick: This committee had such great difficulty in formulating a definition for scene that it was thrown open to the Society, and we are indebted for this one to Mr. Chanier. To meet Dr. Story's objection, I suggest that it be changed now to read "but *usually* taken from the same point of view."

Mr. Crabtree: I move that the words in question be deleted.

Dr. Mees: I move that the definition of "scene" be adopted subject to final adoption six months hence with the word "usually" inserted in it. Motion seconded.

Dr. Story: I believe that "usually" will never make an unsatisfactory definition a satisfactory one. A definition should be sufficiently general to cover the term wherever it is used. I do not think the definition which sometimes applies will do.

Mr. Davidson: I think "usually" is often used in definitions. I do not see why the phrase at the end could not be removed altogether as a matter of fact, but I don't see any objection to the word "usually."

Dr. Story: There are several other faults with that definition as I see it, for instance, "continuous action." It may be intermittent action; it is not necessarily continuous. May I say also that I do not believe we can be too careful about the exact wording of the definition in our nomenclature any more than we can be too particular of the numerical value of our standards. These are the things that the industry looks to our Society to establish, and we should be sure that they get the best we can give them.

Dr. Gage: It seems to me that the real meaning of a scene might be expressed as "a division of the story showing apparently continuous action." If the location of the action is continuously moved, you can move the camera to keep track of it, but if the scene is changed, everything is changed. In a single scene, the camera may have been stopped, but a section of the story on one strip of film shows uninterrupted action as it is supposed to have taken place.

Dr. Story: I should like to question the definition of the word "retake." Is not the re-photographing of a scene a retake unless the previous negatives were unsatisfactory?

Mr. Renwick: We had great diversity of opinion on this term at previous meetings, and speaking for myself I can only say that it was news to me that this was the general definition of "retake," but

I think it expresses the views of its users and is, therefore, in accordance with the Society's intentions.

Mr. Fritts: I move that an amendment be made to the motion, namely, that we adopt the paragraph on "Nomenclature" with the exception of the definition of "scene."

Amendment seconded and passed.

Mr. Porter: Since coming to the meeting, the question has been raised about the new type of lamp coming into use known as "low intensity arc," "reflector arc," etc., as to how it should be defined to distinguish it from the other types in common use, and your Committee suggests this definition as written on the blackboard.

"Reflector Arc Lamp: In a motion picture projector an arc light source in combination with a reflector to project the light beam through the aperture."

Mr. Kunzmann: I am going to offer an alternative: The reflector arc lamp in a motion picture projector is a carbon light source operating in a right angle or horizontal position in combination with the mirror reflector to project the light beam through the projector mechanism.

Mr. Porter: In some cases condenser lenses are used in addition to the mirror, and while the present practice is right angled, I don't think it will necessarily remain so.

Dr. Mees: I think that definition misses the essential point of the reflector compared with the ordinary arc, that the crater of the carbon is turned away from the aperture; in an ordinary arc, the crater of the carbon is turned towards the condenser.

Mr. Porter: In most cases that is true, but how about where they use the prism machines with a right angle turn of the beam of light?

Dr. Mees: It is turned away from the screen, that is, towards the mirror.

Mr. Kunzmann: The prism reflected arc is not a reflector, and I think that some mention should be made in defining this new unit of the position of the arc in relation to the reflector.

Dr. Story: Is not the essential difference between the reflector arc and the ordinary arc, however, that the light is concentrated on the aperture in one case by a curved mirror with or without a lens and in the other case by means of a lens alone?

Dr. Gage: I am afraid I must question the whole definition. You cannot have a reflector arc lamp; there isn't any such thing.

Suppose you start with a right angle or some other angle and face it toward the refractive condenser, would you call this a refractor arc lamp? And, turning the thing around and facing it toward the reflector would you call it a reflector arc lamp?

Mr. Davidson: Cannot a reflector be used on a stereopticon as as well as on a motion picture projector? Should we narrow the definition to apply merely to motion picture projection?

Dr. Mees: I move that this be referred back to the Committee. Motion duly carried.

Mr. Porter: Your committee would greatly appreciate it if you would write them your suggestions.

We are now down to the part of the report referring to new propositions.

At the time we adopted the dimensions for 35 mm. film, no tolerances were specified. The English object to the increased height of the Eastman perforation on the ground that if the sprocket wheels of the various machines were first standardized, the extra height would be unnecessary. The French and Germans propose tolerances which would probably be applicable here. They are as follows:

	English	*French*	*German*
Height	±.0127 mm.	± ?	±.01 mm.
Width	±.0127 mm.	?	±.01 mm.
Longitudinal Pitch	+0, −.012 mm.	.01 mm.	±.005 mm.
Transverse Pitch	±.025 mm. (?)	.05 mm.	±.01 mm.

Also, that forty perforations should occupy 190 mm. ±.2 mm. (German).

The problem, therefore, before us is whether or not it is desirable to add tolerances to the dimensions we have already standardized. If it is, it would seem desirable to conform to European practice and adopt the tolerances given above.

Mr. Renwick: I think this question of tolerances also might well be left over to be considered at the next meeting as the question of perforations is to be dealt with at the congress in Paris. I make a motion that the matter be left until we have the International report in our hands. Motion seconded.

Dr. Mees: I should like to know the opinion of the Society with regard to the standardization of sprockets. The English and French have laid great stress on standardizing the sprockets first. I imagine this Society is in accord with that, but I should like to know the view of the Committee.

Mr. Porter: Your Committee tried to get data together on this subject; we hoped to have a compilation of the design of sprockets here and abroad, but we have not had time to do it. Mr. Jones says by the time of the fall meeting, he will have these data together.

Dr. Mees: What action am I to take should I find myself confronted with a motion to standardize sprockets? Shall I consult Mr. Jones and take his advice?

Mr. Porter: I think that will be very satisfactory to the Committee. How does the membership feel about it?

Dr. Mees: Are you voting against a binding requirement by the foreign committee that sprockets be standardized?

Mr. John Jones: I should vote in favor of the standardization of sprockets although the actual specifications would be matter for consideration.

Mr. Davidson: Would you agree to tolerances?

Mr. John Jones: Yes.

President Jones: The motion before the house is that action on this particular section be delayed.

Motion duly carried.

Mr. Porter: "Europeans are discussing shrinkage in connection with film measurement. They propose to make measurements after the film has been developed and dried, so that it will be in condition to use on the projector, rather than measuring the freshly perforated film as the Society of Motion Picture Engineers decided to do after lengthy discussion of this question. The French propose to let each manufacturer determine the shrinkage of his own film after development and drying. It is proposed to standardize conditions of drying for laboratory test of film, to determine its coefficient of shrinkage; drying, for example, to be for a determined length of time at a fixed temperature, and a definite hygrometric condition. The French discriminate between longitudinal pitch of positive film and negative film, and quite properly make the pitch of the negative film somewhat greater than that of the positive film to allow for the shrinkage which occurs during developing, washing, and drying, so that after these operations, it will have, as nearly as possible, the same dimensions as freshly perforated positive film. Full discussion of the European proposals is invited."

Mr. Kelley: Some time ago, the Department of Standards at Washington undertook to measure the expansion and contraction of film for patent purposes, and I think I could submit their report to your Committee for consideration because they found no definite change they could lay their fingers on. I think you must arrive at a standard by some different means.

Dr. Mees: I think the French are too optimistic in relying on the manufacturer to determine the coefficient of shrinkage of his material. The shrinkage of motion picture film is very difficult to standardize, and I think the Society has been wise in standardizing on film as it is manufactured. What happens in processing is in the hands of the physical chemists.

Mr. Renwick: I agree with Dr. Mees, but there is this very important point, that we have not distinguished between the pitch of positive motion picture film and of negative motion picture film. In Europe, they think they should be different so that positive film may match developed, fixed, and washed negative film.

Mr. John Jones: In that connection, in matching up the negative film with the raw positive, there is not enough difference due to shrinkage to prevent the claws from pulling down the negative to meet the positive. The shrinkage is so slight that it does not warrant the pitch of the negative being more than that of the positive. We do not notice any difference in this. Even a shrinkage of as much as 3 per cent does not make any difference.

Mr. Kelley: It is my impression that we should use the same standard for both negative and positive. The differences are so slight that you can depend on the machine. The negative will vary in the same roll according to how it is dried.

Dr. Mees: It has been our experience in the humid atmosphere of England that the laboratories turn out film with a longer pitch than it had originally. The drying conditions do not dry the film down as far as it was dried by the maker; this does not apply here, where there is uniformly a contraction of film, but I think a difference in pitch would not be advantageous on the whole though it is theoretically an obvious thing to do.

President Jones: Does the Society wish to go on record in any particular respect with regard to this? There is no motion before the house, and I suggest that we proceed.

Mr. Porter: "Your Committee has followed your instructions and investigated the question of camera speed. From the data we have been able to collect, it seems apparent that the best camera men try to stick pretty close to a speed of 60 ft. per minute. In this connection the Committee was greatly aided by Mr. Earl Denison, who submitted stop-watch tests on a number of well known camera men shooting various types of pictures. The matter was taken up with the American Society of Cinematographers, who strongly recommend 60 ft. per minute.

"From the data available, your Committee recommends (for the first time) as standard practice, a camera taking speed of 60 ft. per minute, with a minimum of 55 ft.; and a maximum of 65 ft. when normal action is desired in connection with the Society of Motion Picture Engineers' recommended practice of 80 ft. per minute projection speed."

Dr. Story: We have tentatively adopted a projection speed of 80 ft. a minute with a taking speed of 60 ft. a minute; I should like to know why we propose a taking speed which will give a distortion in action.

Dr. Mees: I agree with Dr. Story in this. In working out the Cine Kodak, we adopted a speed for taking and projecting of 60 ft. a minute, and I have no doubt that it is an advantage for all regular practice. While I know that the theatres will project at 80 ft. or even 100 ft. a minute and that the cameramen will take at 60 ft. a minute, I think the Society should not endorse this practice.

Mr. Kelley: This is a good recommendation. My experience is that a taking speed of 60 ft. a minute and a projecting speed of 80 ft. a minute do not produce an abnormal result. The cameramen are not machines and from watching many at work, I am of the opinion that most turn their cranks at a speed under 60 ft. a minute. We set up a camera having a meter attached giving the rates in pictures per second for the chief cameraman on the Fairbanks lot and had him operate the camera in making tests shots. It was of great interest to us to note that the meter held steady at twelve pictures per second (45 ft. per minute) on all takes. Standards will mean nothing unless cameras are fitted with tachometers.

Dr. Story: I would like to call your attention once more to the general matter of tolerences. As this reads, the standard taking speed is 60 ft. a minute with a minimum of 55 ft. As a matter of fact, the tolerance for normal action is zero; by no vote of this Society can it be made 5 in. more or less. In standards, there are no tolerances. They belong to recommended practice.

Mr. Egeler: May I ask whether this standard of 80 ft. for projection speed has been adopted as a final recommendation? I do not see how you can tie 60 ft. a minute taking speed and 80 ft. a minute projection speed together, and call them normal.

President Jones: Action has been suspended until the autumn meeting; it has not been finally adopted.

Mr. Crabtree: Will not the taking and projection speeds depend on the "pep" of the actors? I have read of cases where the actors have been instructed to act more slowly or faster than normal so that this factor would certainly enter into the question.

With regard to the relative speeds or taking and projection, I do not think it is necessary that they should be equal because a projection speed of 60 ft. a minute certainly shows lag. We have decided unanimously that 80 ft. a minute gives the correct psychological effect when the picture is taken at 60 ft. a minute.

Mr. Renwick: I wish to say something about the history of these recommendations. It is obvious that the members of this Committee are neither cameramen nor projectionists, and we have been guided by the best information we could get. In Chicago, a good demonstration was given and it was the opinion of those present that, with the present high intensity light sources, any speed less than 75 ft. per minute showed flicker and was undesirable, and on that ground 80 was thought very good. The pictures projected at the Chicago convention had been taken at the normal speed of 60 ft. a minute, and the action by all those present was considered normal at the projection speed of 80 ft., so we get this correlation between 60 ft. and 80 ft. Apparently the mind is not satisfied when the projection speed is exactly the same as the taking speed. That is the origin of these recommendations, and we are endeavoring to satisfy the feeling of the Society.

Dr. Mees: I agree with Mr. Renwick that most of the projectors running below 80 ft. a minute are not satisfactory and give flicker, and that is what has settled high speed projection first of all; this means that the pull downs are designed wrong or they would not give flicker. The Society now proposes standards with its authority behind them founded on this error and this is justified by the statement that the eye cannot pick up the error when made.

Mr. Porter: Here is a letter from the Society of Cinematographers which I would like to read to you.

AMERICAN SOCIETY OF CINEMATOGRAPHERS, INC.
1219 Guaranty Bldg.
Holywood, California

April 28, 1925

Re Camera Speeds
Society of Motion Picture Engineers,
Harrison, N. J.

Attention Mr. L. C. Porter

GENTLEMEN:

Replying to yours of March 30 and April 15, respectively, regarding our opinion as to the correct camera speeds, we wish to state that this matter has been discussed from time to time among our members and it is the consensus of opinion of our Society that the correct camera speed is sixteen pictures per second or sixty feet per minute. This speed has been used for years by practically all members of the profession, slower speeds only being resorted to to secure certain comedy and dramatic effects. Over-speeding has only been used where certain directors have attempted to combat the excessive projection speeds which exhibitors have adopted to "turn over their audiences" in the shortest possible time. We are opposed to any taking speed in excess of 60 feet per minute for the following reasons:

1. Sixty feet per minute is sufficiently fast enough to produce smooth action under normal conditions.

2. Faster taking speeds than 60 feet per minute require that more light be used on sets, thereby increasing eye strain of actors. The use of electrical equipment, electricians and electrical energy increases cost of production, to say nothing of the disadvantages to the cinematographer in securing balanced lighting, it being a known fact that better lighting effects are obtained where it is possible to use a minimum of light.

3. Faster speeds than 60 feet per minute require the use of additional negative and positive footage, thereby increasing the cost of raw stock as well as the added expense of laboratory work, longer titles, etc.

4. In recent years, the leading optical manufacturers have improved their products, whereby we have obtained lenses with greater speed. These improved lenses make it possible to use less light and secure very pleasing effcets. However, if we are compelled to increase our taking speed we have the equivalent of the old methods—60 feet per minute with the f/3.5 lenses.

We are glad that you have adopted 80 feet per minute as a standard projecting speed, and trust that you will be able to secure the adoption of this speed by the exhibitors, it having been our experience that productions photographed at 60 feet per minute can be projected at 80 per minute with satisfactory results.

We would suggest that your committee adopt some standard for "projection lights"; that is, an "arc intensity" of so many amperes for a given screen area and length of throw. Of course, we realize the different theaters require special equipment, but certainly something can be done to obviate the necessity of making special prints for exhibition in the key cities as, we understand, is the case of some productions.

We hope that we have answered your questions, and if we can render further assistance along these lines, please call on us.

Sincerely,
JOHN W. BOYLE, *Secretary*

PRESIDENT JONES: What are your wishes with regard to this recommendation? We should have some definite action if only to instruct the committee.

DR. STORY: I should like to see it referred back to the Committee Motion seconded. Duly carried.

MR. PORTER: "We have reviewed the data presented at Chicago in connection with the outside barrel diameter of No 1 size projection lenses, and have been in further correspondence with the manufacturers on this subject. Your Committee now feels that there would be a distinct advantage in the increased illumination possible with the larger diameter barrel now in common use with Bausch and Lomb lenses, giving a full free lens opening of 43 1/2 mm. as against 39 and 40 of other makes of lenses. We, therefore, (for the first time) definitely recommend standardizing on an external diameter of 2-1/32 in. for the No. 1 size lens barrels."

In that connection I have a cable from England which says "agree No. 2 lens barrel. Suggest No. 1 size 2-1/32." In other words, they agree with our recommendation.

DR. STORY: If my memory does not play me false, when we adopted the standard diameter for the No. 2 lens, it was larger than the figures used on the Bausch and Lomb No. 2. That size was adopted in order to include the largest of the No. 2 projection lenses, and the Bausch and Lomb representatives agreed to increase their flange dimensions to fit that standard. At the same time, the other manufacturers agreed to bring their dimensions of the No. 1 lens up to fit the then new Bausch and Lomb No. 1. It was a question of one company modifying its dimensions on one lens and the other company modifying its dimensions on the other, so it would seem that no great injustice has been done to anyone.

MR. REICH: I believe that Dr. Story's memory is incorrect in that we agreed to change the size of our No. 1 lenses. We introduced the No. 1 size lens and established the standard of 1-15/16 diameter in 1908 and this size was not made by others until several years later, during which time many thousands of our lenses were sold. This was at least eight or nine years before Bausch and Lomb Optical Company made their Series 1 lenses.

President Jones: Mr. Porter has called to my attention the No. 19 Transactions, pp. 63-66, in which the entire matter is very clearly stated, and there are two letters given there which will take some time to read here, but anyone can learn the full status by reference to the correspondence on this subject. What are your wishes with regard to this section?

Motion made and seconded that the recommendation be adopted.

Mr. Reich: Before the motion is adopted, I wonder how many have read the letters and know the differences in the standards. The amount of light transmitted through the No. 1 is that coming through the full aperture. When you increase a lens opening from 4 to 4-1/2 or 5 thousandths, the ratio of aperture is changing, and the slight difference in this diameter does not enter into the amount of light transmitted.

Dr. Story: I should like to ask Mr. Reich whether the No. 2 standard as adopted is that of the Gundlach Manhattan Lens Company.

Mr. Reich: It is.

President Jones: In case you consider it desirable, Mr. Porter will be glad to read the correspondence. Are you ready for the question? Motion duly carried.

Mr. Porter: "The only information we have been able to collect regarding film splices is that furnished by Mr. J. H. McNabb of the Bell and Howell Company. Mr. McNabb presents the following as found by them to be best practice. (See figure given in report). It seems to the Committee that this might be offered as recommended practice rather than as dimensional standard. Therefore, to place the matter definitely before you, we recommend (for the first time) the dimensions of splice shown in the figure as Society of Motion Picture Engineers' recommended practice."

Since that time I have recieved a telegram from Mr. Denison which reads as follows:

"Your letter dated May 20 regarding film splices just received. Too late now to do anything for this meeting. At present time I am making further research on the question of film splices and can assure you that I will have very interesting and complete paper together with slides for fall convention."

Mr. Crabtree: I think Mr. Jones has data with regard to the wearing quality of film with splices of varying width.

Mr. John Jones: The life of a splice depends on how the splice is made. I think this is another matter which might be referred back to the committee until the fall meeting.

Motion carried.

Mr. Porter: "The question of standardizing film reel cores has been studied. Mr. J. G. Jones took this matter up with the various camera manufacturers for the committee but found so little interest in the subject that we do not feel that we as yet have sufficient data to make a definite recommendation.

Your committee has also studied the European recommendations regarding the design of sprockets. Mr. J. G. Jones has prepared a review for you which, unfortunately, was not completed in time for printing in the advance copies of our report."

I will ask Mr. Jones to read letters received from four manufacturers at this time.

BASS CAMERA COMPANY
109 N. Dearborn St.
Chicago, Ill.

April 9, 1925

Mr. J. G. Jones,
Rochester, N. Y.
Dear Sir:

I have your letter of the seventh and will say with the Vox Popper in the *Daily Press* that something should be done about it.

We who sell motion picture cameras and have sold them for so many years always have considerable trouble with different new standards of magazine cores.

Just two years ago when an acquaintance of the writer was chief of the Bureau of Standardization of Manufacture under Secretary Hoover, the writer continually brought up the matter of magazine cores and lens flanges.

There is no more reason for the manufacturer to make a flange different for the same size of lens than there is to make plate holders different. All sizes should fit the same size product.

Bell and Howell have of course adopted a certain standard for the large size magazines which is practical whereas other manufacturers have been using the inch standard which seems to be the most practical.

I certainly for one am heartily in favor of this reform and I am sure it will be welcomed in general by manufacturers and consumers so here is more power to you in aiding in this reform.

I remain

Very truly yours,
Bass Camera Company
By Charles Bass

BELL AND HOWELL COMPANY
1801 Larchmont Ave.
Chicago, Ill.

April 9, 1925

Mr. John G. Jones
Rochester, N. Y.
DEAR MR. JONES:

We are in receipt of your letter of April 7 relative to the proposed standardization of the camera core of motion picture cameras.

The question of establishing a standard outer diameter for standard film spools is now about seven years old and the Society doesn't seem to be getting anywhere with it. Several years ago, the Eastman Company for a short while supplied negative film on spools considerably larger than the present 31/32 in. diameter spool. For reasons designated in our letter of October 8, 1921, addressed to the Standardization Committee of the Society of Motion Picture Engineers we believe the size of these spools should be at least 1-1/2 in. to 1-29/32 in. and for the same reasons advanced we would be opposed to the 1 in. core or one of 31/32 in.

Very truly yours,
BELL AND HOWELL COMPANY
By J. H. McNabb, *President*

MITCHELL CAMERA CORPORATION
5025 Santa Monica Boulevard
Los Angeles, Calif.

May 6, 1925

Mr. John G. Jones
Rochester, N. Y.
DEAR MR. JONES:

We have your letter of the 17th ult. in regard to standardizing camera cores.

If you will please refer to the letter by our Mr. G. A. Mitchell to the Chicago convention and dated September 25, 1924, which was published in the TRANSACTIONS of that meeting of the S.M.P.E., you will have our thought in this matter.

You will note that we have adopted a spool measuring 15/16 in. in diameter and our experience demonstrates that this functions extremely well both from a mechanical point and also from an efficiency standpoint.

It meets all the requirements of this mechanism, and permits carrying out the best practices in the handling of the film from the stock room to the laboratory.

In the designing of this spool our Mr. Mitchell had in mind not only the proper functioning of the camera as an individual production unit, but the entire train of procedure necessary to deliver the negative film to the printing stage in its best condition, and this fact is fast being realized and appreciated by the progressive producer as evidenced by the support being given us by the entire industry today.

It is hoped that your Standards Committee will adopt the measurements as we now use them for the reasons as given above and in our former letter. We shall continue to use them without change after the success we have had with them.

It will be impossible for our Mr. Mitchell to attend your spring meeting; however, he wishes for the success of your convention and knows that a great amount of good will be accomplished.

Yours very truly,
MITCHELL CAMERA CORPORATION
By H. F. Beger

UNIVERSAL CAMERA COMPANY
361 W. Ontario St.
Chicago, Ill.

May 11, 1925

Mr. John G. Jones
Rochester, N. Y.
DEAR SIR:

In reply to your letter of April 7 with regard to the matter of camera cores which is to come up at your spring meeting of the Society of Motion Picture Engineers, we believe your position to be well taken as this would help matters to some extent to have the camera cores a trifle smaller to permit a roll of negative film to be placed on the camera core after the wooden core has been removed from the film.

If care is taken by the operators not to get the camera core mixed with those sent by the raw film manufacturers so it is our opinion this improvement would hardly be practical.

If it is decided to change standard to 31/32, we would suggest that the selling date for making them a considerable time ahead to help us reduce our stock of old style parts.

This change, of course, will work quite a hardship on camera manufacturers as it makes it necessary to either discard or rework considerable stock.

Very truly yours,
UNIVERSAL CAMERA COMPANY
By N. Cassidy

MR. JOHN JONES: I think that the diameter of the core is part of the design of the camera, and in some cameras they have to rewind the negative film on the core in order to run the film right.

MR. RENWICK: I move that these letters be published in the TRANSACTIONS of our Society and that action be deferred.

Motion carried.

MR. PORTER: We are again taking up with the American Engineering Standards Committee the matter of getting our standard adopted, but in view of the amount of material which has been referred back, I think we had better wait until some of it has been accepted.

There is to be an international meeting on motion picture matters in Paris this coming June. We understand that Dr. Mees and Mr. Renwick are going to attend this meeting. We recommend that the Society take advantage of this opportunity and authorize them to officially represent us in connection with international matters of standards and nomenclature.

Dr. Story: I move that Mr. Renwick and Dr. Mees be authorized to act for the Society at the International Convention in Paris this summer with authority to submit to them our standards already adopted and to agree to any decision by that conference in accordance with our standards tentatively adopted but without including mechanical tolerances.

Motion seconded.

Dr. Mees: I should like to ask that the Society elucidate the matter. May I point out that the jurisdiction of the International Congress is only advisory and not binding on any country. If we go as representatives of the Society, the agreements we make will be only with the International Congress and will not be standards of this Society and will not be binding on this Society. If you send us with a free hand, we will attempt to have the international standards acceptable to this Society, but if not acceptable to this Society, I shall still attempt to get an international standard adopted rather than not have any. If we go bound not to accept anything other than your standards, unless the International Committee accept them, we should have to leave the conference without voting.

Mr. Porter: It seems to me that Dr. Mees and Mr. Renwick are men of sufficient standing, reputation, judgment, and knowledge of motion pictures here and abroad so that the Society can give them their confidence. I suggest that the Society recommend Dr. Mees and Mr. Renwick go with authority to act and leave it to their judgment. If we do not do this, it will be like a political conference standing in the way of progress. This congress is intended to advance progress in the art.

Mr. Davidson: I agree with Mr. Porter and I make the amendment that the men be sent from the Society with authority to act at their discretion.

President Jones: I should like to point out that the amendment is contrary to the original motion. May I suggest that if you do not like the motion you vote accordingly. Do you wish to withdraw the original motion? Second withdrawn.

Dr. Story: In the light of what has been said, I withdraw my motion.

Mr. Porter: I make the motion that the Society authorize Dr. Mees and Mr. Renwick to represent us at the International Congress with full power to act.

Motion duly carried.

Dr. Mees: May I ask what the recommendations of this Society are on the international standardization of sprockets? That question will come up, and I have no instructions on that.

Mr. John Jones: It was agreed that we favor standardizing sprockets. What those standards will be is a matter of question. There is lots of work to be done in connection with the size of sprocket according to the position in which they are to function.

President Jones: It seems to me that Dr. Mees and Mr. Renwick may wish instructions on points which have not come up here. We have a committee which has given the matter very careful consideration and know a great deal about it, and I think it would be desirable for this body to empower our Standards Committee to consult with Dr. Mees and Mr. Renwick and give them any necessary instructions and advice. I think it is unnecessary for us to go through all that here.

Mr. Porter: We shall be gald to do anything we can to help.

In closing, I should like to say that I have had the pleasure and privilege of serving on many different committees. Generally the Chairman does most of the work. Not so with this Committee, the members are workers, and I certainly want to thank personally the members of this Committee for their whole-hearted support and co-operation.

Dr. Mees: Before leaving the report, I think the Society should pass a vote of thanks to the Chairman and members of the Standards Committee. It is comparatively easy to read a paper, but the preparation of a report is a tremendous piece of work, and then we tear it to pieces and send it back and ask the Committee to do it again, so I propose that the Society give them a vote of thanks.

Motion carried.

REPORT OF THE PUBLICATION COMMITTEE SOCIETY OF MOTION PICTURE ENGINEERS

With the No. 20 Transactions, the present Publication Committee has rounded out one year of activity and has had published three issues. These volumes have not been up to the desired standard for a good many reasons. However, less delay and effort was experienced by the Committee in publishing the No. 20 Transactions than for previous issues. A little care and consideration on the part of the authors would even further reduce the work of the Publication Committee. As all work must be done by the Committee either after hours or sandwiched in with regular business, the Committee would like to suggest that the authors give particular attention to the following outlines:

NOTES ON THE PREPARATION OF PAPERS FOR THE SOCIETY OF MOTION PICTURE ENGINEERS

A. *Title.*—The title of a paper should be as short as possible, but should be indicative of the nature of the text.

B. *Author's Name.*—The author should give his full name.

C. *Author's Affiliation.*—Company affiliation should appear as a footnote on the first page.

D. *Origin of Paper.*—Communication number or place of issue should appear as a footnote on the first page.

E. *Illustrations.*

1. Illustrations should be used only when required to elucidate the text of a contribution.
2. Cuts should be clearly marked showing to what part of the text they refer and where located in the text.
3. The importance of cuts should be marked as an aid in determining their relative size.

F. *Captions.*—A number and a caption or explanation should be given for each picture, diagram and table.

G. *Formulae.*—Equations, formulae, etc., should be given in the exact form desired by the author. Where abbreviations are used they should be consistent throughout.

H. *Pagination.*—Each page should be numbered consecutively.

I. *Summary.*—A summary should be given at the end of each paper showing the number of pages and the number of cuts.

A large part of the time of the Committee is taken up in the proper placing of cuts, sorting of cuts, captions, proper titling of

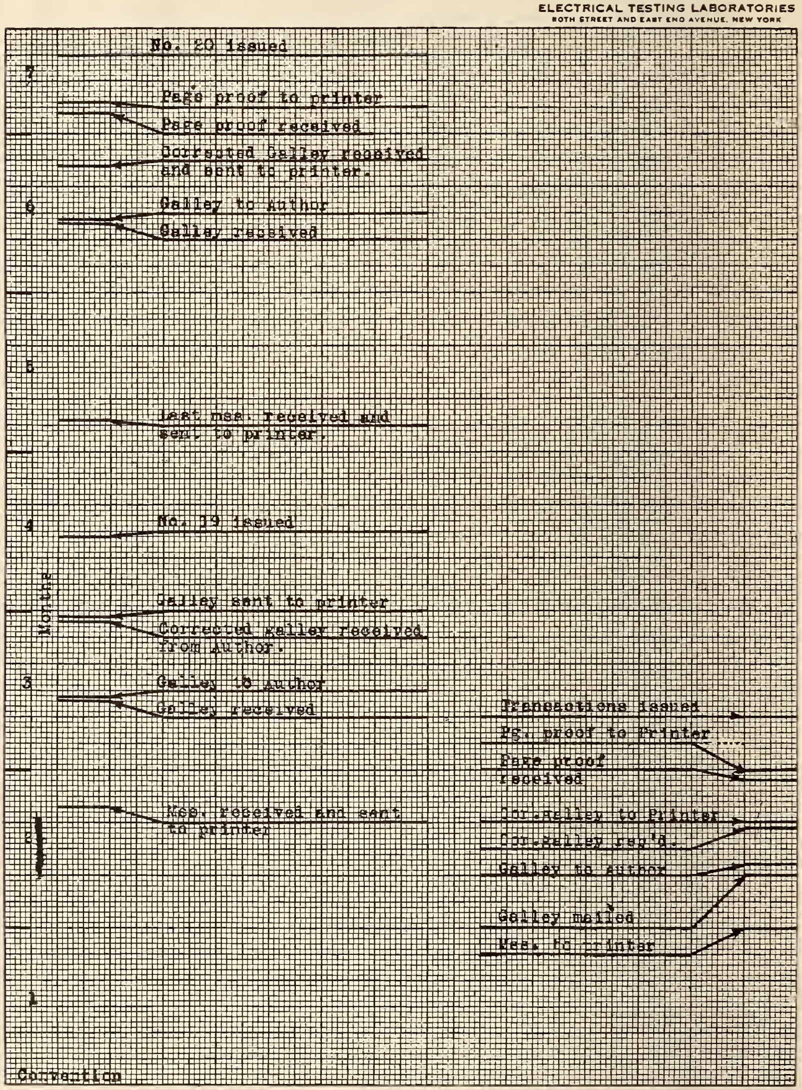


Fig. 1.

manuscript, securing author's full name and company affiliations, etc. All of this work may be obviated with very slight additional work by the author.

There has been some criticism on the part of members, of the delay of issuance of the TRANSACTIONS. In order that you may see just where these delays occur, we have prepared a time table.

An examination of the time table shows clearly where delays occur. As the minimum time from the receipt of the papers to the issuance of the TRANSACTIONS is forty days, it is most important that all papers be in the hands of the Publication Committee not more than ten days after the convention closes. It will then be possible with the proper co-operation from the authors to issue the first number in two months, and the second number at the most desirable time, probably one month prior to the next convention. Even though the TRANSACTIONS are printed in two issues, it is desirable to have all material in promptly so that the papers may be grouped to form a well balanced volume. For the last convention, the papers which were handed in first made up the first volume (No. 19), with the results that the No. 19 issue included sixty-nine typed pages and eleven cuts, the No. 20, one hundred typed pages and forty-three cuts.

The growth and dignity of the society would seem to warrant a little more attention given to the TRANSACTIONS. The Publications Committee offers as suggestions:

(a) That an introduction be prepared for the coming issues, probably in the form of an editorial or editorials written by influential persons in the motion picture field together with abstracts of articles, pertinent to Motion Picture Engineering. Much of this data is already prepared and issued by the Eastman Kodak Company, National Lamp Works, Edison Lamp Works, and Westinghouse Lamp Company, etc., and a committee of one to collect such data, might be appointed by the chairman.

(b) That the TRANSACTIONS be set up in ten point leaded type instead of solid. The cost in printing will be increased about 17 per cent (forty and forty-eight lines per page) but part of this increase can be eliminated by allowing the discussion to follow immediately after the paper rather than placing it on a separate page. In fact this will compensate almost entirely, as many pages of the discussion occupy only a paragraph or two and all papers do not end at the bottom of a page.

May 15, 1925.

Fall Convention

OF THE

Society of Motion Picture Engineers

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Lakewood Farm Imn,

Roscoe, New York

October 5-8, 1925

Everybody had a good time at Roscoe during the 1924 Spring Convention and the demand for another meeting at the same place seemed so universal that it was selected for our Fall Convention.

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RESERVE THE DATES

J. C. KROESEN, *Chairman Arrangements Committee*

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ROSCOE, N. Y.

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Williamson Manufacturing Co., Ltd., Litchfield Gardens, London, N. W. 10, England.
Willat, C. A. (M)
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Wooster, Julian S. (A)
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S.M.P.E. PRESIDENTIAL ADDRESS

Roscoe, New York, October 5, 1925

IT IS with a feeling of genuine pleasure that I come before you once more to say a few words in opening our annual autumn convention. This, I believe, is the twenty-first regular meeting of the Society, and since it is our custom to meet twice each year, it follows that we are just entering the eleventh year of our existence. We are therefore a relatively young organization, and I feel that we should all be very proud of the great progress which has been made in this relatively short period of time.

In this swiftly moving twentieth century, most of us as individuals lead lives that are filled full to overflowing with work and play. We are swept onward by a rapidly moving tide of events with little opportunity to consider whence we have come and whither we are going. While in general it is futile to look backward into the past or to attempt to speculate on what the future may hold, it is desirable sometimes to pause a little and to consider how far we have come and to plan the course to be followed in the future.

Our life as an organization is similar to that of the individual. The motion picture industry has grown so rapidly, inventions and improvements have come so thick and fast, that we as a society have been completely occupied in our attempt to keep up with the procession and we have had little time to deliberately consider the progress we have been making. We have been busy with the details of our daily society life, planning for meetings, getting the papers program ready, publishing the TRANSACTIONS, collecting dues, hunting for new members, and all such things necessary to the welfare of our organization. It may be worth while, therefore, to pause a little and consider our present position. Perhaps we might ask ourselves such questions as these: Are we proceeding in the right direction? How much of what we set out to do has been accomplished? What remains to be done? Has our growth been as great as could be expected? In what directions lie the most fruitful fields for future work?

Before attempting to answer these questions, let us refresh our memories as to the purpose for which the Society was organized. In the words of the framers of our constitution the object of our existence is "Advancement in the theory and practice of motion picture engineering and the allied arts and sciences, standardization of the mechanisms and practices employed therein, and the maintenance of a high professional standing among its members." Just how can we as a society contribute to the "advancement in the theory and practice of motion picture engineering?" Obviously, with our present financial recources we cannot hope to maintain a research laboratory; nor can we operate studios, laboratories, exchanges, or theatres, or in fact any of the actual units which compose the industry. Our influence must, therefore, be more or less indirect. We must encourage, stimulate, and assist the individuals and corporations actually engaged in the production, distribution, and exhibition of motion pictures.

This we accomplish largely by means of our semi-annual meetings at which papers dealing with theoretical and practical subjects of interest to many phases of the industry are read. These papers are published in the TRANSACTIONS and hence reach many who cannot attend our meetings. In this way knowledge is disseminated, and a permanent reference library is being built up. The discussion of the papers are of no little value. They stimulate thought and frequently result in the birth of new ideas which later are developed and applied. The very fact that our papers committee has to work so hard to get papers for our programs proves that the work is valuable; for, if some individuals were not thus coaxed, cajoled, or bullied into writing papers, much highly specialized and valuable knowledge would never become available for the use of others. Frequently the individual does not realize that his knowledge is of great value to others. He becomes so familiar with the details of his own work that he does not realize its highly specialized character and that a knowledge of it might be of great interest and help to others working along the same lines. A very forceful illustration of this state of affairs came to my notice recently. It happened that I had the pleasure of visiting a large producing plant and of being shown many interesting things. A member of this organization, and one actively engaged in the production of motion pictures, had explained and demonstrated how a particular thing is accomplished which to me was of great interest and on which I am sure it would be impossible to find any ade quate information anywhere in the literature. On being asked why he did not write a paper for the S. M. P. E. describing this procedure, he replied that he did not suppose it would be of interest to anyone.

It appears that there was no objection whatever to the publication of the information, but he simply had not realized that it was of any value to anyone else. After considerable urging he agreed to prepare a paper for us on the subject which will probably be given at our next meeting. This exactly illustrates how valuable our activities may be in making available technical information. It also illustrates the difficulties with which our papers committee is confronted. There is no doubt that ample material is available for our programs. The question is how to find it, and to persuade busy men to prepare the material for publication. This illustrates also how difficult it is for a single individual, without the assistance of an active committee and other members of the society, to obtain the technical papers required for a well balanced program. No one person can be in intimate touch with all of the diverse phases of the motion picture industry, and it is only by the co-operation of several individuals that the best results can be obtained.

In any large and growing industry standardization is of utmost importance. We have been very active in advocating standardization and in establishing standards for mechanism and practice. Much remains to be done, however, and I feel this is one of the activities of utmost importance, one which should be given a great deal of attention during the coming years. Efforts towards standardization in our own country have been fairly successful, but in an industry of such world-wide distribution national standardization is not sufficient. We must have international standards. We are in continuous communication with the English, French, and German motion picture groups, and a start towards international standards was made at the Sixth International Congress of Photography held in Paris last July. Some action was taken the details of which will doubtless be set before you by Mr. Porter, the chairman of our Standards Committee.

A permanent commission in America is to be formed to take care of arrangements for the Seventh International Congress which will probably be held in 1930. Dr. C. E. K. Mees, one of our own members, will probably be the permanent chairman of this commission, and we as a Society have been asked to appoint one or two other representatives to serve on this commission. A definite logical program for standardization should be prepared for presentation at the next international congress, and it is not too soon to start active preparation of this. This is a matter which should be kept constantly in mind.

Thus far our efforts towards standardization have been concerned chiefly with mechanisms and film dimensions. This work needs to be greatly extended and broadened. Conditions under which motion pictures are projected are, at the present time, very diverse and in many cases unfavorable. There seems to be little doubt that great improvement can be achieved in this direction. The question of standardizing positive film density, screen brightness, reflection characteristics of screen surfaces, etc., has been discussed at various times in our sessions. Apparently there are many difficulties to be encountered in any such program. However, there is no reason to believe that these difficulties are insurmountable. We must admit, however, that the problem is a very complicated one. Many factors including not only purely objective quantities measurable by precise physical methods, but also some of a subjective nature involving laws of physiological and psychological optics must be considered. I do feel, however, that the matter should be given careful consideration, and while it may be impossible to establish rigid standards, I do believe that the average quality of the projected picture can be greatly improved by the recommendation of ideal values with fairly wide tolerance limits.

The question of membership growth is one that deserves serious attention. In 1922 we had a total membership of 180, while at the close of 1924 this had increased to 210. During the two years between the dates mentioned, a much larger number of new members were obtained, but the resignations occurring during that time kept the actual increase down to 30. The rate of growth of membership during the past two years is therefore much less than during the two or three years preceding 1922. The reason for this falling off in the rate of growth is not entirely self-evident. Is it a lack of activities on our part in going out after new members? Is it due to the fact that we have already drawn into the organization practically all of those available? Probably the answer is that it is due somewhat to each of these causes. While the motion picture industry on the whole seems to be enjoying a healthy growth, there is no doubt that it is tending to reach a condition of equilibrium and it is possible that the number fo individuals connected with the industry who are eligible to membership in our society is not increasing to any great extent. I feel that if we are to add materially to our membership we must do something to interest those in somewhat different fields of motion picture work than those to which most of us at present belong. I sometimes feel that the very name of our society, including as it does the word "engineers," discourages from joining a great many men who really should be members and who would both benefit by association with us and bring valuable contributions to the organization. We have not been able apparently to interest sufficiently men in the production and exhibition branches of the industry. There is little doubt that many people working in these fields should be drawn into the organization. I feel, therefore, that it is only by broadening the scope of our activities that we can hope to obtain an appreciable increase in membership. The future activities of the society, therefore, should be planned to go ahead not only with the type of work which we have been carrying on in the past but to branch out into other phases of the industry to which in the past we have given too little attention.

This brings us face to face with the future. Along what lines should we attempt to extend our activities? Of course, I can only express my own opinion, and I do not feel that I am especially qualified to make authoritative statements on this subject. However, I have given the matter considerable thought and perhaps a few suggestions, even though they be tempered by personal viewpoint, may be of value to those who in the future are to be responsible for our activities. Undoubtedly we may expect a certain increase in the number of motion picture theatres and a great improvement in the average quality of these theatres. There is much valuable work that can be done in improving the production and exhibition of theatrical films. The question of architectural design of the theatre is one which I think should be given particular attention. In only a few cases have motion picture theatres been built according to the best possible design for the exhibition of motion pictures. I believe that this society, by the use of judicious propaganda could have a profound influence toward the betterment of conditions, and this is one of the things on which I hope the Society will concentrate in the future.

It is, however, in the non-theatrical field that I believe the greatest future development will occur. The recent introduction of amateur motion picture photography has opened a tremendous field for the application of motion pictures. I see no reason why we should not be as much or more concerned with this field than with the theatrical.

The application of motion pictures to educational work is also just in its infancy. Here again our organization ought to find a fertile field for its endeavors. There is little doubt that certain subjects can be taught more efficiently by visual methods than by any other. There is much work to be done, however, in determining the best methods of using this new teaching device and how to make films particularly adapted to teaching purposes. Already the motion picture is being used in many of our best schools and universities for showing to entire classes things which in the past could be shown only to individuals and even then under rather unfavorable conditions. Motion pictures are being applied in almost every field of scientific research, and the possibilities, it seems, are practically unlimited.

The use of the motion picture in advertising may also develop to great proportions. There seems to be little doubt that salesmen equipped with properly made films and projectors can appeal to their customers much more efficiently and persuasively than by any other method. This is another phase of development in which we should be vitally interested and which we should encourage.

I have already suggested the desirability of broadening our field of activities. This, I feel, is so important that I wish to return to it again and pay particular emphasis to the need for such action. The majority of the membership of this Society consists of individuals who are interested largely in the technical scientific problems of the industry. Very few of us have any extensive knowledge of many of the problems involved in the making of a finished feature film. Nevertheless, we should be interested in these problems, and those who are particularly concerned with them should be interested in our part of the work. A better understanding and co-operation be-between all of those who contribute to the production of the film will undoubtedly be of benefit. Anything that will produce a closer co-operation between the producer, director, art director, lighting engineer, laboratory man, camera man, projectionist, distributor, and all those who at some point contribute to the production of a picture will react to the ultimate benefit of the industry and hence to the ultimate benefit of every individual connected therewith. We should be interested not only in the production of pictures which are better technically (that is from the standpoint of photographic and mechanical quality) but also from the standpoint of literary, dramatic, and moral character. The fact that we are not intimately concerned with the literary and dramatic material does not mean that we should be indifferent to its quality. I have heard the opinion expressed in a discussion relative to the quality of motion picture productions that the literary merit of the average motion picture is greater than that of the average novelistic literature being produced at the present time. The propounder of this statement, therefore, argues that the quality of the motion picture is all that could be expected under these conditions. It seems to me this argument is not sound, for the modern motion picture need not depend on modern literature entirely for its subject matter when the best of literary efforts for the past several hundred years may be utilized. You may feel that it is entirely beyond our province to concern ourselves with subject matter, but I point out again that the statement of the object of our organization as found in our constitution is that we are supposed to contribute to the advancement not only of the theory and practice of motion picture engineering, but also to the allied *arts* and sciences.

I feel that my remarks have been somewhat disconnected and that I am taking up entirely too much of your valuable time, and, while there is much more that could be said on this very interesting subject, I shall not pursue the argument further, but hope that what I have said may stimulate others of you to think along similar lines.

In this, my valedictory as your chief executive, I should show myself ungrateful indeed if I did not take the opportunity to express my thanks to those who have so ably assisted me during my administration. It has been a keen pleasure to do my part in conducting the affairs of the organization, and I can truthfully say that I have been loyally supported by every individual member. For this support and loyalty I render my best thanks. To the officers also I owe a great debt of gratitude for the way in which they have each discharged their duties. In no other organization with which I have been connected have I found such universal willingness on the part of the members to work for the society. If the two years of my incumbency of this office have been successful, it is due entirely to the loyal support of officers and members. It would be impossible to thank adequately all those who have assisted me. I do, however, wish to take this opportunity to express my thanks particularly to one or two who have, it seems to me, given most generously of their time and efforts. As you know, Mr. J. C. Kroesen has been chairman of the Publicity Committee for some time. He has given to this work many, many hours of his own time, and he has always been willing to take on even heavier burdens. I doubt if the Society has any conception of the amount of work involved in carrying on the activities of even so small an organization as ours. And to Mr. Kroesen I express my sincere appreciation. The chairman of our Publication Committee also has a very difficult task, a task, in fact, which could be very materially lightened by a little more work and thought on the part of the contributors to our TRANSACTIONS. To Mr. Little for his careful and efficient labors in connection with the publication of our TRANSACTIONS, I also tender my most hearty thanks. The other committees have also worked diligently and to them I express my appreciation.

PROGRESS IN THE MOTION PICTURE INDUSTRY

1924-1925 Report of the Progress Committee

Introduction

THE ideal motion picture has been described as one which is projected stereoscopically in natural color, is free from flicker and rain effects, and is accompanied by audible reproduction of the players' words. We are still some distance from this ideal, but it gives us some idea why developments during the past year have been carried along a few principal lines in efforts to reach this goal. They include the production of many mechanical devices, in which the Germans have been especially active, marked interest in color photography, reduction of non-visible radiation in the light beam before it reaches the film, and more attention to the theatre performance along the lines of co-ordination of the lighting effect, music, and screen picture.

American competition is given as the cause for a revival in the building of theatres on the Continent.[1] The larger cities of Germany, Spain, Holland, Belgium, Czecho-Slovakia, and the Balkan states have new theatres of the better class, capable of producing first class performances. Both in France and Germany the producers are active not only with new films, but also in buying the larger theatres of the principal cities. In France the musical accompaniment to the film production is receiving special consideration.

In Europe considerable attention has been directed[2] to the thirty year anniversary of the contributions of the Lumière brothers to the field of cinematography. Special attention has been given to their mechanical developments, and credit is given for the technical principles of modern practice to the work of these two men.

Increasing use of the motion picture[3] in the field of medicine is shown by the taking of motion pictures of the interior of the bladder. They were obtained with the use of a cystoscope combined with a

[1] *Mov. Pict. World,* March 21, 1925, p. 228.

[2] *Kinotechnik,* March 10, 25, April 25, 1925, pp 106, 137, 187 and other publications.

[3] *Sci. Ind. Phot.,* January 1925, p. 7.
Kinotechnik, November 10, 1924, p. 402.

camera; as the crank is turned the cystoscope rotates, permitting a circular exploration.

Respectfully submitted,

C. E. Egeler, *Chairman*
P. R. Bassett
W. T. Braun
J. I. Crabtree
Rowland Rogers

Cameras

Announcement was recently made of an improved motion picture camera[4] for amateur use which employs 16 mm width film, weighs only 5 pounds, and is little larger than a Kodak. 50 or 100-foot lengths of film may be used and the camera loaded in daylight; it is spring driven. The type of view finder employed allows the camera to be held at waist level. An exposure guide and a footage indicator are included. The exposure lever may be locked in operating position so that the user can place the camera on a firm support and include himself in the action.

A so-called "process camera"[5] has been developed which is capable of securing unusual results in trick photography. Among the effects produced are those of "suspended motion," where one image is held indefinitely on the screen, and reverse motion or reversal of action without break in the continuity. The production of multiple images of various sizes is another feature of the camera. With a new professional model camera[6] direct focusing on the film or at the aperture on a ground glass is possible, without the necessity of swinging the lens out of position or moving the front vignetting attachments.

A number of camera devices[7] have been developed in Europe, among which is a triple revolution counter of German manufacture for attachment to motion picture cameras to facilitate the taking of trick pictures and especially double exposure effects. It obviates the necessity in this work for the camera man to watch the revolution counter during the taking of a scene.

[4] *Amer. Cinemat.*, August 1925, p. 6.
[5] *Mot. Pict. News*, February 14, 1925, p. 716.
[6] *Amer. Cinemat.*, November 1924, p. 25.
[7] *Kinotechnik*, November 25, 1924, p. 430.

A range finder[8] suitable for attachment to a motion picture camera is of marked aid to the cinematographer. It works on a principle similar to that of the large range finders used in the Navy.

In an improved German camera the new features[9] of easily interchangeable objectives, a pressure roller at the gate, and a range finder are employed. The end of a scene is marked by a perforation at the edge of the film. The size of the image in the finder changes with a change in objective. Another camera[10] recently placed on the market may also be used as a printer, projector, and enlarger by the use of simple auxiliary apparatus. An amateur type camera[11] measures 9×10.5×4 cm. and weighs 700 g. A fixed focus lens works at f/3.5. A German amateur apparatus[12] is said to combine the functions of a motion picture camera, "still" picture camera, projector, enlarging device, printer, and rewinding device. It uses a standard size film. Lightness in weight[13] is the outstanding feature of a new French camera.

Color Photography

The Szczepanik[14] three-color additive process for colored motion pictures was demonstrated early this year. The three-color records are obtained on the negative by means of a special camera in which the film moves continuously behind a large lens of a diameter somewhat greater than the height of the three frames. Small lenses, each of which is provided with one of the color filters, red, green, or blue, move with the film behind the large lens. In this manner the three-color records are obtained in succession on the negative. It is claimed that optical parallax and color fringes are largely eliminated, since several successive frames are always being exposed at any given instant. For projection a similar optical system is employed, but the definition falls below that obtained with black and white film projectors. Some flicker and lack of color balance were noticeable.

[8] *Kinotechnik,* July 10, 1924, p. 209.

[9] *Kinotechnische Rund.,* January 1925, p. 8.

[10] *Rev. d'Opt.,* November 1924, p. 499.
Kinotechnik, January 10, 1925, p. 7.

[11] *Rev. d'Opt.,* July 1924, p. 342.

[12] *Die Photographische Industrie,* June 23, 1924, p. 515.

[13] *Bulletin de la Societe française de Photographie,* April 1924, p. 86.

[14] *Kinotechnik,* February 15, 1925, p. 61.
Kinotechnik, April 10, 1925, p. 157.

A new German film for three-color photography[15] dispenses with color filters. The usual filter dyes are placed on the film in bands at the proper intervals for the three monochrome images which appear in series. The negative is developed in the usual manner and the positive print made, which is projected additively through a rotating disk bearing red, green, and blue sections. The standard camera and projector are employed. Another color film[16] is made from two separate color negative records taken simultaneously by means of a beam-splitting prism placed in the camera. One record is made from a mixture of red, orange, and yellow light and the other from a mixture of yellow, green, blue, and violet light.

In a four-color additive projection system[17] developed in Great Britain, enlarged images are each in turn projected through a separate focussing lens. Higher screen illumination than is ordinarily obtained results, as the separate lenses may be made of larger diameter than is customary. Another British two-color subtractive process[18] utilizes the principle of cementing in register two separate and complementary images on two film bands. Since the images are then cemented together face-to-face, no emulsion surface is exposed to the wear of the projector.

For color films[19] made by stenciling dye solutions on black and white positive prints, the stencils are cut by hand with an electrically operated needle cutter. Usually six stencils are necessary for each copy, and the most expert workers can only cut three feet of stencil per hour. After cutting, the gelatin is removed from the stencil by means of a solution of sodium hypochlorite. A special coloring machine is employed for placing the dye on the film.

Low cost of production[20] is claimed for a European development known as the "polychromide" process, a four-color subtractive system involving the use of double coated film stock. Red, yellow, green, and blue-violet dyes are employed. In the Daponte[21] method of producing color motion pictures a split beam camera with two lenses is used for taking the picture and a two-color additive process employed.

[15] *Die Photographische Industrie,* June, 30, 1924, p. 543.
[16] *Kinematographic Weekly,* September 4, 1924, p. 82.
[17] *British Jour. Col. Sup.,* November 7, 1924, p. 42.
[18] *British Jour. Col. Sup.,* July 4, 1924 and March 6, 1925, pp. 27 and 10.
[19] *Photographic Journal,* March 1925, p. 121.
[20] *Kinematograph Year Book,* 1924, p. 214.
[21] *Cinematographie française,* April 11, 1925, p. 16.

A German writer[22] remarks that the successful effects achieved by the two-color additive motion pictures cannot be accounted for solely on the basis of physics, but are believed to be largely due to physiological and subjective effects in the observer. This is also believed to be true in the two-color subtractive process.

A news note indicates that roll film[23] and film pack coated with a three-color screen and suitable for color photography will soon be available on the market.

It is also reported that Agfa[24] motion picture film having the same emulsion as screen plates for color pictures will shortly be placed on the market.

Interesting features of color photography patents are discussed in our TRANSACTIONS.[25]

Films and Emulsions

As an improvement in the reversal process[26] for the reproduction of black and white copy containing no half-tones, the procedure of making a print on paper and developing it into a negative is proposed. At this stage it may or may not be fixed, after which it is thoroughly washed and dried. India ink is applied with a tuft of cotton to the entire gelatin surface. The print is then treated with a solution of hydrogen peroxide and nitric acid. Washing in water removes the attached gelatin and leaves a black and white positive print in carbon pigment. In another process[27] the film is developed in amidol and then bleached to chloride. After washing the film is exposed and redeveloped. Reversal depends on the difference in sensitiveness of the bromide and reformed chloride, which is affected by the washing after bleaching. A third process[28] uses a solution of sodium bisulfite and sodium hydrosulfite for the redeveloper after re-exposure. It is claimed that the harmful effect of alternate immersion in alkaline and acidic solutions is avoided, and the second development can take place by chemical action alone without exposure to light. A fourth method[29] is based on a combination of the bromoil and pinatype

[22] *Kinotechnik*, December 10, 1924, p. 441.
[23] *Die Photographische Industrie*, Oct. 27, 1924, p. 951.
[24] *Camera (Luzern)*, April 1925, p. 231.
[25] TRANS. S.M.P.E., No. 21, 1925, p. 113.
[26] *Atelier*, March 1925, p. 23
[27] *Il. Prog. fot.*, April 1925, p. 121.
[28] *British Jour.*, May 9, 1924, p. 280.
[29] *British Jour.*, May 9, 1924, p. 276.

processes. A very clear image must be obtained by short exposure and development in an acid amidol solution. (Process apparently the same as Kodachrome except slight difference in composition of bleach bath.)

Basing his conclusions[30] on a large mass of experimental evidence which he presents, a German writer delimits three types of processes for the reversal of film negatives. The Luppo-Cramer solarization hypothesis is rejected, and the mechanisms of the Villard and Herschel effects are discussed in detail. For motion picture photography[31] by amateurs a German firm uses the same scheme employed in this country of finishing the film after exposure and returning it to the amateur ready for projection.

To avoid the difficulties with reversal processes[32] now employed, a process is suggested involving the use of a special bleach bath to convert the first image into a modification of silver chloride which is not light sensitive. This acts as a negative for the second exposure. The time of washing after bleaching controls the sensitivity and contrast of the residual silver bromide and after the second exposure the reversed image is developed in a suitable developer and fixed, giving a silver image.

Forch[33] found that the inflammability of motion picture film as ordinarily finished for projection is increased by the presence of silver, whereas a similar film supporting a dye image ignites much less readily. In a discussion[34] of the patented processes for eliminating scratches on motion picture film, a German author considers the best method to be the production of a matte effect on the back of the film or the application of a coating of matte lacquer. For the marking[35] of film, the characters are first written on paper with a special acacia ink and the ink sprinkled with a black powder before drying.

An instrument[36] has been devised for measuring the size of particles in a medium of specific gravity greater than that of the particles measured. The apparatus is of the U-tube type and is modified in that the capillary side arm is connected to the sedimentation tube near the top.

[30] *Zeitschrift Physikalische Chemie,* January 20, 1925, p. 337.

[31] *Phoographische Korrespondenz,* December 1924, p. 9.

[32] *Die Photographische Industrie,* January 26, 1925, p. 83.

[33] *Die Photographische Industrie,* October 31, 1923, p. 549.

[34] *Kinotechnik,* January 15, 1924, p. 7.

[35] *Amer. Jour. of Roentgenology,* October 1924, p. 390.

[36] *J. Amer. Chem. Soc.,* December 1924, p. 2709.

A study[37] has been made of the so-called "deterioration fog" which is found in emulsions kept for variable periods without exposure to light. Using definite conditions of development, an experimental emulsion showed an initial fog density of 0.09 which increased in one month to 0.5. Measurements of developability of emulsions recoated in one-grain-layers were also made. The percentage of grains fogged seems to follow an equation similar to Silberstein's equation of photographic exposure. Another instrument[38] has been developed for measuring the swelling of gelatin on rigid supports.

Comprehensive discussions of film handling at high temperature,[39] reducing the appearance of graininess,[40] and static markings,[41] appear in our TRANSACTIONS.

General

A recently expressed English opinion[42] of the ideal motion picture film is that it should be a so-called speaking film, free from rain and flicker effects, in natural colors and projected stereoscopically. It is predicted that the perfection of a continuous projector will eliminate the flicker effects, and it is expected that the other developments under way will bring this ideal motion picture into use before the Utopias are reached in other fields.

An effort[43] has been made in England to form a technical society for projectionists. The aims of the technical society are radically different from those of the projectionists' trade unions, so that their activities should not overlap with resulting delay in the formation of the new society.

Although it is stated that the details in part are being held as military secrets, it is of interest[44] to learn that some work has been done with the photography of objects concealed by water vapor in the form of natural fogs and cloud banks. It is expected that the present developments will be perfected to a great extent. The results depend principally on the use of photographic emulsions sensitive to radiation outside of the visible spectrum.

[37] *Phot. J.*, March 1925, p. 134.
[38] *J. Opt. Soc. Amer.*, August, 1924, p. 181.
[39] TRANS. S.M.P.E., No. 19, 1924, p. 39.
[40] TRANS. S.M.P.E., No. 19, 1924, p. 49.
[41] TRANS. S.M.P.E., No. 21, 1925, p. 67.
[42] *British Jour.*, July 3, 1925, p. 398.
[43] *Kinematograph Year Book*, 1924, p. 216.
[44] *Christian Science Monitor*, December 27, 1924.

The observation of motion[45] as dependent on the functioning of the human eye and its application to the motion picture problems have been studied by a German writer.

As a convenience[46] for the patrons an electrically lighted indicator is proposed to show the number of reels in the show and the particular one showing at the time. This indicator is mounted over the ticket window.

The series of articles[47] on light projection, to which attention was called in last year's report, have been continued during the past year and are well worth reading by all interested in light projection.

The City of Cleveland is considering a plan[48] for the establishment of motion picture centers for children to provide wholesome entertainment for children at nominal rates. The performances would be given on Saturday afternoon. Another plan is to operate motion pictures during the noonday program in high schools for children who cannot go home to lunch. It is suggested that an admission charge of 2 cents be asked for these programs.

Proper shielding of the cooling plate and light source are recommended[49] as necessary to the preservation of the eyesight of the projectionist.

Although America leads the world, Germany leads other European countries in the production of new pictures.[50]

Illuminants

Progress with arc lamps[51] has largely taken the form of perfection of mechanical detail on existing equipments rather than of modification in the principles of design or operation. For very large theatres a high intensity arc lamp of English manufacture employs specially cored carbons, but unlike the American lamps the positive carbon is not rotated. Even crater-burning is controlled by an adjustable system of lamp-house ventilation.

The use of the incandescent lamp[52] as a light source is discussed

[45] *Kinotechnik,* December 25, 1924, p. 469.

[46] *Exhibitors Herald Sup.,* March 28, 1925, p. 20.

[47] *General Electric Review,* 1924-1925.

[48] *Mot. Pict. News,* December 27, 1924, p. 3284.

[49] Trans. S.M.P.E., No. 20, 1924, p. 20.

[50] Trans. S.M.P.E., No. 19, 1924, p. 23.

[51] *Kinematograph Year Book,* 1924, p. 213.

[52] *Die Photographische Industrie,* Sept. 8, 15, 22, and 29, 1924, pp. 795, 825, 849, 876.

Kinotechnik, July 25, 1924, p. 228.

in considerable detail by a German writer, with data on projection lamps and the efficiencies of different projecting systems and condensing lenses. Apparatus for both still and motion pictures is discussed.

A detailed description[53] of the manufacture of tungsten filament lamps for motion picture projection presented at the Schenectady meeting includes some of the manufacturing variables affecting lamp performance.

Laboratory Practice and Apparatus

In a device[54] for periodically washing or changing the water in a film washing tank, a syphon is used which is automatically started and broken at proper intervals by a venturi constriction on the feed water line. The action of the constriction is regulated by the rise and fall of water level in relation to an inverted bell which forms its air intake.

Iron toning[55] is suggested for a hard negative to make it yield softer results.

A motion picture camera[56] can be used as a printer by the removal of the lens and making a light tight connection from the opening to a lamp-house. An auxiliary film magazine is used for the negative film, and the positive is threaded in the camera through the regular feed magazine. Both films are in contact in the gate and are allowed to run into an extra box under the camera.

A new desensitizer[57] known as "Pinakryptol Green Th.," has been found which, although it is a derivative of pinakryptol green, is 40 times as powerful when used in the same concentration. One gram dissolved in 100 liters of water desensitizes so thoroughly that a plate may be developed in bright yellow light.

Among the new equipments[58] introduced in France is a semi-automatic electrically actuated step printer. Notches in the edge of the negative actuate the light change, and the particular exposure is controlled by a punched paper tape resembling a piano player

[53] Trans. S.M.P.E., No. 21, 1925, p. 90.
[54] *Phot. J.*, January 1925, p. 34.
[55] *Amer. Phot.*, March 1925, p. 154.
British Jour., May 8, 1925, p. 274.
[56] *Amat. Phot.*, May 13, 1925, p. 488.
[57] *Photographische Korrespondenz*, April 1925, p. 4.
[58] *Sci. Ind. Phot.*, December 1923, p. 133.

record. A sampling machine for negatives makes at one exposure frames varying in intensity to correspond with densities produced by the printer, and a new title making outfit with an hourly capacity of three thousand feet uses transparencies with black print for titles.

Data covering investigations of photographic developers[59] and an improved sector wheel for Hurter and Driffield sensitometry[60] appeared in our TRANSACTIONS.

Lenses

A new projection lens[61] of English manufacture is claimed to have very high illumination efficiency and is so designed that it is not necessary to move the lens forward and backward when the projector has a front threading gate. Marginal definition is said to be as good as at the center of the field. Projector lenses[62] of large aperture are recommended for use with mirror arcs in conjunction with a single condenser lens.

A German f/2 lens[63] possesses at full aperture very high speed, but at smaller apertures is slower and has lower brilliancy than other types.

A new condenser[64] for arc lamps of foreign manufacture consists of two front plano-convex lenses and two rear strongly curved meniscus lenses. All except the last front component are of nearly colorless fireproof glass which permits the condenser to be brought to about one inch from the arc crater with a resulting increase in light efficiency due to the increased collecting angle subtended by the lens.

The manufacture[65] of curved surfaces other than spherical, with special reference to the use of spherical tools, has been published as part of a "Cinematographic Study of the Working of Optical Surfaces." Suggestions for practical tests of projection lenses were presented at the Chicago meeting.[66]

Lighting Equipment

Some of the producing companies[67] carry powerful and elaborate equipment for the production of desired lighting effects, no matter

[59] TRANS. S.M.P.E., No. 19, 1924, p. 28.
[60] TRANS. S.M.P.E., No. 21, 1925, p. 85.
[61] *Kinematographic Weekly Sup.*, December 11, 1924, p. 78.
[62] *Kinotechnik*, August 25, 1924, p. 269.
[63] *Kinematographic Weekly*, July 24, 1924, p. 80.
[64] *Kinematographic Weekly*, February 26, 1925, p. 82.
[65] *Rev. d'Opt.*, July 1924, p. 334.
[66] TRANS. S.M.P.E., No. 20, 1924, p. 75.
[67] *Mov. Pict. World*, June 6, 1925, p. 681.

where the pictures are to be taken. One company boasts of two 1600-ampere portable generators, one of 800-ampere and another of 400-ampere rating, in addition to a 300-kilowatt generator mounted on a trailer. All of these units are equipped with their own engines. The lighting equipment includes two 30-inch arc searchlights, several of smaller size, 15 high intensity arc spotlights, 50 smaller spot lights, and 150 side lighting units. If used at one time these equipments could furnish an enormous amount of light for almost any location and almost literally turn night into day.

Photomicrography

Successful motion pictures[68] of microscopical objects are only possible if the camera and microscope are separated so that vibrations of the former are not transmitted to the latter and if the field can be observed during the process. This is possible by means of the Goldberg microscope attachment, which contains a semi-transparent mirror that reflects part of the light perpendicularly into the camera. The movement of the object can be observed during the operation, and consequently it can be maintained in focus. Sharp pictures may be obtained at distances from 7 to 80 cm.

Physics

Of especial interest in connection with the inventions[69] of devices to produce cold light which appear from time to time is the complete classification of various types of luminescence which appears in a recent publication. Each type is clearly defined. It is of interest to note that the efficiency of the firefly[70] as a producer of cold light may not be as high as is ordinarily supposed on account of the lack of measurement of non-radiated heat. The light efficiency of phosphorus is only about one-thousandth that of the Mazda lamp.

For the determination of the percentages of light reflected by surfaces, a new reflectometer has been developed which is simple in construction yet has good accuracy.[71]

[68] *Kinotechnik*, September 25, 1924, p. 320.
[69] *Gen. Elec. Rev.*, February 1925, p. 103.
[70] Trans. I.E.S., April 1925, p. 392.
[71] Trans. S.M.P.E., No. 21, 1925, p. 101.

Projectors

A continuous projector[72] of German manufacture (Leitz) employs a complex lens system in which the light passes through six lenses and is reflected four times before being sent toward the screen. The resulting light loss is estimated at 50 per cent. From the condensing lens light passes to rotating and oscillating mirrors, a total reflection prism, into the projection lens, to another rotating and oscillating mirror, the second projection lens, mirror, and then to the screen. It is reported that the projection is bright, crisp, and steady, and the machine can be run at speeds above normal or at two or three pictures a second only. It appears to be a marked scientific advance but has two drawbacks: (1) The first cost is high, and (2) the wearing qualities are still undetermined.

Another optical system[73] for continuous projection utilizes an optically correct glass ring on whose inner periphery are a number of lenses, the whole rotating around the ring center, which is the common focus of all the lenses. Projection speeds as low as three pictures a second are stated to be satisfactory. Still another continuous projector[74] which carries up to 5,000 feet of either standard or narrow width film is similar in appearance to a standard phonograph. A continuous film movement[75] is used on a projector produced in Germany for advertising purposes in show windows. It is entirely automatic in operation.

An English projector[76] recently introduced has a horizontal film box and automatic rewind, which uses a large diameter central hub, and a split spool in the lower film box. For re-projection the outer half of the spool is unlocked, placed in the upper horizontal film box, and the film threaded through a curved track protruding from the box. The shutter sends a current of air to the film.

At the Leipzig Spring Convention[77] held in 1923, the A.E.G. new model projector shown was fitted with a device for projecting still

[72] *Kinematographic Weekly,* September 4, 1924, p. 78.
Kinematograph Year Book, 1924, p. 212.
[73] *Die Photographische Industrie,* August 22, 1923, p. 419.
[74] *Mot. Pict. News.,* February 23, 1924, p. 898.
[75] *Kinotechnik,* February 25, 1925, p. 84.
[76] *Kinematographic Weekly,* June 26, 1924, p. 64.
Kinematograph Year Book, 1924, p. 211.
[77] *Die Photographische Industrie,* March 21, 1923, p. 136.

pictures. A shutter placed in front of the film gate both absorbs heat and generates a blast of air for cooling the gate.

Various methods[78] have been employed for reducing the heat in the light beam or rapidly cooling the film in mirror arc projectors. For both cooling the beam and concentrating light to the film gate, an optical device has been devised which fits on the lamp-house. A brass cylinder carries a negative concave lens and a large diameter positive convex lens; the combination produces a slightly negative value. About 2 per cent loss of light and 50 per cent heat reduction are claimed, although the first figure is obviously incorrect.

For the cooling[79] of film by the use of an air-blast, one system takes air directly from the projection room, while the other uses moistened air. The data showed that the film life was nearly doubled when using moistened air. The use of a cooling cell[80] containing a solution of copper sulfate is criticized on the basis that the efficiency of the lamp is decreased by 40 per cent. The air ventilating shutter scheme is recommended, since it is said to decrease the heat by 50 per cent without affecting the light intensity. Another writer discusses the absorption of heat[81] by photographic silver density and presents measurements obtained to show the effect of certain liquids intended to absorb the heat in a projection system. Temperature data[82] have been obtained in Germany for ordinary and reflector arcs for film cooled by compressed air.

Exception is taken to Flinker's data[83] on the shrinkage of motion picture film exposed to an air blast; the point is made that if the life of a film is assumed to be 500 projections, the total exposure time would be considerably less than that required to cause a shrinkage of 1 per cent, which is considered the practical limit.

As a speed indicator,[84] an automobile speedometer has been used attached to the projector machine shaft. Another European device[85] stops the projector when the lamp-house is moved to one side by opening the motor switch.

[78] *Kinematographic Weekly,* June 12, 1924, p. 48.
[79] *Kinotechnik,* May 10, 1925, p. 216.
[80] *Kinotechnik,* January 15, 1924, p. 13.
[81] *Amer. Phot.,* June 1922, p. 397.
[82] *Kinotechnik,* May 25, 1924, p. 136.
[83] *Kinotechnik,* August 10, 1924, p. 258.
[84] *Kinematographic Weekly,* April 16, 1925, p. 87.
[85] *Kinematographic Weekly Sup.,* April 2, 1925, p. 87.

In a hotel ballroom[86] where it was desired to install a motion picture projector in such a way that the elaborate furnishings would not be interfered with, such as modification in the design of the chandeliers on account of interference with the light beam, the problem was solved by directing the beam in such a manner that it did not strike the chandeliers. This was effected by the use of a two-mirror periscope which dropped the beam several feet below the level of the projector objective. A tandem condenser system was employed with special large diameter objective lenses, incandescent lamps being used to project the pictures 145 feet.

A new lamp unit[87] for theatre projectors uses a relay condenser system and incandescent lamps.

Projection Room Equipment and Practice

A film inspection machine[88] has a set of fingers and rolls on an automatic rewind, so connected with the driving mechanism that a poor patch, break in the perforation, or a tear in the film, stops the rewinding.

Coating the perforation area[89] of a film with opaque white at the change-over point is reported to be a satisfactory method of indicating to the projectionist that the end of a reel is approaching. Another change-over signal[90] suggested to audibly warn the projectionist is increase of the film thickness so that it would make a noticeably different sound on passing through the projector gate.

For a film joiner[91] a glass plate is mounted on a wooden base on which half a hack saw blade is mounted. The film is pushed under the blade with the free edge projecting from the smooth side. The other half of the blade with the edge ground flat is used to scrape the emulsion off the film.

The allotment of adequate funds for the equipment and maintenance of the projection room is strongly recommended as necessary to give the patron his due as well as from the standpoint of good business.[92]

[86] *Amer. Cinematographer,* August 1925, p. 4.
[87] Trans. S.M.P.E., No. 20, 1924, p. 82.
[88] *Mot. Pict. News,* November 22, 1924, p. 2658.
[89] *Kinematographic Weekly,* September 25, 1924, p. 68.
[90] *Kinematographic Weekly Sup.,* December 11, 1924, p. 76.
[91] *Kinematographic Weekly,* June 18, 1925, p. 56.
[92] Trans. S.M.P.E., No. 20, 1924, p. 43.

Radio Vision

As a leading editorial writer[93] states, "radio vision is not an impossibility, and it is conceivable that in any home there may be a white screen on which will appear a moving picture from any station where something of interest is going on." The work of one of our members and his recent report of progress[94] in the TRANSACTIONS has been followed with interest by the Society. English[95] and French[96] experimenters are also active on the problem.

Shutters

An excellent discussion of translucent shutters was presented before our society.[97]

Standardization

It is proposed in Germany that cores[98] in film spools be standardized for motion picture cameras with a standard position of the film with respect to the emulsion coated side and a standard manner of winding raw film by the manufacturers. The disadvantages of having to rewind film before putting it in the camera are discussed. In another discussion of standardization[99] of film widths, it is proposed that it would be wise for German manufacturers to adopt the 16 mm. width for amateur use as has been done in this country.

A cinematographer[100] discusses the demand for rapid projection by theatre managers, which he states is often 70 feet per minute or more, and advocates returning to the standard of 16 pictures per second as a means of reducing the loss in torn sprocket holes and other film damage.

Statistics

Government reports[101] show a considerable falling off in film imports for 1924 as compared to 1923. While 2,228,660 linear feet of negatives valued at $942,807 came into the country in 1924 as

[93] *New York Times,* March 21, 1925.
[94] TRANS. S.M.P.E., No. 21, p. 7.
[95] *Christian Science Monitor,* December 27, 1924, p. 12.
[96] *Christian Science Monitor,* December 4, 1924, p. 7.
[97] TRANS. S.M.P.E., No. 20, 1924, p. 53.
[98] *Kinotechnik,* December 25, 1924, p. 465.
[99] *Die Photographische Industrie,* Feb. 2, 1925, p. 127.
[100] *Amer. Cinemat.,* March 1925, p. 7.
[101] *Mot. Pict. News.,* July 11, 1925, p. 189.

compared with 2,064,390 valued at $657,509 in 1923, imports of positives for 1924 amounted to only 4,502,031 linear feet valued at $241,065 in comparison with 7,053,232 linear feet valued at $323,493 for the previous year. How small a comparative total these f gures represent is aptly illustrated by the fact that American exports of positives were in 1924 nearly 180,000,000 feet or approximately 40 times as great as our imports, while the 8,000,000 feet of negative exported in 1924 were nearly four times the amount of negatives imported.

According to the official German statistics,[102] Germany exported during 1924, 48 million meters (157 million feet) of raw motion picture film and 8 million meters (26 million feet) of printed film compared with 29 million meters (95 million feet) of raw film and 13 million meters (42 million feet) of printed film exported in 1923.

There are at present 4500 motion picture theatres[103] in Germany with 1,000,000 seats. Berlin has 300 theatres with a patronage of 100,000 persons per day. New York is said to have a daily attendance of 600,000. World production of motion picture film is given as about 500 million meters (1 billion, 640 million feet) per year. Germany now exports about 80 million meters.

An analysis[104] of accidents in motion picture theatres reveals the fact that only 6.3 per cent are a result of fire.

Stereoscopic Projection

For the projection[105] of stereoscopic pictures a French method superimposes two images simultaneously on the screen. A relief effect is obtained by means of the so-called disk pulsator. The total light falling on the screen is constant at all times, but the intensity of illumination of the two images is varied in a continuous manner by means of a glass disk having dark and light zones. A partial stereoscopic effect[106] is planned for an English development known as the Pulsograph. It operates on the principle of projecting pictures alternately from a pair of films. Another process[107] for stereoscopic motion pictures uses only one camera, one projector, and a single film. No experimental details are given.

[102] *Science, Ind. Phot.*, January 1925, p. 7.
[103] *Die Photographische Industrie,* Feb. 23, 1925, p. 184.
[104] *Mot. Pict. News,* March 7, 1925, p. 1031.
[105] *Cinematographie française*, March 7, 1925, p. 14.
[106] *Kinematograph Year Book,* 1924, p. 215.
[107] *Kinematographic Weekly Sup.*, January 22, 1925, p. 81.

Studio Lighting

In discussing the illumination[108] of motion picture studios a report prepared by the Société Française des Electriciens covers both the photographic requirements and the physiological effects on the skin and eyes. Since the effects on the skin may be remedied by the use of grease paint or other preparations, the report emphasizes particularly the effect on the eye. Two suggestions are made to diminish the harmful effects: (1) As much as possible of the preliminary work should be done in subdued light, thus exposing the eyes only while the film is being exposed; (2) Diffusing material should be placed between the actors and the light source or glass to absorb the ultra-violet rays. The author concludes that the final solution lies in the use of panchromatic negative film which will obviate the use of light sources harmful to the eye.

The use of a blue filter[109] for examination of the lighting quality of a studio setting is proposed. Blue bulb photographic incandescent lamps are recommended for "bank" lighting effects to supplement daylight. Yellow tinted screens are useful in portraiture when an enclosed arc is employed which tends to give distinctly violet light.

Where electricity[110] is not available, as on distant locations, magnesium candles can be used as light sources. The need for protecting the eyes against strong violet light is discussed.

Studio Effects and Practice

In order to produce the illusion[111] of ghosts or similar phantoms floating upward or in any direction in the air, the objective of the motion picture camera is slowly moved in any desired direction by a device fastened to the top of the camera.

In a recent motion picture film[112] certain very busy sections of Paris were represented without vehicles or pedestrians. This effect was achieved by the use of an old device which consists of using very long exposures by means of a slow emulsion, a small diaphragm opening and a very dense colored filter. Under these conditions each passing object crosses the field for only a minute fraction of the total exposure and does not affect the register of fixed objects.

[108] *Sci. Ind. Phot.*, February 1924, p. 17.
[109] *British Jour.*, May 15, 1925, p. 286.
[110] *Die Photographische Industrie,* March 9, 1925, p. 282.
[111] *Kinotechnik,* January 10, 1925, p. 18.
[112] *Sci. Ind. Phot.*, January 1925, p. 11.

Soft focus effects[113] have been obtained by the use of veilings to cover part of the opening of the rotating shutter of a motion picture camera, thus giving the film a sharp image for part of the exposure and a soft image for the remainder. Different effects may be obtained by choosing fine or coarse veilings or veilings of different color or by changing the ratio of the veiled opening to free openings.

Suggestions are given for the use of make-up under various lighting conditions[114] and a few of the standard methods of securing trick effects are briefly described in recent publications.[115]

Natural effects are obtained[116] by the artistic utilization of light, with judicious placing of spot and flood units.

Super-Speed Motion Pictures

A French inventor[117] demonstrated in England last year motion pictures taken at speeds varying between 2,000 and 30,000 pictures a second. For the highest taking speeds the film band was held stationary and the image caused to traverse it by the rotation of a prism placed in the optical path of the light beam. The illumination was furnished by electric spark, the frequency being controlled by charge and discharge of large fixed condensers across a spark-gap. In this way records were successfully taken showing bullets propelled by high-explosives leaving the barrels of guns and penetrating various substances.

K. Gordon and G. Gimber gave two lectures[118] on slow motion cinematography before the Royal Photographic Society in which the relative merits and mechanisms of the Debrie, Pathé, and Cinechrome ultra-rapid cameras were discussed, as were experiments in connection with slow motion as carried out in the Gaumont Laboratory by the latter speaker.

Talking Pictures

For the recording[119] and reproducing of sound in a German development, the microphone current is amplified and caused to vary the intensity of a glow lamp similar to a Geisler tube which exposes

[113] *Kinotechnik,* February 25, 1925, p. 77.
[114] *Kinematographic Weekly Sup.*, January 29, 1925, p. 88.
[115] *Phot. J.*, January 1925, p. 36.
[116] Trans. S.M.P.E., No. 21, 1925, p. 21.
[117] *Kinematograph Year Book,* 1924, p. 216.
[118] *Kinematographic Weekly,* June 12, 1924, p. 55.
[119] *Kinotechnik,* December 1922, p. 857.

a narrow band at the edge of the film. The sound is reproduced by transmitting the variations in light from this band to a photo-electric cell, which in turn operates a loud speaker. The same general principles[120] appear to be used in another device for reproducing sound from a film record in which a photo-electric cell and an electrostatic telephone are employed.

A German writer[121] points out that when heard with both ears, it is possible to determine the direction of a sound to within 3 per cent, which makes it difficult to produce the illusion of sound coming from a single character on the motion picture screen. The desirability of having a stereoscopic arrangement for recording and reproducing sound is proposed.

Improvements in the Phonofilm apparatus were descibed before our Society at the Chicago meeting.[122]

Theatre Practice and Effects

It has been pointed out that the colored lighting effects[123] produced by the Clavilux are not intended to suggest anything other than their own intrinsic beauty. While they have been largely used as solo features, they can be employed for the production of subordinate lighting effects synchronized with the music and other action. It has also been used for the decoration of the picture title and sub-titles, both in monochromes and color. The projection of mobile and static settings for dramas, dances, pantomine, and ballets are other applications. It is predicted that soon the electrician must evolve into an artist on a par with the organist.

A German director[124] proposes for the sake of convenience and saving of time in orchestra rehearsals and for the adapting of music to film plays that a device be employed by means of which the orchestra leader may reverse or accelerate the film to repeat certain scenes at will. He also proposes a device to register "film seconds" which shall be visible to the leader and a device whereby the leader may retard or accelerate the film within limits.

[120] *Mot. Pict. News,* Sept. 5, 1925, p. 106.
Die Photographische Industrie, Nov. 15, 1922, p. 945.
Amer. Cinematographer, August 1925, p. 9.

[121] *Kinotechnik,* December 1922, p. 862.

[122] Trans. S.M.P.E., No. 20, 1924, p. 17.

[123] *Mot. Pict. News,* May 30, 1925, p. 2699.

[124] *Kinotechnik,* December 10, 1924, p. 442.

Basing his opinions on experiences[125] as a solo rehearser for the Dresden Opera, another conductor emphasizes the necessity for close co-operation between the illuminating engineer and the musical stage manager. A color music pianoforte recital is suggested.

The importance of co-ordinating the lighting effect[126] with the performance has been given especial attention by the managers of our outstanding theatres. At one large house a lighting rehearsal is used to work out the details of the lighting effect.

A curtain draw[127] which can be controlled from remote places has been recently introduced. The equipment is motor driven and by the judicious use of leather and wood in combination with the metal parts practically noiseless operation is secured. Control may be effected from as many places as is desired.

Flexible and complete control in addition to adequate lighting equipment form the basis of effective theatre lighting.[128] Proper combination of temperature and quantity for the air are necessary in theatre ventilation.[129]

Colored lighting effects have been employed with marked success[130] to supplement the picture projection, and offer many possibilities for the embellishment of the program.

Visual Education

In the educational field[131] considerable stress has been laid on the ability to teach certain subjects by motion pictures with better results than where the ordinary forms of instruction are employed. Some studies and experiments[132] have been made showing that motion pictures offer promise of effecting a material saving in time in that branch of education which consists in imparting information. From 40 to 62½ per cent saving in time was effected where the motion picture used was well constructed and adapted to the purpose.

The general acceptance of educational motion pictures[133] is progressing slowly in England, but it is encouraging to note that the

[125] *The Illuminating Eng.*, October-December 1924, p. 160.
[126] *Mot. Pict. World*, April 4, 1925, p. 6450.
[127] *Mov. Pict. World*, May 16, 1925, p. 321.
[128] Trans. S.M.P.E., No. 20, 1924, p. 23.
[129] Trans. S.M.P.E., No. 21, 1925, p. 13.
[130] Trans. S.M.P.E., No. 21, 1925, p. 38.
[131] Trans. S.M.P.E., No. 20, 1924, p. 65.
[132] *The Educational Screen*, January 1925, p. 13.
[133] *Kinematograph Year Book*, 1924, p. 217.

government recently appointed a committee of educators to determine the value of the motion picture in education which rendered a very favorable report to the effect that it did not impart instruction in a shallow way as many thought, so that the lesson was soon forgotten, and that instead of stinting the students' powers of imagination it helped to develop them.

The U. S. Department of the Interior[134] in a recent bulletin states that a large number of state institutions and those of larger cities regard visual education as of sufficient importance to warrant its organization into distinct departments. In Germany[135] as well this subject is receiving considerable attention. A number of articles have appeared discussing different phases of this subject. In the technical high school[136] at Charlottenburg and at the Munich "filmschule" motion picture photography and projection are taught. The latter school is supported by the Bavarian government and gives a two-year course in cinematography. During the first year the student is instructed in the theory and practice of general photography. During the second year, attention is given to the study of the theory of motion picture photography, film finishing, and projection.

A new handbook[137] on visual education discusses the sources of supply for the materials of visual education, includes a bibliography of the subject, and among several articles of interest includes one of particular value entitled "The Place of Motion Pictures in Education." Articles published on the fundamentals of graphing[138] give interesting data for students of visual education.

X-ray Motion Pictures

X-ray pictures[139] of the heart were taken by photographing the image formed by X-rays on a calcium tungstate screen. Seventeen pictures per second were obtained with the X-ray tube operating at 80 kilovolts and 200 milliamperes. A lens of quartz and uviol glass was used, of aperture f/1.55.

[134] *Bulletin No. 8, Dept. of the Interior*, Washington, D.C., 1924.

[135] *Die Photographische Industrie*, November 10, 1924, p. 1023.
Die Photographische Industrie, December 8, 1924, p. 1135.
Visual Education, December 1924, p. 446.
Educational Screen, January 1925, p. 9.

[136] *Kinotechnisches Jahrbuch*, 1922-23, p. 16.

[137] *Visual Instruction Handbook of Visual Instruction Association of Amer.*, New York City, June 1924.

[138] *Visual Education*, July 1924, p. 190 and August 1924, p. 238.

[139] *Bulletin des Rehçerches et des Inventions*, June 15, 1924, p. 581.

DISCUSSION

Mr. Ives: There was a reference in the paper to making two-color films cemented face to face. I suppose it would not be improper for me to say that I patented this idea so many years ago that I have forgotten the date. (U. S. Patent 1,248,864, December 4, 1917, application filed February 4, 1916.)

THE PREFOCUSING BASE AND SOCKET FOR PROJECTION LAMPS

R. S. Burnap*

Synopsis

This paper describes a special lamp base and a special socket for projection lamps. The lamp filament position is set accurately at the basing operation, so that lamps are interchangeable without socket adjustment in projection equipment.

PROJECTION equipment usually requires that the light source be placed accurately at the correct operating point on the optical axis. To accomplish this with incandescent lamps using the standard Edison medium screw base, special adjustment of the mirror, if used, and of the socket must be made for each lamp. Often, even when provision has been made for socket and mirror

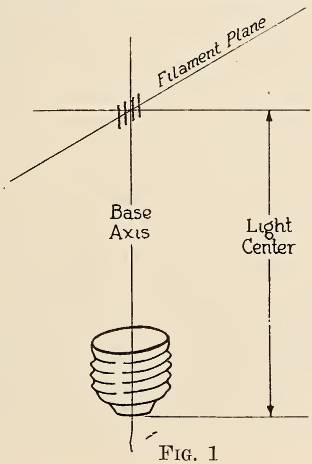

Fig. 1

adjustment, no attempt is made to align the filament due either to inexperience on the part of the user or the difficulty of adjusting a hot lamp. The ideal situation from the viewpoint of the user of the equipment would be a condition where lamp and mirror adjustments are unnecessary.

The requirements (see Fig. 1) for a set up to meet this ideal condition are:

(1) Accurate lamp light center

* Edison Lamp Works of General Electric Co., Harrison, New Jersey.

(2) Accurate axial alignment of filament and base
(3) Positive location of filament plane
(4) Correctly aligned socket
(5) Correctly aligned mirror

The standard Edison base does not meet these requirements for several reasons: First, because it is practically impossible to manufacture large lamps and to base them with the required accuracy. Second, because with a threaded base, the filament plane cannot be positively predetermined with reference to the socket.

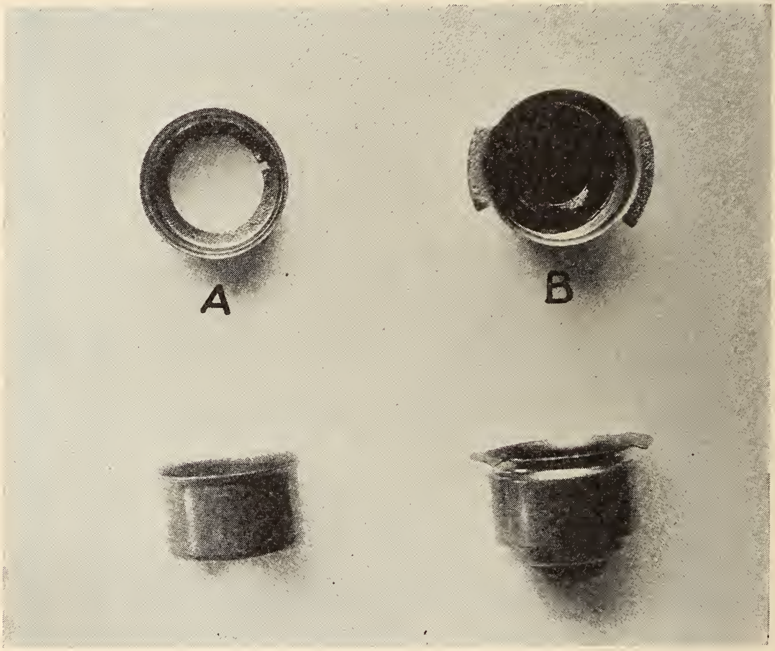

Fig. 2. Prefocusing Base
A. Inner Shell
B. Outer Shell

To meet these requirements a new base and socket have been designed. The base consists of two shells (see Fig. 2), one of which, shell *A*, is attached to the lamp seal in the usual manner. This shell fits in the outer flanged shell *B* and may be moved in and out, rotated, or rocked about the bead of the outer shell to align the filament. After alignment the two shells are fastened permanently with solder. The outer shell carries two unequal flanges which in connection with the barrel of the shell align the base in the socket and locate the filament position accurately.

The socket (see Fig. 3) is simple and rugged. It consists of a shell with engaging ears for the base flanges. The bottom contact is pressed against the eyelet of the base and holds the flanges firmly against the socket ears. The use of two unequal flanges permits of inserting the lamp in only one position in the socket, which is a desirable condition for use in optical systems using short focus condensers. The form of the insulation of the shell is unimportant except

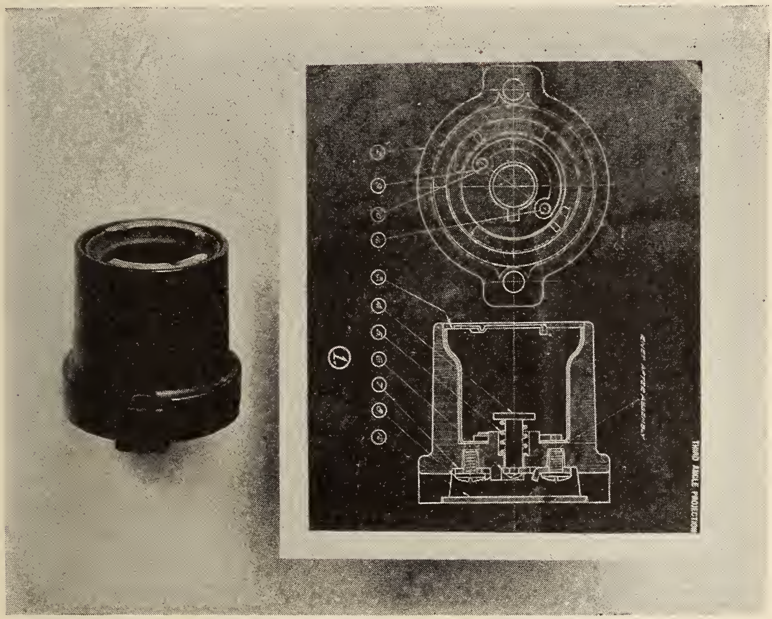

Fig. 3. Prefocusing Socket Construction

that a true surface must be available for alignment and for attaching the socket to the projection equipment. To obtain the maximum accuracy, the equipment manufacturer should locate sockets by trial and fasten securely in place.

The handling of this base in the factory is still in the development stage. Fig. 4 shows an experimental model for aligning lamp filament and base. In brief, the device consists of a solid socket, an adjustable bulb holder, and two lenses which project images of the lighted filament to a screen. The bulb is shifted until the image of the top of the filament and the image of the front of the filament fall within outlined spaces on the screen. The two base shells are then soldered together, thus insuring positive and accurate location of the filament with reference to the barrel and flanges of the outer base shell.

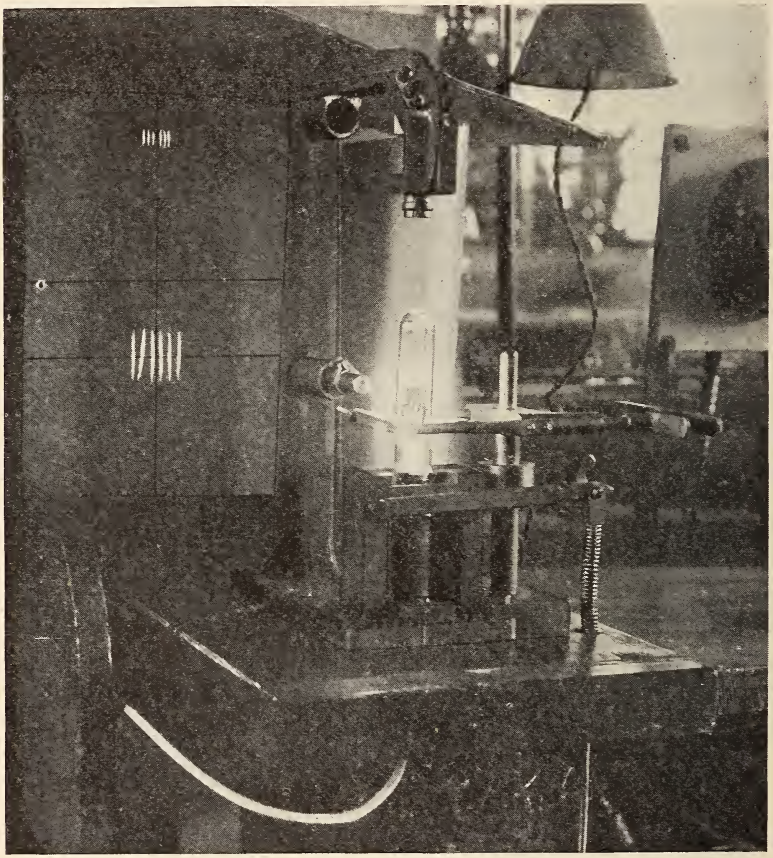

Fig. 4. Filament Aligning Jig

This method of basing corrects the unavoidable errors of glass assembly in lamp manufacture and permits the manufacturer to turn out uniform product which will automatically focus correctly. Fig. 5 shows an unbased lamp, a lamp with inner base shell, and a completed lamp.

The trend is toward requiring greater accuracy in the location of the lamp filament. The prefocused base meets this requirement both for the lamp and equipment manufacturers, because the lamp manufacturer can reduce his tolerance for the final product without increasing loss due to lamp rejections, and because the equipment manufacturer can dispense with socket and mirror adjusting devices and can guarantee results. Admitting the need for a prefocusing base, the design should be such that the base will have universal application and be reasonable in cost.

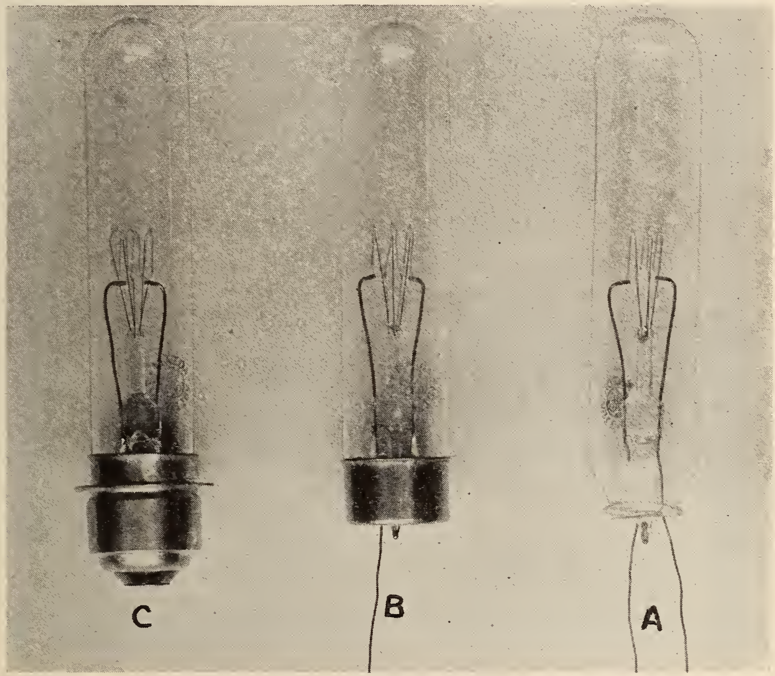

FIG. 5
A. Unbased Lamp
B. Inner Shell Attached
C. Completed Operation

Several types of pre-focusing bases are already in use, each adapted to the purpose for which it was designed. Other manufacturers are considering pre-focusing bases for their new models. With a view to simplification of base types, as now being worked out for lamp types, the lamp manufacturers are proposing a universal purpose base. There is a danger, of course, that a new base will lead to further diversification rather than to the desired standardization unless all projection equipment manufacturers approve and use this base. This base meets every requirement for filament alignment and uses a socket of simple and therefore rugged design. All possible adjustments are provided for aligning the filament accurately with reference to a sturdy outer base shell. The smooth cylindrical surface of the outer base shell forms in connection with the wide flanges excellent aligning surfaces for engagement in the socket. If it is desired to meet especially accurate focusing requirements or conditions of vibration, the socket shell can be split and arranged to clamp tightly about the outer base shell, thus making socket and lamp rigid. At present it does not seem desirable to try to meet all conditions of operation with one socket type. Furthermore, the manufacture of these bases follows standard methods and is done on automatic machinery, thus keeping the cost low.

DISCUSSION

Mr. Ziebarth: This was a very good demonstration. We tried to get the lamp manufacturers to make a pre-focusing base about two years ago, but we failed to get them interested. We have made a base of our own, and it would be difficult to change now. We have a very satisfactory way of centering the lamp in our Filmo projector, which is described in the 1924 Transactions in a paper by J. H. McNabb.

Mr. Palmer: Have they made any sockets to handle high wattage lamps like a 900-watt lamp for projection machines?

Mr. Richardson: These are small lamps, that is as far as standard projection is concerned. I noticed one of the lamps was off center considerably; with the taller lamp would not this error be increased?

Mr. Benford: Practically every one of the lamps is off a little to the left; if the paper had been adjusted a little more carefully the lamp would not have looked so bad.

Mr. Burnap: The first question refers, I believe, to the Bell and Howell base: It is unfortunate that we are several years late. We hope that Bell and Howell can some day see their way to come to this socket because it will take a bulb of any size, which the Bell and Howell base as now used will not do.

In connection with high wattage lamps, we have not any more than considered the use of a pre-focusing base for high wattage lamps because unless bases are made on automatic machinery the manufacturing cost is excessive. In order to make bases on automatic equipment we must talk in quantities of thousands of bases. We are not prepared to do this for large lamps at the present time, but we have considered it and hope soon to add the large wattage lamps to this type of focusing base.

Mr. Porter has just made a comment to me to the effect that where large lamps are used, particularly motion picture lamps, the projectionists who are the experts on the job should be able to focus them with the adjusting mechanism available.

Mr. Richardson brought up the question of light center and the effect on accuracy. All the lamps for which we plan to use this base will be of the same light center as those which we have been demonstrating: that is, 2-3/16 inches from filament center to flanges. For high wattage lamps, the base will be larger which will insure accurate alignment for the longer light center.

Mr. John Jones: How accurate do you have to position the light source in order not to impair the results?

Mr. Burnap: As the demonstration outfit is set up, due to the magnification used, an error of an inch on the screen represents less than half a millimeter variation for the filament position. As to what limits should be taken, we feel that if we hold the lamp within half a millimeter, we shall meet the requirements of every one. Actually, at the present time, pre-focused lamps are more accurate than the requirement stated.

Mr. Richardson: If the center of the lamp filament is on the optical axis of the system, the falling off of screen illumination is progressively tremendous. I did not mean to be harshly critical.

Mr. Palmer: I should like to emphasize the desirability of having these sockets or some similar device for the higher wattage lamps, because, regardless of the fact that the lamps are put in by experts, it is frequently necessary to change the lamps quickly, and if we had such a socket, it would eliminate errors and result in much better projection.

President Jones: One of the questions, I believe, was how high a wattage lamp can be used in this base. I believe that has not been answered.

Mr. Burnap: It is standardized up to 660 watts.

AN EXHIBITOR'S PROBLEMS IN 1925

Eric T. Clarke*

IN THIS paper I want to discuss some of the problems confronting the exhibitor of motion pictures. These problems do not strictly concern motion picture engineers, yet it is the business of the exhibitor to present to the public the result of your labors. Having been connected with the industry less than two years, I feel much more free to express opinions now than I shall later when I know more about the subject. After all, the membership of this organization is composed of men who are each specializing in some particular line of the work; the exhibitor has the advantage of a more general, if more superficial, view of the art. The subject is almost unlimited in its scope. As it would be futile to try to cover it in one paper, I shall confine myself to the question with which we are immediately concerned. Next year will probably find us working on other problems.

There is no need to dwell on the influence of motion picture entertainment. It is already recognized by the general public that motion picture entertainment is one of the most powerful factors in our modern life. The influence is far-reaching. Those who object to the movies represent a dwindling minority, and even they have to recognize that, whether they like it or not, the public is going to insist on having motion picture entertainment. In this connection, it is interesting to realize that almost all the recent theatre construction has been in the direction of movie houses. Scarcely anyone would now think of erecting even a concert hall without equipping it for the presentation of motion pictures.

The type of motion picture performance has developed rapidly, for it is only a few years ago that we had the so-called "nickelodeon" with the mechanical piano. This soon gave place to the small theatre with organ accompaniment. The serious-minded church or concert organist was at first inclined to object to what he considered a debasement of his art; yet, in a remarkably short time an entirely new organ technique was developed, and it may be of interest to know that the school of music of the University of Rochester maintains a

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department for special instruction in the art of motion picture accompaniment. In the next stage came the motion picture house with orchestra. Here again the first class musician was at first unwilling to engage in the work, and not without justification, considering the manner in which the average movie conductor butchered classical music. This difficulty has already been largely overcome, and we, in Rochester at least, find very little trouble in recruiting the best available talent for our theatre orchestra. At the moment we are engaged in pointing out to serious-minded American composers the almost virgin field of composition for the accompaniment of motion pictures, and it is already safe to prophesy that the most lofty-minded composers for orchestra will be interested in writing suitable scores for use in accompanying motion pictures.

More recently there has arisen the large motion picture house elaborately equipped for the presentation of the so-called "de luxe" performance with a big symphony orchestra and in addition short stage presentations. The question naturally follows, "What will be the next type of what we might call 'super-de luxe' motion picture entertainment?" Frankly, I do not know, and there is perhaps little need for speculation on this head, since there lies before us at this moment ample opportunity for the further development in our effort to arrive at the ideal de luxe performance. At all events, the de luxe performance is a young child growing rapidly and has a big future before it. Those who, like us, are responsible for its development have very little precedent to serve as a guide, but we have almost unlimited space in which to spread ourselves. Of course, there will doubtless be all kinds of motion picture shows, varying from the small-town and fourth-run neighborhood house, up to the elaborate downtown house, presenting a diversified program. It is the de luxe program that I wish to discuss in this paper.

At the Eastman Theatre in Rochester we must play every week to at least one-eighth of the population if we do not wish to lose money. Let us begin therefore by considering the type of audience which we wish to attract. It is safe to assume that most old-time theatre patrons are movie-goers. We find also that the concert-going public is being attracted by de luxe shows. This is the so-called "high-brow" class which we cannot ignore if we want one-eighth of the population every week. The vaudeville-goer is also a movie-goer. The gradual tendency toward the inclusion of films in vaudeville performances springs from many causes, but it proves that vaudevillegoers like films. The de luxe house, in short, is really welding a new audience out of all the groups and classifications of the public. Play-goers, concert-goers, and vaudeville patrons are only three out of the number of classifications which might be made, but they will serve to make clear that individual preferences must be satisfied if we wish to attract all these people to our house. In the first place, it is clear that they form a high-class audience. We have found it perfectly safe to equip the house with unusually beautiful and expensive appointments. It is a discriminating audience that distinctly prefers real quality to tawdry allurements. The most successful features are never morally questionable. Our biggest success at the Eastman Theatre has been Harold Lloyd in "The Freshman," and a survey of the twelve most successful pictures of the past season contains only one picture which parents might possibly have objected to their children seeing. That picture came twelfth on the list. Pictures with a strong sex appeal may succeed in other types of houses, but I know for certain that they can never beat the attendance records in a de luxe house. This audience, moreover, is not to be attracted by circus methods. Unlike the Broadway houses in New York, we, at the Eastman, must keep on appealing to the same audience week after week, and it does not pay to attract our audience by sensational means. This is a matter which it will be well for distributors to consider in producing their illustrated advertising sheets. As I hope to point out later, producers have in general shown a high degree of artistry and enterprise. Exhibitors are more and more becoming interested in high class presentations. The distributor who comes in between has been lagging behind, content with producing a type of advertising which is really aimed at the exhibitor buying the pictures. It should not be used for attracting a high class audience. We find it necessary to maintain our own staff of poster men. The posters now produced in quantity may be successful for certain classes of houses, but at best they convey an entirely false impression of the artistry and photographic beauty contained in the feature film. The cause of this condition is, as I see it, two-fold; firstly, the distributor is not really in touch with the public, the contact is via the exhibitor; secondly, people of artistic appreciation engaging in the motion picture industry are more to be found in the producing end than in the distributing end. To appeal to one-eighth of the population in a city where other forms of entertainment are available calls for a diversification of program that will contain something to appeal to the particular tastes of the classifications I named above. The de luxe program has clearly come to stay, and the tendency is toward greater program variety.

For this purpose the exhibitor, as will be seen, must have short features. Experience has established the two-hour show as a suitable length. Experience also teaches that a well-diversified program with six or seven numbers is far more attractive than a program in which the feature runs the full two hours. Let us prepare an imaginary program:

Every bill should contain an overture. We have found this an ideal number if about eight minutes long. Every second more than nine minutes takes away from whatever success you may have been achieving with the crowd up to that point. Take note that this makes the selection of overtures something to engage attention—to get variety, appeal, and proper length.

Every bill should contain a weekly film news number. I consider the weekly, if good, next in importance to the feature. We have tried all sorts of lengths and have made up our minds to certain things. First, if less than six minutes in length, the weekly leaves the audience dissatisfied. The average subject runs somewhere between one and one and one-half minutes. Five subjects are too few. Second, you can show news up to fourteen or fifteen minutes without tiring your audiences. Feature lengths, however, are such that we usually do not show news above ten minutes. We take all four news services, and make for ourselves a composite Eastman Theatre Current Events.

Every bill should have an act. This can vary all the way from the tableau shown for half a minute or so, which we have to arrange when we get a long feature, to a big act of twenty-five minutes. We rarely exceed ten minutes for an act, since, if we have time, we find it better to program two acts instead of one.

Every bill should have a comedy or novelty film of some kind. It diversifies the show, and it is practical, too, for if placed after the feature and before the overture, it permits the seating of the crowds before the overture starts.

Now, to sum up, we have this time-table:

Overture	8 minutes
Weekly	10 minutes
Act	10 minutes
Comedy or Novelty	10 minutes

If we take these as our minimum, a feature film that runs longer than an hour and twenty-minutes will hurt its own chances of success by its length.

What can be done in the art of concise presentation has never been demonstrated to better purpose than in "He Who Gets Slapped," where a story of intricacy, full of details, was excellently presented in a seventy-minute film. This was a great credit to Metro-Goldwyn and to Victor Seastrom, the director. Had this been a longer picture, I do not think it could have made so remarkable a success as it did. When pictures are longer, we can do three things: (1) reduce the number of items in the program; (2) cut the picture; (3) run it faster. Of the three, it is clear that we least of all wish to sacrifice variety. As to cutting, we recognize that the producers ought to be more competent to cut than we are; yet, I am frank to say that during the past year we have had many features come to us in a condition where the elimination of some hundreds of feet actually improved the success in exhibition. I could mention several features which time did not force us to cut, but which we cut for this reason. As to the speed of projection, this subject has already been discussed before your body on previous occasions. Your organization recommends eighty-five feet per minute. I believe, myself, that ninety feet per minute is more satisfactory from the audience point of view. I know, and I have no hesitation in admitting that, when we showed the "Ten Commandments" a few weeks ago, it was necessary to run the entire feature at a speed of one hundred feet per minute. This may be bad engineering, but the remedy lies with the producer and not with us.

Bear in mind that in making up the program as we did just now, I was including only the necessary minimum of diversification. The ideal program would be made up of seven numbers instead of five. It is a commonplace among exhibitors that you cannot attract an audience with scenics; yet, it is no less true that a good scenic picture not exceeding six hundred feet in length, if well accompanied musically, will get the audience in the required frame of mind and will prepare them for a greater enjoyment of that which follows. I believe in two reel comedies. No bill is complete without a good laugh, and while the old-time slap-stick has been done to death, the producers of first class comedies have so far shown no lack of ability to think up amusing situations. The short comedy with a real story is at last coming into its own.

Taking the program as a whole, the most difficult part to arrange satisfactorily is an act. We have found by experience that grand opera and ballet divertissements have no more place in the de luxe program than jugglers or balancing feats extraordinary. Our knowledge of the successful act is in the main negative. We know that our composite audience is not satisfied if we merely transplant items from other types of entertainment, such as opera and vaudeville. We know also that they are entitled to something more than straight concert numbers. Furthermore, I do not believe in prologues. An atmospheric prologue can sometimes be arranged successfully where the aim is to get the audience into the right frame of mind for viewing a feature picture, but there is little sense in presenting an act based on a picture which the audience has not seen. The motion picture acts offer at the present moment the biggest field for experimentation.

To sum up, our problem in program making, expressed commercially, is the desire to get the people to come to the theatre in the expectation of seeing a good show rather than to decide according to the attractiveness of the feature picture alone. Until we succeed in this endeavor, we shall be subject to the wide fluctuation in drawing power of the feature pictures.

The feature will, of course, in every program remain the headline attraction around which the program must be built. The feature represents the universal solvent. It is the common ground on which all sections of our audience will meet. The producers know that in selecting the feature to be shown we must not flout any section of our public. They know that motion picture features must always appeal to the masses. Books may be written and published with numbered copies autographed by the author for private circulation only; plays may be produced in bijou theatres for a hand-picked public; but motion pictures will fail unless they appeal to large numbers. The exhibitor operating a large house with a heavy overhead per week does not like to take chances. He naturally prefers the so-called "box office" pictures. This is the stock explanation given by producers in answer to the question, "Why are the movies so 'samey'?" Regarded in this light, I am frankly surprised that there has been so much artistry and enterprise shown in the production of motion pictures; for in the great run of movie houses where the feature film is almost the only attraction, the exhibitor is not likely to see the argument against the "sameyness," when the risk of a loss on the presentation stares him in the face. I believe that the development of the de luxe program, paying as it does the highest film rentals, is the biggest individual step in the direction of rewarding the producer who has dared to make something out of the ordinary. A well diversified program asks for this variety. The unusual picture, if carefully presented in this manner and honestly advertised, can be made successful. The American premier of "Siegfried," which we showed in our smaller house last Easter for a week, played to ninety-five per cent of theoretical capacity.

Unusual pictures are all the time being produced. The trouble is that they do not always get a showing over the country. The exhibitor is not to be blamed for failing to see the possibility in an unusual picture. Rather, if blame must be given, it lies with the distributor who too frequently fails to offer the picture in its correct light from a fear that the exhibitor can only be successfully approached by extravagant praise and box office allurement. The public has undoubtedly been misled, partly by the wrong kind of advertising posters, as I said before, partly by the presentations of old stories with new titles which often have nothing to do with the subject matter of the feature. The exhibitor in consequence has been misled into the belief that the public wants only the type of picture to which the public has previously responded. He has no accurate means of telling whether the public who responded to his advertising actually enjoyed the performance. This, by the way, is the fundamental advantage that we in Rochester feel we have over those operating theatres on Broadway. We do not enjoy the floating population of the metropolis, and our size is such that report by word of mouth brings a direct result at the box office. We find today that a successful presentation in New York is no assurance of a successful presentation in our own theatre.

Being the biggest theatre in Rochester, the Eastman is able to make its own choice of all the features which we may consider best for it. In the attempt to make this an intelligent choice, I have during the past twelve months personally screened just about 300 features. From this total come the 52 which the Eastman Theatre presents during the year. Of these 52, I frankly have not seen more than fifteen that could be classified as important contributions to the art. The other 37 consist of what are called "program pictures," pictures for the film fans, most of them presenting individual stars who have a large following which will stick by them without regard to the merit of the particular feature. I presume that, as on the legitimate stage, big names will always be an attraction. It is interesting to note, however, that there is a slowly growing public taste for the feature film which aims primarily at the story and the careful casting for types rather than for the presentation of big names.

It goes without saying that we sometimes make mistakes in the selection of pictures. When judging a picture "cold" in the screening room, it is often difficult to imagine oneself a member of the audience in the big house with orchestra accompaniment and other trimmings. Feature comedies are particularly hard to judge in the screening room. It is almost impossible to tell where the big laughs are going to come. The response varies with the different showings. Laughter is contagious, and a nine o'clock audience will often roar, while a five o'clock audience will sit in silence because the house is only half full. When I say that we make mistakes, I mean errors of commission rather than omission. For each instance where we fail to present a successful picture in the Eastman Theatre, I can think of at least seven instances where our expectations of success were misplaced.

It is very hard to single out any particular common cause of failure, but I might list some of the reasons why pictures fail. Most producers seem to overlook the fact that motion picture houses operate on continuous performance and that more than half the audience arrives during the showing of the feature and stays for the beginning. The story and sub-titles must always be so arranged that the picture will not be entirely unintelligible to those who have arrived after the beginning. The action must always be interesting no matter what reel is being shown. With this thought in mind we now screen pictures beginning with the third or fourth reel.

A common cause of failure is to be found in pictures which have been conceived at too great a length and then boiled down to movie length. Occasionally certain pictures strike us as disjointed and scrappy. I do not know whether this arises from the disjointed manner of production technique, but it is a pet theory of mine that slowness in studio production and the high quantity of retakes on scenes is bound to communicate itself to the audience in the form of dragginess.

Most features which we see nowadays are long on execution but short on idea. The public is appreciative of good photography, costumes and sets—particularly of good casting. It is the ideas that are usually lacking. This is evident from the frequency with which a successful idea is copied. In comedies you see old gags used over and over again. In features you find one outstanding success followed by such a deluge of similar pictures that the public taste soon cloys. Sheik pictures gave place to flapper pictures. These soon passed and at the moment we have a succession of "Covered Wagon" sequels. There are at this moment some historical western pictures of such outstanding merit that one could forecast another success such as the "Covered Wagon" achieved were it not that the recollection of the original success is too clear in people's minds.

Undoubtedly the most important cause of failure lies in trite story material. You start to screen a picture. You see a hackneyed story obviously building up to a situation. It beguiles the time to call the plays. It is as good as a ball game for you are more often right. Whoever has crossed the mountains on a railroad train must recall seeing far below the station which the train is not due to reach for another hour. After staring for a while, the attention wanders and you wake up at your destination. The best ball games are those where the result is uncertain until the last man is out. Suspense carefully maintained up to the last reel is about the most certain assurance of success. Only too often is this overlooked in the desire to present the unusual. This desire often degenerates into forced situations from which the scenario writer cannot extricate his characters gracefully. This results in the "last reel flop," the feature ailment that almost always proves fatal. Whenever we find ourselves wrong in calling the plays, we are delighted, for here may be the "new twist," the thing we can be sure that the audience will appreciate.

DISCUSSION

Mr. Clarke: One thought has come to me since preparing this paper. Some time ago we had to address the camera college of the Fox Film News, and I took up with them one subject which we had difficulty with; namely, the awkward speed of marching shots in weekly film reels. It comes back again to this question of speeds. If this society is correct in setting its footage speeds, there has got to be a change in the industry, because the weekly film news are instructing their men to shoot at 16 frames per second, and we are exhibiting at 24. Whenever we have a marching subject in a weekly film, we try slowing it down to the point where the marching looks right, but then we always find flicker. The Fox people issued an order that marching shots should be taken at 85 feet per minute with the idea that it should be taken at the exhibiting speed. It had a remarkable effect while it lasted, but the matter has lapsed, and they are being taken again as they were before. Those of you who have seen "The Phantom of the Opera" will recall seeing the musical director beating time. It is impossible to run this correctly.

Mr. Richardson: I regard this as one of the most valuable papers presented to this society. It is, however, quite typical of the exhibitor in one respect. In all my experience in the industry, covering a period of many years, I have yet to find the exhibitor who, without prompting, will lay any stress whatsoever on the importance of the manner in which the picture is placed before the audience—those various things having immediately to do with the picture upon the screen as the audience sees it. By this I do not mean the play, as such, but the image seen upon the screen.

It is unfortunate, and, I do not say this in criticism, that in a paper of this sort Mr. Clarke has not drawn attention to the evil effect of faulty projection. I say this because, while those in theatres of the type of the Eastman have to all intents and purposes perfection in those various items which go to make up high grade projection, it is a fact that one of the worst evils the motion picture industry has to contend with is that the average theatre (and average as here used means a vast majority of theatres) does not have high grade projection.

It seems to me there was great opportunity for Mr. Clarke to do a service to the industry by stressing the importance of high grade projection in this paper for the benefit of those who sadly need to have that point emphasized to them.

I believe Mr. Clarke overlooked one other thing which is of vast importance, namely, color effects such as are now being used in many motion picture theatres. Taking the Capitol Theatre, New York City, as a convenient example, I firmly believe that a large percentage of the people who patronize it do so in preference to patronizing other nearby theatres because of the wonderfully beautiful color effects used in the Capitol.

I should like to ask Mr. Clarke whether the wonderful hand colored pictures, such as were put out by Pathé Frères along about 1906 to 1908, would not be a welcome addition to the program of today? They were mostly "trick" pictures, such as a girl dancing inside a bottle, etc., but they were wonderfully effective and beautiful.

Also, what was the relative cost of gettting a 90 per cent attendance in those 90 per cent programs? By this I mean to ask if additional advertising was responsible for a part of the attendance at those shows. Also, what is the relative value of the "star" in the matter of box office pulling power?

I desire to compliment Mr. Clarke on beginning his pre-screening of features at the fourth reel. As he says, one of the great drawbacks encountered by the theatre goer is inability to "pick up the story" in many features, if he or she happens to come in in the middle of the show.

Mr. Palmer: Mr. Richardson asked whether the name of the "star" has anything to do with the attractiveness of the picture; that is, the ability to draw people into the theatre. Is the public interested as to who directs the picture and who produces it; that is, do people recognize that one producer makes better pictures than another?

Mr. Clarke spoke of the "Last Laugh" (Mr. Clarke's remarks interspersed) and criticized it because it had no titles. I should like to ask whether this picture with titles would be considered an exceptional one by his audience and what their reaction was if he has shown it.

With regard to cranking speed: Mr. Clarke mentioned specifically the cranking speed with marching scenes. Is there any other place where the difference between the speed at which the picture is taken and that at which it is projected is annoying and undesirable?

Dr. Hickman: I gathered in listening to Mr. Clarke's paper that to fill the largest theatre in any town one has to appeal to a very large percentage, and therefore it is essential that the program shall have a popular flavor, the roping in of the high-brows becoming a matter of secondary importance. If that is so, one must assume that it is impossible to give the best program in the largest theatre in any town; it must be given by the house of second importance. Mr. Clarke has based his argument on the behavior of Rochester and taken the Eastman Theatre as an example. It has the opportunity of the best of everything, but always one hears the expression: "There is a magnificent film at the Regent this week, but the family prefer the Eastman building." During the last few weeks we have had three or four films of outstanding importance: Harold Lloyd in "The Freshman," "The Beggar on Horseback," and "The Street of Forgotten Men." The last is a magnificent film; it was the less superior Harold Lloyd picture, which received the advertisement and drew the people.

There are three kinds of humor: the presentation of the bizarre in rapid contrast; the second kind, the joy at other people's misfortunes; and the third, the mention of the unmentionable. I think the Harold Lloyd picture succeeded because Lloyd took his clothes off and finally his trousers. I present these arguments in contention of the fact that if this is the kind of film the general public must have it is not possible to fill the largest theatre with the best pictures. On the other hand, the music at the Eastman Theatre is the best you can hear. I suggest that in the long run the best has paid: large numbers of people go to the Eastman Theatre in spite of the films to hear the music which the theatre itself has educated them to like.

Pictures are no longer a novelty and one must fill the theatres not only today but for years to come. Mr. Clarke has said that the important thing is to generate a confidence that there is always a good show to be seen at your theatre rather than to lure people on special occasions by "feature" picture advertising. The definite question which I put to Mr. Clarke is: "Does he think this solid reputation is best built up by following what is believed to be public taste; or by presenting material which is known to be the finest available?" I may say frankly that I incline to the latter view.

Mr. Clarke: Answering the various questions that we have had: Mr. Richardson's question as to why I omitted color: that was not inadvertent, but I felt there was no need to repeat a subject which had quite some discussion at your last convention. Of course, the color is the most interesting binder or cement that holds the units of your program together, but I took it for granted that those attending the convention were familiar with the paper by your president and Mr. Townsend on the work done at the Eastman Theatre.

The question of the revival of the hand-colored pictures: I am personally not enthusiastic for the revival of old films in a house of the type of the Eastman because there are only fifty-two programs open, and we want to have this given over to the new program, but we have, every Saturday morning, the films of the Hays organization and the interesting color pictures of years ago should find their place in those programs.

Mr. Richardson: I didn't mean to revive the old subjects but the old process.

Mr. Clarke: With respect to hand coloring, I believe that the development of the color processes has already reached a point where hand coloring can be detected and appears poor.

Mr. Richardson: I think you have effects there which it would be impossible to produce in the natural colors.

Mr. Clarke: Well, I am inclined to think that the thing which appeared so attractive years ago would not today when you have had a succession of pictures with colored sequences. I think most of the features have been in Technicolor, and those already have reached the point where the hand color does not stand up. We have screened a large number, and I have not felt justified in taking them for the Eastman although I have two other theatres to operate.

As to the "star" value: This is assured value. The program picture with the established star is like so much sugar in the grocery store; it is the one sure thing the exhibitor has in a business that varies tremendously. The fluctuation between features from week to week is like a saw-tooth; the fluctuation of pictures of certain stars is less so. Let us take the Swanson group: you will find less fluctuation, so that the exhibitor who showed the last picture and is dating the next can be more nearly certain of the volume of business to expect from it. I could say a lot about the star business from the exhibitor's point of view. I didn't include it because I thought it foreign to this body, but I feel that there always will be stars, and if only the vehicles for these stars can be more carefully supervised, the exhibitor and the public will gain by it. We have had the experience of stars who are steadily on the down grade. We have certain stars who are too directly classified in the type of work they are showing. I have particularly in mind the Corinne Griffith pictures, all of which, until the last one, have had a certain smack which is not wholesome. There is now an attempt to rebuild the damage which need not have been done. It need not be that the star will be the outstanding attraction, more so than the subject matter. Some day, the ideas will catch up with the execution. When they do, the star will be relatively less important.

Mr. Richardson: I asked about the advertising in a 90 per cent program.

Mr. Clarke: We hardly fluctuate advertising in Rochester at all. I allow the publicity director a gross sum for the year which averages so much a week, but his departures are very slight, because we appeal to the same audience each week. This would apply more to a house which was not doing a neighborhood business, and the Eastman Theatre is in reality only a large neighborhood house.

Mr. Richardson: The feature does, however, have a tremendous influence.

Mr. Clarke: Oh, yes. The feature is the outstanding thing at this moment in the program. Our only idea is to fill up the valleys in this saw-tooth by giving a quality of program which would increase the minimum.

Mr. Palmer asks whether the director has an influence. If I am not mistaken, it is only within the last few years that we have had the featuring of the director to the public. It has been very necessary, and we include the name of the director in our program. If the producers feature the individual the exhibitor will pass it on to the public, and the public will become more discriminating. That is bound to come. I think it was Wid Gunning who was first in telling producers that they should feature their directors, and I think the next thing will be to feature the camera man, that is, the technical expert. At present the list of credits is so long that it means nothing; we rip it out because we print a program.

With regard to the producer: I don't think the public cares a hoot under whose name the picture is published. The point is that when a concern is producing a large number of pictures it is going to produce all kinds, and in producing all kinds it will produce some for one audience and some for another, and the same individual may enjoy one and loathe the other, so that the institutional name is not worth much. The house that picks and chooses its features has no benefit to gain by popularizing the producing company.

As to "The Last Laugh," this was titled and was shown, I believe, in Los Angeles with titles. This was about the most horrible idea I could conceive. It could not improve the picture a particle. "The Last Laugh" was not suitable for the continuous program. If we had had our smaller "two-a-day" house available at the time we got the picture, that is where it would have been played. It should not have been shown for continuous program because it was unintelligible to anyone arriving after the beginning. It remains the finest artistic achievement ever made in motion picture presentation.

Projection speeds: Frequently, if we are forced to hold to a tight schedule, we will run the picture at a certain speed and slow down on the titles; we can run a scene fast where there is mere gesture. We have a most elaborate cue sheet issued by our projectionist to his men. I am sorry this is necessary, but the confines of the two hour program have yet to be recognized. I was talking to Mr. Marcus Loew about this last summer and said I was gratified to see the six or seven-reel features produced, and he said that this was no accident; they had recognized this as exhibitors. Famous-Players is coming to this very rapidly. First National, on its own productions, has not yet seen the light.

With regard to "The Street of Forgotten Men": The exhibitor, after all is in business, and while in the particular Eastman Theatre I don't have to show any profit, I have no endowment, and I must run the Theatre so that it will attract the largest audience. You can measure the success of a picture only by the size of the audience. I thought "The Street of Forgotten Men" was one of the best pictures of the kind I had ever seen, but it is one on which unfortunately we could only expect a limited audience. I am not trying to arrange that the Eastman have all the good pictures and the Regent the poor ones; I am trying to arrange them to get the best audience for the picture. This picture could have been presented at the Eastman, but I think it would have fallen below the average. At the same time we are not strictly commercial. We had "The Beggar on Horseback,"—a picture five years ahead of the public taste. The Eastman owed it to the industry to present that picture with a big orchestra, but we died with it. I might sum up the point by saying that Mr. Eastman did not build the theatre with the idea of duplicating the type of performance given elsewhere. Mr. Richardson's ideas strike me in this way. I am not so much concerned with the rest of the exhibiting world. If they want anything we have, they are welcome to it without charge. The color presentations are open to any theatre that may want to have them. Our idea is to use the theatre as a place where we can test out the possible future type of threatre presentation, and I hope that our experience will serve as an example to those not so fortunately situated.

Mr. Palmer: I don't think I made my question with regard to cranking speed quite clear. Mr. Clarke mentioned the specific case where a group of marching men were photographed at a lower speed than that at which they were projected. Do you find any other cases where you would say that the cranking speed in taking would improve the showing on the screen?

Mr. Clarke: If I get your point right it is this: That the taking of the marching shot at the speed of exhibition will give the proposed reproduction of the actuality. I mention marching shots because that is the place where it is the most important and where the music must most closely fit. We can get by with other scenes where the projection may be slower; that is, where the relation between the original taking speed and the exhibiting speed may be further apart without harm.

Mr. Porter: One of the problems which has been discussed a number of times in this society is that of reaching the greatest number of people, the greatest number of classes of people, interested in motion picture work, and we are sadly lacking in our membership representatives of the exhibitors. Only recently one of the exhibitors resigned, and I have wondered why that is; is it because the material which we describe and discuss is of no value to the exhibitor? If this is the case, what can we get which is of interest? Mr. Clarke is thoroughly acquainted with what we are doing, and while it is slightly off from the subject of his paper, I think we should appreciate it if he would tell us if the society is of value to him and how we can make it more so.

Mr. Clarke: That is difficult to answer. I have not read the Transactions as much as you are giving me credit for doing. The exhibitor has a lot to do, and it is only by reason of the fact that we are looking for the new and unusual that we can justify ourselves in keeping in touch with your organization. I do not think that constituted as it is the organization could be of direct benefit to the exhibitor; I think it could be of indirect benefit, but when I think of some friends of mine in the same line of work, I don't think there is much in their daily round of work that they will feel they can put aside to keep in touch with the Society. As I look at it, it is the one learned society in the whole industry and can take a place that will have the most pronounced influence in the tendency of the art and will stand within the three essential ends of it; but the average exhibitor is concerned with next week's show and not with the future tendency of the industry.

WASHING MOTION PICTURE FILM

K. C. D. Hickman*

ONE cannot be certain whether such a dry subject as washing will interest this Society even though it is of great importance to the motion picture industry.

Because washing is an invisible process and its progress difficult to follow, little has been known about it. The important things we do to motion picture film are to make pictures on it, develop, fix, and project it; and the washing which is involved between some of the stages has been regarded as a nuisance. Although everybody recognizes the need for sufficient washing, exactly how and how long it should be done has been left to guess work.

There is a well known quotation often misplaced as to biblical origin that "Cleanliness is next to godliness." Just as lack of godliness is not apparent till the next life, lack of photographic cleanliness is often not effective until the film's next life, that is, until the film has passed from its creator to the unfortunate people who have to project it.

I propose to deal with the subject of washing not in the way you would like it best as engineers and practical men. There are no cut and dried rules which can be applied without mental effort; the best I can do is to go through the elementary theory, then the more extended theory, and indicate finally how the information can be applied to your own laboratory problems.

Washing of film is largely akin to washing any other material with a thin porous surface. Consider the well known action of having a bath. If you sat quite still at one end of the bath with a piece of soap at the other and then simply got out and jumped into bed you wouldn't be clean and you wouldn't be dry. First, you must bring the soap into intimate contact with yourself, then you must give the dirt time to diffuse out, and then you must rinse away the soiled water. Finally, if you didn't dry with a towel, besides catching cold you would leave streak marks all over yourself. Motion picture film, fortunately, needs no soap, only water for cleaning. Suppose we consider the three main processes involved in its washing. The first

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stage is the application of water and the allowing of time for the salt to diffuse out; the second is the mechanical operation of getting the freshly diffused salt away from the surface and dispersed among the main bulk of liquid; then, thirdly, there is the renewal of the water in the tank, analogous to rinsing. One might add a fourth stage,—squeegeeing the film before drying, which is the same as wiping the body with a towel after the bath.

You may say "We know all this." The question which concerns the practical man is what is the quantitative magnitude of these

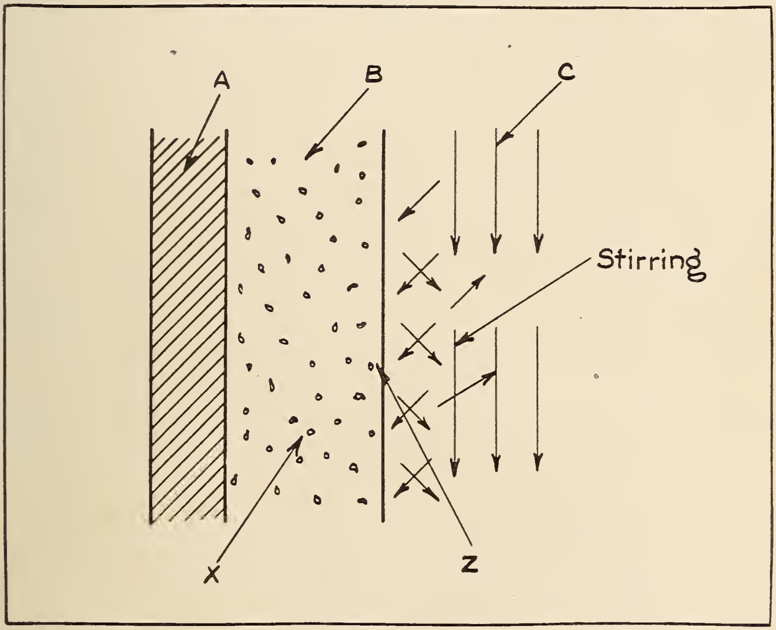

Fig. 1
Diagram illustrating diffusion of salts from emulsion layer

operations? They are *diffusion, agitation,* and *renewal.* We can find out the magnitude of any one by making the other two infinite. We can find the rate of diffusion of hypo from film by making the agitation and renewal of water at the surface of the film so great that an increase has no effect on the rate of washing. Having found the first, by a process of elimination and calculation we can deduce the other two.

Fig. 1 is a diagram of a motion picture film section. *A* is the base or support, *B* the swollen gelatin full of hypo solution, and *C* the surrounding wash water. For the purpose of our argument we will suppose the stirring and rate of renewal of C is infinitely great. In what manner and in what time is the hypo going to come out of the film B into the water C? You know there is a Kinetic theory of gases and solution which supposes that all matter is made up of excessively small particles. When a typical "salt" like hypo goes into solution, its ultimate particles are unfastened from close solid contact with one another and are permitted to wander about indiscriminately among the particles of water. They move at high speed for enormous distances compared with their own size, but in reality only a minute fraction of a millimeter, before they bump into one of their fellows and suffer a change of direction. In solution, therefore, the particles must be pictured as moving higgledy-piggledy in every direction, eternally colliding and proceeding on new paths. It is a property of "salts" that the particles can become electrified. If two electric wires are placed in solution, the salt particles bumping about acquire an electric charge when they happen to hit one of the wires, which charge they give up when they wander over to the other.*

Consider any particle of hypo at the position X in the layer B. Whichever direction it moves in, it is sure to meet another particle and be given the right about. There is thus no tendency for it to leave B. However, a particle near the surface in the position Z, should it happen to shoot out into the water, will find no other "hypos" there to bump it back, and will be carried away by the stream.

There is, therefore, a tendency for the salt to diffuse from a region of high concentration to one of low; for the particles to move from a crowded district to one uninhabited. This is the inner mechanism of hypo removal. We want to know exactly how long this process takes for motion picture film. Do the particles in the emulsion layer behave exactly as they would in a layer of perfectly still water or do they suffer a resistance and cage-like cramping from the jelly network?

I must apologize at this stage for referring only to my own work and that of my collaborator, Dr. D. A. Spencer, of the Royal College of Science, London. It happens that he and I are the only people who have been forced in the course of their work to measure these constants.

* This is scientifically inaccurate, but is sufficiently true to complete the picture.

The method used is an electrical one, depending on the increase in conductivity of wash water after it has been contaminated with hypo. A measuring cell is placed in the water after it leaves the main, and a second one after it leaves the motion picture film. When any hypo is present the two are out of balance and a humming noise is heard in a telephone. By an extension of the scheme the exact amount of hypo present can be made audible.

The Nature of the Washing Process

Experiments[1] have shown that hypo leaves the film exponentially down to the least detectable traces, a limit represented by perhaps two parts per million in the swollen gelatin. Saying that the removal is exponential means that as time proceeds arithmetically the difference in concentration between the hypo in the film and the wash water decreases arithmetically. The quantity of hypo leaving at any moment in proportional to the quantity which remains behind at that same moment. It is the ordinary law of organic growth or shrinkage and is represented by the equation: $dM/dt = K(A-M)$, where K is the washing constant of the film and A the hypo originally present.

To the practical photographer the constant K conveys little information. He will find the "half-period" a useful guide. The half-period, a term borrowed from the science of radio-activity, is the time required for the amount of hypo in a film washed in running water to decrease by half.

No matter how much hypo there is present at a particular moment, whether 20 per cent or one part in a million, it will take a certain exact time, characteristic of the film in question and varying from emulsion to emulsion, for half of the amount to diffuse away.

Suppose the half-period is one minute for a certain motion picture film. After the film has been transferred from the fixing bath to the wash water, a time will be reached when the film holds, say, 8 per cent of hypo. Exactly one minute later it will hold 4 per cent, and a minute after that 2 per cent, and in another minute half of 2 per cent or 1 per cent, and so ad infinitum.

The writer has found, by means of the electrical testing apparatus[2] previously referred to, the half-period of a large number of negative and positive emulsions and found that it varies between the

[1] Hickman and Spencer, *Phot. Jour.*, 1922, *46*, 225.

[2] Hickman, *Phot. Jour.*, 1923, *47*, 208.

extreme limits of ten and forty seconds. No film ever lost half its hypo in less than ten seconds or took longer than forty in a rapid stream of water.[3] Negative motion picture film had a half-period in all cases examined of less than thirty seconds and positive film of about twenty seconds. These figures apply only to an "ideal" stream.

"Ideal" Washing Conditions

At the risk of redundancy I will say a word or two about the meaning of what may be termed the "ideal" stream. The washing law states that the rate of removal is proportional to the difference in strength between the hypo solution in the film and that in the wash water. When the water is moving in a sluggish stream past the surface, the actual layer in contact with the gelatin may be very rich in hypo; as the velocity increases the contact layer becomes weaker and weaker until it is virtually pure water. Any further quickening will give no detectable increase in the rate of washing. The author was able to determine the ideal stream under two widely different conditions. The first experiment consisted in allowing freshly fixed film to wash in a pipe through which water flowed from a fully open faucet at the rate of some gallons a minute. In the second case the film was suspended in a large box and subjected to a highly atomized spray and the drippings from the lower end collected in a measuring device. The amount of water used was less than an ounce and a half a minute. The rate of washing was followed electrically and found to be identical in the two cases. Repetition of the two experiments showed that the ideal stream had been just realized; increasing the water supply made no detectable alteration in the rate of washing, decreasing the flow gave a perceptible retardation. In the case of the spray washing, it was possible to calculate from the experimental data that the hypo concentration in the film of condensing water was about one-fifteenth that in the emulsion at any moment. It would seem, therefore, in the case of the first experiment that the water in actual contact with the film must have been contaminated to a similar degree. With the spray every little droplet had been driven into intimate contact with the surface and then removed by draining to make way for successors; with a large stream less than one per cent had been near the film, the rest, like the fellow travelers of the gentlemen who went down from Jerusalem to Jericho,

[3] Hickman and Spencer, *Phot. Jour.*, 1924, *48*, 537.

had passed by on the other side. The use of an ideal stream, therefore, does not involve expensive apparatus or impossible experimental conditions; it simply means that the water shall be violently agitated at its actual point of contact with the film. We can consider the effect of washing at this speed as though it were quite easy to realize.

Washing Calculations

Let us assume the average half-period of motion picture film under ideal conditions to be twenty-five seconds. Then, in two hundred and fifty seconds the concentration will have fallen to 2^{-10} times or to 1/1024 its original value of, say, 20 per cent hypo. Now a hundred square centimeters of emulsion in the average swollen state induced by half an hour's immersion, occupy about one cubic centimeter. In this volume there will be 1/5000 of a gram of hypo, or half a milligram. The quantity of silver in a similar area of film of optical density 1 is about 0.01 grams. There are many theories of fading, but it seems generally admitted that the hypo must act by virtue of its nascent sulphur or by supporting bacterial life, in which case both sulphur atoms are available.

Concerning Fading

Pursuing the latter assumption, we may write the equation:

$$4\ Ag_2 + Na_2S_2O_3.5H_2O + CO_2 + \text{bacteria} + \text{gelatin}$$

$$\text{equals}$$

$$2Ag_2S + Na_2CO_3 + \text{more bacteria} + \text{oxidized gelatin}$$

Then, 4×108, or 416, grams of silver will be attacked by 248 grams of hypo. To alter the whole of the deposit of density 1 in a square decimeter, we shall require $0.01 \times \frac{248}{416}$, roughly 0.005 grams of hypo. At the end of the 250 seconds washing, however, all but 0.0005 grams of hypo have been removed. There is thus only enough left to cause the fading of one-tenth of the deposit. The "fading" is merely conversion to the brown sulphide and is not noticeable except when very bad. The hideous discolorations which are sometimes met with are produced by quantities of hypo enormously in excess of anything we are discussing here. Fading according to this equation probably only occurs under exceptional conditions in hot damp climates. In the ordinary course of events the action is purely chemical, thus:

$$2Ag + Na_2S_2O_3 + \tfrac{1}{2}O_2 = Ag_2S + Na_2SO_4$$

Most of the sodium thiosulphate is oxidized and destroyed while the damp film dries.

The Properties of Tanks

Practically, the ideal washing stream can only be realized by use of a spray or an extravagantly wasteful flow of water. When film is placed in a tank whose contents are vigorously stirred, equilibrium is attained in the quickest possible time, that is to say, the washing is ideal down to the limits imposed by the contaminated wash water. After that the film has to wait until the water becomes changed sufficiently to complete the process.

Consider water flowing continuously into any vessel and passing to waste at the same rate, so that a constant level is maintained. If vigorous mixing is allowed, the waste water consists partly of stale fluid, partly of fresh, and after the passage of unit volume through the tank the concentration will have fallen to half; of two unit volumes to one-quarter, of three to an eighth, and so on. The concentration in the tank is falling according to the same law as obeyed by the film; only the half-periods vary between much greater limits. A spray hitting a vertical film may have an effective half-period of less than a second; a tank which takes an hour to fill will have a half-period of one hour.

It is a property of a series of exponential numbers that their logarithms plotted against time as a linear function give a straight line. The typical die-away washing curve of motion picture film plotted logarithmically yields a straight line. When, however, the log. washing curve of the film in a big tank with well stirred contents is obtained it has the form shown in Fig. 2. The portion *a* is the ideal film curve slowly merging into *b*, which is the water changing capacity of the tank. This capacity is quite simply the ratio of influx to volume. For efficient washing it should have a factor near the half-period of the film. It becomes quite impossible, however, to circulate a hundred gallons a minute through a hundred gallon tank. There are only two remedies: one is to abandon large vessels, the other is to wash by changes or in cascade.[4]

If the film is transferred successively through a cascade of, say, five baths in which water is circulating in a counter direction, the hypo may be allowed to accumulate until each bath contains perhaps one-tenth of the one previously. The first bath will, therefore, hold one-tenth of 20 per cent hypo or two per cent, the second a tenth of 2 per cent, while the fifth will be virtually pure water. The final

[4] Hickman, *Kine Weekly*, Dec. 25, 1924, *49* and Jan. 1, 1925, 110.

concentration of the film will be somewhere about 10^{-5} of 30 per cent, or one part in five hundred thousand. Yet the water which ultimately passes away with 2 per cent of hypo is the same water which has previously been used for the refined cleaning of the film.

Practical Recommendations

Owing to the fact that the washing arrangements in most processing machinery are already installed, it is not easy to give

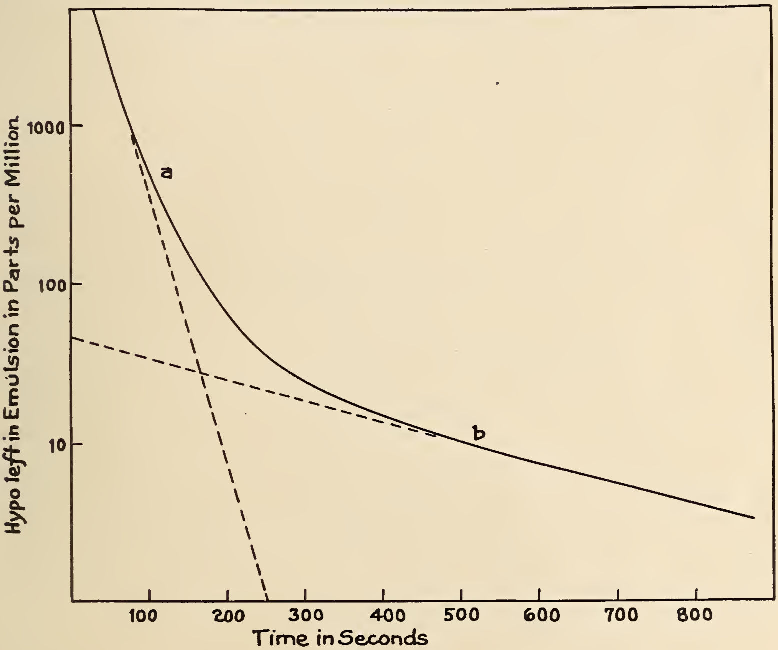

FIG. 2

Typical graph showing merging of film washing curve with tank washing curves. The figures for concentration of hypo, i.e., "washing" are plotted exponentially.

revolutionary advice for the improvement of washing. Explaining as we have done the theory of hypo removal to those operating a developing plant will probably enable them to increase its efficiency better than concrete recommendations made in the absence of knowledge of their exact requirements. However, the following remarks may be useful.

In small studios where motion picture negative is often developed by hand on wood frames, the efficiency of the washing tanks can be increased tenfold if they are never allowed to become contaminated by surface hypo from the freshly fixed racks.

This surface hypo can be removed by a few seconds' rinse in a separate tank which need have no water flowing through it but need merely be filled afresh each day. A better method is to spray the rack from a rose at the end of a flexible pipe. Care should be taken that water finds its way between the woodwork and film so that it is not only the emulsion side which gets sprayed.

From time to time suggestions have been made for the complete washing of film by sprays. It has always proved useless where racks are employed because the spray never cleans the hidden woodwork sufficiently to prevent diffusion onto the emulsion side when the film is unwound later. Resort is generally made to tanks.

The design of tanks presents little difficulty from the point of view of washing, however troublesome the constructional details may be. Tanks should be as small as will deal with the film output. The smaller the volume, the more quickly the stale water is replaced. The entrance and overflow pipes should be situated as far apart as possible. Contrary to accepted practice, it is not necessary for the exit to be at the bottom. Except in the beginning stages gravity has no effect on washing except in absolutely still water. Still water is to be avoided because it gives poor washing; hence, provided they be far apart, the entrance and exit pipes may be placed wherever convenient to the engineer. Similarly there is no advantage in having the water entering by a number of holes along a length of piping. Each stream sets up an eddy current which is interfered with by the next. It is better to let the water enter in one vigorous stream which will set up a strong current in the bath.

The washing arrangements in use with continuous processing machines comprise sprays, tubes, or tanks. In tube machines the film travels down a succession of tubes containing fresh water, whence it passes to the drying machinery. We once saw a developing machine in France where the film passed in succession through six tall vertical pipes. Water was fed in *parallel* through the first three, and thence in *parallel* through the last three. This is emphatically inefficient procedure. The whole of the water should have been directed into the top of the sixth tube, out of the bottom, and into the top of the fifth and so in *series* through the whole number. The hypo laden film would have entered the first tube, met dirty water, which, however, contained many times less hypo than the emulsion, and proceeded into cleaner water as it itself became clean.

Because there is bound to be a lot of mechanical transference of hypo from the fixing solution, just as there is with racks, however efficient the tanks or cascade tube system, it will pay to install a rinsing loop to secure the same action as the spray recommended for use with the wood frames. This is shown in Fig. 3.

The film leaves the hypo bath and is carried over three rollers to form an inverted spiral loop and thence into the washing tank or tube. The inverted loop is contained in a box which may be filled with overflow water from the wash tank. Vigorous agitation is

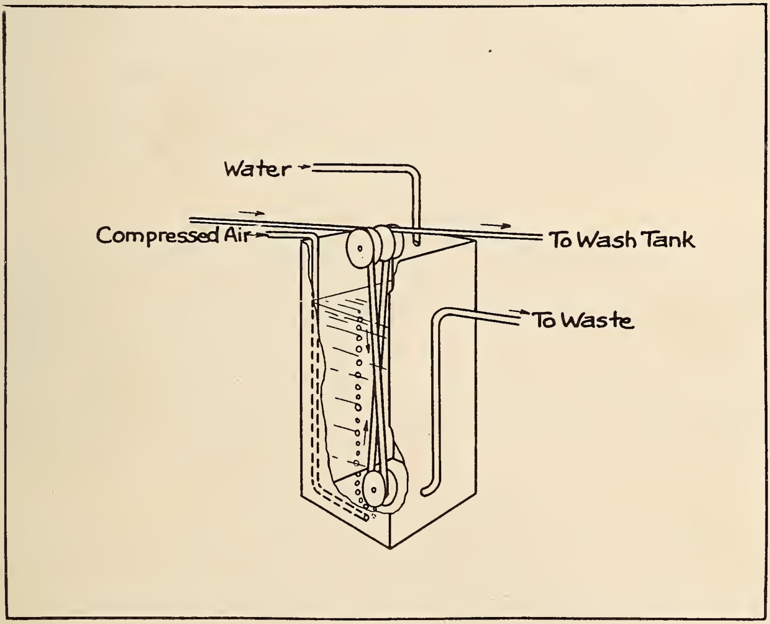

Fig. 3

Rinsing tank for insertion in continuous processing machine

essential, best secured by compressed air. Alternatively, a spray of atomized water from a nozzle fills the box with mist and rinses the film equally well.

It was emphasized early in the paper that agitation is essential if all the water in the tank is to be brought in contact with the film. There is probably no stirring agent so thorough as compressed air admitted to the bottom of the vessel. The bubbles do not depend for their efficacy on the velocity of injection but on their buoyancy which is effective throughout their passage through the liquid and not only near the jet. Large bubbles have this valuable quality that they remove airbells adhering to the film and scavenge away the products of recent diffusion.

Nevertheless, there are many who object to compressed air stirring because it involves pumping machinery. Compressors are expensive and difficult to keep in good order. If under oiled they over heat and wear unduly; if over oiled, oil spray gets into the air blast and finds its way onto the film.

It has caused many photographers who use rack development to install mechanical rocking devices to keep the racks in agitation. This rack agitation is no substitute for good tank design and sufficiency of water, but with these, it gives excellent washing. The rack is coupled to an oscillating arm which moves it slowly backwards and forwards in the direction of greatest resistance to the water.

Squeegeeing before Drying

However efficient the washing operation, there must remain some hypo in the wash water. The permanence of the film is increased therefore if the surface layer of the wash water is removed. Indeed, as drying proceeds any water left segregates into droplets which shrink down and leave all their impurities in localized areas. It is at these spots that fading will begin. This is a reason for squeegeeing equally as important as its effect on the appearance of the dry film.

Procedure in Special Cases

Conditions obtain sometimes when only a very small quantity of water is available for film washing, and the question arises how best this can be applied. The answer is to split the water into the greatest number of successive changes that can be used without making the bulk of each bath too small to cover the film. Consider ten gallons of water used in one bath to remove 4 ounces of hypo contained in one pint volume of swollen emulsion on a length of motion picture film. The hypo will divide itself in the ratio of the volume of emulsion to that of wash water, which is one to eighty. The washed film will contain one-eightieth of four ounces, or one-twentieth of an ounce of hypo. When ten gallons are used in ten successive baths of one gallon the result is much more perfect washing. The first bath will reduce the hypo to one-eighth, the second to an eighth of an eighth or a sixty-fourth, and the tenth to $1/8^{10}$, an infinitesimally small amount.

Nature of Washing Water

Nearly all town water supplies are suitable for washing film. Brackish water, containing common salt, is to be avoided, but lime and magnesia, as carbonate and sulphate, are probably harmless, and the carbonates perhaps beneficial. Very hard waters merely need more perfect surface removal by pneumatic squeegee before drying. Iron salts occurring in acid and peaty waters may discolor the film, but they are not likely to affect its permanency. Therefore, contrary to accepted belief, the nature of the water supply is not of vital importance.

A question which often arises at sea is whether sea water can be used in place of fresh. For a couple of soakings of three minutes each, yes; but for final treatment, emphatically, no. At least three three-minute soakings should be given in a small quantity of fresh water.

Temperature Effects

High temperatures cause the emulsion to swell and hinder washing in much the same degree as they quicken the diffusion process. The net result is that the hypo washes out at about the same rate whatever the temperature of the water. This does not apply to heavily hardened emulsions which do not swell in warm solutions. Film hardened in strong alum or formalin will wash a little quicker in summer than in winter. In ordinary processing, however, there is little detectable change.

In conclusion it must be repeated that while this paper describes no new experimental work, it is founded on material previously published by the author in conjunction with Dr. D. A. Spencer in other journals. This must be the excuse for quoting our own work exclusively in references. It is hoped that the results restated here may be of use to those processing motion picture film.

Summary

The nature of hypo removal from motion picture film is examined and shown to be an exponential process. Suggestions are made for calculating the amount of washing needed to secure immunity from fading.

The design of apparatus is considered in relation to the natural washing properties of the film.

Rochester, New York,
September 28, 1925.

DISCUSSION

Mr. John Jones: What would be the lowest temperature recommended for washing film, and what would Dr. Hickman consider the minimum amount of water necessary per linear foot of motion picture film?

Dr. Sheppard: I should like to ask Dr. Hickman in reference to the experiments with different emulsions whether the differences of behavior were due to thickness of the film or whether there were any other variables.

With regard to swelling: This question bears not only on the thickness dry but the thickness when wet. Has Dr. Hickman any data on this which would bear on the thickness dry and on the amount of swelling?

Mr. Richardson: In the past I have had many samples of faded film submitted for an opinion as to what was wrong, but have referred the matter to laboratories. I would like to know if the fading of film would or could be due to lack of proper washing; also, if film can be injured through excessive washing.

Mr. Crabtree: It has occurred to me that squeegeeing the film with a rubber or air squeegee as the film passes from one tube to another in a processing machine would help to remove the residual solution at the surface and economize with regard to the amount of water necessary. I should like to know if Dr. Hickman has tried such an experiment.

Dr. Hickman: With regard to Mr. Jones' query as to the lowest temperature possible: The swelling and shrinkage of a gelatin emulsion is largely irreversible until you have melted or dried it again. If this is the gelatin film (drawing), and you have developed it at the favorable developing temperature, and it has swollen this distance (indicating), and you wash it at some lower temperature, although the natural thickness to which the gelatin would have swollen at this lower temperature is half way between these two points indicated, at this temperature the gelatin will not shrink back unless it is left there for a long time, in which case syneresis may set in. With water much colder than the developer, therefore, washing will take longer, but where the water is much warmer, washing will take place at about the same rate because the swelling will make up for the quickened diffusion.

With regard to the least possible amount of water necessary for washing, I could get away with 5 ounces of water per foot if I were perfectly sure that the film were in intimate contact with the spray. On the European continent sprays are very common. Such a small quantity of water must be considered more in the nature of an ideal and probably one would have to use more than a pint of water in commercial practice.

With regard to Dr. Sheppard's question, he will remember that this paper has been abstracted from three or four others. The removal is there shown to come down to one part per million, though there is a minute amount of hypo left on the image which varies from emulsion to emulsion.

Dr. Sheppard: I was referring not so much to the tail as to the cut at the bottom of the diagram.

Dr. Hickman: It is only the thickness, that is, the active thickness of the gelatin at the moment of washing which determines the rate.

With regard to Mr. Richardson's question of fading: That is a subject on which I should like to say a lot. Fading can take place under two widely different conditions of use. If you wash down to a hundred parts in a million, you consider that the film is adequately washed, but if the film is going to hot climates, then any sulphates can undoubtedly be acted on by bacteria to produce a form of sulphide fading. The amount of washing given a film should be dependent on its destination.

With regard to whether an indefinite soaking injures the film: Get the washing over in the quickest possible time. Additional washing induces reticulation, which causes the natural clumping of the grains to become more pronounced. Also, as the gelatin behaves as a culture medium all the time the film is exposed to water, it is acting as a camping ground for any passing bugs which may produce pitting or have some deleterious effect a long time afterwards.

With regard to Mr. Crabtree's remark about squeegeeing: Mechanical squeegeeing is impracticable between tank and tank because of the possible detachment of the emulsion around the sprocket holes. Nobody likes mechanical squeegeeing; there is no doubt that its introduction will reduce contamination to about half. Half its hypo is carried on the surface and half within the gelatin so that you will "ginger" up the washing by introducing a system of rational squeegeeing.

Mr. Richardson: You said something about the excess washing increasing graininess. Do I understand that excess washing will produce graininess?

Dr. Hickman: I will say that any tendency to graininess is increased on prolonged washing. Some of the long soakings given where the water changing is poor produces reticulation greatly in excess of what a quick wash would have done.

Mr. John Jones: What would be the lowest temperature permissible as an economic measure?

Dr. Hickman: The point is that you have not got to increase the volume for the temperature; the volume needed is determined by the amount of hypo coming out of the film and the dilution coefficients of your system. An increase in time perhaps of 10 per cent or 20 per cent of time will be needed but not of volume.

Dr. Sheppard: May I add an emphasis on the point brought out that transfer from warm developer to cold water brings on graininess? I made an investigation on reticulation some years ago and found that any condition tending to produce reticulation increased graininess, and transfer from a warm developing solution to cold wash water would favor reticulation and bring on graininess.

Mr. Richardson: I would like to add that in the last year or two I have had occasion to examine many pictures on screens with a powerful glass, and have bcen astounded at the difference in graininess of the pictures. I believe if anything could be done to control and reduce graininess, it would be most beneficial. I believe Mr. Denison will back me up in that.

Mr. Denison: I agree.

Dr. Hickman: The essence of the whole thing in not increasing graininess is to have the temperature of the wash water the same as the rest of the solutions.

A NEW CAMERA FOR SCREEN NEWS CINEMATOGRAPHERS

J. H. McNabb*

THERE is probably no position in the motion picture industry that offers more trying and hazardous situations than that of the news cinematographer. His exploits in obtaining current events of the day in pictures are replete with thrills and adventures that would in themselves make suitable material for an ideal adventure photoplay. While a considerable part of the current screen news material is made by free lancers and is gathered from all corners of the globe, many of the larger screen news companies employ a trained corps of cinematographers stationed at important cities throughout the country, whose major duty is to scoop an important event or item of news interest.

These men are constantly at their posts, many of them having police and fire alarm bells stationed in their sleeping quarters, and they are on the spot almost as quickly in a catastrophe as are newspaper reporters, police, firemen, and others. Of paramount importance in their work is the equipment which they employ to make their pictures. Heretofore they have been burdened by cameras, tripods, carrying cases, and luggage, which frequently approximated fifty to seventy-five pounds in weight. This heavy equipment is usually carried from point to point and set up at advantageous and strategic positions. Very often their load is shouldered up ladders and fire escapes to attain some particularly desirable location. At times they have had to make provision for securely fastening bulky equipment in the cockpit of an airplane, and under trying and most difficult positions lean out and turn a crank with the plane traveling anywhere from 85 to 100 miles per hour. At important events and parades they have had to climb to the top of buildings, operate their camera, and manipulate the tripod from automobiles, trucks, and, in fact, in every conceivable position.

Now comes a new development in cameras which appears to ideally meet the requirements of this class of occupation—the Eyemo, a hundred-foot standard automatic camera built by the

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Bell and Howell Company of Chicago. With it the news camera man can master almost any situation and secure pictures which before would not allow the time required to even set up a tripod. Eyemo is held in the hand and focused and dialed by sighting through the finder tube. (See Fig. 1.) Being automatic, a touch of the trigger sets it in motion and photographs instantly any field or action visible through the matched viewfinder units, which correspond to the focal length of the lens used at the photographic aperture. It will accom-

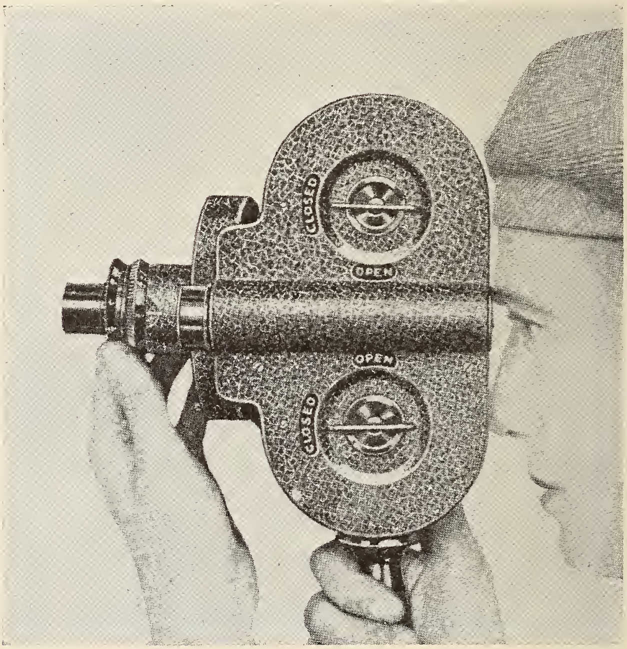

FIG. 1. Showing normal position for operating the Eyemo Camera.

modate lenses of any focus from 40 mm up to 20 inches. The change from one lens to the other is made almost instantaneously. This is a particularly desirable feature for the news man, who may stand off at a distance in crowded events and secure close-ups of prominent people which otherwise would not be obtainable with the use of a tripod. (See Fig. 2.)

While there is hardly a situation known to the news camera man where the Eyemo automatic should not be more practical to use and operate than the old crank-turning camera with its cumbersome tripod, it offers for the professional cinematographer some equally important advantages. It will eliminate carrying bulky apparatus on location and especially over hazardous passes, mountains, and, in fact, for almost any difficult elevation. For stunting in the air and trick work in comedies, it should be ideal.

Some of the pertinent features of the new Eyemo, which might be mentioned here for convenient comparison with standard crank-turning and tripod units, are as follows:

	Eyemo	*Average Standard Outfit*
Weight of camera	7 lbs.	15 to 30 lbs.
Weight of tripod	$1\frac{1}{2}$ lbs.	17 to 40 lbs.
Size	$4\frac{1}{2}\times6\times8$ irregular	$5\times11\times12$
Lens range	40 mm to 20 inches Interchangeable micrometer focusing.	40 mm to 6 inches special focusing mountings
Lens equipment	Standard f/2.5	Standard f/3.5
Kind of operation	Automatic Spring Motor	Hand cranking
Shutter	170°	170°
Finder	Direct vision upright image, full clear field for each focal length lens.	Indirect reverse image, inaccurate field for different focal length lenses.
Speed	Variable and accurate to desired operation.	Pure guess work, two turns of crank per second.
Lens dials	Adjustable through finder tube while in operation.	Adjustable only by moving to front of camera.
Capacity	100 ft. daylight loading 120 ft. darkroom loading	100, 200, or 400 ft.
Footage per winding of spring motor (2 to 3 windings per 100 ft.)	35 feet to 50 feet.	

It has been determined by actual tests that a spring motor driven camera may be operated while held in the hand with uniformly steady results when using any focal length lens up to 3 inches. Lenses of longer foci, that is from 4 inches up to 20 inches, require the assistance of a tripod for steadiness. But the tripod does not need to be a bulky panorama and tilting type, now employed with crank-turning cameras. Almost any light folding, metal, still camera tripod may be employed; the one used with Eyemo weighs only one and a half pounds.

The spring motor is controlled by a governor, which assures equal and uniform exposure for each frame, as the film moves at constant speed at all times. The motor starts off at full speed the instant the operating trigger is pressed and stops instantaneously when the trigger is released. There are no cut-outs necessary in the negative because of lag or exposure deficiency in acceleration, nor over-exposures in deceleration; also, the camera is always stopped with the shutter closed, so that scenes may join each other without requiring the cut-outs that ordinarily must be made on cameras

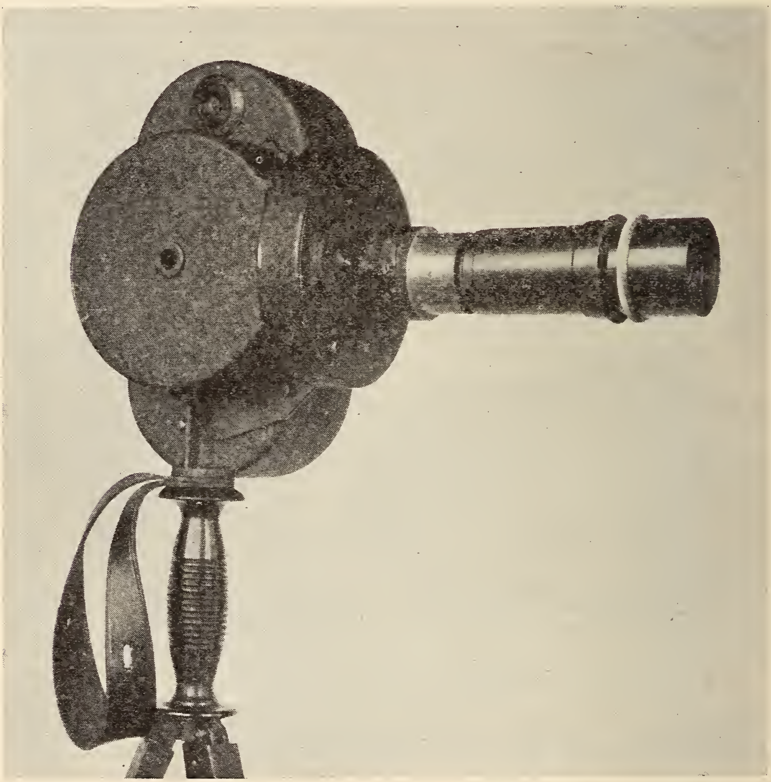

Fig. 2. Showing set up of Eyemo camera on tripod when using long focus lens.

turned by a crank. The governor adjustment also permits of setting for any desired speed from eight to sixteen exposures per second. When set at a predetermined point, the resultant exposure speed is accurate within one half of one per cent; the speed also is variable while camera is in operation, a feature which will be found very valuable in comedy trick work.

For faster speeds, that is from sixteen to thirty-two exposures an adjustment in the governor at the factory will provide for this operating ratio. For superspeed (up to 128 exposures) a specially designed governor, spring motor, and gearing may be incorporated in the camera frame, but at a sacrifice of the lower speeds; that is, it is not possible to provide for interchangeable normal, double normal, and superspeed in the same instrument of this type of construction.

DISCUSSION

Mr. Crabtree: Did Mr. McNabb send along a model of the camera so we could see it?

Mr. Ziebarth: No, but it is the same shape as the Filmo but somewhat larger. It operates in the same manner, and there is practically no difference at all between the two.

Mr. Crabtree: How many feet of film will run through the camera at one winding? Is there any trouble at low temperatures?

Mr. Ziebarth: Thirty-five to fifty feet at all temperatures. At one time we had trouble at low temperatures, but we have overcome this.

TELEPHONE PICTURE TRANSMISSION

Herbert E. Ives*

THE picture transmission system which is now in daily commercial operation over the lines of the Bell System is to be distinguished from earlier efforts toward the same end by two features: First, the pictures as received are completely commercial in their character; that is, they are immediately available for all sorts of technical uses, for which they are in fact practically indistinguishable from original photographs. Second, the system is, unlike earlier experimental systems, so worked out that it utilizes without change the existing telephone channels, whether these be wire or radio. The distance to which pictures may be sent is limited only by the distances over which commercial telphone service is available

The simplest analysis of a picture resolves it into a large number of small patches or elements of varying values of light and shade. A picture transmission system therefore involves first of all some means for analyzing a picture into small elements, or "scanning" it. It involves next some means for communicating a record of the values of these elements to a distant point. It involves finally some means for assuring that the recomposition of the picture elements at the receiving end shall place these in their proper relative positions; that is, some means for synchronizing the sending and receiving apparatus.

The scanning of the picture is accomplished in our apparatus by first preparing the picture to be sent in the form of a transparent film, which may be bent into cylindrical form; this cylinder is then advanced and rotated by a screw motion so that the scanning light spot traverses the entire film in a spiral. A similar spiral motion is imparted to the sensitive photographic film upon which the picture is received at the far end.

For the purpose of communicating the values of light and shade from one end of the system to the other, we use at the sending end a photo-electric cell. A small spot of light is focused on the transparent film, and, after passing through the film, enters the photo-electric cell. The electric current produced in the cell is directly proportional

* Bell Telephone Laboratories, Inc.—For a more detailed description of the method and apparatus here discussed, see "Transmission of Pictures Over Telephone Lines," Bell System Technical Journal, April 1925, p. 187.

to the illumination of the cell and follows the variations of light and shade instantaneously. At the receiving end, the electric current which is controlled by the action of the photo-electric cell passes through a narrow ribbon which stands in a magnetic field and by its resultant lateral movement acts as a variable diaphragm in an optical system through which light from an appropriate lamp is passed. The light after passing through this "light valve" falls upon a photographic film and builds up a picture in narrow adjacent strips.

In order to synchronize the rotating cylinders at the two ends of the line use is made of synchronous motors. These are driven by a master tuning fork, impulses from which are sent both to the apparatus at the sending end and to that at the receiving end.

The picture transmission system as just outlined calls for what is ordinarily described as direct current transmission for the picture signal and for a separate communication line to handle the synchronizing pulses. Telephone lines are not ordinarily set up for handling the low frequencies which a direct current picture signal would involve, and it is furthermore uneconomical to use two separate circuits for picture and synchronization signals. For these reasons, both the picture and synchronizing signals are impressed upon carrier currents of voice frequencies suitable for transmission on ordinary telephone lines. The picture signals are carried on a frequency of approximately 1300 cycles per second, the tuning fork impulses on a carrier of approximately 400 cycles per second. Both these alternating currents are sent over the same line and are separated from each other at the receiving end by means of electrical filters, so that the light valve and the synchronous motor each receives only its own proper current.

In the system as now in operation, the picture to be sent is placed on the apparatus in the form of a positive film transparency of size 5 inches by 7 inches. The pitch of the screw which provides the rotation and translation of the film is 100 threads per inch. Pictures of this size and grain are transmitted in approximately seven minutes, and transmission may be made simultaneously to a number of points, as, for instance, from Washington to New York, Chicago, and San Francisco, as was done at the inauguration of President Coolidge, March 4, 1925. The picture is received as a negative, from which any number of prints can be made by ordinary photographic methods for distribution to newspapers or other customers. By working from wet negatives and using the transparency film at the sending end while still wet, the overall time of picture transmission may be kept below half an hour; the greater part of the time is consumed in the purely photographic operations.

Pictures transmitted in the manner described meet with a number of uses. The widest use at present is in the newspapers, which are now able to show, in a few hours, pictures of events happening at the other side of the continent. A vivid illustration of this use was furnished at the time of the Santa Barbara earthquake, news of which appeared in the New York papers in the evening, while the following morning papers had a full pictorial record. Another large field of usefulness promises to be in connection with police identification work, not only in transmission of photographs of wanted individuals, but of their finger prints. Practical trials have shown that electrically transmitted finger prints may be identified within a few minutes of reception, thus making it possible to identify suspects who, under ordinary court procedure, could not be held long enough for the ordinary methods of communicating this information. The transmission of signatures and legal documents is another field. Medical information, such as X-ray photographs, electro-cardiograms, and other information on which a specialist can make quick diagnosis lend themselves readily to transmission.

The use of electrically transmitted pictures in the motion picture industry has thus far been confined to the transmission of "stills" which by this means may precede the arrival of the film reels by a considerable interval. The showing of lantern slides or still pictures on motion picture film, exhibiting events of a few hours before in distant places, is a possible feature for moving picture theatres to be provided by this service. The necessary time consumed in the transmission of a single picture would make the transmission of an entire moving picture film a lengthy operation. By utilizing pictures of coarser grain and special apparatus adapted to handle roll film, it should be possible to transmit "flashes" of several seconds duration at a moderate cost.

IMPORTANCE OF THE VILLAGE THEATRE

F. H. Richardson*

ABRAHAM LINCOLN once said: "God must love the common people, because he made so many of them." Judged by that standard the motion picture industry surely must love the village theatres, because it has created so very many of them.

I do not believe the industry as a whole or anyone inside or outside of it, except, perhaps, for a limited few who have given the matter more or less extended thought, have any sort of adequate conception of the literally huge importance to the country as a whole of the thousands of small theatres located in the villages which form the centers of activities for farming communities scattered throughout the length and breadth of this great land of ours, and throughout a considerable portion of the territories of our Canadian sister to the north.

These are the days of excitement. We have arrived at the stage of human existence, in this country and Canada, at least, where the functions of eating, working, and sleeping no longer suffice to fill the human life. Amusement—play—now forms an integral part and parcel of human existence. Amusement is no longer regarded as in the nature of a luxury. It has become, or rapidly is becoming, a vital necessity, especially insofar as it has to do with the younger generation. Time was when the farmer boy or girl was satisfied to toil from break of day until darkness settled down six days in the week, with church on Sundays, perhaps prayer meeting Wednesday evening, an occasional neighborhood party winter evenings, and a circus once during the year. The farmer boy and girl of that day knew nothing different, hence were, preforce, satisfied with that kind of an existence. That day has forever passed. Just what caused its passing we need not discuss here. The fact that it has passed is sufficient. The farmer boy and girl of today expect and demand their fair share of what the modern world terms amusement, or entertainment, and unless it be supplied them, indeed because it is NOT being supplied to them in any adequate way, they are deserting the farms and villages by the tens of thousands, flitting like dazzled moths to the bright lights of the

* *Moving Picture World*, New York City.

cities, where the men are fed into the factories and mills, and the girls, or at least many of them, into something far, far worse.

That this would be to some extent true under any conditions, it would perhaps be idle to dispute. We may, however, fairly assume that the greater the amount of clean, wholesome amusement and entertainment the country or village center can and does offer the young people of the community, the greater is the likelihood of them being contented to remain where the country needs them most and help with the work of the farm, upon which the whole fabric of society must depend for its very existence.

It is to discuss briefly with you the possibilities for providing much highly satisfactory amusement and high grade entertainment through the medium of the village theatre that I have been moved to set forth this argument, with the hope that it may serve to direct the attention of men of greater ability than myself who will find some practical method for putting into effect the more or less crude ideas I shall advance.

First of all, let us examine into the present situation with regard to the village theatre. It is quite true that an occasional privately owned and managed small-town theatre which happens to be in the hands of a man of exceptional ability puts on a very satisfactory and creditable show. Its film service is excellent. Plenty of light is used for projection. Its equipment is up-to-date and in a good state of repair. Its projectionist is a man of considerable ability, its seating comfortable, and its ventilation at least passable.

All this is true, in greater or lesser degree, with an occasional small town theatre. On the other hand, we have a vast number of village theatres which are owned or managed by men who know little or nothing about the show business. For the most part, they are men who, fascinated by that magic term the "show business," rushed blindly in without any capital to speak of, fondly imagining that they had only to get a "machine," some seats, a screen, a room, and the public would immediately pour a stream of dimes and quarters into their waiting pockets.

These "theatres" eek out a precarious existence for the most part by renting the very cheapest possible junk service, paying small attention to decoration, the comfort of their patrons, or to ventilation. Some man or boy with little knowledge or experience is hired to "operate" old, worn out projectors, using the minimum possible screen illumination. The net results can only be termed amusement or entertainment by a very great stretch of imagination.

These "theatres" might just about as well not exist at all, insofar as concerns their presumed function of providing public entertainment. As a rule their projection equipment is antiquated, badly worn, and very thoroughly inefficient. The screen very often is basically very poor, and usually its surface is more or less dirty with the accumulations of months, if not of years. Ventilation very often is largely a matter of imagination. The music is supplied by a girl who drums on a decrepit old piano, apparently with the idea of creating as much noise as possible. The films are rainy, battered, old junk.

Nor is this description, terrible as it is, in any degree an exaggeration in very many cases, though of course I do not mean to intimate that there is no medium between this extreme and the relatively few really high grade village theatres of which I spoke. As a matter of fact, I have spoken only of the extremes, between which there is almost every possible variation.

However, where the extreme in inefficiency exists, the community of that village and the surrounding country of which it is the center is left, to all intents and purposes, without any sort of amusement and entertainment other than those few simple ones named in the beginning, and in this day and age such lack is the nature of a calamity. I will even go further and say that it is a very serious matter indeed for any community to be deprived of really excellent motion pictures. I make that last assertion having in view the educational as well as the amusement value of motion pictures of today and the further value of the news reels in enabling people to actually view most, if not all, the happenings of modern life which have large public interest.

However, the purpose of this paper is not to find fault and point out inefficiency and failure except insofar as that may be necessary in order that a cure may be suggested for the ill. I propose to suggest something designed to be in the nature of at least a partial remedy, which may cause you to gasp a bit when you first hear it, but I nevertheless ask your very serious consideration of the matter.

I have tried to show you that village theatres taken as a whole are far from what they ought to be. I have suggested that good motion pictures, available regularly to the public of farming communities and small towns, would be of distinct, actual benefit to those communities. I think you will all agree that such entertainment would, at least to some extent, aid in inducing the young people of country places and on farms to be more content with a life which, without such things available, is more or less lonely and dull, not to say dreary. Obviously such entertainment would also be of distinct value to the older people of such communities, who also need the education and amusement it would provide. It would, in fact, be highly beneficial to them from any and every possible viewpoint. The question then is how may it be made available to these communities?

I believe the failure of the average village theatre to provide satisfactory entertainment is in great measure due to the fact that, as matters now stand, few villages and their surrounding communities provide sufficient possible income to pay the necessary overhead expense of putting on a really good motion picture show and at the same time provide any adequate return to their owners, and it is to discuss this very point and to point out at least one way in which this situation may be met that I have claimed your attention.

It is a well established and generally accepted fact that public moneys gathered through taxation may be expended in any manner and for any purpose which will be of direct benefit to the whole of the community from which the said moneys were collected or a direct benefit to any substantial part thereof and an indirect benefit to the rest of the community, always provided there be no evidence of intent to individual favoritism.

Public moneys gathered through taxation are expended for schools and for their equipment and for the employment of teachers. Public moneys are expended for public libraries, for their equipment, and for attendants therein. Public moneys are expended for the improvement of streets and roads. Even though certain individuals may never use the schools, the libraries or some streets or roads, they nevertheless are acquired and maintained partially at their expense, because they are in the nature of public necessities and (or) are beneficial to the community as a whole.

Is it not also true that, under modern conditions, rural communities have a very real need for the educational and amusement and entertainment values supplied by the motion picture? Who would even attempt to question, much less dispute, so patent a fact? And if it is a fact, pray tell me why public moneys, gathered through taxation, should not be used to forward the supplying of high grade amusement, education, and entertainment through motion pictures in such communities, always provided the expenditure be done reasonably?

And right here the question arises as to just what the term "reasonably" might mean when applied to such a proposal.

As has been noted, one of the chief stumbling blocks to the supplying of a really good motion picture entertainment in the great majority of village centers is the fact that sufficient revenue is not available to justify men of any considerable business competency investing sufficient capital to erect and equip a really good theatre building, and the employment of really competent help, and the rental of really good film service. If all this be done, I think I am safe in saying that in four cases out of every five there would either be nothing left for the owner when the bills were paid and the interest on invested capital deducted or certainly not sufficient would remain to tempt a man of real business ability—a man with sufficient ability to handle a theatre intelligently. In fact, it is doubtful but that, in many communities where such a theatre is sadly needed, the maximum possible average income would be insufficient to meet the necessary expenses of operation without considering the owner and his presumed income at all.

The possible solution to a situation such as this seems to me to be very obvious and very simple. The village community needs good roads. It needs a public library. It needs schools. *It needs a motion picture form of entertainment.* The village authorities would not for a moment hesitate to raise money for any of the first named purposes by taxation, or at least to order a referendum at an election to empower them to raise it or to use any available moneys for roads, schools or libraries. They would not hesitate, for example, to authorize a referendum on a proposed taxation for the purpose of building and equipping a public library or for any other thing the community as a whole stood in need of and for which there was a precedent.

The village community as a whole, including the surrounding farming territory, needs a high class motion picture entertainment anywhere from two to six times a week. Would it not, therefore, when a new town hall is to be erected, be well to incorporate therein a commodious, comfortable, well equipped motion picture theatre? Would it not be well that this be done in no niggardly manner, but with sufficient expenditure to provide a really good, cozy, well equipped little theatre throughout?

I will myself make the assertion that where no town hall or other publicly owned building which would lend itself to such an enterprise is to be erected for a term of years, the village might well provide and use public funds to build a separate theatre building and to equip it throughout in a first class manner.

In either event, the theatre would be the property of the community, and, through its elected officers, be under its direct control. The community would thus be in position to prevent the showing of objectionable productions and to use the theatre auditorium for many purposes other than motion picture shows—amateur theatricals, public meetings of various sorts, traveling shows, church meetings, or bazaars, and even sermons on Sundays, all during times when the motion picture theatre function would not be in the least degree interfered with.

Such a theatre could be handled in any one of several ways. It could be placed in general charge of a man selected for his ability as motion picture projectionist, thus assuring well projected productions, the manager-projectionist to handle the theatre under the advisement of such official or officials of the village as might be given charge of the matter, any revenue over and above necessary operating expenses to go into the village treasury or any deficit to be paid out of it.

It might be rented or furnished rent free as might seem advisable under the individual condition to someone, the admission prices, class of film service, and ability of the projectionist to be under the control of the village authorities, the renter possibly, under some conditions, being guaranteed a fixed minimum income.

It would also be quite possible for a number of villages which required only one or two shows per week to employ jointly a very competent projectionist either as a manager-projectionist or merely as a motion picture projectionist by so arranging the days upon which shows would be given in each village that he could attend to them all without interference. This would admit of sufficient remuneration being offered to procure a projectionist of ability who could be relied upon to give a high grade show, the entire box office income to be paid into the various village treasuries.

However, it is no part of my purpose to discuss details such as these in a paper of this sort. In fact, I have small ability in business and do not feel myself competent to do so. My whole and sole purpose is to try to point out to you the value of the establishment of comfortable, well equipped village theatres and their operation under conditions which would insure a good programme, well presented from the projection viewpoint, all to the end that these communities be assured of real entertainment in the form of motion pictures plus the educational value of many available productions and the visual news reels. To this we must add the fact that those who seldom roam far beyond the boundaries of their own community may enjoy near-travel through motion pictures.

My proposal amounts, in effect, to a reasonable subsidizing of the village theatre with public funds where such a course seems necessary in order to insure high class motion picture entertainment, and I have tried to show you that such subsidization is fully justified by reason of the direct and indirect benefits to be derived by the communities at large, as well as by the country at large in a considerable degree.

Supply the young men and women of country places with plenty of the really splendid entertainment contained in well presented modern motion pictures, and a great stride will have been made toward checking their rush cityward, which all too often ends in disaster, and which in any event merely still further overcrowds the already congested centers, at the same time robbing our farms of more of their already too scant supply of labor.

The motion picture has a great mission to perform in this respect, but it cannot possibly perform it when placed before village people as a dimly lighted discolored, shaky, fuzzy, rainy abomination, from which great chunks of the action has been amputated, especially if this libel on the motion picture be presented in a crowded, uncomfortable, poorly ventilated and more or less ugly "hall," which may only be termed a "theatre" because of the fact that it really does not seem to be anything else.

DISCUSSION

Mr. Richardson: In preparing this paper I hesitated and wondered if it was a matter which would properly come before this body. I am very glad I did it, however, after talking with some of the members. It is a matter which might well come before this society because it is one that could be made of great importance to the motion picture industry in expanding its field of useful activities. My only hope in preparing the paper was to set before you certain ideas for consideration by those able to inaugurate something of this kind. This paper might also prove of interest to newspaper men if it were brought before them, particularly those who furnish syndicated articles to rural newspapers.

if it were brought before them, particularly those who furnish what is known as "latent insides" to rural newspapers.

I don't imagine the paper will provoke much discussion because it is a matter one must think over before fully realizing its importance. I don't regard the paper of any large value merely through its reading. Its value, if any, will come through the Society getting the matter into the newspapers.

Dr. Hickman: Mr. Richardson's paper strikes me as very interesting, but my experience in England, however, is that there is a great feeling against anything which draws on municipal support or taxation. One knows that the value of good entertainment is enormous, but when a body of men like ourselves makes a motion that the particular entertainment they are interested in should be provided from public funds, the immediate feeling is that they are doing more for themselves than for the public. One can see that this type of entertainment would be excellent, but in doing anything they will do much more for the cinema industry than for the village communities themselves. One of the points Mr. Richardson raised is that we want to prevent the people who raise food from coming to town. What sort of entertainment are we going to show them? Are we going to give intensive lessons on cabbage growing or are we going to show them magnificent ladies strutting up and down the marble halls of town houses? My impression is that the only thing it will do is to make the whole crowd of them leave in a bunch. We believe that the motion picture in England has been more responsible for the vacation of the small towns than anything else. I don't wish merely to launch a criticism against a most interesting paper. With regard to the existing average theatre, I do agree that the condition of the film they get is perfectly disgraceful, and I cannot see why it is necessary for a film to have got to this stage when it is shown, or why a duplicate print in better preservation cannot be supplied by a motor service coming from village to village. None of the people will attend the performance more than once, and perhaps if the picture were shown only once in each town some form of better films on a more economical basis might solve the situation. I do not believe that any form of municipal support is good in itself or will receive support from the public who have to foot the bill.

Mr. Richardson: I thought of what Dr. Hickman has said. I am partially in a position to refute some of it, because a considerable number of villages have incorporated a theatre in their town hall, and it invariably has worked very well. There has been no protest against it, and the theatre may be and is used for many other purposes. The only question that has not been proved is the use of public funds for the improvement of the show. How the public would consider that end of it I do not know. The service which village theatres, or many of them, are giving is disgraceful, and the result is that the people don't attend them.

REFLECTOR ARC PROJECTION—SOME LIMITATIONS AND POSSIBILITIES IN THEORY AND PRACTICE

Sander Stark*

BARELY two years ago, the practicability of reflector arc projection was a very much debated question. Under certain limited conditions its success in the laboratory or in the hands of an engineer was beyond question. To one skilled in the handling of optical machinery, the operation of this type of arc illuminant presented no very serious difficulty. But the motion picture engineer was confronted with the problem of how the man in the field—the projectionist—would react to such an unconventional piece of machinery. The field for the reflector arc, obviously, was the small and medium sized theatre, where, in so many instances projection is in the hands of the more or less inexperienced group of projectionists. The many virtues of the reflector arc—all of which hinge upon decreased cost of operation and maintenance—are such as would appeal to just this particular class of motion picture theatres.

The development of the mechanical refinements which led to the introduction of the reflector in motion picture projection would probably make a very interesting story in itself. There are others more intimately connected with this development to whom I shall leave the recording of this story. Reflectors have long been used with horizontal carbon arcs in immense searchlights and flood lights. They have been used with incandescent lamps both in flood lighting and in lantern slide projection for many years. We have employed reflectors in motion picture projection in imaging the filaments of an incandescent lamp in the interspaces of the filaments themselves.

In the seventeenth century a Dane, Thomas Walgenstein, traveled all over Europe demonstrating a simple form of lantern slide projector in which the optical system of the illuminant consisted of a spherical reflector.[1] The Carl Zeiss firm described in their catalog of 1911 the optical system of their "Epidiascope"[2]—a more

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[1] *Eine neue Spiegel-Projektionslampe. Flinker, Die Kinotechnik,* September 20, 1923, p. 427, Vol. 5.

[2] Carl Zeiss, Jena, "The Epidiascope." Mikro 243.

or less universal projection apparatus, in which the illuminant consists of a parabolic reflector in the focal point of which is located the crater of a 25 ampere horizontal carbon arc in combination with suitable condensers. But it was not until May of 1921 that the reflector arc was first introduced in Germany as a unit expressly designed for motion picture projection with a carbon arc. And it was not until 1923 that the reflector arc fever reached America. Indeed, in view of the manifest optical and mechanical advantages, the astonishing part of the whole situation, it seems to me, is not only that the reflector was not introduced to motion picture projection many years previous to its recent inception; but that the reflector, instead of the condenser, was not actually the first optical unit in the motion picture illuminant.

The purpose of this paper is not so much to present material that is essentially new, as it is to assemble in a concise way some useful information scattered throughout the literature of the past three hundred years on the properties of surfaces of revolution generated by conic sections as applied to reflectors for arc projection. Some of this information, and possibly a great deal of it, may already be known to many of you. It seemed, however, a worth while effort to gather in one short paper data on the necessary conditions to be satisfied in order to procure maximum results from any particular reflector system. It seems that if the really important things relating to reflector arc projection were presented in this way,—as a sort of tabulation of available facts and figures relative to this particular field—some of the unnecessary confusion and uncertainty which prevails in this field of motion picture projection may be somewhat lessened.

The Spherical Reflector

One of the properties of a spherical surface is that the radius of curvature in all meridians is the same, the surface being generated by the rotation of a circle about its diameter. This property, obviously, makes a spherical surface very easy and simple of manufacture. It is natural, therefore, that a reflector having spherical surfaces should have been the first type to be used in reflector arc lamps. It would be fortunate, indeed, if a spherical reflector commanded the same respect from an optical standpoint as it does from a financial and manufacturing standpoint. A spherical reflector is free from spherical aberration for an object in its center of curvature—where object and image are superposed. For any other position of the source, other than the center of curvature, the reflector possesses aberrations, which in some instances become exceedingly large.

The experimental work[3] in which we have been interested for the past few years, on the improvement in optical performance of illuminating systems for motion picture projection, has led us to the conclusion that the factor of prime importance, in improved performance of such optical systems, is the correction of spherical aberration. We have satisfied ourselves that of two optical systems, each having the same speed, same magnification, and same focal length, the system which is spherically corrected is far superior to the uncorrected system in respect to both quantity and quality or uniformity of illumination. It is for this reason that we have laid such great emphasis upon the use of spherically corrected illuminating systems in motion picture projection and have introduced the use of parabolic correcting surfaces in illuminating systems employing condensers. The introduction of such corrected condensers was an unqualified success. Since it is a worth while effort to spherically correct a condensing system whose angular aperture is of the order of magnitude of 60°, it seems as if it should be equally worth while to consider the spherical correction of reflecting systems whose angular apertures are in the neighborhood of twice this amount or 120°. It is from this viewpoint that I wish to bring to your attention the optical efficiencies of the various reflecting systems employed in reflector arc lamps.

In Fig. 1 is shown a curve representing the spherical under-correction of an ordinary spherical reflector having two parallel spherical curves for zones up to 60° from the axis. By spherical under-correction, we mean that the rays of light from the margin of the reflector cross the optical axis nearer to the reflector than do the rays of light from zones of the reflector nearer the optical axis. This reflector is one that is actually being used at the present time in reflector arc lamps in a diameter of 8 inches. In the figure here illustrated the diameter has been increased from 8 inches to 8-5/8 inches in order to allow for the representation of a zone 60° from the

[3] "The Function of the Condenser in the Projection Apparatus," H. Kellner, Trans. S.M.P.E., Nov. 1918, p. 44.

"Some Uses of Aspherical Lenses in Motion Picture Projection," H. Kellner, Trans. S.M.P.E., May 1922, p. 85.

"A Demonstration Model Showing Lens and Condenser Action in the Motion Picture Projector," S. Stark, Trans. S.M.P.E., October 1922, p. 79.

axis. The working distance, or distance of the arc to the reflector, is 4 inches, and the distance from the reflector to the aperture is 24 inches, there being an axial magnification of 6 to 1. At an angular aperture of 60° from the axis there is an amount of spherical under-correction equal to about 250 mm or 10 inches; that is, the marginal rays cross the axis about ten inches in front of the aperture. This accounts for the extremely hazy and diffused spot on the cooling plate when spherical reflectors of such large angular aperture are employed. The spherical under-correction in this reflector is so great that the marginal portions are in reality of no value whatever—even when used with the highest speed projection lens—a 5 inch Series II working at a speed of f/2.0. If a screen be placed a few inches ahead of the projection lens, and the image of the reflector, as formed by the

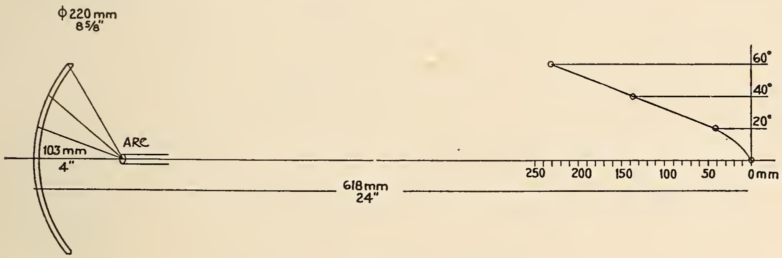

Fig. 1

Showing spherical aberration (under corrected), in millimeters, for zones up to 60° from the axis for a spherical reflector, having two parallel spherical curves; the focal length of the reflector being such that there is an axial magnification of the source of 6 to 1, the working distance of the source being 103 mm.

projection lens, is observed, it will be seen that a portion of the reflector equivalent to about 6-3/4 inches diameter is illuminated and being used when the source employed is very small, a five ampere arc, for instance. The remaining portion of the reflector from 6-3/4 inches diameter and greater is dark and not functioning.

As shown in Fig. 1A, due to the high spherical under-correction of the reflector, the rays of light from the marginal zone are unable to pass through the film aperture to the projection lens. In other words, the reflector is functioning usefully only through an angular aperture of about 45° from the axis, corresponding to a diameter of 6-3/4 inches and indicating that with a spherical reflector of this sort, 150 mm or 6 inches of spherical under-correction represents just about the maximum, let us say under-corrected illumination, that can be made to pass through the film aperture to the projection lens. This means that a spherical reflector of 6-¾ inches diameter having a working distance of 4 inches and an axial magnification of 6 will deliver to the screen nearly as much light as will the same reflector 8 inches in diameter when small light sources are used. As a matter of fact, this same reflector is supplied to the motion picture trade in a diameter of 6-5/8 inches. You will note that we have said that the 6-¾ inch diameter reflector will deliver *almost* as much light as the 8 inch diameter reflector. In actual practice, however, the 8 inch diameter reflector will deliver somewhat more light for the reason that the marginal zones of the reflector will also usefully image portions of the crater off the axis when sources as large as say a 25 ampere arc are used, whereas we have been considering only the imaging of a point on the axis.

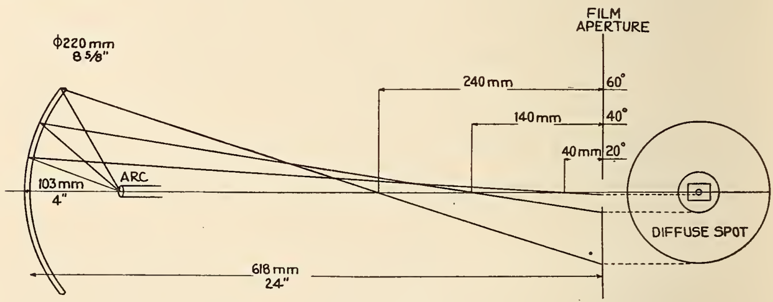

FIG. 1A

Showing crossing points and position of rays from zones 20°, 40°, and 60° for the reflector shown in Figure 1. Note the large diffuse spot due to zone at 60°.

We may mention at this point also that this apparent "bunching" of the rays from the marginal zones produces greater illumination on the optical axis than at points removed from the axis, resulting in screen illumination which is brighter in the center than at the edges.

The Combination of Parabolic Reflector and Condenser

A parabolic surface is generated by the rotation of a parabola about its axis and is free from spherical aberration for an object or image in two points, its focal point and infinity.

In Fig. 2 is shown the spherical under-correction of a combination of parabolic reflector and condenser for zones up to 60° from the axis. Reflector and condenser each have a diameter of 8 inches, the working distance of the arc being about 3-½ inches. The focal length of the unit is such that there is an axial magnification of 6 to 1. It will be seen that there is spherical under-correction of about 80 mm or a little over 3 inches in the 60° zone. This is a great improvement over the spherical reflector having a spherical under-correction of 10 inches in this zone. This spherical under-correction is due only to the condenser as the parabolic reflector is free from spherical aberration for an object in its focal point. It is possible to correct this unit further by employing a parabolic correcting surface on the condenser. The general performance of the system would not be improved sufficiently to warrant the introduction of an aspheric condenser.

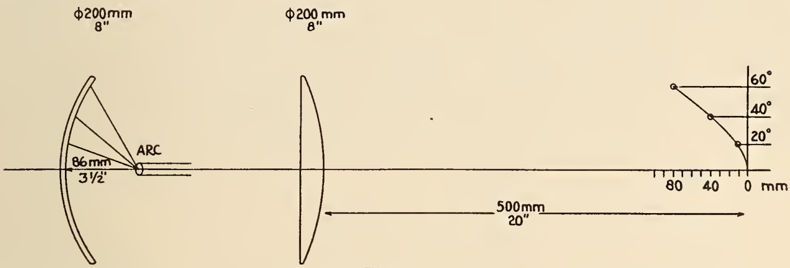

FIG. 2

Showing spherical aberration (under corrected), in millimeters, for zones up to 60° from the axis for a combination of parabolic reflector and simple plano convex condenser; the focal length of the unit being such that there is an axial magnification of the source of 6 to 1, the working distance of the source being 86 mm.

With this unit, the spot on the cooling plate is fairly sharp, not diffused as in the case of the spherical reflector. The screen illumination is much more uniform and much greater than with the spherical reflector. If a screen be placed a few inches in front of the projection lens, it will be found that the whole of the reflector is brightly illuminated and functioning usefully, so that in spite of the 80 mm of spherical under-correction, light from the marginal portions of the reflector still passes through the film aperture into the projection lens, utilizing an angular aperture of 60° from the axis.

Combination of Mangin Mirror and Condenser

A Mangin mirror is a reflector in which the spherical aberration has been reduced to a minimum by the proper choice of two spherical curves. In the general use of the term it is spherically corrected for its focal point and infinity. The Mangin mirror or lens mirror was invented in the late 80's by Captain Mangin, a French Army Engineer. It is really a combination of a spherical reflector and a negative lens which neutralizes the spherical aberration of the reflector. It was designed as a substitute for a parabolic mirror.

Although ordinarily in the strictest sense of the word an optical system with a few exceptions, can be spherically corrected for two zones only—axis and margin or axis and some intermediate zone—we can, however, distribute the proportion of under-corrected and over-corrected zones in such a manner that under any specified condition the system performs the best it possibly can. It is in this sense that we shall use the term "spherically corrected." When we say that a Mangin mirror is spherically corrected for an object in its focal point, we shall mean that with the restrictions placed upon it such as spherical surfaces, diameter, magnification, etc., it has the best possible spherical correction, and not necessarily that the crossing points for axis and margin coincide.

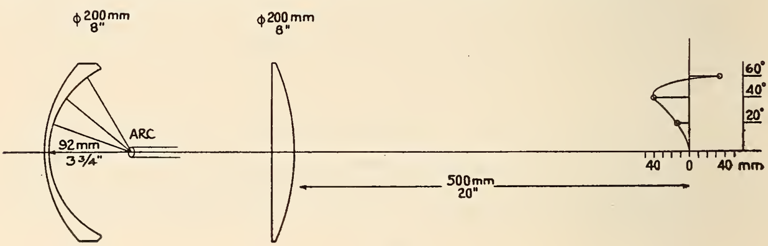

FIG. 3

Showing spherical aberration in millimeters, for zones up to 60° from the axis for a combination of a Mangin mirror corrected for its focal point and infinity and a simple plano convex condenser; the focal length of the unit being such that there is an axial magnification of 6 to 1, the working distance of the source being 92 mm.

In Fig. 3 is shown a combination of such a Mangin mirror and condenser. The diameter of both Mangin mirror and condenser is 8 inches, the working distance of the reflector being about 3-¾ inches. The focal length of the unit is such that there is an axial magnification of 6 to 1. From a study of this curve it is evident that this is a very well corrected system, there being a maximum spherical over-correction of about 30 mm in the 60° zone and a maximum spherical under-correction of about 40 mm in the 40° zone. This system which is partially over-corrected and partially under-corrected is the result of combining the marginal spherical over-correction of the Mangin mirror with the spherical under-correction of the condenser and represents a better spherical correction than the combination of parabolic reflector and condenser in which the spherical aberration is all under-corrected. If the image of this reflector be observed on a screen placed a few inches in front of the projection lens, we shall find, as in the previous case of parabolic reflector and condenser, that the whole of the reflector is illuminated and being used up to an angular aperture of 60° from the axis.

The spot on the cooling plate will be just a little sharper and the screen illumination just a little more uniform than it is with the parabolic reflector and condenser. The screen illumination although greater than that obtainable with an ordinary spherical reflector will be less than that of the parabolic reflector combined with a condenser due to the loss of light by absorption in the double passage through such a thick reflector. Due to the shape and size, it is necessary in order to prevent excessive breakage to make this reflector of heat resisting glass.

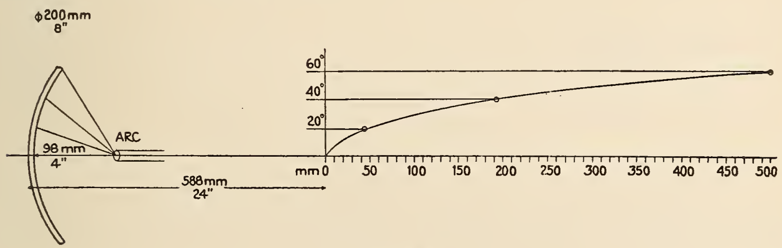

Fig. 4

Showing spherical aberration (over corrected), in millimeters, for zones up to 60° from the axis for a parabolic reflector, having two parallel parabolic curves when used for finite imagery; the focal length of the reflector being such that there is an axial magnification of 6 to 1, the working distance of the source being 98 mm.

Parabolic Mirror used for Finite Imagery

In Fig. 4 is shown a curve representing the spherical over-correction of a parabolic reflector when used without a condenser in imaging an object at a finite distance. This reflector has a diameter of 8 inches and a working distance of about 4 inches. The focal length is such that the axial magnification is 6 to 1. The spherical over-correction of a reflector of this sort used in this way amounts to 500 mm or 20 inches. It may appear at first glance that this system is much inferior to the ordinary spherical reflector having a spherical under-correction of 250 mm or 10 inches. As a matter of fact, the 500 mm of over-correction in the parabolic reflector used for finite imagery just about corresponds to 250 mm of under-correction of the spherical reflector as far as optical quality of imagery is concerned. The reflector here illustrated is hardly superior to the spherical reflector. If the image of the reflector, as formed by the projection lens is examined on a screen, it will be found that only the portion of the reflector equivalent to an angular aperture of 45° to 50° from the axis functions usefully; that is, puts light through the aperture into the projection lens, the remainder of the reflector being dark when small light sources are used. The spot on the cooling plate will be sharper than when the spherical reflector is used, although not as sharp as with the combination of either parabolic reflector or Mangin mirror with condenser. The quantity of light projected upon the

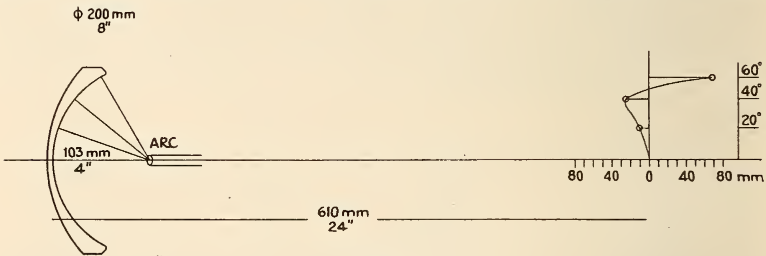

FIG. 5

Showing spherical aberration in millimeters for zones up to 60° from the axis for a Mangin mirror corrected for infinity and its focal point, when used for finite imagery; the focal length of the reflector being such that there is an axial magnification of 6 to 1, the working distance of the source being 103 mm.

screen will be about the same as with the spherical reflector, the evenness or uniformity of illumination being better. This latter is due to the fact that the spherical over-correction of the reflector counteracts to some extent the fact that the center of the arc crater is brighter than the portions nearer the rim with the result that more light is thrown to the margins of the field than otherwise would be the case.

Mangin Mirror used for Finite Imagery

In Fig. 5 is shown the spherical aberration in a Mangin mirror corrected for an object in its focal point when used for finite imagery. The diameter of the reflector is 8 inches, working distance 4 inches, and focal length such that the axial magnification is 6 to 1. There is a spherical over-correction of about 70 mm in the 60° zone and a spherical under-correction of about 30 mm in the 40° zone. This is a fairly well corrected system even when used for imaging an object not in its focal point. The spherical correction is not as good, however, as when it is combined with a condenser, although it is better than the spherical correction in the combination of parabolic reflector and condenser and, of course, far superior to the spherical reflector or parabolic reflector when used without condenser. The image of the whole reflector as formed on a screen placed a few inches in front of the projection lens is brightly illuminated, indicating that as far out as the 60° zone light passes through the film aperture to the projection lens. The screen illumination is even, although not as uniform as when the Mangin mirror is used in combination with a condenser. The uniformity of illumination is slightly better than the combination of parabolic reflector and condenser and far superior to the spherical reflector or parabolic reflector without condenser. The spot on the cooling plate is very well defined, not quite as sharp, however, as the combination of Mangin mirror with condenser, but slightly sharper than the combination of parabolic reflector with condenser, and far better than the spherical reflector or parabolic reflector without condenser. The quantity of light projected to the screen by this reflector will be slightly more than that projected by the combination of Mangin mirror and condenser, considerably more than that projected by either the spherical reflector or parabolic reflector without condenser, but less than that due to the combination of parabolic reflector and condenser. This is due to the absorption which occurs when the light passes through such a thick reflector twice. Due to the size and shape, the reflector must be made of heat resisting glass to prevent excessive breakage.

The Modified Mangin Mirror

In Fig. 6 is shown a curve representing the spherical aberration of a reflector which we have called a modified Mangin mirror, because it is spherically corrected for an object not in its focal point, a true Mangin mirror being corrected for an object in its focal point. The diameter of this reflector is 155 mm or 6-¼ inches. The working distance is 80 mm or about 3-¼ inches. The focal length is such that the axial magnification is 7 to 1, instead of 6 to 1, as is the case with the reflecting systems so far described. It was found necessary from a manufacturing standpoint to reduce both diameter and working distance and to slightly increase magnification, because the size and shape was such that the reflector became impossible of construction if large diameter and working distance were maintained and the reflector constructed to take in a cone of light 60° from the axis.

It is evident that the spherical correction of this reflector is excellent and illustrates very nicely what can be done along these lines by proper choice of two spherical curves: the maximum under-correction is only 15 mm in the 40° zone, the maximum over-correction being 40 mm in the 60° zone. The whole of the reflector functions usefully through an angular aperture 60° from the axis. The spot on the cooling plate is more sharply defined than with any of the systems so far mentioned. The screen illumination is more uniform than with any of the systems so far described with the exception possibly of the combination of Mangin mirror with condenser. The quantity of illumination although greater than that obtainable with

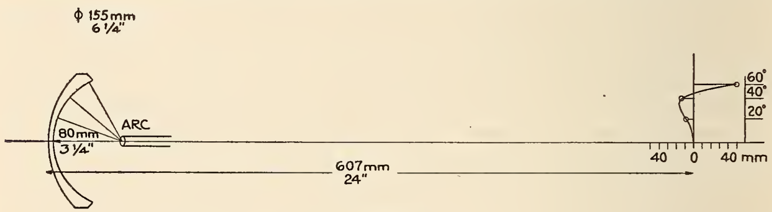

Fig. 6

Showing spherical aberration, in millimeters, for zones to 60° from the axis for a reflector corrected for finite object and image distances by suitable choice of two spherical curves; the focal length of the reflector being such that there is an axial magnification of approximately 7 to 1, the working distance of the source being 80 mm.

a spherical reflector, a parabolic reflector without condenser, and possibly with a Mangin mirror in combination with a condenser, is not as great as that obtainable with the combination of parabolic reflector and condenser or Mangin mirror alone. Due to the shape and size of the reflector, it is necessary to construct it of heat resisting glass in order to prevent excessive breakage.

The Elliptical Reflector

It seems that since the advent of the Reflector Arc in motion picture projection, the standard of screen quality or uniformity of illumination has fallen considerably. Whereas, previously, we were very critical and exacting in having the screen evenly illuminated, we now seem to tolerate a screen with a center considerably and noticeably brighter than the edges. The enormously decreased cost of operation has pushed into the background the idea of quality of illumination. It is very true that an ordinary spherical reflector will produce a brighter central illumination on the screen than will, let us say, for example, a modified Mangin. But a modified Mangin mirror produces an evenly illuminated screen which a spherical reflector, by the very nature of its optical defects cannot possibly do. In spite of this, a spherical reflector is often chosen in preference to another type because, since the center of the screen is bright, one has the impression of more light on the screen.

It has been our experience that any reflecting arc system employed with, say a 25 ampere arc, should have an axial magnification of 6 to 1. The average useable crater diameter of a 20 to 25 ampere horizontal carbon arc is between 5 and 6 mm. A magnification of 6 to 1 will image this as a 30 to 36 mm arc image, which is just large enough to cover the film aperture nicely.

The highest speed projection lens, a 5 inch Series II, will pass a cone of light slightly over 10° from the axis; that is, a cone of light whose total angular diameter is 20°. This immediately makes it useless to employ illuminating angles of more than 10° from the axis. If the magnification is 6 to 1, then the total angular aperture of the reflector must be 6 times 20° or 120°. In other words, the reflector must take in a cone of light 60° from the axis. It is valueless to take in more, if the magnification is 6 to 1, because the illuminating cone will then be larger than 20°, the limiting angle for the highest speed projection lens. Thus, when the magnification is fixed or determined (we recommend 6 to 1 magnification) and the maximum illuminating cone is known (20°), the maximum useable angular aperture of the reflector is immediately fixed (120°). For very low amperage arcs, such as 5 or 10 amperes, where the useable portion of the crater is less than 5 mm in diameter and where it becomes necessary to use a larger magnification, say 7 to 1, in order to cover the film aperture, then the angular aperture of the reflector can usefully be increased to 70° from the axis or 140°. Most reflector arcs, however, are used with arcs of 20 to 25 amperes where a magnification of 6 to 1 is sufficient.

Always keeping in mind that the reflector should have a total angular aperture of 120°, it is advisable to have a reflector of as large a *diameter* as possible in order that the shadow or projected area of the positive carbon and its supporting mechanism should cut off as low a percentage of the useable reflector area as possible. However, the mechanical limitations of lamphouse mounting, etc., permit of a maximum distance between reflector and aperture of only about 25 inches. If we assume this distance of reflector to aperture to be 24 inches and also assume a magnification of 6 to 1, then the working distance of the arc is immediately determined as 4 inches, (24 inches divided by 6). Thus, knowing the required working distance to be 4 inches and the required total angular aperture to be 120°, the necessary diameter, 8 inches, of the reflector also follows. Finally, we may sum up the requirements of an ideal reflector to be (1) total angular aperture 120°, (2) total illuminating cone 20°, (3) magnification 6 to 1, (4) working distance 4 inches, (5) distance of reflector to aperture 24 inches, and (6) diameter of reflector 8 inches.

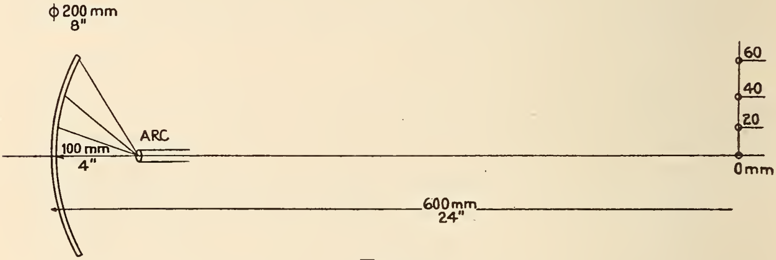

Fig. 7

Showing complete spherical correction in all zones, for an elliptical reflector, having an axial magnification of 6 to 1, and a working distance of 100 mm.

Having in mind these ideal requirements, more or less of a mechanical nature, in Fig. 7 is shown the spherical aberration of an elliptical reflector, 8 inches in diameter, having a working distance of 4 inches and an angular aperture of 60° from the axis. The distance from reflector to aperture is 24 inches and the axial magnification, 6 to 1. There is no spherical aberration whatever in this reflector. The whole of the angular aperture of this reflector functions usefully. The spot on the cooling plate is sharper than with any of the reflector systems previously mentioned, and the screen illumination is greater and more uniform than with any of the other systems. The shape of the reflector is such that the projection angle can be as great as 30° before the arc flame touches the edge of the reflector.

An elliptical reflector or rather an elliptical surface is generated by the rotation of an ellipse about its major axis. Such a reflector is free from spherical aberration for an object or image in either of its geometrical foci. The equation of this particular generating ellipse is

$$\frac{x^2}{350^2} + \frac{y^2}{245^2} = 1$$

The major axis of the ellipse is 700 mm, the minor axis 490 mm; the geometrical focus being 100 mm.

The following is a self explanatory table in which is listed in order of best to worst the seven reflecting systems discussed in respect to practicability, definition of spot on cooling plate, uniformity of screen illumination, quantity of screen illumination, and spherical aberration.

Table showing the order into which the various reflecting systems fall in regard to practicability, definition of spot on cooling plate, uniformity of screen illumination, quantity of screen illumination and spherical aberration.

No.	Practicability	Spot Definition	Screen Uniformity	Screen Illumination	Spherical Aberration
1	Spherical	Elliptical	Elliptical	Elliptical	Elliptical
2	Parabolic without Condenser	Modified Mangin	Modified Mangin	Parabolic with Condenser	Modified Mangin
3	Elliptical	Mangin with Condenser	Mangin with Condenser	Mangin without Condenser	Mangin with Condenser
4	Parabolic with Condenser	Parabolic with Condenser	Parabolic with Condenser	Modified Mangin	Parabolic with Condenser
5	Modified Mangin	Mangin without Condenser	Mangin without Condenser	Mangin with Condenser	Mangin without Condenser
6	Mangin without Condenser	Parabolic without Condenser	Parabolic without Condenser	Parabolic without Condenser	Parabolic without Condenser
7	Mangin with Condenser	Spherical	Spherical	Spherical	Spherical

Under practicability we include those questions relating to initial cost and subsequent cost of replacement due to breakage, and the general ease of mechanical manipulation.

The following is a bibliography of foreign articles on reflector arc projection, there being practically nothing of any importance in English journals on this particular subject.

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Condenser Lamp, Reflector Lamp, and Fire Protection of the Projector
M. Flinker, Die Kinotechnik, *6*, p. 13, 1924.
The Different Forms of Reflecting Mirrors Available for Projecting Lamps
C. Forch, Die Kinotechnik, *6*, p. 31, 1924.
The Effect of Cooling Chambers With Reflector Arc Lamps
H. Joachim & H. Schoenig, Die Kinotechnik, *6*, p. 91, 1924.
Shadow-Free Slide Projection With Stationary Lamp House and the Use of Reflector Lamps
M. Adam, Die Kinotechnik, *6*, 20, p. 373, 1924.
Comparative Brightness and Temperature Measurements on Reflector Arc Lamps
Dr. Joachim & Dr. Noack, Die Kinotechnik, *5*, 7, p. 175, 1923.
Comparison of the Danger of Film Burning with Condenser and Reflector Lamp
C. Forch, Die Kinotechnik, *5*, 19/20, p. 457, 1923.
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W. Winsenburg, Die Kinotechnik, *5*, 21/22, p. 491, 1923.
Objectives With Large Aperture for Motion Picture Projectors with Mirror Arcs
M. Adam, Die Kinotechnik, *6*, Aug. 25, 1924, p. 269.
Light Intensity Measurements on Projector Arcs
M. Flinker, Die Kinotechnik, *6*, July 25, 1924, p. 221.
Photo Technical Investigations on the Cinematographic Projector
Meinel, Phot. Ind., May 30, 1923, p. 259.

DISCUSSION

Mr. Benford: In one slide Mr. Stark showed a combination o a parabolic mirror and a condenser with under-correction. One optical fact of importance is that if the light source is moved toward the mirror, the light rays will diverge, and the divergence is an angular maximum at 60°. I think that combination could be made almost exact optically by moving the light source toward the center of the mirror. Also, all the light reflected from the front surface of the Mangin mirror does not form a focus spot. There is a loss of 5 per cent which does not take place in the other combinations.

I do not believe that it is an exact rule that the angular apertures of objective and condenser have a fixed ratio regardless of the nature of the condenser. The angular opening of a paraboloid will be less than that of an ellipsoid, and the other forms will each have a different collecting angle.

Mr. Egeler: Mr. Stark showed several systems using non-spherical glass surfaces and listed them in the order of practicability. Are all the systems practical from the standpoint of the present art of optical manufacture?

Mr. Richardson: Cannot the ordinary reflector be changed to eliminate spherical aberration without thickening the edge?

Mr. Palmer: In regard to the elliptical reflector, that seems to be the best type of reflector from Mr. Stark's description: How much loss in efficiency do you get by a slight displacement from the proper focus of the mirror? It could not be expected that the mechanism would always be operated under theoretically correct conditions, and I should like to know the loss in efficiency due to displacement from the theoretically correct position.

Mr. Griffin: What is the relative cost of the various systems listed?

Mr. Gray: It would seem to me as if the question of high spot temperature encountered with mirror arc projection is a problem in the field. I was wondering whether in any of the systems mentioned, considering equal screen results with any two, whether the difference in temperature might not be considerable.

Mr. Stark: Mr. Benford's suggestion of moving the source towards the reflector, in the combination of parabolic reflector and condenser, in order to decrease the residual spherical aberration of the combination, is very much to the point except that the source should be moved away from the reflector instead of toward it. A parabolic reflector and condenser is spherically under-corrected, as shown in Fig. 2. The problem, then, is to introduce spherical over-correction in some way in order to counteract the spherical under-correction of the condenser alone—which under-correction is actually the residual aberration of the combination. If the source is moved toward the reflector from the focal point, the beam of light as a whole is diverging, the image formed is virtual and under-corrected, and the combination with the under-corrected condenser becomes still more under-corrected. If, however, the source is moved away from the reflector from the position of the focal point, the beam of light is converging, the image, formed at a finite distance, is real and over-corrected, and the combination with the under-corrected condenser will be more nearly corrected, obviously, if the over-correction introduced is not too great.

It is true that in any of the Mangin combinations there is a loss of approximately 4 per cent at the first surface which does not occur with reflectors having parallel surfaces.

It is not true, strictly speaking, that the ratio of the angular aperture of the reflector to the angle of the illuminating cone is the axial magnification of the system. For the purposes here considered it is, however, a simple and satisfactory approximation. In Gaussian optics, where only aberrationless systems having very small angular apertures, such that only the paraxial region need be considered, the magnification is represented by the ratio of the tangents of half the angular aperture of the reflector to half the angle of the illuminating cone. In systems of large angular aperture, the magnification for a corrected system is represented by the ratio of the sines of half the angular aperture of the reflector to half the angle of the illuminating cone. The particular magnitudes with which we are dealing in this problem are such that the ratio of the angular aperture of the reflector to the angular aperture of the illuminating cone is very nearly equal to the ratio of the sines of half these angles respectively—and we have consequently used this method of expressing it on account of its simplicity.

Answering Mr. Egeler's question regarding the practicability of the manufacture of non-spherical optical units, I should say that it is practicable at the present time to manufacture on a commercial basis and of an optical quality suitable for motion picture illuminating systems both parabolic and elliptical reflectors. Not so long ago, it would certainly have been impracticable to do this. Recently, however, there has been considerable experimental work conducted in just this particular field with the result that methods of manufacture have been developed whereby the production of elliptical reflectors of good optical quality, on a commercial basis, and within reasonable cost, has been accomplished.

Mr. Richardson's suggestion of decreasing the spherical under-correction of the spherical reflector shown in Fig. 1 by moving the source nearer to the reflector is not a solution to the problem. If the source were moved in such a way, the axial image would move away from the reflector at a proportionally increasing rate until when the source is in the focal point of the reflector, the axial image would be at infinity and the marginal image at some finite distance from the reflector (the margin being under-corrected). Moving the source toward the reflector would result in increasing the spherical aberration instead of decreasing it. On the other hand, if the source were moved away from the reflector, the spherical aberration would progressively decrease until, when the source is in the center of curvature of the reflector, the spherical aberration would become zero—the spherical reflector being spherically corrected for object and image in its center of curvature.

If the spherical reflector shown in Fig. 1 were to be distorted in such a manner that spherical aberration were reduced to zero—the imagery being effected by reflection only—the resulting surface would be the ellipse shown in Fig. 7. We can, on the other hand, restrict ourselves to the use of two spherical surfaces, and by suitable choice of the radii of curvature of these two spherical surfaces effect spherical correction by a combination of reflection and refraction, as in the case of a Mangin mirror. The best that can be accomplished in this direction is to reduce the spherical aberration to a minimum by properly balancing the residual zonal under-correction with marginal over-correction. For a specified focal length or working distance and a specified magnification, there is just one combination of two spherical curves that give such spherical correction, and these curves always result in a reflector which is thick at the margin.

Regarding Mr. Palmer's inquiry concerning the accuracy with which it is necessary to hold the source in the geometrical focus of the ellipse—this is more or less difficult to answer. Certainly, the best results will be obtained if the source is maintained accurately in the proper position. If the source is nearer the reflector than its geometrical focus, the reflector will be under-corrected for this increased magnification; while if the source is further from the reflector than its geometrical focus, the reflector will be over-corrected for this decreased magnification. The amount of over-correction or under-correction will be greater or less as the source is further removed from its correct position. I do not believe that the question of accurate positioning of source should occasion any alarm, as the modern construction of reflecting arc lamp houses is such that the positive crater can be held in its proper position within exceedingly small limits.

I must confess to Mr. Griffin that I am not intimately acquainted with the cost or prices of the various systems described. It would seem reasonable to suppose that the spherical reflector is the cheapest. The parabolic reflector of commercial quality costs somewhat more. Possibly the elliptical reflector would cost as much as the combination of parabolic reflector and condenser. The reflectors of the Mangin type all cost considerably more than the spherical reflector—which is the reason I place them in the lower positions in the table of practicability.

Mr. Gray's question of temperature at the film gate brings up a problem on which we have done no experimental work whatever. It is without argument, I believe, that the temperature at the cooling plate will be approximately the same for any of the systems described. No radical differences in temperature are to be expected. All the systems shown have the same angular aperture and the same magnification, and if due allowances are made for the heat absorption of the condenser in the combination of parabolic reflector and condenser, as well as for the heat absorption in the Mangin types, the temperatures should all be about the same. It would also be reasonable to expect a slight increase in temperature in the better corrected systems due to the fact that the spot on the cooling plate is more sharply defined. I might refer Mr. Gray to a few of the papers listed in the appended bibliography.

Mr. Griffin: What result will the elliptical mirror have if used on the arc lamps already under construction? We happen to be making one with which we project lantern slides with the same optical system. I suppose this can be done with an ellipse and would not necessitate radical changes in design. How soon will the elliptical mirrors be available?

Mr. Little: In reference to Mr. Palmer's question in regard to the necessity for accurate focusing, a general statement might be made to the effect that any reflector formed by the revolution of conic sections of equal focal length are equally sensitive; therefore, the sensitivity of a reflector of this character is directly proportional to the focal length. That is, the longer the focus, the less the sensitivity.

Mr. Kunzman: Are the mirrors manufactured to definite crater diameters for a given amperage and carbon combination?

Mr. Beggs: I should like to know how ellipses versus Mangin would compare when made of heat resisting glass?

Mr. Stark: Without having given the problem any previous thought, it would seem that if an auxiliary prism with condenser or decentered condenser alone were to be placed near the elliptical reflector, lantern slides could be projected if the slides were sufficiently near the auxiliary system to be fully illuminated.

Mr. Griffin: The carbon is there and is 8 inches long, so that there would be 10 inches or 12 inches of obstruction.

Mr. Stark: Could not the slides be projected in the same manner in which it is now accomplished with a spherical reflector?

Mr. Griffin: By moving the spherical reflector, you get a parallel beam, and at a point where the beam becomes parallel, about 16 inches from the outer surface of the mirror, we insert a 20 inch condenser. The slide is placed close to the condenser, and it works out well.

Mr. Stark: Exactly the same method can be employed with an elliptical reflector and with better results. The group of conic sections includes the circle, ellipse, parabola and hyperbola. The surfaces of revolution of the first three curves are the ones generally used in optical practice. The sphere is free from spherical aberration for an object in its center of curvature and is badly under-corrected for an object in its focal point,—in which position of object an approximately parallel beam is obtained. A parabolic reflector is free from spherical aberration for an object in its focal point, in which position of object a parallel beam is obtained. An ellipse is midway between the parabola and sphere, and consequently, with an object in its focal point the resulting parallel beam, although not as perfect as that of a parabola, is better than the parallel beam obtainable from a sphere. I do not know definitely as yet just when we shall be in a position to place elliptical reflectors on the market.

Mr. Little's statement is correct—the longer the focal length of a reflector, the less effect will a given displacement of source have on optical performance. A displacement from correct position of the source with respect to a reflector might be disastrous with a reflector of short focal length and with no noticeable effect whatever with a reflector of greater focal length.

Mr. Kunzman's question relating to the crater diameter for which the reflectors were designed: I would say that for all of the reflectors discussed, we have assumed the crater diameter of a 20 to 25 ampere horizontal carbon arc, this being in the neighborhood of 5 to 6 mm.

In answer to Mr. Beggs—in view of the great thickness of glass at the margin of the reflector, it is necessary in order to prevent excessive breakage to construct all Mangin types of reflectors from heat resisting glass. With the thinner types—such as the spherical, parabolic and elliptical reflectors—ordinary optical glass well annealed is entirely satisfactory.

TRANSACTIONS

OF THE

SOCIETY OF MOTION PICTURE ENGINEERS

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MEETING OF OCTOBER 5, 6, 7, 8, 1925

ROSCOE, N. Y.

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SUMMARY OF REPORT OF STANDARDS AND NOMENCLATURE COMMITTEE WITH ACTION TAKEN BY THE SOCIETY

A COMPLETE list of the standards and nomenclature in effect October 1, 1925, has been prepared and included with Volume No. 2 of the Schenectady TRANSACTIONS.

The Committee again recommended the final adoption of the matters presented at Schenectady, last May, as follows:

(1) *Perforation of positive film*—a rectangular hole 1.98 x 2.79mm with rounded corners

(2) *Aperture Sizes.*—

Camera: 0.700″ high x 0.925″ wide; 0.035″ radius corners
Printer: 0.757″ high x 1.000″ wide; 3/64″ radius corners
Projector: Already standardized as 0.725″ high x 0.950″ wide; square corners

N.B. Camera aperture corners may be either square or rounded, but the projector aperture corners must be square. These sizes produce the black border.

(3) *Projector Speed*— 80′ per minute, plus or minus 5

(4) *Camera Speed*— 60′ per minute, plus or minus 5

(5) *External diameter of projection lens barrels*—
No. 1 lenses, 2 1/32″, No. 2 lenses, 2 25/32″

(6) *Tolerances on dimensions of films*—None

(7) *Definition of "Scene"*

"A division of the story showing continuous action in the same locale or set, and usually taken from the same point of view."

(8) *Definition of "Reflector Arc"*—

"In a motion picture projector, an arc light source in combination with a reflector, to project the light beam through the aperture."

All of the above matters have stood the required six months, were given the final approval by the Society, and thereby become officially adopted.

The following matters were referred back to the Committee for further consideration:

(9) *Recommended practice for film splicing*

(10) *Dimensions of Camera Reel Cores*

(11) *Dimensions of Sprockets*

A report of the Sixth International Congress of Photography, recently held in Paris, was given together with the actions which were taken there.

October, 1925. L. C. PORTER,
Chairman, Standards and Nomenclature Committee.

REPORT OF THE STANDARDS AND NOMENCLATURE COMMITTEE

GENTLEMEN:

You will recall that action on most of the matters presented in our report at Schenectady, last May, was deferred out of deference to the Paris Convention. Unfortunately, neither of the men you appointed to officially represent the Society, i.e., Messrs. Mees and Renwick, finally attended the convention. However, Dr. Sheppard of the Eastman Kodak Company was there and took the responsibility of representing the Society of Motion Picture Engineers at the International Congress. That Congress decided to accept our policy of six months' delay (reckoning from July, 1925) before their actions become final. This gives us time to enter any comments or objections before the actions taken by the Congress are adopted.

The co-ordination of any oppositions that may arise was put in charge of the following committee:

Germany, Prof. Lehmann; France, L. Lobel; Great Britain, a delegate to be appointed by the Cinematographers Manufacturers Association; Czecko-slovakia, C. J. Brichta; United States, a delegate to be appointed by the Society of Motion Picture Engineers.

Mr. L. Lobel was appointed Secretary to this Committee.

In the event of a lack of agreement through correspondence between the members of the executive committee, at the expiration of the time fixed above, these members shall meet in Paris on a suitable date to formulate the definite resolutions.

Your Committee has studied carefully the official report of the Sixth International Congress of Photography held at Paris last June. While we do not find any actions taken at this Congress that would make it seem desirable to change our recommendations of last May, still we feel that the proceedings and discussions of so important a body of men are of sufficient interest and value to warrant printing them in their entirety in our TRANSACTIONS. We are, therefore, presenting them as a supplement to our report.

No new matters have come to the attention of the Committee since last May. We are, therefore, again presenting the matters which were not definitely settled at Schenectady, as follows:

1. Form of perforations for positive and negative 35 mm film
2. Dimensions for camera and printer apertures
3. Projector speed
4. External diameter of No. 1 and No. 2 projection lenses
5. Camera speed
6. Film splicing specifications
7. Definitions for "Scene" and "Reflector Arc"
8. Tolerance in dimensions of 35 mm film and shrinkage in drying
9. Dimensions of film reel cores
10. Sprocket design

Realizing the difficulty anyone would have in finding out the exact status of our Standards and Nomenclature, due to our prolonged discussions, changes, and, in the early days, diversity of committees handling these matters, your Committee has prepared a complete list of all Standards, Nomenclature, and Recommended Practice which is officially in force, as well as matters under consideration as of October 1, 1925. The Standards and Recommended Practice lists are arranged according to date of official adoption. The Nomenclature list is arranged alphabetically. In every case the date of official adoption is given and also the number of the TRANSACTIONS containing the discussion. These lists will be included in the envelopes with the second volume of the Schenectady TRANSACTIONS, so that every member of the Society will receive copies.

We are in receipt of a letter from the American Engineering Standards Committee inquiring as to the status of our standards and offering to assist in international standardization. It is our belief that if final action is taken on the matters brought up last May, we shall be in a position to present our standards to the American Engineering Standards Committee, and there is little doubt that they will be accepted and adopted by that body.

Now, let us take up in detail the matters pending final adoption by the Society:

Form of Perforation

Your Committee has been in touch with the English, French, and German Societies and are advised by Mr. L. Lobel of the French organization that they have agreed to the same form and dimensions of perforation for positive film which we have recommended, i.e., a rectangular hole 1.98 x 2.79 mm with rounded corners. (Fig. 1).

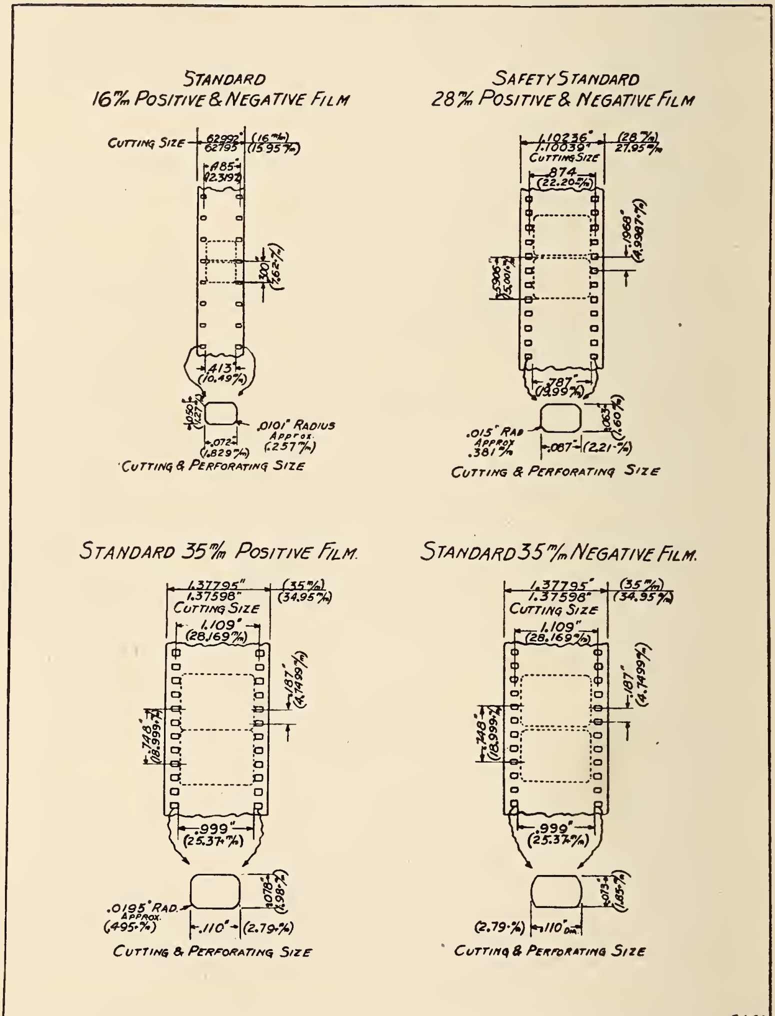

Fig. 1.

There seems, however, to be some feeling on the part of Pathé that their perforation, 3 mm long x 2 mm high, having straight top and bottom edges but ends formed by the arc of a circle and joined to the top and bottom by rounded corners, *is better, and this may be standardized also.* For negative film they also have accepted our practice of perforations 2.79 x 1.85 mm with rounded ends (Fig. 1).

The action taken by the Paris Congress on this matter is as follows: "Form of Perforations: One shall use optionally the Kodak perforation, rectangle of 2 x 2.8 mm with rounded angles on a radius of 0.5 mm or the Pathé perforation, limited by two parallel lines traced 1 mm apart, and on opposite sides of a circle 3 mm in diameter, and rounded on a radius of 0.5 mm.

"Common limit of two successive images at mid-distance from two consecutive perforations."

This does not differentiate between positive and negative film. Fig. 2 shows the various forms discussed at Paris.

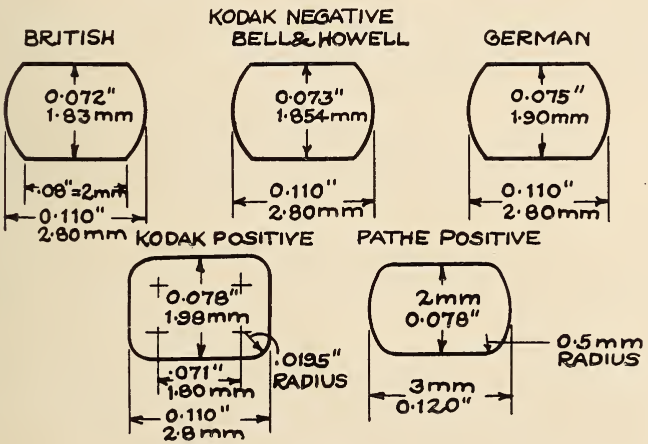

Fig. 2.—Table of perforations showing variations in standards.

Note: Kodak and Pathé positive shaped holes were adopted as International standard for positive and negative film.

As the use and value of other forms of perforations than the rectangular with rounded corners for 35 mm positive film, proposed at the Roscoe meeting a year ago (as shown in Fig. 1), seems doubtful, and as the foreign practice seems to be going also to the same perforation, your Committee recommends that you now accept, for final standardization, this form of perforation.

DISCUSSION

Mr. Crabtree: Did the foreign societies recommend both those perforations or only the Pathé?

Dr. Sheppard: They recommended that both the Kodak and Pathé positive perforations as shown at the bottom of the figure be recommended as official for positive film and for negative film. The opinion of the meeting was that positive film should have the same dimensions as the negative film. No official American representatives were present, but the point of view in favor of the existing American negative perforation was brought forward. However, the vote went in favor of identical dimensions for negative and positive film.

Mr. Crabtree: May I ask Mr. Jones if the positive rectangular perforation is satisfactory for all present machinery; the upper negative (indicating) is only suitable for negative machinery. Why was it adopted for both positive and negative?

Dr. Sheppard: With the exception of this country, identical perforation dimensions are acceptable for positive and negativefilm; in the other countries cameras, printing machines, and projectors are made with differences very slight from the recommended perforations.

With regard to Mr. Crabtree's last remark, the defining dimensions of the two positive perforations are so close that they could be operated on any machine.

Mr. Richardson: I have gone to considerable trouble to get reports from men handling motion picture projectors, and they may be presumed to know more than we do about it. They all report that this perforation (indicating Pathé) is the strongest, has less tendency to fracture, and goes through more quietly and with less strain on the film.

Mr. Porter: Mr. Richardson submitted reports on a large number of films obtained from different projectionists, and these data were considered by the committee.

Mr. Chanier: Pathé and Kodak perforations are about alike; there is no difference in wear and tear.

Mr. Ziebarth: In my experience I have found that Bell and Howell, Pathé, and Kodak perforations would not check or tear from running through projection machines that were properly adjusted and operated. In fact, I have found long before the perforation became damaged the film was so badly scratched that it would be a disgrace to show it, and under poor operating conditions any one of the three mentioned perforations would become damaged as easily as the other.

Mr. Richardson: Reel upon reel is ruined on the first run because it has not sufficient strength in the corner of the perforation.

Will you call attention to the fact that the adoption of the recommendation does not prevent the use of the Pathé perforation?

(*Motion thereupon duly passed to adopt recommendation.*)

Aperture Sizes

In regard to camera and printer apertures, your Committee believes it to be the consensus of opinion in the Society that the black border is desirable. To obtain it we recommend the following aperture sizes:

Camera:	0.700″ high x 0.925″ wide; 0.035″ radius corners
Printer:	0.757″ high x 1.000″ wide; 3/64″ radius corners
Projector:	(Already standardized as 0.725″ high x 0.950″ wide: square corners.)

The camera aperture corners may be either square or rounded, but the projector aperture corners must be square.

DISCUSSION

Mr. Crabtree: May I ask whether anybody is printing film so that it will have a black border?

Mr. John Jones: We made films similar to those used abroad and showed them before the Society to prove the advantage, and it was unanimously voted that the black border film gave a steadier appearing picture. We propose to standardize this even if it is not used. The camera apertures should be smaller in order to show a black border. If you do not adopt it, all right; but if you do adopt it, you have the dimensions.

Mr. Porter: I think it is our function to recommend what will give the best results although they are not in practice right now.

Mr. Ziebarth: Answering Mr. Crabtree's question, the Bell and Howell camera aperture is 0.720″ high x 0.965″ wide, and their printer will print the full picture size, 0.750″ high x 1.000″ wide. The film, being transparent outside of the camera aperture, would leave a black frame around the picture when printed. We have been using these sizes for several years.

MR. PALMER: I am heartily in favor of the recommendation as given because it has been very ably and fully demonstrated before this Society that the black border does give a steadier picture, and I think that a square cornered picture is better looking on the screen than the round cornered one.

(*Motion passed to adopt above dimensions.*)

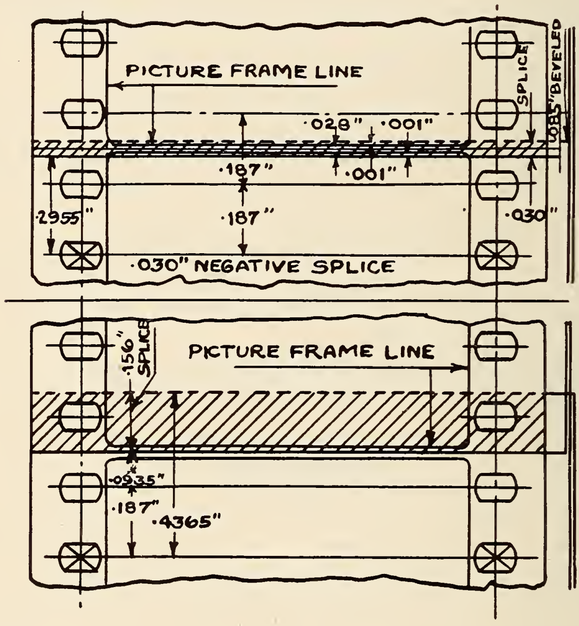

Fig. 3.—Proposed dimensions for film splices.

Projector Speeds

With regard to projector speeds, we again recommend as standard practice 80′ per minute, with a maximum of 85′ and a minimum of 75′.

(*Motion passed to accept above recommendation.*)

External Diameter of Projection Lens Barrels

Regarding the external diameter of projection lens barrels, we recommend 2-1/32″ for No. 1 lenses and 2-25/32″ for No. 2 lenses.

(*Motion passed to accept these dimensions.*)

Camera Cranking Speed

Regarding camera speed, we recommend as recommended practice:—a camera taking speed of 60′ per minute, with a minimum of 55′ and a maximum of 65′ when normal action is desired, in connection with the Society of Motion Picture Engineers recommended practice of 80′ per minute projection speed.

(*Motion passed to accept speeds recommended as above.*)

Film Splicing

Regarding film splicing, we propose as recommended practice the dimensions shown in Fig. 3.

DISCUSSION

Mr. Porter: Since the report was prepared, we have had Mr. Denison's discussion, in which he told us that the Technicolor people use a narrower splice, and that Famous-Players use a full hole splice.

Mr. Ziebarth: The splice shown in Fig. 3 is the same as the Famous Players except that they have moved the splice so that the scrape leaves the dividing line between the pictures. This does not make the splice any stronger, and there is the possibility of it showing on the screen when projected.

Mr. Denison: The reason we moved the margin over was to take care of checking; it doesn't make the splice better.

Mr. Richardson: I understand that this is not a recommendation to others than manufacturers although it may be followed by men in the projection room.

Mr. Porter: We are proposing this as "recommended practice."

Mr. Griffin: Regardless of recommended practice, I think Mr. Denison's point is well taken. I think there is still room for consideration of this splice matter, and there is no doubt that Mr. Denison's splice does protect film after it has become slightly damaged.

Mr. Ziebarth: I do not believe that moving the splice 0.015″ will stop the checking or strengthen the film after it is checked.

(*Motion duly passed to refer the matter back to the Committee*)

Tolerances in Film Dimensions

Your Committee again lays before you the question of tolerances in the dimensions for 35 mm film.

Considerable data on the question of film shrinkage were obtained by the Bureau of Standards at Washington, D. C., and the tests they made are summarized as follows:

DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS

Report
on
THE SHRINKAGE OF MOTION PICTURE POSITIVE FILM
Requested by
The U. S. Patent Office in letter dated January 16, 1925.

1. This work was done to answer the following questions:

First: What amount of shrinkage will occur if a strip of standard positive motion picture film having sensitive coating on one side be soaked in water for *ten* minutes and then dried?

Second: So soaked for *forty* minutes and then dried?

Third: Will either of the films so treated further shrink when exposed to form a positive image, developed, washed, *but not fixed*, and dried?

Fourth: Does a film which has been treated as in Questions 1 or 2 shrink to a greater or less extent than an untreated film when further treated as in Question 3?

In the next experiment, the films Nos. 1, 2, 3, 4, 5, 6, 10, 11, and 12 were exposed or printed to form a positive image, developed for five minutes in a standard positive motion picture developer (E.K.Co. Formula No. 16) washed for thirty minutes and dried *without* fixing. The interval of time between the drying and measuring was 22 hours.

Tabulating all the results obtained:

Dimensional Changes in Length in mm. per Meter of Length

	Dried but not developed	Developed washed and dried	Total
No washing	0.000	0.062	0.062
10 m. washing	0.252	0.284	0.536
20 m. washing	0.492		
40 m. washing	0.926	0.080	1.006

Following the above experiments, films Nos. 1, 2, 3, 4, 5, 6, 10, 11, and 12 were fixed in hypo, washed thoroughly, and dried, showing the following additional shrinkage:

Millimeters per Meter of Length

1	2	3	4	5	6	10	11	12
0.496	0.190	0.406	0.272	0.268	0.346	0.382	0.470	0.274

Films 3, 10, and 12 were later soaked in water for two hours, and their lengths measured wet. The gains in lengths were as follows:

Millimeters per Meter of Length

3	10	12
5.684	7.550	5.304

Average 6.174

(Signed) GEORGE K. BURGESS, *Director.*

The Paris Congress seems to consider it desirable to take shrinkage into consideration and specify tolerances on the film dimensions. The action taken by the Congress was as follows:

New Positive Film

The dimensions below are fixed on the hypothesis of a shrinkage not exceeding 1.5 per cent ,after which the film has been subjected during 720 hours to a current of moving air at a velocity of 3 m per second at a temperature of 60° Centigrade and a relative humidity of 70 per cent.

Pitch: The hundredfold of pitch, measured between homologous points of two perforations separated by 100 complete perforations, should be equal

+1.00 mm.
to................................475
−0.00 mm.

+0.05 mm
Distance from axis to axis of two rows of perforations 28.15
−0.10 mm.

New Negative Film

Pitch: The hundredfold of pitch, measured as above, ought to be

+2.00 mm.
equal to..............................475
−0.00 mm.

All other dimensions and forms of perforations as for the positive film.

Table 1

Table of Negative and Positive Film Showing Variations in Standards

	British Finished Negative, Positive Raw Stock	*British Newly Finished Prints*	*French Negative*	*French Positive*	*German Negative and Positive Raw Stock*	*Kodak Negative and Bell & Howell*	*Kodak Positive*
A	1.375″ +0.003 −0.0 35mm +0.0 −0.074	1.375″ +0.003 −0.0 35mm +0.0 −0.074			34.9mm +0.1 −0.0	1.3779″ +0.0 −0.002 35mm +0.0 −0.05	1.37790″ +0.0 −0.002 35mm +0.0 −0.05
B	1.110″ 28.20mm	1.110″ 28.20mm	1.109″ 28.15mm	1.109″ 28.15mm +0.050 −0.050	1.110″ 28.2mm +0.01 −0.01	1.109″ 28.15mm	1.109″ 28.15mm
C	0.072″ 1.83mm	0.072″ 1.83mm	0.073″ 1.85mm	Pathé or Kodak	1.90mm +0.01 −0.01	0.073″ 1.85mm	0.078″ 1.98 mm
D	0.110″ 2.80mm	0.110″ 2.80mm	0.110″ 2.80mm	Pathé or Kodak	2.80mm +0.01 −0.01	0.110″ 2.80mm	0.110″ 2.80mm
E	0.1870″ 4.748mm	0.1865″ 4.737mm	0.1875″ 4.76mm	0.1864″ 4.73mm +0.013 −0.0	4.75mm +0.01 −0.01	0.1870″ 4.748mm	0.1870″
F	0.7480″ 18.98mm	0.7460″ 18.948mm			0.7480″ 19.0mm	0.7480″ 18.98mm	0.7480″ 18.98mm
G	11.9687″ +0.0 −0.03125 304mm +0.0 −0.794	11.9375″ +0.0 −0.03125 303.21mm +0.0 −0.794			11.9687″ 304mm +0.160 −0.160	11.9687″ 304mm	11.9687″ 304mm
H	Mask or frame line	Mask or frame line			Mask or frame line		

Note. The International Standards are for raw stock, stock manufacturers to agree to their stock not shrinking more than 1½%, the test being 720 hours' exposure to a current of air at a velocity of 3 metres per second at a temperature of 60°C and a relative humidity of 70%.

Your Committee feels that it is impractical to set tolerances to allow for shrinkage which various manufacturers think their film will undergo. We believe we were absolutely right when we set dimensions for freshly perforated negative raw stock, and we do not recommend the addition of any tolerances or an effort to consider positive film when it is ready for projection.

(*Motion made and seconded not to recommend tolerances.*)

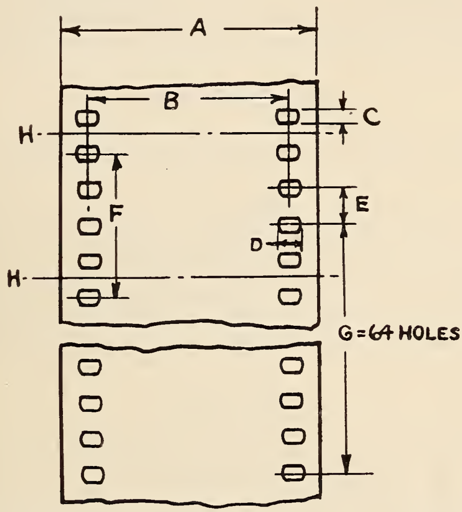

Fig. 4.—Indicating dimensions referred to in above table.

Camera Reel Cores

We have found so little interest among the camera manufacturers in the question of standardizing film reel cores that we recommend laying this matter on the table for the time being.

The Paris Congress ruled as follows on this question:

Film Reel Cores for Magazines of Taking Cameras

While reserving for the next Congress a definite decision, after careful investigation the Congress invites manufacturers to conform for the creation of new models to the dimensions recommended below:

Exterior diameter	50 mm.	
Interior diameter	20 mm.	
Width (equal to that fixed for the film)	35.0	+0.0 mm. −0.1 mm.

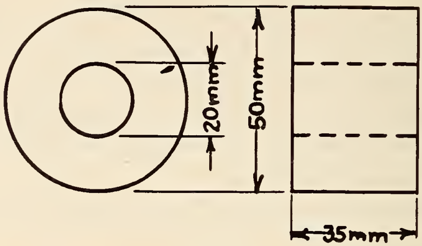

Fig. 5.—Recommended dimensions for camera bobbins and raw film core.

DISCUSSION

MR. PALMER: What is the diameter the Eastman Company is using?

MR. JOHN JONES: It is practically one inch or 25 mm.

I ask that it be referred back to the Standards Committee. The information came in late, and we have had the matter up before for consideration and would like more time on it. I make that as a motion.

(*Motion passed to refer the matter back to the Committee.*)

Sprockets

Your Committee must confess that it has fallen down completely on the question of standardizing sprocket design. No American data have been collected on this subject since the Schenectady meeting.

The Paris Congress had considerable to say on this subject, as follows:

Sprocket Teeth

For projectors, apparatus for taking, perforators, pull-down;
Dimensions of 16 tooth sprockets:

Width of sprocket	34.80mm. ± 0.2
Distance from axis to axis of teeth (across pitch)	28.00mm. $^{+0.00}_{-0.04}$
Width of aperture	24.00mm.
Width of lateral bearing surface	5.40mm. ± 0.1
Diameter of sprocket at the base of the teeth	23.85mm. ± 0.05
Total diameter of sprocket including teeth	26.45mm. ± 0.05
Angular separation of teeth	23° 30min.

The base of the teeth (cut C D) is included between two limits respectively defined by a rectangle (of which the apex can be optionally rounded):

width 1.7mm. thickness 1.40mm. $^{+0.00}_{-0.05}$

and through the figure formed by the two long sides of the same rectangle and by the arcs of the circle circumscribed to the rectangle (b) (the apex can be optionally rounded)

Width of teeth at the head . . . . 1.5 mm.

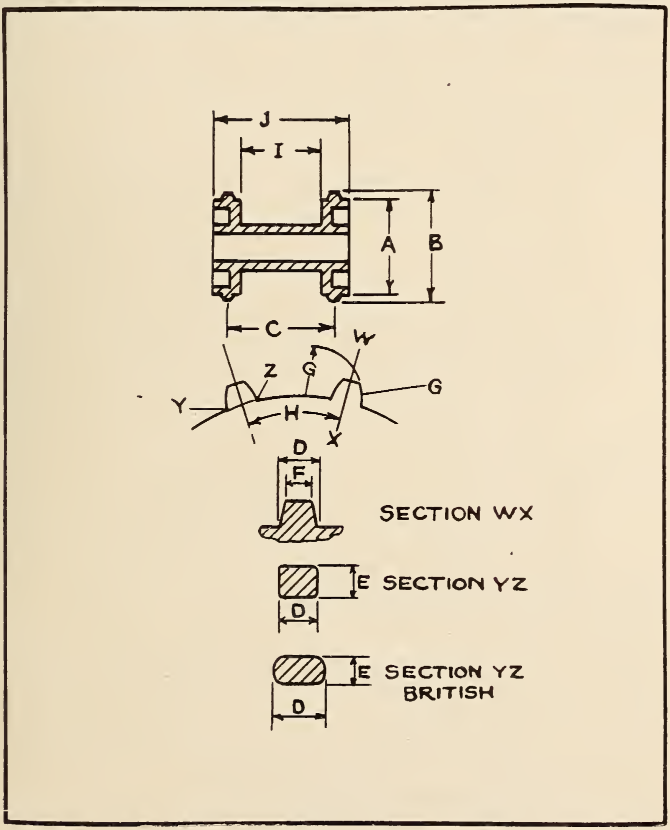

Fig. 6.—Indicating dimensions referred to in following table.

The cross section of teeth through a plane perpendicular to the axis of the sprocket allows two arcs of symmetrical circle of 1.8 mm radius normal to the circumference representing the section of the sprocket.

Table 2

Table of Four Picture Sproket Showing Variations in Standards

	British Old Standard	*British Proposed New Standard*	*American (Simplex)*	*French Pathé*	*German*	*Kodak Recommendation*	*International*
A	0.9375″ +0.003 −0.0	0.942″ +0.002 −0.0	0.9375″	0.942″	0.9375″	0.945″	
	23.812mm +0.076 −0.0	23.927mm +0.05 −0.0	23.812mm	23.827mm	23.81mm +0.0 −0.002	24.0mm	23.85mm +0.05 −0.05
B		1.045″ +0.002 −0.0		1.055″	1.040″	1.045″	
		26.540mm +0.05 −0.0		26.75mm	26.41mm +0.0 −0.002	26.54mm	26.45mm +0.05 −0.05
C	1.1025″ +0.001 −0.001	1.10″ +0.001 −0.001		1.110″	1.1025″	1.10″	
	28.0mm +0.025 −0.025	27.90mm +0.025 −0.025		27.90mm	28.004mm	27.940mm	28mm +0.0 −0.04
D	0.075″ +0.001 −0.001	0.085″	0.075″	0.075″	0.070″	0.073″	1.7mm for rectangular shape
	1.90mm +0.025 −0.025	2.16mm	1.90mm	1.90mm	1.70mm	1.754mm	2.1mm for circular shape
E		0.050″		0.061	0.061″	0.050″	
		1.270mm		1.50mm	1.50mm	1.270mm	1.4mm +0.05 −0.0
F		15° angle			0.061″	15°–20° angle	1.5mm for rectangular shape
					1.50mm	0.01″ par	15° for circular shape
G		Clear normal involute			Clear normal involute	Clear normal involute	1.8mm radius

H	1.841″ 4.676mm	1.850″ 4.6990mm	1.841″ 4.676mm	1.850″ 4.6990mm	1.841″ 4.676mm	1.8555″ 4.713mm	4.683mm
I							24mm
J							34.8mm $^{+0.02}_{-0.02}$
H+0.006″ for film	1.853″ 4.707mm	1.8614″ 4.727mm	1.853″ 4.707mm	1.8614″ 4.727mm	1.853″ 4.707mm	1.867″ 4.742mm	4.717mm

Kodak's summary gives the above sprocket as the best for running film of 11 31/32″ with six teeth engagement and no interference from 1.72% swell down to 2% shrinkage of the film.

Remark I. Sprockets for any other number of teeth to have same circular pitch.

Remark II. In the design of all machines with sprockets not more than six teeth should engage film.

Remark III. Sprocket teeth at YZ section can be either rectangular or circular, but the film contact face must not exceed 1.76mm corners to be removed

Remark IV. All parts conforming to these international standards to be marked *S* with the maker's name.

Perforation pitch of film KMA Standards

Positive stock 11–31/32″ for 64 holes = 304mm = pitch 1.870″ = 4.748mm = 474.8mm. } for 100 holes
Finished print 11–15/16″ for 64 holes = 303.21mm = pitch 1.865″ = 4.737mm = 473.7mm. }

Number of teeth in taking: One shall take account in the construction of the apparatus that the number of the teeth in contact with the film shall never exceed six.

Sprockets with more than sixteen teeth: Sprockets having a number of teeth above 16 should be established on dimensions equivalent to those defined above; the number of teeth in contact with the film should not exceed six.

Distinctive marks: The mechanical parts conforming to the dimensions above provided shall carry a distinctive sign constituted by the letter S (initial of Standard) at the center of a circle and the name of the manufacturer.

DISCUSSION

Mr. John Jones: We have not had time to analyze these dimensions for sprockets, and I would like it referred back to the committee.

Mr. Crabtree: Are these dimensions intended to cover cameras, printers, processing machines, and projectors?

Mr. John Jones: Every case should be analyzed. The design of the sprocket should be made to conform to the number of teeth engaged.

(*Motion passed to refer the matter back to the Committee.*)

Film Gate

The Paris Congress recommended on Projector Gate width as follows:

Width of gate runners on all apparatus, projectors, machines, etc. $35.1 \begin{smallmatrix} +0.10\text{mm.} \\ -0.00\text{mm.} \end{smallmatrix}$

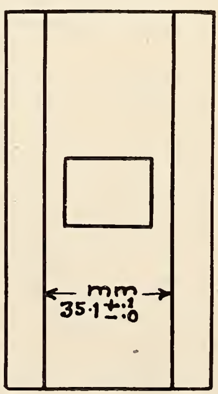

Fig. 7.—Recommended dimensions of projector gate runners.

Scene

We again present to you the definition of "Scene" as amended at Schenectady, i.e., "A division of the story showing continuous action in the same locale or set, and usually taken from the same point of view."

(*Motion passed to accept definition as above.*)

Reflector Arc Lamp

We have not been able to improve on the definition for "Reflector Arc Lamp," which was referred back to us last May. We, therefore, present it again as follows: "In a motion picture projector, an arc light source in combination with a reflector, to project the light beam through the aperture."

(*Motion passed to accept definition as above.*)

Conclusion

In conclusion, the Chairman thanks the members of the Committee for the hearty support they have given him during the past two years, and also expresses his appreciation of the confidenceplaced in him by the President in appointing him to handle such important work for the Society.

(Signed) L. C. Porter, *Chairman*
J. G. Jones
Herman Kellner
F. F. Renwick
F. H. Richardson

October, 1925.

DISCUSSION (continued)

Dr. Sheppard: I do not wish to delay the meeting, but you may be interested in hearing something about the International Congress of Photography in its relation to cinematography. So far as this Society is concerned, it was represented by only "unofficial observers" but its specific recomendations on standards were duly brought before the meetings.

The Sixth Congress was notable for more than one reason. It was the first international photographic congress held since the European War, and occurred after an interval of fifteen years. The progress of photography has been very great in this time, while cinematography has come to the front ranks as a major industry. Indeed, in view of this advance as well as by reason of the logic of operations, it is perhaps to be expected that photography will before long be recognized as a section or dependent phase of cinematography. It was in any case natural that one out of four sections of the Congress' proceedings was devoted to cinematographic standardization. Two other events marking the occasion may be mentioned. It coincided with the French celebration of the hundredth anniversary of the invention of photography by Niépce (actually of date 1822), and the international circle was happily completed by a representative German delegation. Those who attended will always doubt that the "confusion of tongues" referred to in connection with the building of the first skyscraper is a sign of disunion and division. The necessity of translation may slow down the proceedings, but the effort to understand and to make understood seems to ensure a thorough discussion of the points at issue.

A word on the constitution and prospects of the Congress may not be amiss. It is to be remarked that there exists a sort of "board of regents" for this International Congress in the shape of a Permanent Commission largely controlled by the Societé Française de Photographie, the Association Belge de Photographie, the Fotografiska Foreningen of Scandinavia, and the Royal Photographic Society of Great Britain. The United States and Germany have no representative national photographic societies like these to ensure their participation and forward their interests in regard to the International Congress, but for this country the Society of Motion Picture Engineers and the Optical Society of America are in touch with the situation The next Congress it is proposed to hold in London in three years' time. A movement westward having thus begun, it is eminently desirable that the following Congress be held in America, and I venture to hope that the Society will bear this in mind. The meetings were held in the rooms of the Societé Française de Photographie, so that a genuine photographic environment and proper facilities for sectional meetings, specific demonstrations, and so forth were secured. Registration commenced on the morning of June 29, and those attending the Congress were provided with a very full set of abstracts of the communications to be made. These were available both in French and in English through the courtesy of "Science et Industries Photographiques" and "The British Journal of Photography," respectively.

After the opening session, presided over by Professor Ch. Fabry of the University of Paris, the Congress proceeded to the business of sectional meetings. The four sections and the vice presidents appointed to secure international representation were:

Section I. (Theory of Photography and Sensitometry)

Mr. Callier, Director of the Belgian Optical Company, Ghent (Belgium); Dr. R. Garriga-Roca, Director of the Barcelona Photographic Paper Company (Spain); Professor H. Luther, Director of the Photochemical and Photographic Institute, Dresden (Germany); Dr. S. E. Sheppard, Assistant Director of Research, Eastman Kodak Company (U.S.A.); Dr. T. Slater-Price, Director of the Laboratory, British Photographic Research Association (Great Britain).

Section II. (Technical and Artistic Photography)

Mr. G. Cortezo, Secretary of the Royal Photographic Society of Madrid (Spain); Professor R. Koegel, Munich (Germany); C. de Santeul, (France).

Section III. (History)

Professor J. Albertotti, Padua University (Italy); L. Cartagena, Secretary of the Spanish Photographic Society (Spain).

Section IV. (Cinematography)

C. I. Brichta, Curator of the Cinematographic Division of the Technical Museum, Prague (Czecho-Slovakia); L. Gaumont, Honorary Chairman of the French Cinematographic Syndicate (France); Professor E. Lehmann, Charlottenburg (Germany); A. S. Newman, delegate of the English Kinematography Manufacturers Association (Great Britain).

Before the conclusion of the opening session, Mr. L. P. Clerc thanked the members of the Permanent Commission for securing participation by their nationals and the various donors, notably the Eastman Kodak Company, whose financial support enabled the printing of the Congress Transactions to be effected.

The meetings of Section IV. (Cinematography) were always fully attended, and the standardization proposals debated in great detail and at length. The standardization of sprocket dimensions did not appear to offer great difficulty in the matter of obtaining agreement. Points agreed upon as guiding principles were (a) that the sprocket dimensions should be the same for cameras, perforating and printing machines, measuring machines, and projectors; (b) that sprocket dimensions must allow for the expansion and shrinkage of the film. A maximum shrinkage of 2 per cent was assumed; (c) if not more than six teeth engaged, danger from moderate shrinkage would be avoided.

On the other hand, the question of standardization of film dimensions proved a very ticklish matter and eventually one on which complete unanimity was not attained. The proposal of the French (M. Lobel) to standardize shrunken film was found not to be feasible in view of the variations in the material. It was considered that standardization should be limited to:

(a) raw film dimensions leaving the perforating machine,

(b) raw film dimensions with a contingency of maximum shrinkage.

In regard to *perforations,* both the Eastman Kodak positive perforation and the Pathé positive perforation (new type with rounded corners) were accepted as standard. This option departs from the principle of rigorous standardization, but it was pointed out that the over-all dimensions are the same in both, so that both can be run on any machine. Whilst a generally satisfactory compromise was felt to be reached on *positive* film dimensions,this could not be effected for negative film. The European and British delegates strongly favored substantial identity of dimensional standards for both positive and negative film; the American viewpoint that the existence of different negative film perforations and standard dimensions corresponding to the existing Bell and Howell cameras should be recognized was urged by the Eastman Kodak Company's representatives but without affecting the general sense of the meeting in favor of substantially identical dimensions for both negative and positive, which was so affirmed by vote.

On the motion of Mr. Vinten, seconded by the writer, it was agreed that the recommendations reached should be held in abeyance for six months to allow for criticism, ratification, or objection,by the national representative bodies of the different countries. A committee to act as "clearing house" for these reactions was formed consisting of five members: Professor E. Lehmann (Germany), L. Lobel (France), W. Vinten (Great Britain), Brichta (Czecho-Slovakia) ,and a member of the Society of Motion Picture Engineers, to be appointed (U.S.A.). This permanent committee is to collect and report on all material furnished from different countries affecting the standards recommended.

Another aspect of the activities of the Congress which does not come under the cinematographic section is, however, of great importance for cinematography. This is the standardization of sensitometric conditions. In the discussion of these questions by the section it was noteworthy that the principal point of difference, namely, the standard of light, was largely affected by motion picture practice. The theoretical unit of light for photographic purposes is recognized to be one candle power of white light given by a black body at 5000° K. This apparently purely theoretical and academic definition is based on the assumption of daylight or sunlight as a normal condition of photographic exposure. It is, however, difficult to realize a practical standard of white light of 5000° K., and the recommendations of the section were in favor of the practical unit of 2360° K. A point in the discussion was that the increasing practice of artificial illumination in motion picture negative making on the one hand and the universal use of artificial light for the making of positives throw considerable doubt on the fundamental reason for taking a daylight or sunlight unit. On the other hand, a standard of light of 2360° K. is a low temperature value compared with the sources used in motion picture work. It is evident that the sensitometric standardization continues to be dominated by consideration of past "still" photography and that the subject requires very definite consideration from the view point of cinematography.

There is sometimes a disposition to regard the proceedings of such congresses as praiseworthy but unimportant. This is likely to become less and less true. No country can afford, in regard to its industrial interests, to neglect the technological trend of its compeers. The sense, if not always the authority, of this trend tends to be expressed in international standards. In this sense the conclusions reached by the cinematographic section of the Sixth Congress are significant and important.

President Jones: I am sure that the Society appreciates the work which Mr. Porter and his committee have done in preparing this and previous reports dealing with nomenclature and standards. I feel that we as an organization owe them a great deal, and in behalf of the Society I tender our thanks and appreciation for the good work that they have done. I know it has involved a great deal of work on his part in order to place these matters so clearly and concisely before us.

I take this opportunity to suggest, in view of the fact that we have adopted certain standards not entirely in accord with the recommendations of the Paris Congress, that the Congress be informed as to our actions and that the differences existing between our standards and their recommendations be definitely pointed out. They should also be informed as to the reason for our adopting the standards we have. The recommendations of the Congress were made with the understanding that they were to stand six months before final approval, thus giving an opportunity for those disagreeing to register protest and to present their viewpoint on the matter. It is desirable that the Congress should have a definite statement of our actions and the reasons therefor. It seems to me desirable to prevent the final adopting by the Congress of standards not in agreement with our own. I do not know exactly how this matter should be handled, but I suggest that the chairman of the Standards Committee, or perhaps our president, should forward to the office of the Congress in Paris a complete statement of the situation. This matter should be attended to promptly, since the time remaining before the expiration of the six months' probationary period is rather short.

SUPPLEMENT TO REPORT OF STANDARDS COMMITTEE

Report of Proceedings of International Congress of Photography held at Paris, 1925

L. P. Clerc

Section IV. CINEMATOGRAPHY.

First Meeting, June 29, 1925

DR. A. S. Newman representing the Royal Photographic Society of Great Britain and the Kinematograph Manufacturers Association of England read the following address:

It is evident to all those who are engaged in whatever capacity in the Cinematograph industry, that the unification of its products and certain essential parts of apparatus is a vital necessity.

Economical production, absolute interchangeability, and perfect quality can only be maintained under very favorable conditions. The first and most important of these conditions is the standardization of essential dimensions.

It is surprising that an industry of such importance can have existed for so long and have made such progress without international standardization. Cinematography interests all people, appeals to an army of scientists, engineers, and organizers. It employs large staffs; its products are found in all countries.

Some years ago we recognized in England the necessity for standardization in the cinematograph industry, and we think the Kinematograph Manufacturers Association was the first to institute a committee to that effect. Mr. W. C. Vinten and myself sat on this committee from its formation. Mr. Vinten is actually its president. Mr. Vinten and myself are also members of the Royal Photographic Society, and when this Society recently appointed a committee to deal with the same question, we were appointed members of this committee. We thus represent both societies.

We also have with us Mr. Blake of the Kodak Company; Major C. J. Fox, treasurer of the Kinematograph Manufacturers Association; and Mr. A. W. Kingston, delegate of the Camera Men's Society; all three members of the Royal Photographic Society.

I will first describe to you what the standards committee of the Kinematograph Manufacturers Association has done up to the present time. At the time of our first meeting in the early part of the year 1920 complete chaos existed as regards dimensions of film issuing from various factories. No one knew exactly what should be the pitch of perforation, the width of film was not fixed, the shape and dimensions of perforations varied from one manufacturer to another, also their position in relation to the edge of the film. Each manufacturer employed, particularly for sprockets, the dimensions suggested to him by his personal experience acquired by the most onerous methods, losses of time and money, complaints of customers, etc.

I think I can claim for our committee that it had a useful influence on the cinematograph industry throughout the world. Notwithstanding the fact that the dimensions proposed by us have not been universally adopted, the discrepancies have already been lessened. We have, however, encountered much opposition on the part of certain branches of our industry and a certain dislike of all alterations, even trivial details.

We have been pioneers and have encountered opposition—which is the lot of all pioneers. We do not complain for we find a tendency becoming more noticeable towards unification in the sense that we have suggested.

Our first care was to recommend adoption of measurements very little different from the average of those most generally employed, seeking to follow the line of least resistance and to reduce to a minimum the inconveniences of any alterations on the manufacturing side. The majority of films vary only slightly from the dimensions we have suggested, and having fixed the limits of tolerance we can state that practically all films new or old which have passed through our hands have complied with these limits. It is only quite exceptionally that we have encountered new films diverging from the dimensions we have recommended.

Our committee had been in existence for a year when the Society of Motion Picture Engineers of America appointed in its turn a standards committee, with which we soon entered into relations. About the same time we sought to discover if similar committees were in existence in other countries, but found it impossible to obtain information on this subject. Eighteen months after its formation our committee published a report, copies of which were distributed throughout the world. It was received with numerous criticisms. If certain of these were in the nature of complaints others were justified, and we had to take account of them.

Our colleague Mr. Vinten took part in a Congress in the United States as a delegate from our committee. The American committee accepted a certain number of our conclusions and from that time an effective collaboration between the two committees was assured.

We much regret that at the last moment the two delegates from the Society of Motion Picture Engineers found themselves unable by personal circumstances to attend this Congress, but we hope that, thanks to the presence amongst us of several members of this Society, an international agreement can be concluded. The attendance of the United States is the more necessary to us, as this country probably controls at least half of the world's production of cinematograph films, and consequently nothing truly international can be realized without its agreement. Let us hope at least that our decisions will be such as may commend themselves to our American confrères.

The proposal made to consider as fundamental measurements the dimensions of the Maltese Cross sprocket, and to deduce from them the normal dimensions of films, has our entire approbation. Possibly, some will ask why our committee has not adopted the same starting point. At the beginning of our labors the variations in the dimensions of films were much greater than at present. These dimensions had been progressively evolved from those adopted by Edison for the Kinetoscope. Measures taken after nearly thirty years on old films which have shrunk to a greater or less extent had, for example, reduced the pitch by about 2.4 mm. Our committee thus started from the middle of almost inextricable difficulties to establish a basis from which standard sprocket dimensions could be computed.

In the letter addressed to our Society your secretary Mr. Lobel asked that our delegates should be given full powers to permit the rapid settlement of points under discussion. In our opinion the time that the Congress can devote to the discussion of these questions is too short to permit a definite settlement of matters of such importance. For thirty years most complete disorder has reigned, and we think that a year would not be too much to arrive faithfully at the most favorable decision for the interest of our industry. We consider the method adopted by our American colleagues much wiser; when their committee decides on the subject of new dimensions, the application of this decision is advertised for six months. If no serious objection is raised against this decision, it is put into force at the end of this period. In the event of any opposition arising, the matter is further discussed and the application is again advertised for six months.

But consider, Gentlemen, we have come here with the hope and firm intention of making final decisions in the interest of all concerned and if I raise this objection on behalf of the Society which I represent it is in no way in a spirit of obstruction. I trust that you will receive these remarks in the same spirit with which we make them. We have come here in our own interest, certainly, but also in the interest of all. We are now at a scientific meeting and science knows no reticence or politics.

Our powers permit us, except as regards those dimensions in which we have already come to an agreement with the Society of Motion Picture Engineers, to listen to all reasonable proposals and to collaborate in your decision, but to avoid any misunderstanding we must declare that if the fact of sitting on the Congress involves for us the obligation to accept in any of the cases the decisions of the majority, we cannot think it right to partake in these discussions. If such were the case, we would ask you none the less to authorize us to attend your meetings but to abstain from committing ourselves or voting.

I trust, Gentlemen, that this declaration to which you have accorded your kind attention will have clearly defined the attitude of the English delegates. As for us, we are absolutely assured that we can count upon the kindness and cordiality of all our colleagues.

In accordance with Mr. Newman's proposal the Congress agreed not to consider decisions final for a period of six months, during which period various international organizations might raise any objections.

Mr. W. C. Vinten on behalf of the Kinematograph Manufacturers Association and Mr. M. Flinker, president of the Standards Committee of the German Technical Kinematograph Society, on behalf of this Society distributed notes and sketches showing precisely the dimensions actually standardized by each of these international groupings.

On the proposal of Mr. Lobel, president of the Cinematograph section of the French Photographic Society, and after interventions from Messrs. Newman and H. Joachim (Akt. Ges. Hahn), the Congress decided to discuss in the first place sizes of Maltese cross sprockets for projectors. Mr. M. Flinker considered differences between sizes adopted by the German Technical Kinematograph Society and the proposed sizes negligible, and therefore, accepted the latter.

Mr. L. Lobel translated an article published by Mr. Flinker in No. 12 of "Die Kinotechnik" (25th June 1925), reprints of part of which had just been distributed.

In this article "On the present state of Cinematograph Standardization," Mr. Flinker recalled that in few cases were goods so much the object of international exchange as cinematograph films. The manufacture of machinery being centered in a small number of countries, one would naturally expect that before long mutual adaptation of films and apparatus would be effected. If none of the suggestions for standardization which the author enumerated had been put into effect, it was because with the exception of the system proposed by the D.K.G. (German Technical Kinematograph Society) none of them constituted a complete list. A table adjoining the article compared the various international standards and pointed out the differences. He approved of the step taken by the Cinematograph Section of the French Photographic Society and declared that the German delegation came to the Congress with the intention of working for the common interest.

Mr. Newman mentioned that if the standards committee of the K.M.A. had not specified the shape of teeth, it was because this question was about to be discussed when the invitations to the present Congress were sent out, and it appeared wiser to leave it to the decision of the Congress.

Professor E. Goldberg (Ica Akt. Ges.) and Dr. Joachim drew attention to the necessity of fixing the number of teeth on the sprocket engaging with the film for a definite number of teeth, the tolerances of shrinkage or stretching being a function of this number. He proposed the engagement of seven teeth. Mr. J. Marrette (Pathé Cinema) considered that the pitch should be independent of the diameter of the sprocket and that one should fix either the length of the arc on which the film should engage with the sprocket or the number of teeth on the sprocket engaging with perforations of the film. The pitch of sprockets should be measured at the base of the teeth.

Mr. Flinker mentioned that the standards committee of the D.K.G. took into consideration the number of teeth engaged in the film. He recalled an article published by him in 1921 (Kinotechnik, V.III. No. 18, p. 685) in which he showed that for a shrinkage of 2 percent there was no danger to the film until the number of teeth engaging was increased to eight. It is up to the manufacturer to conform with this. The following proposal of Mr. Marrette was accepted by the Congress.

A 16 tooth sprocket shall engage with the film with a maximum of six teeth.

As regards the diameter of the sprocket measured at the base of the tooth, Mr. M. Flinker proposed the diameter already adopted by the D.K.G. of 23.81 mm with a negative tolerance of 0.02 and without a positive tolerance. Mr. Marrette was quite agreeable to 23.81 mm $\pm$ 0.01. Messrs. Vinten and Newman indicated that it was owing to the fact that the English climate was very damp (film thus showing less shrinkage) that the K.M.A. had just been led to recommend a slight increase on the diameter of sprockets and to adopt for the diameter at the base of teeth dimensions of 23.927 to 23.977 admittive for the pitch of positive film a normal value such that the length measured over 64 perforations would equal 303.21 mm plus 0.0 and minus 0.79.

Dr. H. Tappin (Goerz Photochemische Werke) stated that the shrinkage of films made at the same works at different times is never constant and that it is impossible for manufacturers to give precise values for the pitch of the film when ready for projection. Professor Goldberg recalled that under the conditions specified in the proposals of the German committee the Agfa, Goerz, and Lignose factories were engaged in keeping the shrinkage to a maximum of 2 per cent.

Mr. L. P. Clerc read the following observation communicated by Dr. C. E. K. Mees, (Eastman Kodak Company):

The standardization of film dimensions and their perforations is for us of very great importance. In discussing this question with the Society of Motion Picture Engineers, Mr. L. Lobel, president of the Cinematograph Section of the French Photographic Society proposed that the standards for perforated film should be based on the films having already passed through various manipulations and drying, the manufacturer in perforating the film having regard to the percentage of shrinkage which he thinks probable for the products of his factory. This procedure appears to us absolutely impracticable and would be the cause of endless trouble. In the establishment of standards one can only standardize the mechanical parts; thus a perforator works on raw stock and not on positive film ready for projection. If each manufacturer were at liberty to adopt for the perforation of this raw stock as many different pitches as he may be led to suppose his films have shrinkage values we should find ourselves in a state of complete chaos.

Apparently the French Photographic Society considers film shrinkage a simple and well defined phenomenon and deems that a film of known origin will always show the same shrinkage. Unfortunately we know definitely that this is not the case, and we must protest strongly against the adoption of any recommendation which would lead to the modification for each manufacturer of the pitch of his perforator.

The following proposal formulated by Mr. M. Flinker on behalf of the German delegation was adopted unanimously, applying immediately to the German and French machinery manufacturers but with reservation for a period of six months by the English delegates and American members. The diameter of the sprocket measured at the base of the teeth is fixed at 23.85 mm ± 0.05.

Second Meeting, June 30, 1925

Mr. Newman in the chair. On the question of a decision on the width of the Maltese cross sprocket, Mr. Decaux (Establissement Gaumont) remarked that it was preferable that this measurement should be less than the width fixed for the film, that is to say, less than 35 mm. In practice when a Maltese cross has been in use for some time, the films being always narrower than 35 mm particularly when they are old, there is produced a certain wear on the diameter of the sprocket which reduces its diameter except at its two extremities which maintain their original diameter. If the film of normal 35 mm width be now run on this machine, it will bear on the raised sides of the sprocket with a risk of damage. It is thus preferable that the length of the sprocket should be reduced. Mr. Decaux proposed the size of 34.8 ± 0.2 mm, which will give manufacturers the required latitude to avoid this trouble. The Congress adopted this proposal unanimously:

The width of the sprocket (length over cheeks measured parallel to the axis) is standardized at 34.8 ± 0.2 mm.

The proposal of the French Committee conforming to the dimensions adopted by the D.K.G. for a distance between teeth measured from centre to centre of the tooth was adopted:

The distance from centre to centre of the two rows of teeth is fixed at 28 mm$+0.0-0.4$.

After an intervention by Professor Goldberg saying that the tolerance shown for the exterior diameter of the sprocket should be slightly increased, the Congress decided that:

The overall diameter of sprockets including teeth is fixed at 26.45 ± 0.5 mm.

The following proposal was also adopted without discussion:

The width between cheeks is fixed at 24 mm.

From the above figures it will be seen that the width of each of the two cheeks will be 5.40 mm.

As regards the shape of teeth, Mr. Newman proposed that the driving faces of the teeth should be contained within a curve generated from the circle, the maximum allowance being made towards the top of the tooth. It will be sufficient, for example, to describe a circle very slightly less than the actual diameter of the sprocket. Mr. Flinker asked that the tangents at the base of each tooth should be produced below the corresponding diameter. Mr. Decaux observed that in cutting the sprocket teeth there was always a slight radius at the base due to the sharp corner of the milling cutter being slightly removed. The film cannot thus adapt itself to a portion of the base of the tooth normal to the working diameter. For the last twenty years the Gaumont Company have avoided this trouble by leaving at the base of the tooth a slight undercut sufficiently deep for the working base of the tooth to retain its correct form, notwithstanding any alterations in the shape of the cut. No decision was made on this point.

On the question of the shape and dimensions of the section of the base of the tooth, Mr. Vinten proposed to adopt as a section of the tooth the portion of a circle of 2.16 mm diameter contained between two chords symmetrical about the diameter and 1.27 mm apart. Mr. Flinker considered that it was useless to radius the lateral faces of the tooth, since cutting is thus rendered more difficult, while there is up to the present no practical evidence of any advantage of this shape. He proposed a rectangular section of 1.7 by 1.5 mm with an optional radius on the corners. Mr. K. Geyer (apparatus manufacturer) did not see any advantage in the shape recommended by Mr. Vinten. It was necessary more or less to radius the corners. Unfortunately this meant diminishing the useful width of contact between the tooth and the film. Mr. Decaux considered it unnecessary to make the tooth particularly wide on the face in contact with the edges of the perforation. Owing to the pull exercised by the teeth on the film the latter wore and buckled at the parts in contact with the extremities of the tooth. The size of 1.7 mm appeared to him to be ample. It is, on the other hand, preferable to avoid contact on the lateral faces of the perforations with the sides of the tooth. Mr. Debrie (apparatus manufacturer) proposed that one should retain the tooth width of 1.7 mm, leaving to manufacturers the option of radiusing the lateral faces. Dr. Joachim did not think there was any danger to the film if one took the precaution of slightly radiusing the edges of the tooth. He did not see any disadvantage in the form of the tooth varying between the two limits proposed. Mr. E. Blake of Kodak Ltd., suggested that before finally deciding on the shape of the tooth it was needful to fix the shape and dimensions of the perforations. Professor Goldberg supported Mr. Debrie's proposal to adopt two shapes of tooth, the sections at the base being respectively a rectangle and that portion of a circle enclosed by two equal and parallel chords. He considered that the shape of the tooth should be standardized before that of the perforations owing to the extreme complication of the latter question. Supposing that the question of perforations could not be agreed upon it would be extremely annoying if the question of teeth could not be decided upon. Mr. Debrie remarked that three perforations—Edison, New type Pathé, and new type Kodak—are practically the same size in their rectilineal part. He insisted that the shape of the tooth should be discussed before the shape of the perforations, all the more because in the course of years projectors would have to pass films having these varying shapes of perforations.

After an intervention by Mr. R. E. Crowther (Kodak), Mr. A. W. Kingston asked that the question of whether the shape of the tooth or the shape of the perforations were to be first decided should be put to the vote. By fourteen votes against eight, the Congress decided to fix first the shape of the tooth.

In the name of the English delegates Mr. Vinten again proposed the section of the base of the tooth suggested at the beginning of this discussion. Mr. Debrie maintained his proposal for the two limits, high and low, for the shape of the tooth at the base, the rectilineal part of this section having a width of 1.7 mm. The Congress adopted this proposal unanimously.

Mr. Vinten suggested that the section of the tooth on the plane of a diameter of a sprocket should show the sides making angles of 15° with the normals to the axis of the sprocket. Mr. Flinker and Mr. Lobel proposed to fix the width of the tooth at the top at 1.5 mm. The latter proposal was adopted. It was decided also that the profile of the tooth should be that already adopted by D.K.G.; that is, a profile limited by two arcs of 1.8 mm. radius normal to the working circle of the sprocket.

Third Meeting, July 1, 1925

Mr. C. J. Brichta in the chair.

Mr. A. W. Kingston read the following communication:

As a representative of the Kine. Camera Men's Society of Great Britain I have been asked to affirm that this society fully approves of this Congress and the ends which it seeks to attain. May I say as representing the oldest incorporation of Cinematograph operators that in the important question of improvements in cameras and accessories it would be very desirable that manufacturers should get in touch with one another and with associations formed analogous to that which I represent. We think that appreciable advantages should result from this in the general interest. Manufacturers would surely effect economies in time and money if before proceeding with alterations to existing machines or before creating new models they took the advice of operators. It is a fact that in the only branch of English production which is at the moment prosperous—the production of industrial and topical films—important improvements have been made within the last few years all of which have been suggested by operators, and I am sure that members of the Congress will be interested in examining several photographs which I have arranged on the table—photographs which demonstrate these various improvements. There is still more progress to be made before we get the ideal camera, equally suitable for topical work and for the studio. A light camera, easy to load, permitting rapid substitution of interchangeable lenses, will be certainly assured of a hearty reception. The growing demand would inevitably lead to the scrapping of cameras now in use. The standardization of film cores would be also very desirable for the operators, and I also consider standardized perforations essential. High speed cameras extend their field of application from day to day.

One word also concerning tripods: The lack of initiative on the part of manufacturers in the supply of light legs, rigid and easily handled, is much regretted by operators. No progress has been made since 1910.

I should like also to suggest that a very useful step could be taken by the Congress in initiating the formation of an international federation of cinematograph operators which would offer to its members traveling abroad advantages similar to those which the automobile clubs ensure for their members. Operators who more and more have to work in foreign countries could be helped out of the numerous difficulties they encounter. Such an affiliation could certainly procure for them many advantages with regard to administrative formalities, customs, police visas, various authorizations, etc.

On behalf of the D.K.G., Professor E. Lehmann agreed with Mr. Kingston's proposal; many operators belonged to this society, and Mr. G. Seeber member of the committee of the D.K.G., very willingly agreed to go into this question in Germany and study it with his society.

Returning to the discussion of the shape of the sprocket tooth the Congress unanimously accepted the following proposal:

The thickness of the tooth at the base is fixed at 1.4 mm, ±0.05.

As regards 32-toothed sprockets, Mr. Flinker observed that, provided the number of teeth in engagement with the film was limited to six, the same calculations for 16-toothed sprockets would apply in the case of sprockets having thirty-two teeth. Mr. Vinten considered that there was no need to conform to the American recommendation of adopting different diameters for upper and lower sprockets, particularly as one would then risk error in reassembling after an operator had dissembled his machine. Mr. Marrette considered that while in principle it might be preferable to adopt slightly different pitches for top and bottom sprockets, practically the wear of the film on sprockets running continuously is negligible. He proposed, therefore, to adopt for both sprockets the same circumferential pitch already adopted for the Maltese cross sprocket. Mr Debrie considered that the number of teeth on top and bottom sprockets should be left to the decision of manufacturers, it being understood that sprockets shall be calculated on the same basis adopted for the Maltese cross sprocket. After an intervention by Mr. C. J. Fox these proposals were adopted.

The agenda now called for a discussion on the perforation of positive film. Mr. Lobel on behalf of the French committee proposed the adoption of the new Pathé perforation; namely, the portion of a circle of 3 m diameter limited by two equal chords 2 mm apart but, with rounded corners. Mr. E. Schmitz objected that 65% of the world's production had adopted the new Kodak perforation, a rectangle measuring 2.8×1.98 mm with corners rounded to a radius of 0.5 mm. Mr. Debrie observed that the differences between these perforations are fairly small. Mr. Marrette mentioned that in 1908 Pathé's had adopted an enlarged perforation with rounded corners, and he was happy to state that the Eastman Kodak Company had now adopted a practically identical perforation, the lateral arcs simply being replaced by straight lines in the new Kodak perforations. Mr. Debrie proposed that the Pathé perforation and the Kodak perforation should be retained simultaneously, which would not present any new difficulties since the two perforations were practically the same. He asked the representative of the Kodak Company, however, to bring to 2.0 mm the height of the perforation now fixed at 1.98 mm. Mr. Blake saw no objection to this modification provided it is accepted by the Society of Motion Picture Engineers during the period of six months.

Dr. Tappen mentioned that after the introduction of the new perforation by the Kodak Company the Goerz Photochemische Werke had tried to adopt this perforation for their films supplied to the United States, but their customers had not received this modification favorably. He thought that the Society Agfa found the same difficulties; up to the present customers having insisted upon the old type perforation. Mr. Geyer was afraid that there are several difficulties to overcome in making punches corresponding to perforations with rounded corners, but there was no objection against leaving open the adoption of either perforation. Dr. S. E. Sheppard stated that the Eastman Kodak Company had entirely overcome all mechanical difficulties in the manufacture of punches. Further, it appeared to him that if suitable, limited dimensions were fixed, the shape of perforations could be left to the choice of those interested. Mr. Vinten proposed that the Congress should adopt as standards both the Kodak and Pathé perforation, but suggested that the question should be further discussed, say, in two years, possibly at the next Congress. It is hoped that by that time, in conformity with a decision taken at a previous meeting, new projectors will be manufactured in such a way that sprockets may engage only six teeth with the film once the possibility of a reduction in the height of the perforation will thus be in sight, which will give the film greater wearing properties.

A tolerance of ± 0.005 mm was proposed by Mr. Lobel on the height (2.0 mm) common to both perforations. Dr. Sheppard inquired whether this tolerance related to the perforation itself or to the punch or the perforator. He considered that the height of 2 mm would only be accepted with a tolerance of ± 0.02. Mr. Vinten objected that such a tolerance would be excessive in the case of 4-punch perforators, any errors on the punches being possibly in the same direction and thus exaggerated. At his suggestion the Congress decided that the height of the perforations should be 2 mm (measured on the punch) with no tolerance.

After an intervention by Mr. E. Blake, who thought the tolerance allowed by D.K.G. excessive, and by the French committee on the question of the width of negative and positive raw stock, and after a discussion, the Congress adopted the following resolution:

The width of negative and positive raw stock is fixed at 35 mm $+0.0-0.1$.

On the proposal to fix the width of projector gates between 35 and 35.1 mm, Mr. Blake and Mr. Decaux objected that the width so fixed was hardly sufficient. Notwithstanding the fact that after development and drying the width of the film was reduced to 34.8 mm allowance must be made for splices which both by reason of the pressure applied to the film and on account of slight inevitable defects in the alignment of the two ends, are always materially larger. There is no drawback from the point of view of lateral steadiness or of the gate being wider than the film; generally speaking, the film tends to run on one side of the gate; after a machine has been in use, even though the shafts may be perfectly parallel, there is always something sufficiently out of square in the neighborhood of the sprocket to give rise to play and lack of parallelism, which leads to the film running out of square on to one side of the gate. On the other hand, too narrow a gate has the objection of risking a break in the film due to the joins catching at the corner in passing the gate. Professor Goldberg remarked that in a large number of projectors of German makes the width of the gate did not exceed 35.05 mm, but Mr. Schmitz observed that it is precisely on these projectors that accidents are most frequently occurring. Mr. Vinten mentioned that the "Simplex" projector has no lateral guide for the film. On the proposal of Dr. Joachim the Congress decided:

The width of projector gates is fixed at 35.10 mm $+0.1-0.0$.

The French committee, having suggested that the pitch of the perforation of positive film should be determined after developing and drying under conveniently determined conditions, the American and English representatives spoke strongly against this innovation. Dr. Sheppard considered the proposal of the German committee on the same subject inacceptable, but the maximum shrinkage allowed in this proposal could be provisionally admitted as a basis for the determination of pitch of perforations. Mr. Blake on behalf of the Kodak Company stated that he could not accept the definition of maximum limit for shrinkage owing to the very different conditions under which stock is stored and methods of drying after developing by the various users and under different climatic conditions. Mr. Vinten considered that the manufacturers of the films should not be held responsible for variations in pitch which may manifest themselves in perforated film, when the user submits this film to abnormal conditions or keeps it for a considerable time before using it.

Mr. Schmitz stated that it was only for the past three years and following the example set by the Pathé works, that manufacturers had normally supplied perforated film. Until this time the operation of perforating was carried out by the printer in accordance with his needs and on film whose tendency to shrinkage had already considerably diminished. The pitch of the perforation then remains reasonably constant. Nowadays, on the contrary, the manufacturer of the film supplies to his customers, frequently a considerable distance from the factory of origin, perforated film which is not used until a long time after perforation, the film being perforated when the emulsion is fresh and still very moist. Under these conditions shrinkage is very accentuated, and the pitch is, therefore, considerably less than that of the new stock. There is also to be added to these circumstances normal drying of the film during exhibition and local conditions which may influence the film in course of working, especially in very dry climates. To sum up, the film perforated by the manufacturer so soon after sensitising does not retain its pitch, the shrinkage is all the greater when considerable time elapses between perforation and use and when the film is kept in a hot or dry atmosphere.

Mr. Decaux mentioned that to avoid these objections the Gaumont Company had kept to the old method of perforating the film themselves, keeping it in stock for a certain time in order that the perforating may not be carried out until after the initial period, during which film shrinkage is particularly rapid.

Mr. Geyer recognized that if perforation is carried out by the manufacturer of films, only the raw stock can be standardized, but the manufacturer should guarantee that the shrinkage would not at any time exceed 2 per cent.

Mr. Lobel stated that agreement seemed impossible on the subject of shrinkage, and the consumer who had no confidence in the manufacturer's perforating had always the option of himself perforating his own films. Mr. Blake mentioned that the Eastman Kodak Company was always pleased to supply unperforated film.

After this discussion the Congress decided that standardization should apply to all stock.

At the request of Professor Goldberg and in conformity with the opinion expressed by Dr. Sheppard, it was agreed that the dimensions about to be decided upon should be established on the hypothesis of a shrinkage not exceeding 1½ per cent after 720 hours drying in a current of air moving at a speed of three metres per second at a temperature of 60° Centigrade and a relative humidity of 70 per cent.

Dr. Joachim remarked that one was accustomed to consider only the pitch (4.75 mm) between two consecutive perforations, when from the point of view of steadiness of projection it was necessary to consider the distance between two perforations separated by four spaces (19 mm) a distance which should be constant to within 0.01 or 0.02 mm throughout the length of the film, failing which there was a great disadvantage of the variation attaining nearly 2 per cent in passing from one film to another, such films still running on sprockets which had already been defined. It was thus necessary to distinguish between these two tolerances, local and general. If this variation of 0.01 or 0.02 mm on the height of the picture (0.05 to 0.1 approx.) were not to be tolerated, it was necessary to consider the distance between two consecutive holes, and it would be sufficient to fix the distance of two holes separated by 100 spaces; that is, the length of 100 pitches.

Professor Lehmann considered that it was necessary to standardize not only the distance between two successive perforations but also the distance between two consecutive pictures, for it is the latter which controls the steadiness of the picture on the screen. He proposed that in the same film the variation tolerated for this dimension should not exceed 0.02 mm.

Mr. Debrie stated that the dimensions fixed for sprockets corresponded to a circumferential pitch of 4.712 mm; if a pitch of 4.75 was admitted for perforating the film at the average of its shrinkage (reckoned at 1½ per cent) it would have a pitch of 4.715 mm practically identical with that of the sprocket. He proposed, therefore, to fix the length of 100 perforations of raw positive stock at 475 mm $+1.0$ mm -0.0.

Mr. Blake stated that while admitting the probable maximum shrinkage of 1½ per cent, the Eastman Kodak Company could not hold that in no case and no matter under what conditions the film had been stored should shrinkage be less than this limit. The maximum shrinkage of 1½ per cent holds good only for the conditions of drying above specified.

The Congress decided that the dimension of 10^0 perforations should be fixed for positive stock at 475 mm $+1.0-0.0$.

Fourth Meeting, July 2, 1925

Mr. Vinten in the chair.

Mr. Kingston presented and handed around some photographs showing various improvements carried out by English manufacturers on topical cameras on the suggestions of the members of the English Kine. Camera Men's Society. He showed also some photographs showing the Proszynski's Aeroscope camera, driven by air compressed with a hand pump into a reservoir inside the camera, and which due to gyroscopic stabilization could be held in the hands while taking.

In conformity with the English proposals the distance from centre to centre of the two rows of perforations on positive film was fixed at 28.15 mm $+0.05-0.0$.

Before opening the discussion regarding the dimensions to be adopted for the negative film, Mr. Flinker remarked that the same 16 toothed sprocket, the dimensions of which had been accepted for projectors, could be used for cameras, the only difference being in the centre distance between the teeth, which might be fixed at 28.2 mm. The same milling cutter could thus be employed for cutting positive and negative sprockets. Mr. Geyer suggested that the dimensions of negative film should first be determined from which the sizes of sprockets could be deduced. The Congress supported this proposal.

Mr. Vinten suggested that with the exception of the pitch the same dimensions and the same perforations (Kodak Pathé) could be adopted for negative stock as for positive, the Bell and Howell camera being the only one in which the old type negative perforation was necessary.

Mr. Schmitz thought the Kodak Company must meet the views of apparatus manufacturers on the question of the shape and dimensions of perforations to satisfy the needs of the American market, the majority of which used the B. and H. Camera. They would have to continue to supply films with the old type perforations (sharp corners, height of hole 1.85 mm) and a pitch of 4.7499 mm. Mr. L. P. Clerc observed that an international standardization would not take account of immeasurable dimensions, resulting from the conversion of fractions of the English inch to its metric equivalent. Mr. Flinker remarked that if Mr. Vinten's proposals were accepted, the French, English, and German apparatus manufacturers would be compelled to make alterations to their models, and there was no reason why the American manufacturers should be the only ones to refuse. Mr. Vinten drew attention to the fact that the conversion of existing models would not cost more than about two pounds. Dr. Sheppard objected that the Eastman Kodak Company and B. and H. had not been able to reach an understanding on this subject. Mr. Kingston supported the proposal, adopting for negative film the same dimensions of perforations with the exception of pitch as for positive film. It was very desirable that cameras should be standardized in all countries. Mr. Vinten after a recent journey to the United States bore him out that this question was difficult to solve, but he considdered that a decision of the Congress would probably lead to B. and H. conforming to the general opinion to the benefit of all.

Mr. C. J. Fox and Dr. Sheppard asked that it should be put to the vote. The Congress resolved unanimously:

The shape of perforations and the distance from centre to centre of the two rows of perforations shall be the same on negative raw stock as on positive stock.

Mr. Flinker considered that the same pitch should be adopted for negative and positive film although several apparatus manufacturers required a different pitch for the two films. Germany and the United States had already adopted the same standard for both.

Mr. Vinten proposed to adopt measurements of 475 mm +2.0, −0.0 for the measurement of 100 perforations of negative film. Dr. Sheppard objected that a pitch even so little larger than 4.75 mm. would not run on the B. and H. camera, and consequently the United States could not accept the positive tolerance proposed by Mr. Vinten.

Mr. Decaux observed that before talking about the pitch necessary for the working of any given machine it would be advisable to examine for what reasons the pitch of negative film should be greater than that of the positive. Negatives are frequently stored for a considerable number of years, during which time the shrinkage continues to increase. On the other hand to consider only a fairly new negative that has already gone through the operations of developing and drying and has consequently already shrunk; no matter what type of printer may be used, it is certainly desirable that the pitch of the negative should correspond approximately to that of the positive stock in order to avoid running risk of movement due to the adhesion of the two films which militates against the steadiness of the projected picture. Mr. Decaux proposed that since 4.76 mm had been adopted as the maximum pitch for positive film, 4.77 mm should be fixed as the maximum pitch of the negative.

Mr. Marrette considered that the film manufacturers have to satisfy the requirements of their customers, and it is up to the manufacturers of machinery to come to some understanding. Mr. Schmitz hoped that the decision of the Congress might have a useful influence on the apparatus manufacturers.

Mr. Vinten's proposal was unanimously adopted with the exception of abstentions on the part of the representatives of the Eastman Kodak Company.

Mr. Marrette proposed that the Congress should choose some marked characteristic mark which should be stamped by manufacturers in addition to their own mark on sprockets conforming to the dimensions adopted. He suggested the letter "S," initial of "Standard."

Mr. S. H. Wratten and Mr. Clerc suggested that the date of the Congress should be included in the characteristic mark. Mr. Decaux objected that punching too long a mark risked interfering with the accuracy of the finished part. Mr. Marrette proposed to adopt as a distinguishing mark of sprockets conforming with specifications of the present Congress the letter "S" inside a circle. The design can be changed (square, triangle, etc.) in order to constitute in the event of any subsequent modification the distinctive mark of subsequent Congresses. This proposal was adopted by a majority.

Mr. Vinten remarked that in cameras the sprocket serves only to guide the film, the movement being carried out by claws and that under these conditions the sizes of these sprockets could be absolutely identical with those of Maltese cross sprockets.

On the proposal of Mr. Flinker supported by Mr. Marrette, the Congress decided that the sizes already adopted for projector sprockets should apply also to cameras, perforators, printers, and other auxiliary apparatus.

Dr. Tappen mentioned that the standardization of camera retort cores had been the subject of an enquiry in Germany and that agreement had not been established between apparatus manufacturers. Mr. Vinten hoped that a proposal emanating from an international Congress might have more authority and would perhaps enable the desired standardization to be effected. Mr. Ferrari laid stress upon the importance of this question of standardization to operators.

Mr. Newman proposed to adopt an outside diameter of 50 mm for cores. Mr. Marrette remarked that this diameter might prove rather large in the case of 120 m. film rolls. Mr. Newman stated that many troubles arose from the cores being too small in diameter, the friction functioning better with a large diameter than with a small, the difference between the initial and final diameters being proportionately less as the diameter of the core is increased. Dr. Tappen thought that an exterior diameter of 50 mm could be adopted after an enquiry had been made among operators. It should be well understood furthermore that the projected standardization should apply only to professional cameras and not to small capacity amateur cameras. Mr. Kingston suggested that film manufacturers should specify whether they agree to deliver their films on standardized cores in order to permit of reverse work. Mr. Marrette agreed willingly on behalf of Pathé Cinema provided the shape of the cores was completely specified. Mr. Newman considered that if such a recommendation is made the manufacturers should adopt the recommended dimensions in their new models.

Mr. Ferrari observed that as regards the internal diameter it was the diameter of the driving dog which was more important than that of the shaft. Mr. Kingston foresaw some difficulty in standardizing the centre hole of cores owing to the variations in the shape and dimensions of the driving shaft . After an intervention by Mr. Jourjon, Mr. Clerc remarked that if the largest of the diameters in use was adopted as a standard it would be easy to make use of intermediate bushings for each type of camera.

Mr. Marrette suggested that the width of cores should be the width already fixed for the film.

Mr. Flinker asked if recommended means of driving could not be proposed. The majority of members were of the opinion that a decision on this point should be left to the next Congress.

The president put to the vote, and the Congress adopted, the following proposal:

While reserving to a further Congress a definite decision, after further enquiry the Congress suggests that manufacturers should conform in the design of new models to the following recommended dimensions for cores: External diameter, 50 mm; Internal diameter, 20 mm; width equal to that fixed for film.

Mr. Kingston hoped that film manufacturers would regularly keep in stock film wound on the cores just specified; some of the film wound emulsion out; some with the film wound emulsion in, in order to avoid rewinding. The manufacturers represented at the Congress were agreeable to this.

Fifth Meeting, July 3, 1925

Mr. A. S. Newman in the chair.

The text of the resolutions agreed during the previous meetings drawn up by Mr. Flinker and translated by Mr. Lobel was adopted.

As regards the period of six months allowed before putting these resolutions into effect, the Congress adopted the following arrangements:

The resolutions voted by the Congress shall be definitely adopted after a period of six months counting from the July 4, 1925, provided no opposition is formulated by national organizations taking part in the deliberations of the Congress.

The centralization of such opposition was entrusted to an executive committee of five members. The K.M.A. and the Society of Motion Picture Engineers should appoint their respective delegates to the committee, the other nations will be represented by Professor Lehmann (Germany), Mr. Brichta (Czecho-Slovakia), and Mr. Lobel (France), who will perform the duties of Secretary.

In default of agreement by correspondence the members of this committee will meet in Paris to draw up the text of final resolutions.

Sixth Meeting, July 4, 1925

Professor Charles Fabry in the chair, assisted by Prof. J. Albertotti and Prof. R. Luther, Dr. Slater Price, the chief Reporter, and the general Secretary.

Mr. L. Lumière suggested that a resolution should be taken to indicate the most desirable frequency with which the International Photographic Congress should be held. After interventions by Messrs Clerc, Crowther, Gaumont, Luther, Kingston and Ferrari proposing intervals of two to five years Mr. G. Labussière proposed that the next Congress only should be decided upon and suggested in order to strike an average of the views expressed, to fix the date of it in 1928. On behalf of the English delegation Mr. S. Read supported this proposal, which was unanimously adopted.

Mr. Slater Price suggested that the Royal Photographic Society would be pleased to invite the next Congress to London. Unanimous applause demonstrated that in this case the invitation would be received with general satisfaction.

Mr. L. P. Clerc, chief reporter, remarked that the powers of the permanent committee would shortly expire, and it was necessary to proceed with the nomination of a fresh committee to assure the preparation and propaganda for the next Congress. It would not be sufficient to renew the powers of the previous committee on which many nations were only represented by a small number of members, especially by comparison with the large number of French members, to whom under the powers accorded to them the committee had had to entrust the organization of the actual Congress; he invited the members present to formulate proposals for the representation of their respective countries in the permanent Committee.

On behalf of the English delegation Mr. S. Read proposed to enroll as Members of the Committee, Dr. Slater-Price, Acting President of the Royal Photographic Society and at least three members to be appointed by the said Society.

Prof. R. Luther proposed to add to the German members of the previous committee (Professors Goldberg, Luther, Miethe, and Dr. von Rohr) Prof. E. Lehmann, acting president of the D.K.G. and two members to be appointed by the Society.

Colonel Morisseaux, President of the Belgian Photographic Society proposed to add Messrs. Callier and Puttemans, members who were retiring, the acting President of the said Society and other members to be appointed by it.

In the absence of the American delegates it was proposed to add to Dr. Mees, who was retiring from the committee, the presidents of the Optical Society of America and Society of Motion Picture Engineers and members appointed by either of these Societies.

For Italy, Prof. Albertotti proposed to add to the retiring members Dr. Namias and Captain Clementi, Professors A. Gardasso, Senator Kingdom, Director of the Physical Institute of Florence, and Charles Bonacini, Director of the Astronomical Observatory of Modena.

For Spain, there would be added to Mr. Garriga-Roca the acting Presidents of the Royal Photographic Society and the Photographic Union of Spain and their delegates.

For Austria, Professor Eder and Professor Dolezal, retiring members, would be re-elected and would be joined by the acting President of the Vienna Photographic Society and its delegates.

Sweden would be represented by the acting President of the Fotografiska Foreningen and other members appointed by this Society.

The French Society of Photography would be represented by its acting Presidents, by various members appointed by it, and by the Secretarial members of the Sixth Congress.

The national organizations of countries not mentioned above could be represented on the permanent Committee by getting in touch with the President or the general Secretary who would be ultimately appointed.

The permanent Committee would retain the power of adding to its number any persons whom it was thought would be of assistance.

To facilitate relations between members of the permanent Committee a Secretary would be appointed in each country.

If, as Dr. Slater Price hoped, the next Congress would meet in London the President and the general Secretary of the permanent Committee should be appointed by the Royal Photographic Society. The whole of these proposals were adopted unanimously, as was also the proposal made by Mr. Clerc to nominate as Honorary President General Sebert, the previous President.

THE QUESTIONABLE EDUCATIONAL VALUE OF MOTION PICTURES

Alfred W. Abrams*

TO DETERMINE the value of any means of accomplishing a result one needs to have clearly in mind the nature of the work to be accomplished. It is also advantageous to know quite definitely the fundamental principles involved in the application of the means employed. This is nowhere more true than in the field of education.

We are spending in the United States large sums of money and a vast amount of energy upon what is called education in the belief, generally held, that every citizen should be fitted to enjoy as fully as possible the advantages of our social and political opportunities and to meet the responsibilities that come to him. It behooves us to determine what constitutes true education.

Definitions of education have varied in form, but they all directly or indirectly stress such things as organized knowledge, real experience, training, capacity for appreciation of cultural values, and ability to initiate action. Never do we find a claim set up that mere information constitutes education.

Subject matter varies greatly in its significance for education, and of any given subject some parts are of much more consequence than others. Knowledge of the composition of a stick of dynamite may be very needful for certain persons, but it can not be so generally and vitally useful as an understanding of the principle of representative government.

The test of education is ability to make sound judgments, to initiate a course of reasoning, to apply knowledge to new uses, to react effectively upon data or conditions presented. Education is to be judged not by the number of items that have been presented and impressed upon the mind but by the changes the mind has undergone through its own exertions.

While these statements do not furnish a complete basis for determining the educational value of motion pictures, they serve as starting points.

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The persons who are being educated through agencies maintained for the purpose may be grouped into two classes: first, those attending a "school" of one kind or another; second, those whose education is being extended through organizations of various sorts. School exercises are graded, frequent, and thoroughly systematized. Extension activities are less frequent, often intermittent, and generally patchy in character. The attendant of a school has definite assignments of work to be done. For the other class, information is given, ideas are formulated, desires are aroused or intensified on special occasions, but little previous preparation is made, the individual does not participate in discussions and little formal response is expected.

Educational extension is not to be ignored. In the aggregate it counts for much. For many persons it is the chief dependence. But in any consideration of the educational value of picture expression it must be remembered that in volume and in importance school exercises far outrun those of all others that serve groups of persons.

In what I have to say I am chiefly concerned with the problems of the school classroom. Insofar as a school undertakes to give mass instruction through auditorium exercises, its work is in character essentially the same as what I have classed extension activities. It is in the classroom where day after day for eight years or more of the elementary school and four years of the high school, not to mention the college and university, small groups are being instructed in a systematic, intelligently conceived course of studies, trained to think and given abundant practice in expressing ideas acquired. From an educational point of view it is necessary that our theories and practice of visual instruction shall fit into the larger features and purposes of the school program.

There has been a tendency on the part of some to make absurd claims for pictures as a means of education; such as the shortening of the school course by several years, the possibility of learning with but little effort, and the unlimited range of subject matter that can advantageously be presented through them.

On the other hand, conservative persons, including many educators, have failed almost altogether to see the significance of picture expression when dealing with material things.

We should all recognize that whenever we attempt to visualize objects for the first time we must bring the organs of sense, chiefly the eye, to bear upon them or upon pictorial representations of them.

No other conclusion is at all tenable. If this fact can be established not only as a theory but as a working principle, the cause of visual instruction is won, and we can join hands with those who insist, on equally good grounds, that language is a better medium for expressing relations, ideals, general truths, and metaphysical conceptions.

With these introductory statements, already too far extended, let us consider the place of motion pictures in the school program. In doing so it will be necessary at certain points to compare them with "still" pictures.

Let me say at the outset that I have no desire to quarrel with motion pictures. I am as desirous as anyone to discover their true relative place among the various means to be profitably employed in securing educational results. I have no doubt that for certain purposes and at certain times they are decidedly useful. But I cannot avoid the recognition of relative values.

The chief field for picture expression is that of the material world. Only indirectly do pictures represent anything but objects. The mental process by which we perceive objects and combinations of objects and apperceive their meaning is called observation. This is much more than looking at the objects or their pictorial representations. The process is complicated. It requires close and definite analysis of details, necessitates time for a recall of previous experiences, involves association of ideas, and includes judgments as to significant relations.

The motion picture presents a succession of objective phenomena with too great rapidity to allow these steps to be taken except by a person who is already thoroughly familiar with the phenomena presented, and even such a person sees and recalls only enough to pick up and carry along the story that is being told.

The motion picture serves as a very good means of testing ability to observe. But before testing there should be training. The ability to observe does not come by intuition. If observations are to be made to a purpose, there must be a selection of features that are worth attention and a passing over of what is non-essential. It is the function of the teacher to create in the mind of the learner standards for observation and to direct practice. It is not enough that the pupil snatches from the passing pictures certain scattered impressions. There is need for pointing out what the learner is failing to see. It is not of much use to do this after the picture has passed from view.

The test of what a pupil is gaining from a picture is his ability to express what he is acquiring. As a means of teaching there is much less value in the report of the pupil given after the picture has been removed than in his statements made while the picture is still before him. In the latter case there is opportunity for the teacher to build up the power that is found deficient. In this respect there are obvious advantages in the still picture.

Unless the phenomena represented by the picture are so simple as to offer no real problem, discussion is necessary to learn their full significance. If discussion must be based upon such partial observations as learners are sure to have made, the full value of the picture cannot be gained. To extend the range of observation and interpretation is the very purpose of the classroom exercise, not primarily for the sake of the information or knowledge to be gained, but to increase the ability of the pupil to do this sort of work. The motion picture does not encourage such extension of observation and interpretation.

In the whole matter of training in observation, the still picture offers superior advantages except in observing a single aspect, namely, that of motion. The only other aspects of objects that can possibly be perceived through the sense of sight are size, form, position, and color. All these are static. There can be no possible advantage so far as observation is concerned in having the object in motion. It is necessary to a full observation that the picture remain before the eye for a considerable length of time. Take the matter of size. Size cannot be expressed except in terms of some unit of measure. An appreciable amount of time is required to select a familiar and practicable basis for comparison and determine the quantitative relation that exists between the object and the unit selected. As to color, not all reds, for example, are alike. There are differences in hues and shades. Look along a street where there are half a dozen brick buildings to find, if you can, two that are alike in color. This is a very simple case. But observation that notes difference in these static aspects is something that is required for success and enjoyment in every walk of life.

The supreme field of the usefulness of motion pictures is the one in which motion plays a large and essential part. Understanding this, we have one guiding principle for making and for using this form of picture.

But even here there is opportunity for comment. Movements may be resolved into a limited number of types, and when the learner has become familiar with a certain type it is not necessary for him to see actual motion to visualize what takes place. A still picture of a team of horses tugging in the harness is sufficient to call up the needed mental picture of action and the probable result.

I have already suggested the part played by the teacher in visual instruction. There is little place for the teacher in the use of motion pictures. Indeed, some enthusiasts have been so unwise as to claim that by using motion pictures a considerable part of the teaching force can be eliminated. The attempt to talk while a motion picture is running can not be a large success, for attention is divided between seeing and hearing. To precede or follow a showing of a picture by verbal statements is not visual instruction, even if it may lend some aid to it.

The use of motion pictures is related to the problem of attention. Attention is of two kinds, voluntary and involuntary. Motion pictures appeal chiefly to the latter. One impression after another beats upon the retina. The pupil looks to see what comes next, not to analyze what is being presented. At least he can only apply a part of the ability to analyze previously acquired in various ways. Involuntary attention depends upon what comes from without. Voluntary attention depends upon an inner reaching of the mind to gain understanding. The ability of the pupil to direct and hold attention upon an object or problem is the mark of a trained mind, and this ability it is the function of the school to develop. I do not believe motion pictures are as well calculated to accomplish this result as still pictures are when used by a competent teacher.

It is claimed that motion pictures are interesting, hence useful for school exercises. Interest is a result, not a means. The new born babe is not interested in anything. As he acquires experience with his environment and learns that certain things contribute to his enjoyment or success, an interest in them is established. Interest that is worth anything leads its possessor to put forth sustained effort to secure a desired result. One is interested in whatever one knows thoroughly or can do well and continues to find advantageous. Interest may begin with involuntary attention, but it assumes importance only when it calls for further effort. It is admitted that still pictures require more effort both by the teacher and the pupil, but the result of this effort is a growing interest. My observations lead me to believe that after the novelty of so-called educational motion pictures has worn off the interest of pupils in them becomes weak.

The field of motion pictures is primarily entertainment and not education. The factors of entertainment are novelty, rapid change, variety, striking features, frequent surprises. In general, these factors do not contribute largely to education; on the other hand, they often interfere with it. It does not seem likely that educational films for the schoolroom will be made that will long satisfy pupils who have attended motion picture theaters. To them motion pictures come to mean something quite different from what the school program requires. Even children are not insensible to the fact that there is a time to work as well as a time for relaxation and freedom from sustained effort.

Since pictures present only the objective facts on which the higher mental processes depend, they are only starting points in education. Above material phenomena rises the whole range of human thoughts, ideals, emotions, and actions. The latter are best expressed and understood through language expression. The development of subjective mind depends at the outset upon experience with objective matter. The tests of education I mentioned at the outset can be met only by the mind that has digested and assimilated and is ready to react upon with precision and certainty the sense percepts gained through pictures. These processes involve concentration and close mental effort and are aided by the stimulus and guidance of a competent teacher.

A motion picture to succeed at all must be complete in itself and carry its message without the aid of a teacher. On the one hand it does too much for the pupil in that it presents its story with fullness; on the other hand, it does too little in that it does not exact a mental picture created by the pupil through his own efforts. There is too much presentation and too little self expression.

There are mechanical and administrative difficulties in the way of the general use of motion pictures in the classroom. Most teachers are not likely to operate projectors successfully. To depend upon special operators to appear at stated intervals is not good administration. To be of service in carrying out a course of study, pictures are needed for use at the moment the topic is to be taken up. Showing a picture some days or weeks later must prove to be unsatisfactory. The use of pictures must synchronize with a pre-arranged program.

It must remain exceedingly difficult and expensive to place motion pictures in the classroom precisely at the time needed.

The occasional use of motion pictures may have value in introducing a certain amount of variation from the somewhat uniform school program. A different means of approach offers a new stimulus that helps to accomplish the ends in view. The main dependence in education, however, must be upon something better than novelty.

As to the matter of the cost of using motion pictures in schools I need not speak at length. The fact must be faced that at the present time the amount that is expended annually by a particular school for equipment is small. The cost of motion picture equipment including film service is now high. It is not probable that it can be materially reduced. My own investigations show that boards of education seldom include in their budget an item for such pictures. The use of motion pictures is generally unofficial. If they are provided for at all, the money for them is furnished by parent-teachers associations, is raised by teachers and pupils, or is secured by paid admissions. Such a procedure can not be far reaching. Further, it is well to consider whether the money that is expended would not bring larger results if invested in still pictures and adequate equipment for their use.

Motion pictures may serve a useful purpose in furnishing an initial stimulus for study. They may also present in story form the ensemble of static phenomena that have already been perceived through other means. They may thus play an important, though subordinate, part in a general scheme of education. I believe it would be of real advantage to those who are interested in promoting the use of motion pictures to recognize the limits of their usefulness and to proceed at once to assemble for co-ordinate use the most significant still pictures procurable in the form of prints or slides and be zealous to secure their systematic use. Up to the present time millions of dollars have been spent in attempts to produce educational motion pictures. Most of this investment has been unprofitable. It should be easy to see what a fraction of this expenditure would bring if distributed wisely and proportionately over the whole field of visual aids to instruction.

It is often said that there is already an adequate supply of still pictures. This is far from the truth. Most of those in use are of little significance for school work and are of very poor quality. Further, the time is at hand for giving less thought to extending the circulation of pictures and much more to determining the character of the results that should be secured from them and what preparation the teacher must make to do her part in accomplishing such results. The wide extension of visual instruction will come when it has demonstrated its usefulness and practicability and not before.

DISCUSSION

Mr. Cook: It is with a good deal of diffidence that I venture to discuss the very masterly paper that we have just listened to from Dr. Abrams. It is in such marked contrast to the papers we have had previously on the subject that it comes like a dash of cold water. It would be presumptuous in me to question a great many of the statements of Dr. Abrams, although I am not in accord with them. Dr. Abrams has had an unequaled experience in connection with his branch of the New York State Board of Education for a great many years. We are all familiar with the work he has done.

I think that much of Dr. Abrams' criticism is justified by the status in the use of so-called educational motion pictures, but sometimes we may make a mistake in considering only the present status of an art rather than visioning its possibilities under improved conditions.

It so happens that it has been my modest part in the motion picture industry to be connected with a company which, for nine consecutive years, has furnished motion pictures under contract to the New York City Board of Education. Our experience has corroborated Dr. Abrams' remarks regarding the average teacher's mechanical and business ability. Dr. Abrams has expressed it very mildly. We have sent out trouble men only to tell the teacher to insert the lamp in some cases and in others to turn the switch. There are many mechanical troubles which can be obviated in improved projection equipment. There are now prefocusing lamp bases which will eliminate trouble in this respect.

Probably much that Dr. Abrams has said about the present available motion pictures is justified. He is not enthusiastic, however, about slides. Yet the slide industry has been many years in developing and has reached a relatively higher development in education than has the educational motion picture.

Our experience with the Board of Education was that we had just about as many opinions with regard to the merits of a motion picture as we had principals and teachers who viewed them. The lack of unanimity was startling. A picture which would be accepted with acclaim by one school would be severely criticized in another. The principal difficulty in the past has been an attempt to adapt existing entertainment or instructive pictures to educational use. That has been about all that the educator has had to work with, and they were not at all suited to pedagogic use.

As many of you know, several manufacturers are developing narrow width motion picture equipment that is much more economical, more easily operated, is free from many of the drawbacks of the professional size of film, and would seem to be more ideally adapted to classroom instruction than anything yet available.

Co-operation should be worked out between the textbook author and the film producer so that the school would own and show films prepared in collaboration with the textbook. This would seem to overcome a great many of the difficulties and problems outlined by Dr. Abrams and which only seem at present insuperable obstacles.

Going into details, color, while not commercially available, is apparently well within the possibility of the near future. It will enormously enhance the value of certain forms of educational films. For that matter, most of the textbooks are subject to a similar criticism in the lack of color in the illustrations.

The objection to novelty in the use of the film hardly seems to be a very strong one. If we can arouse the interest by novelty, it would be an advantage.

I agree with Dr. Abrams on the undesirability of the teacher talking during projection. It is impossible for the student to watch a picture carefully and listen to the teacher at the same time. It is better to do all the talking before, or after, or stop the film. You all know how disconcerting it is to hear some one in front of you in the theatre talk about the picture. A child's mind is not so well able to cope with this double attention as ours.

Again, Dr. Abrams deprecated the use of films because they were not self-sufficient, and I do not see that they should be considered as self-sufficient. I think their purpose is to correlate with the textbook.

Dr. Abrams: I intended to say that they are too nearly self-sufficient. They present to the mind all the facts; I want something left for the student to construct for himself. The architect sees the building before his drawings are made. It is this constructing process that is vital. You cannot plaster education on the mind. You cannot, with pictures alone, make sure you are getting the mental reaction you are after. We should leave something for the child to do and compel him to go to books to read.

Mr. Cook: The fact that so much has been spent without appreciably beneficial results in the field of educational motion pictures should not deter us from continuing efforts in the same direction. We are all familiar with the recent casualties in air navigation, with the tremendous expense preceding it, and with the loss of life, but I do not think there is any doubt that air navigation will continue. Should we not draw beneficial conclusions from past experience and put those experiences to advantage in moving on to the successful use of what I believe most of those present agree is one of the great educational media of the future?

Mr. Beggs: I think the reason people well versed in book learning are apt to be killed in traffic is that they are too good at the "static stuff." Life is not static, it is moving rapidly. We should give children ideas of moving things, and for this how could it be done better than with the motion pictures?

Mr. Richardson: The one thing that struck me forcibly was your asserting that the teacher should not talk during the showing of a motion picture, and that the action is too rapid for the student to assimilate the proposed lesson. You have made a broad assertion. Teaching by stereoptican slides you admit has value. What would you suggest as the proper way to go about securing a really adequate set of still pictures?

Dr. Abrams: I did not mean to convey the idea that when a motion picture is presented it does not yield certain information, and, of course, it must start some reaction. I meant to say that with any mere presentation you are chiefly testing what is already in the mind of the observer. You need something more. The teacher should give the pupil a more exact training in "how to observe," which involves eliminating non-essentials. If I find a teacher asking, "What is in this picture?" I say her method is wrong. I am using the picture to put over a particular idea. I read a book for a particular purpose, and am a poor reader unless I can skim over the page until I reach the paragraph I want and pick what I need out of it. Now, I am expecting the school is going to give the student this training, not mere presentation. Still pictures will not do much if they are merely put on the screen and looked at.

A picture should be a direct challenge to pupils. Most people do not know how to observe. Take, for example, the matters of size and form of objects. I was telling somebody here about the use of a picture of a coffee tree. The teacher had the pupils talk about the coffee industry to show what they had learned. When one little girl was talking I said: "Mary, tell me how big this coffee bean is that you are talking about." She didn't know. I said finally: "Name some fruit that grows around here that is like coffee." She looked at me and said: "Cucumber?" There is too much of that sort of thing. Motion pictures would be fine if used along with other means of developing these static elements. We are not after the picture on the screen but the mental picture that is built up in the mind of the observer. We must get that kind of picture, and when static elements are important, we must observe those elements. In working out the details of the coffee industry, you could advantageously put on a film showing the operations. The motion picture tells a story; it is good for narrative, not for description.

I should like to work with somebody interested in motion pictures who would recognize that you must have something besides showing motion. I should like to find some one who would put a fraction of the money into still pictures that is going into motion pictures. You say it will not cost much to provide motion pictures. I wish you would tell me how much it would cost an average school in a town of two thousand inhabitants to provide enough to scratch the surface of this course of study.

Mr. Cook: They don't exist yet.

Dr. Abrams: But if they did; how much money do you think the schools should put into motion pictures?

Mr. Cook: I answer that by saying, would you go to an architect and expect him to answer you at once if you asked him how much it would cost to build a house?

Dr. Abrams: A firm sells a set of lantern slides for $300; 500 slides in teaching various subjects do not go far, and I predict the time will never come when any considerable number of schools will have in their own organization any large supply of pictures. The problem is one of circulation. Pictures would lie idle too much of the time. In this country there are at least forty or fifty bureaus acting as distributing centers. Supplying these distributing centers with the right material in sufficient quantity for them to pass on to schools and organizations would be a good business.

While you might put a hundred films in a town like Roscoe, what would be the condition of them at the end of the year? Schools do not know how to keep them at the proper humidity and to handle them properly. Can schools advantageously own lantern slides? No. One city recently spent about $8000 in buying lantern slides. Individual schools bought them largely from funds raised by selling old rubbers and newspapers—500 or 600 slides in a set—the same set in each school. The money expended could have been better used for equipping classrooms with projection apparatus. Each of the schools in this case could receive annually for use when needed, free of charge, at least 10,000 slides from the State collection. A topic is taken up in one school once during the year. There must be a scheme for circulating visual aids to instructions.

Mr. Richardson: You made the assertion that you had seen a great many sets of slides, but they were all valueless in school work. There apparently have been mistakes made in the production of slides; could you suggest how sets of slides having real value in educational work might be produced?

Dr. Abrams: Most of the pictures offered us have been made from the tourist point of view. Not many of the things we see on a tour to Europe are what the schools want for geography. I want to know what a country looks like. I should like, for example, to give our boys and girls in New York a mental picture of what the western plans of the United States look like. I cannot get anybody to photograph them. A man who went on a long trip across the African plateau told me when he came back there wasn't anything there to photograph. "Why, there was nothing but a big flat plain," he said. And I said, "If that is the characteristic feature of that country for hundreds of miles, why didn't you show it?" Most of the people who go out, even if they are good photographers, don't know the subject photographed. Others go out knowing everything about the subject but don't know how to manage a camera.

Another thing: these commercial houses putting out slides don't want to pay much money. You cannot get good pictures and adequate organization of them unless you are willing to pay some one who has a definite idea of what they are for. When a concern is filming a subject for motion pictures, it would be a small job to make a parallel collection of still negatives. The New York State Department of Education would not collect negatives and work out titles if it could go to the trade and buy what it needs.

Mr. Denison: A gentleman recently came into this meeting who has had great experience in photographing pictures all over the world, including most of the Burton Holmes pictures. Mr. Cowling is here, and I think he could throw some light on educational travel pictures.

Mr. Cowling: I might say that you can't afford to make still pictures. There is not enough demand to pay for them. I say that after almost starving to death trying to make a living out of it.

The question of subject is the main item, and it wouldn't pay you to go into Central America with a still camera because you find that many stills that you can make are not better than you can buy.

Dr. Abrams: I cannot find one-tenth of those I want. I have looked in vain to find good pictures for the raising of dates on the north coast of Africa.

Mr. Cowling: It would cost about $500 to do one country, taking into consideration a long trip covering several countries.

Dr. Abrams: But a man going out there might say: "When I find a good tree loaded with dates, I am going to make two, three, four, ten negatives and dispose of them to different parties.

Mr. Cowling: You must make a motion picture first if you want to make expenses out of it.

Dr. Abrams: I want to awaken an interest in all people to carry along with the motion pictures the still pictures and build up the whole scheme of visual instruction.

Dr. Sheppard: We have very greatly appreciated Dr. Abrams' talk and his discussion of the relation of the still to the motion picture, but we are at present considering motion pictures rather than stills. The most important thing Dr. Abrams has said was in his initial points on the essentials of education in the early stages. He disclaimed considering the motion picture in higher education. He is dealing with education in the early stages, or primary education.

Now, in the field of higher education I think we can foresee the kind of picture we want. In higher education, and in those phases between higher education and research—and the research man is always educating himself—the function of the motion picture is in the analysis of motion; it is not so much moving pictures as pictures of motion. Motion we represent to ourselves, because we cannot understand it, by a series of positions. That is not the true way in which things happen, but it is the only way we can form a concept of motion. Motion study has taught us much concerning manual operations and about complicated things like the gait of a horse;

I once saw a motion picture of a pigeon after the left hemisphere of the brain was removed, which has no meaning for me but filled the pathologists who were studying it with enthusiasm and from which they presumably learned something. These are simplified themes, and it is understood that these people select out the items they are going to treat. In the study of motion in an explosion engine the motion picture is being used and in countless fields of that type, and the selective element is always present. It is upon the study of pure movements, the problems of velocity and acceleration, that some concentration should be made by the author who is working for visual education. That demands, however, a different type of equipment or a modification of equipment. It will need the slow movie, and the possibility of stopping for stills and the explanation and discussion between teacher and pupil. I wish to suggest that we think along these lines and do not proceed on the idea that it is enough to present a series of pictures which merely lull the senses for the time being. You can evoke magnificent visions by drugs, and you can drug the senses through the eye, but no one would advocate that as a method of education.

We cannot get away from the psychological analysis of education, as Dr. Abrams has emphasized. I am sure that the application of motion pictures to education will be a flivver if we don't bear this in mind. I do not feel that what Dr. Abrams has said is against the use of motion pictures in education; I think it is merely a guide to the right way.

Dr. Abrams: There has been a tendency to make the films five hundred or a thousand feet long, and if you analyze them, you will find from 25–60 per cent of the film is still. I should eliminate the still parts. Why not, when you want to show the form and size, use still pictures and run a short film to present movement? Stopping a motion picture does not give you the same effect as a still picture made carefully for definite purposes. If you photograph something as a still and select the position to give the most telling view and work under favorable light conditions, you get a better result.

You are right that I did not come here to condemn motion pictures, but I can tell you that you cannot do everything with either motion pictures or with stills; each has its purpose and its usefulness.

Mr. Richardson: I think you gave the answer to the whole thing in that coffee illustration, as I understood it. The thing to do would be to use the stills to explain the size and the view of the coffee bean, followed by a motion picture showing the process of growing and harvesting the coffee.

Dr. Abrams: That is all there is to it.

Dr. Hickman: During the past five or six years I have been teaching and lecturing with and without the use of the projection lantern, and my opinion, for what it is worth, is that there are a thousand and one ways in which motion pictures can be useful for teaching purposes and an equal number of ways in which they are certainly not worth their expense.

There are two processes involved in imparting knowledge: first, you may take your student to the water, and then you have to make him drink. Projecting motion pictures before him might be described as taking him to the water, but whether he drinks or not is dependent on his own mental effort and possibly the insistent voice of the teacher. For my own lectures I had two or three hundred slides, many of which I gave up because the students went to sleep. The knowledge was so easily displayed that it evoked no interest. The things it was absolutely necessary for them to learn I wrote laboriously on the blackboard, and they copied them equally laboriously into their notes. This applies not only to figures and tables but to drawings also. The lesson was learned because we both put an effort into it. Dr. Ingold of Leeds University has often said that lectures teach nobody anything except the man who lectures, the man who takes the pictures, and the man who makes the slides. While probably neither he nor I really agree with such a sweeping generalization, there is a very great deal of truth in the suggestion.

Surely the true usefulness of motion pictures lies in the portraying of motion; that is, in presenting something to the student which can be shown him by no other mechanical means known.

Dr. Abrams has said that the most important thing to visualize before the students is the size, quality, texture, and environment of the object in question. He suggests motion pictures do not do this. I suggest, on the other hand, that a properly prepared picture will do this better than anything else. He says a picture of the coffee bean conveys no idea of the size or the hardness of the bean. Had that same coffee bean been shown in a squirrel's mouth an idea both of the hardness and the size would have been shown in relation to a known object, the squirrel. Suppose I were to give you the quantitative data of a giraffe, saying that it is so many feet high and that its neck projects at such and such an angle. Has that given you an idea as effective as a picture of a giraffe with a man standing somewhere near to scale him and give the correct impression of size?

The tirade which has been lodged against motion pictures and pictures in general for teaching purposes is surely that these pictures have been badly taken and improperly presented, that those taking the pictures are ignorant, and that the whole process of the pictorial recording of knowledge is bad from beginning to end. I wish to protest that this need not be so; the value of these things is simply what you make them, and their use in teaching the effort you put into them and the skill with which you present them.

Dr. Abrams: I think you will agree there was nothing in Mr. Rogers' paper contradictory to what I said, but I suspect you like his paper better than mine because he talked in your favor, and I seemed to talk against your interest. Yet, I can see that you men realize that we are trying to get at the fundamental basis of this matter, and I hope I have not done you any harm. It is what the individual learner does that counts. You cannot look once at a picture you have never seen before and tell all there is in it. You must approach it from different angles. That picture is asking you a lot of questions, and any picture, whether still or in motion, is not going to accomplish much unless it gets mental reaction from the person who is trying to study it. In the field of entertainment it is different. There are educational extension activities which are not very serious, but they offer some stimulus and people have gone out benefited. They want something rather relaxing and something that calls back what is in mind. An illustrated lecture may have some value, and a motion picture may give stimulus, but only when you have discussion and interchange of mind and mind are maximum results secured.

President Jones: In reply to Dr. Abrams with regard to the suggestion that Mr. Rogers' paper may please us more than his, I think that is not necessarily the case. We have all felt that the present application of motion pictures to educational work is not altogether satisfactory, and we want to find out what is wrong with the present method of using them. He has told us of some of the faults. Knowing what the troubles are, we can try to find a remedy.

MOVIES FOR TEACHING—THE PROOF OF THEIR USEFULNESS

Rowland Rogers*

SEVERAL years ago our Society invited me to read the paper on "Can the movies teach?" I did. Then I ventured the assertion that there were few or no genuine educational motion pictures.

Times change. We progress. Now I venture the assertion that there are some genuinely instructive pictures. By this I mean pictures that have been classed as "pedagogic," whatever that may mean. Strictly, "movies for teaching" are those suitable for use in the classroom or assembly hall to supplement or correlate definitely with existing courses of study given in schools.

Recently I sent a questionnaire to a number of directors of visual instruction in the larger city schools and also to a number of state universities which are supplying motion pictures to schools in the smaller towns and cities. The list of films which they use for teaching is quite large. The following films received several votes each as being among the five best: "Hat's Off," "How Life Begins," "Milk—Nature's Perfect Food," "Inside Out," "Lumbering in the North Woods." I have brought one of these films here today and propose to show it to you. This is the best way for you to find the answer to the question, "Can the Movies Teach?" No matter how brilliant may be the oratory of your speakers and no matter how persuasive may be the logic of their words, we still face the age old proposition that "seeing is believing." This brings me to the theme of our discourse and the first point I wish to make.

There are two principal ways to express ideas: (A) One is by means of sounds. As we are not dealing here with the communication of ideas by means of sound, we pass over quickly the entire subject of the language of the spoken word. (B) By means of pictures. No student of history has any doubt that the picture language was of very early origin and that picture writing preceded what we call the real writing of today. Words are used as a means of visualization. The direct development of picture writing was the use of the picto-

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graph and the ideograph. Next, there doubtless developed a system of syllable writing to be later followed by alphabet writing, and so, during the course of centuries, there developed the language of the written word. There seems little doubt that writing is a child of pictures.

In the preface to the Merriam Edition of the Webster Dictionary is the following interesting statement:

> Noah Webster was inspired to write a dictionary for his fellow Americans, because a dictionary, more than anything else, in the range of devices and instrumentalities for culture, should supplement the school and the elementary spelling book and should make the population *eye-minded*, so to speak, as well as ear-minded, ... make the common language visible to the eye as well as audible to the ear, ...

The movie maker (today's Webster) is adapting the age old picture language to teach in school, church, and factory.

I do not need to come here with a brief in support of the use of pictures and especially photographs as a means to convey ideas. Arthur Brisbane (an editor should know), has been quoted as stating what is really a repetition of the old Japanese Proverb, "One picture is worth a thousand words." I am informed that the circulation of the New York *Times*, which, in its daily edition, relies almost entirely upon the language of the printed word, has a circulation of about 350,000. This paper was established nearly seventy-five years ago.

On the other hand, the New York *News*, a tabloid newspaper, established about five years ago, has a daily circulation of around 900,000. Pictures need no support to prove their value.

You, as members of the Society of Motion Picture Engineers, know that there is no such thing as a *moving* picture. A moving picture is a blur. All that we see projected on the screen is, of course, a series of still pictures projected so as to simulate life and action.

The main function of the motion picture is to express pictorial movement.

Still pictures well represent still life. A mountain in its majesty is well visualized by a "still," but a still picture of a motionless hunter feverishly chasing a motionless mountain goat is an anomaly. You can multiply indefinitely for yourself the illustrations where motion is essential, especially if you are a fisherman, a golfer, or a tennis player.

The still picture at times presents an untrue picture, lifeless, dull, inanimate.

Movies are the art of pictorial movement. In movies all the principles of the still picture lives. Line, light and dark remain. Color prevails with the addition of action. The movies do not displace the still but supplement and co-ordinate with it. There is no more conflict or competition than between your thumb and forefinger. The field of usefulness of the motion picture or picture movement is distinct from the field of the still. Millions love movies. Originally the novelty of movement in pictures was sufficient to attract; now merit plus movement are essential.

In the spring of this year I made a survey on the use of the motion picture for teaching. While doing this bit of research I visited many schools and talked with many school people in different cities. These include New York, Newark, Chicago, St. Louis, Cleveland, Kansas City, and Pittsburgh. I was in communication with many other cities and educators.

In the following cities the work of visual instruction by means of motion pictures is being conducted successfully: Washington, D.C.; Meriden, Connecticut; Cleveland, Ohio; Pittsburgh, Pennsylvania; St. Louis, Missouri; Kansas City, Missouri; Chicago, Illinois; Newark, New Jersey; New York, New York; Detroit, Michigan.

The following universities are taking a definite interest in the use of the motion picture for teaching, endeavoring to evaluate it and to have it function to its best advantage. The Universities of Utah, Chicago, Illinois, Indiana, Arkansas, Iowa State College, California, Wisconsin, Minnesota, and Texas.

There is not room in this brief report to present all the facts. They lead to three conclusions:

1. That there is a place for the motion picture in the scheme of education in the United States.

2. That there is a genuine need for such an efficient tool as the motion picture under the prevalent practice in American schools.

3. That there is a demand in the school systems of the country for the motion picture as a visual aid to instruction.

Among the recommendations made are the following:

The pictures should be essentially those subjects which may be visualized best through motion picture action. The field of the still picture should be avoided;

A printed teacher's guide should accompany each reel;

Research to evaluate the motion picture for teaching should be conducted and the findings be announced publicly and serve as a guide to future production;

There should be an efficient production organization which includes on its planning staff both teachers and educators. This organization should be capable of expansion and contraction as needs require. No large salaries should be paid. Waste in production should be eliminated;

The sales and production organizations should have the guidance of people who have sold text books, slides, and other visual aids.

There should be courses in visual instruction offered to teachers to promote a better knowledge of the value of visual aids and greater familiarity with motion picture projectors.

The use of the motion picture holds out three promises:

1. To teach efficiently, 2. To save time of both pupil and teacher; 3. To save some cost of teaching.

Most of the thinking in connection with the motion picture for teaching has been along the line of the effectiveness of the movie to impart ideas. There are other factors which are of equal and probably greater importance.

With the growing complexity of modern life, with the introduction of the radio, the telegraph, the telephone, the aeroplane, the automobile, we have invented nothing until the coming of the motion picture which will stimulate to quicker thinking, which will enable us to impart information with a saving of time and without a loss of efficiency.

I attach as exhibit a report of some research which was carried on in the schools of New York; New Brunswick, New Jersey, and Meriden, Connecticut. I make no generalizations from the report. It holds a promise. The gist of the facts is that by the use of motion pictures the time for imparting a given amount of information was cut in some instances 40 per cent and in others 62½ per cent without a material loss of efficiency.

The following list of questions was asked a selected well-informed group of educators and people interested in visual instruction. Their replies are tabulated. Movies are proving their usefulness.

VALUE AND FUNCTION OF MOTION PICTURE FILMS FOR TEACHING

Function	Yes	No	Query
A. Should motion picture films be correlated with existing studies in curriculum?	22		
B. Should they be correlated with textbooks?	19	3	
C. Should they be correlated with other visual aids?	21		

VALUE			
A. Do films promote more efficiency in teaching by helping to			
(a) Impart information to the student effectively?	16		4
(b) Arouse the students' attention?	19		1
(c) Hold the students' interest?	17		2
(d) Encourage the students' observation and active effort?	16	1	3
(e) Stimulate his memory retention?	14	3	3
(f) Assure a minimum and uniform standard for imparting information?	11	4	4
(g) Aid to overcome inefficiency of inferior teachers?	9	7	2
(h) Stimulate and encourage slow students and reduce the number of repeaters?	12	1	5
(i) Stimulate and encourage students with a low intelligence quotient?	12		6
B. Do motion pictures save time by helping to			
(a) Impart, in a limited time, a greater amount of information effectively than oral or printed instruction?	17	1	3
(b) In what other ways			4
C. Do motion pictures save cost by			
(a) Reaching many students simultaneously?	14		3
(b) Reducing "student mortality" or repeaters?	9	3	5
(c) Reducing truancy?	12	1	4
(d) Other means			

THE HIGH INTENSITY ARC

Frank Benford*

Introduction

THE high intensity arc is in many respects so radically different from the plain carbon arc that they are nearly as far separated as is the carbon arc from the incandescent filament. It is true that both are arcs having current passing between spaced electrodes, and both have carbon as the current carrier, but here the resemblance ends. In the carbon arc the carbon itself is the source of light, while in the high intensity arc the carbon is secondary in the production of light and acts as a holder for the real source of light which is a small body of luminous gas. The current density in the carbon arc is about 0.33 ampere per square millimeter of crater area, while the current density in the high intensity crater is 1.2 amperes per square millimeter. These differences emphasize the fact that the high intensity arc is radically different and requires its own mechanism and technic for its proper operation.

This arc is not the first one historically to use a salt-bearing electrode for the production of luminous gas, but it is the first one to so control the gas that it can be used for projection purposes. The flame arc of fifteen years ago had a luminous flame extending between electrodes, and this flame being exposed to convection currents, was fluctuating in intensity and in constant motion. Also, plain carbons have always given some kind of crater on the positive electrode, so that two of the basic elements of the high intensity arc, the luminous gas and the crater, are individually old in the art of illumination. The ingenious feature of the high intensity arc is the combination of a luminous gas with a deep crater in which it is momentarily confined and thus stabilized in space and in emission of light.

Electrodes

For the sake of brevity only one size of electrode will be described. The 150 ampere arc is the one in most common use and takes a 16 mm positive and an 11 mm negative. The shells of both are of

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extreme hardness. The Brinell tests show them to be as hard as mild steel, but being carbon they are brittle and require care in handling. The core of the positive is 8 mm diameter, and it is heavily impregnated with fluorides of cerium and thorium. These salts will be recognized as being the ones used to give the Welsbach mantle its selective radiation and under the electrical conditions in the arc they are extremely effective light radiators.

These fluorides are extremely stable and do not change into gas except at temperatures near the boiling point of carbon. This is a necessary condition, for if salts with a low temperature of vaporiza-

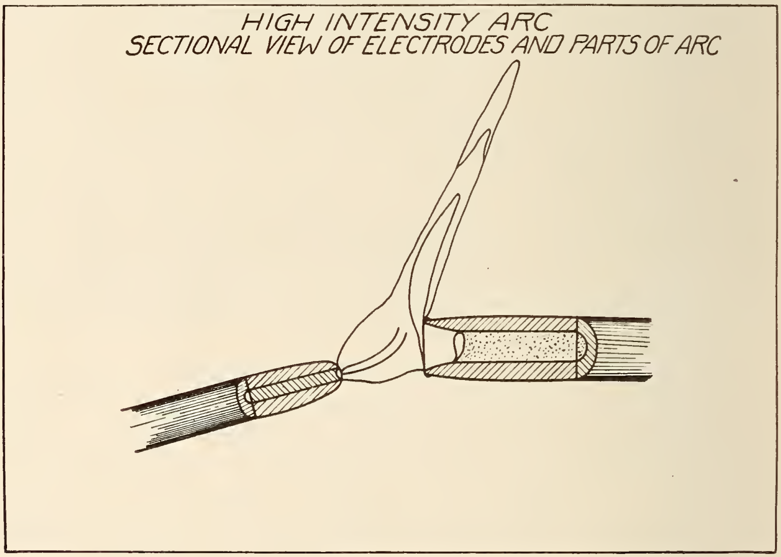


Fig. 1.—A sectional view of the high intensity arc showing the cores, crater, and position of the arc stream and flame.

tion such as sodium chloride are used they will boil off in a great burst of gas and leave the electrode just plain carbon. In addition to a high vaporization temperature, the selective radiation of cerium and thorium render them excellent light sources, for not only is the zone of greatest radiation within the limits of the visible spectrum, but the spectrum lines are so numerous as to make the spectrum function visually as a continuous spectrum.

The core of the negative is 3 mm in diameter and is of soft carbon. The size of the negative is considerably less than in older arc practice, and the carbon gas is given off with a relative high velocity. This is a vital feature, for the proper maintenance of the arc depends upon the strength and stability of this stream of carbon

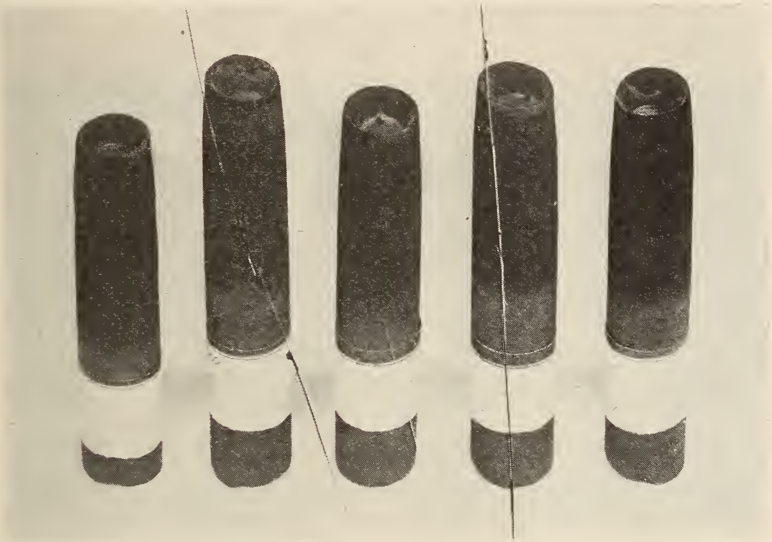


Fig. 2.—Typical craters.

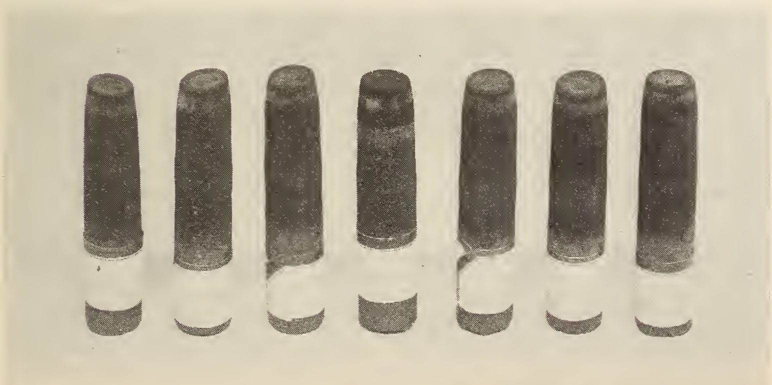


Fig. 3.—Craters when electrodes are improperly adjusted.

gas. It has been found that the lamp may be placed on its side or inverted, and the negative gas maintains an invariable relation to the two electrodes.

In speaking of the component parts of the high intensity arc the following terminology is usually employed:

"Arc stream"—The violet stream of carbon gas extending from the tip of the negative to within several millimeters of the plane of the crater.

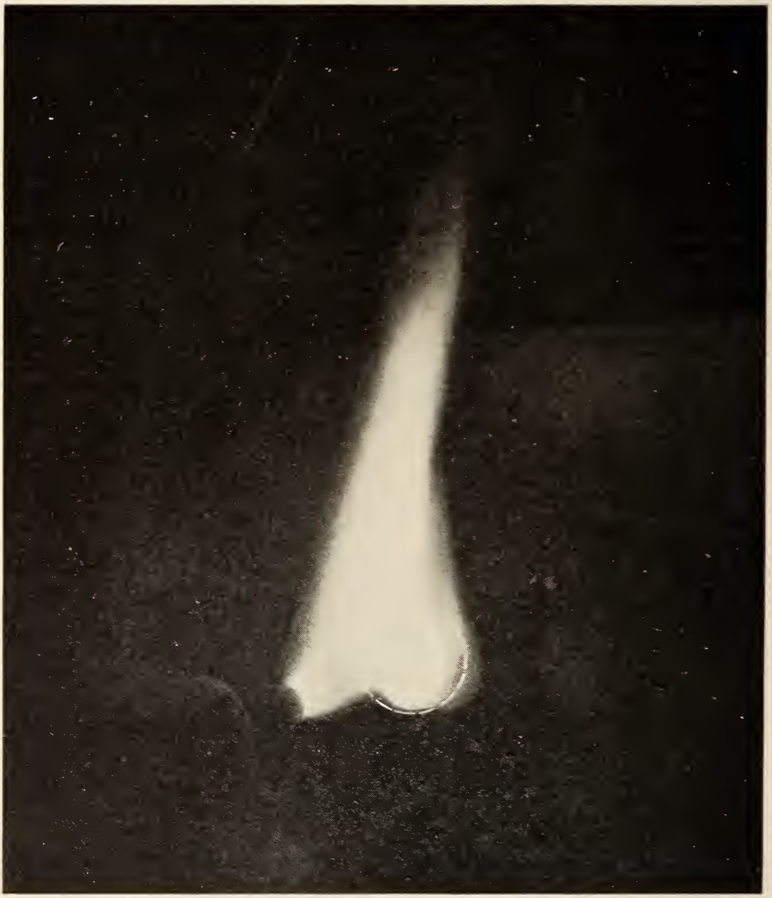


Fig. 4.—A high intensity arc in operation. The white circle was drawn in to define the limits of useful light in searchlight practice.

"Crater gas"—The light-giving gas contained within and adjacent to the crater on the end of the positive electrode.

"Flame"—The jet of gas formed by the combining of the gas streams from the negative and from the crater.

The crater gas has by far the highest brilliancy. The flame is next, being composed in part of the crater gas that escapes over the upper rim of the crater, and the arc stream is lowest in intensity, being perhaps identical with the arc stream from pure carbon electrodes.

A very necessary condition is the formation of a deep and symmetrical crater, and in order to secure this the positive is rotated at about sixteen revolutions per minute. The original lamps also

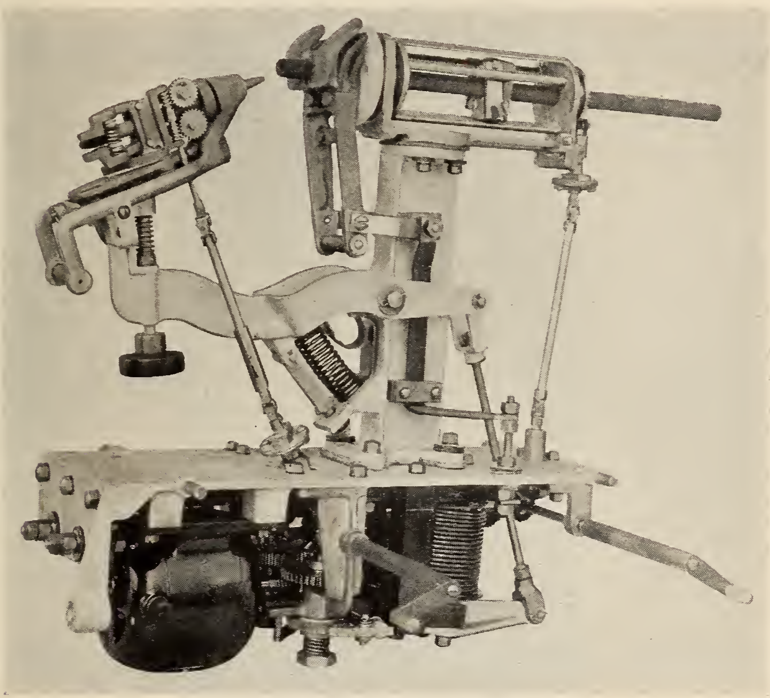


FIG. 5.—A motor driven studio mechanism for both floodlighting and projection

rotated the negative, but this was found to be an unnecessary refinement and is no longer used.

Mechanism

The proper functioning of the high intensity arc calls for a very strict adjustment of the electrodes with respect to one another, and when used as the light source in a searchlight the crater must be held accurately at the focal point. A searchlight lamp therefore has the following functions:

1. Rotation of positive at a constant rate
2. Feeding of positive to keep crater at focal point
3. Feeding of negative to maintain constant current
4. Maintenance of electrodes in accurate alignment
5. Protection of both electrodes from oxidation by the air.

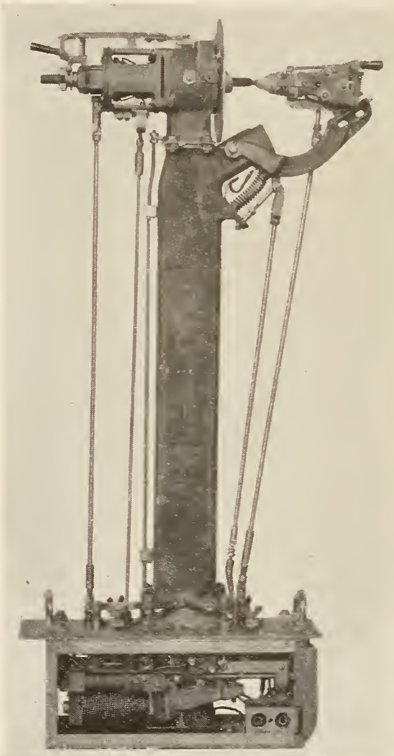


Fig. 6.—A full automatic lamp for searchlight service.

The mechanism to carry out these five features is much more elaborate than is required for the plain carbon arc and various lamps that are full automatic, semi-automatic, and mechanical feed, and manual operation has been developed for different services, but it will be appreciated that the high intensity mechanism in its simplest form is more elaborate than the low intensity lamp. Item No. 5

above has a long history in the development of the mechanism. The original lamps had an alcohol burner under each electrode for several inches back from the arc, and the non-oxidizing alcohol flame served as a protection against the oxygen of the air. But alcohol introduced too much of a complication in military service, and other ways were devised to obtain almost the same resistance to oxidation.

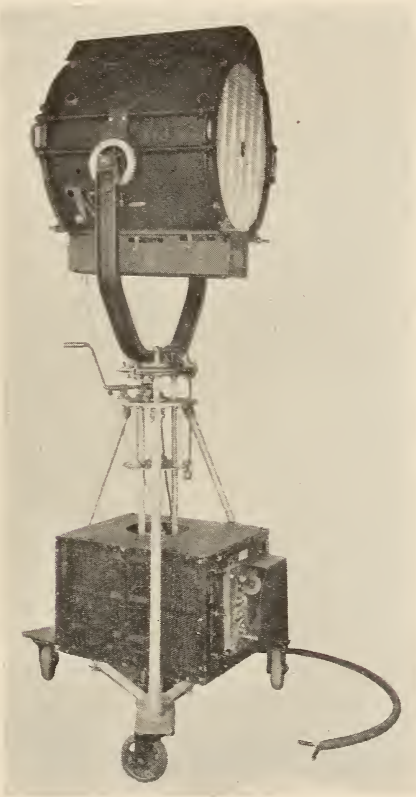


Fig. 7.—A high intensity studio light complete with switches and rheostat.

Adjustment of Electrodes

The reason for the care taken in adjusting the electrodes of the high intensity arc is obvious when we remember that the light source is the small volume of gas contained within the crater. The light is bright or dim according as the crater is full or empty, and the steadiness of the light depends upon the steadiness and freedom from turmoil in the luminous gas.

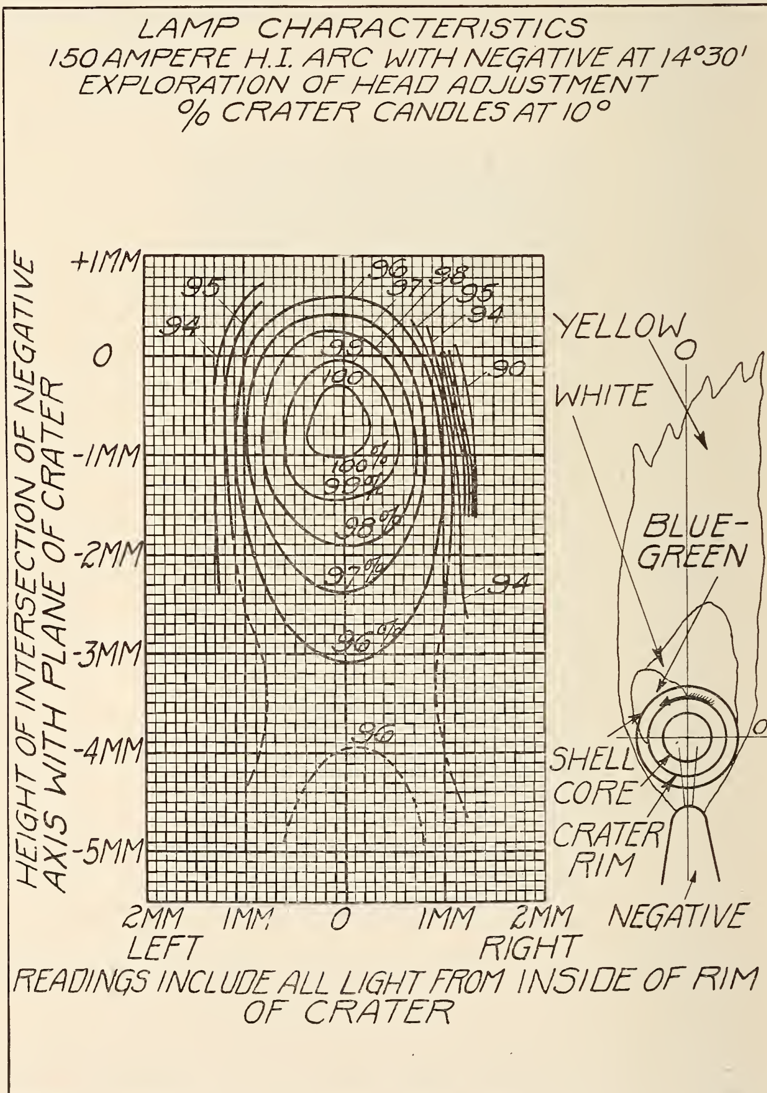


Fig. 8.—An analysis of the influence of the position of the negative axis upon the output of useful light.

There are three principal forces acting upon the gas and by properly balancing these against one another the arc can be brought into control. First there is the stream of carbon gas or arc stream given off with high velocity from the negative. Second, there is the upward thrust of the magnetic field induced by the current through the arc. The third force is the convection forces set up by the 9000 watts being expended at the arc.

The luminous crater gas leaves the core with a low velocity, and if not interfered with would stream out of the top of the crater so that only the upper part would be filled. The arc stream may be directed against the upper part of the crater so as to oppose the escape of the crater gas, and by delaying its escape the crater is kept full to the bottom edge. The current now passes through about 8 mm of gas and heats it to a temperature that is apparently 1500°C higher than is possible with solid carbon.

The arc stream has a pronounced effect on the form of the crater, and considerable experimental work has been done to find the best adjustment. As a general rule the deepest crater gives the most light but it has been found possible to deepen the crater over its customary depth and at the same time decrease the useful light. This condition occurs when the negative is adjusted so that its axis intersects the plane of the crater several millimeters to one side of the center. This is mentioned to illustrate the sensitiveness of the arc to the adjustment of the electrodes, and to explain why special lamp mechanisms are necessary to hold the electrodes properly under the various hardships that the lamps (the military lamp in particular) must undergo.

Operating Characteristics

The most striking feature in the operation of the high intensity arc is its continuity. Not that the arc does not break, but when an outage does occur the pick up is almost instantaneous, and a rupture of the arc usually means nothing more than a momentary drop in illumination. Upon starting a fresh trim of electrodes several seconds are consumed in bringing the positive up to approximate final temperatures and to develop a crater of sufficient size to collect crater gas. But once in operation, a break in the arc results in a drop of intensity only during the period that it takes the negative electrode to come up to the plane of the crater. It is not necessary for the hot carbons to touch because the crater gas is a good conductor when hot, and the arc will jump across ten millimeters of hot gas. In the type of mechanism where the negative head is actuated by a spring, the time during which the arc is out is therefore but a small fraction of a

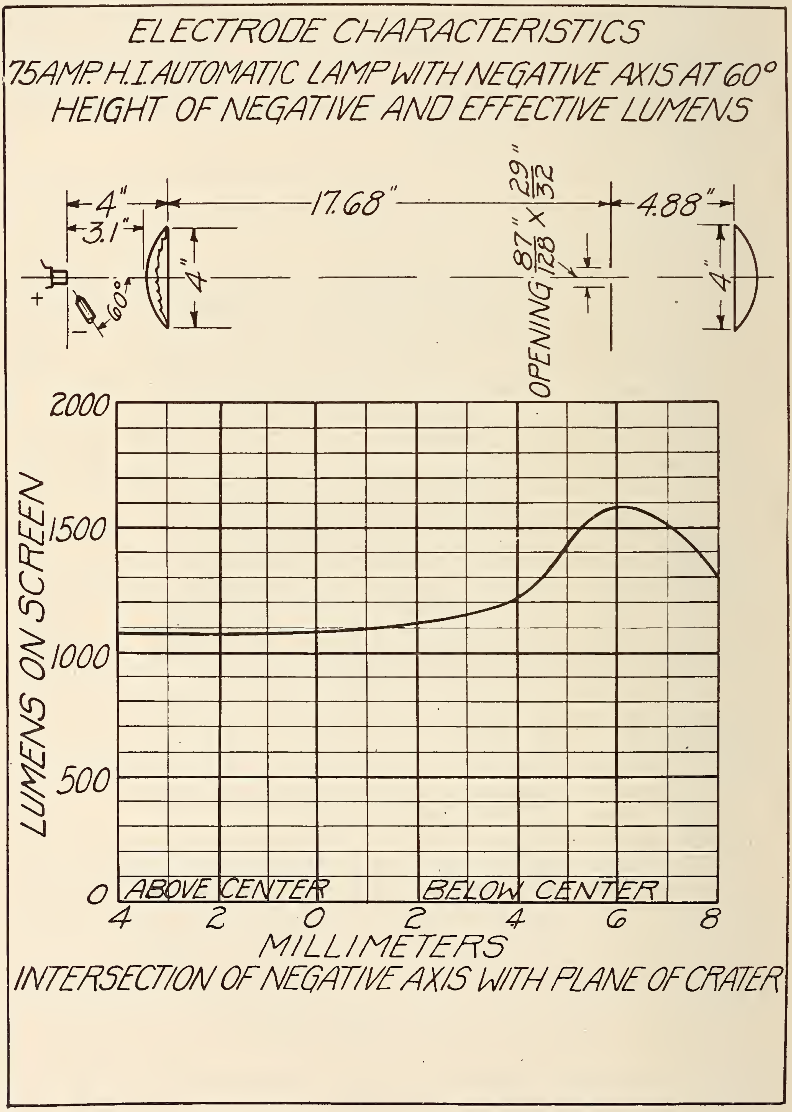


Fig. 9.—Relation between screen illumination and height of negative electrode.

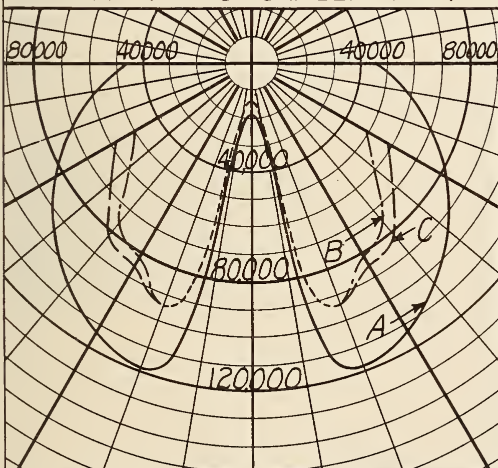
second, but if the negative must be fed forward, then several seconds may elapse, and if the feed is too slow it may be necessary for the negative to enter the crater and establish carbon contact.

The second feature of the arc is its relative steadiness of operation. There is a flicker of small amplitude that is continuous, but this flicker is largely in the gas that spills over the sides of the crater.

36" BECK SEARCHLIGHT LAMP
TEST AT NEW YORK NAVY YARD

VOLTS TERM.	120
VOLTS ARC.	73
AMPERES	150
WATTS	18000

PHOTOMETRIC TEST
DISTRIBUTION OF CANDLE-POWER IN HORIZONTAL PLANE



ZONE 0 TO	LUMENS A	LUMENS B	LUMENS C
10	2268	1742	1742
20	24998	19610	19610
30	78300	59700	60700
40	146300	109000	112700
50	222800	160600	169300
60	302190	208100	224400
70			
80			
90			

READINGS TAKEN AT VARIABLE RADIUS ON 80 FT. BAR
A- FLAME AND CRATER
B-CRATER ONLY-ELLIPTICAL DIAPHRAGM
C-CIRCULAR DIAPHRAGM, DIA. OF CRATER IMAGE

FIG. 10.—An analysis in one plane of the bare arc into total light, crater light, and light coming from within a fixed radius of the center of the crater.

It gives the searchlight beam a noticeable flicker around the edges, but in motion picture work this flicker is largely overcome by the

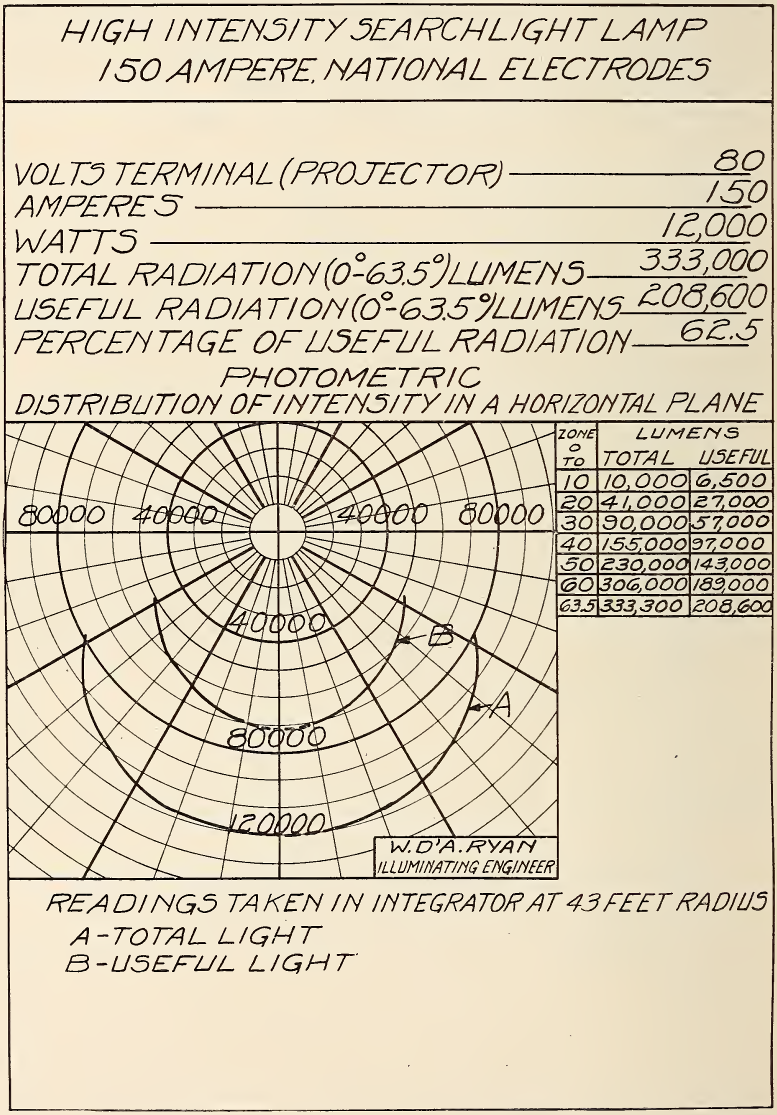


Fig. 11.—An analysis in all planes to show total light and light useful for searchlight projection.

optical arrangement, particularly at the aperture, that reduces fringe light to a minimum.

A third, and a most valuable feature, is the permanence of position of the light. In motion picture projection the active area of the plain carbon arc is much larger than required at any particular moment so that the movements of the crater will not take it out of focal position. The high intensity arc is fixed in position, and the crater forms a light source of invariable size and position.

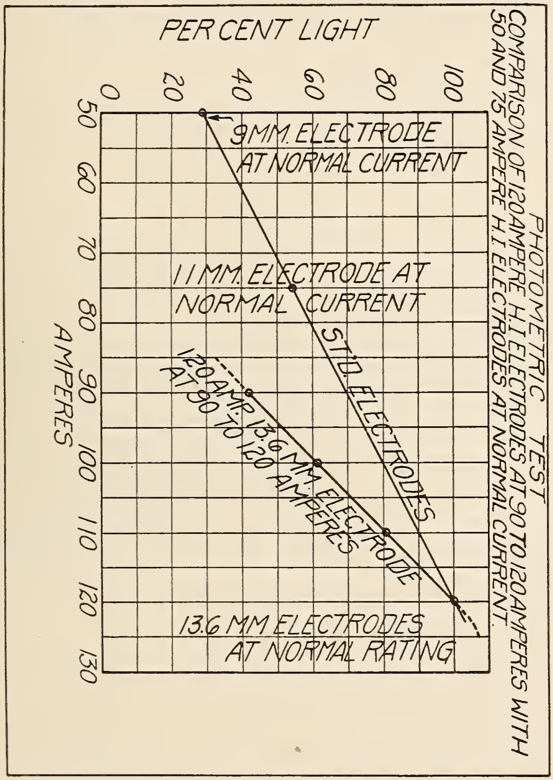


Fig. 12.—The upper line shows the relation between light and current when the various electrodes are operated at their rated current. The lower line shows the decrease of light when the same electrode is operated at reduced current.

Photometry of Bare Arc

There are several peculiar features about the generation of light that make the photometry of this arc of peculiar interest. It is a rule, although not a universal one, that light not originating in the immediate neighborhood of the focus is wasted so far as projection is concerned. Therefore, in the photometry of the high intensity arc it is necessary to separate out the light that comes from the flame which extends six to eight inches above the crater. The lower part of this flame, being composed of crater gas, is highly luminous, and the whole flame and arc stream contains some 37 per cent of the total output. In the development of these electrodes it was necessary to constantly determine the percentage of waste light, for in many cases an electrode would have a greatly enlarged flame with no equivalent gain in useful light.

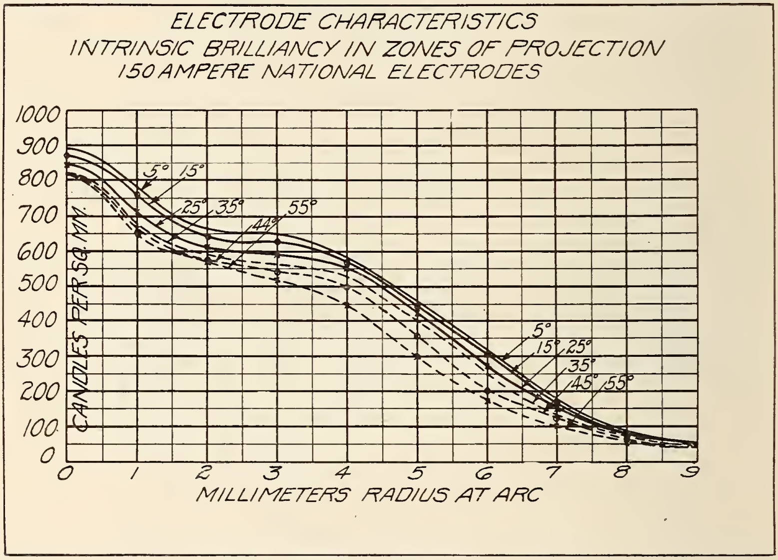


FIG. 13.—An analysis of the brilliancy of the arc made so that all useful light is included.

It has been the practice to project an image of the bare arc upon a screen and have in this screen an opening of proper size and shape, so that only the useful light can pass through into the photometer. For equal currents the useful projection light exceeds that of plain carbon by nearly 90 per cent, and for floodlighting where all light is useful the excess amounts to about 250 per cent.

Intrinsic Brilliancy

In practically all projection work the intrinsic brilliancy of the light source is the criterion of its usefulness, and judged by this standard the high intensity arc is without a peer and almost without a competitor. The brilliancy in the center of the crater, where the gas is deepest, is 850 candles per sq. mm, as against 135 candles per sq. mm for plain carbon and 35 candles per sq. mm for a tungsten filament. It is thus by far the most intense source of light available, and in those cases where brilliancy is of first importance this arc is supreme.

Measurements show the brilliancy of any particular area of the crater to be almost directly proportional to the depth of gas at the point under observation, with a practically constant addition due to the surface of the crater. This indicates a brightness of over 715 candles per square millimeter due to the boiling carbon.

Color Analysis

If we judge the temperature of the gas by its color, we find a color temperature of 5400° Absolute, or about the same as the color temperature of the sun after it has been filtered by the earth's atmosphere. The high intensity spectrum is composed of a weak background due to the carbon walls of the crater overlaid with a large number of bright lines due to the core salts and to the combinations formed between these salts and the carbon. It has also been surmised that the nitrogen of the air unites with the other components to form cyanogen and other elusive compounds that form at the high temperatures found in the crater. The number of lines distinguishable in the visible spectrum with a low power spectroscope runs into the hundreds, and there is no region that may be said to form a dark space. For purposes of illumination the spectrum is therefore continuous. The only region that might be taken as an exception to this is in the violet region, where the lines from the carbon gas give a pronounced peak. The projected beam, be it either searchlight or motion picture projector, does not ordinarily show any strong excess of violet because this light is strongly absorbed by the glass in the optical system, and the resultant spectrum takes on the general characteristic of bright sunlight, with a small excess of energy in the blue and violet region.

Some years ago comparative tests were made to determine the camera speed of projected beams from plain carbon, high intensity arc, and from unreflected light from Cooper-Hewitt arcs with glass tubes. The basis of comparison was equal illumination on the plane of test. The speeds found were one, five, and five in the order used above, and with unreflected light the ratio figure for the two arcs would have been considerably higher.

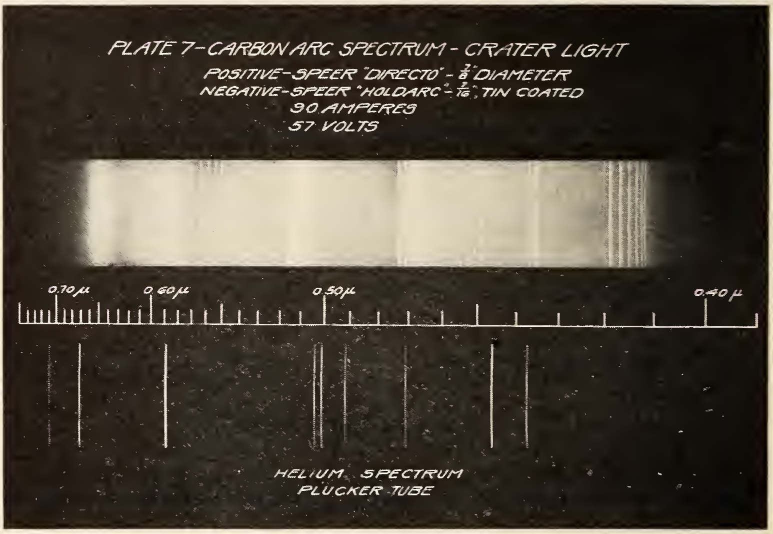


Fig. 14.—The continuous spectrum is from boiling carbon, and the spectrum lines are from carbon gas and possibly cyanogen.

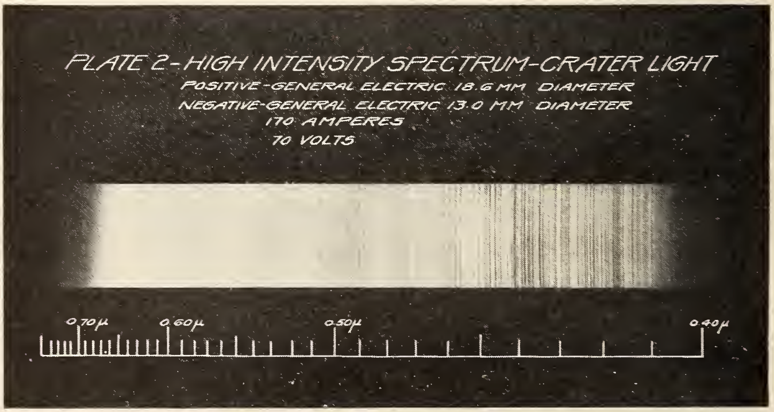


Fig. 15.—The multiplicity of lines from the high intensity gas almost completely obscures the continuous spectrum of the carbon crater walls.

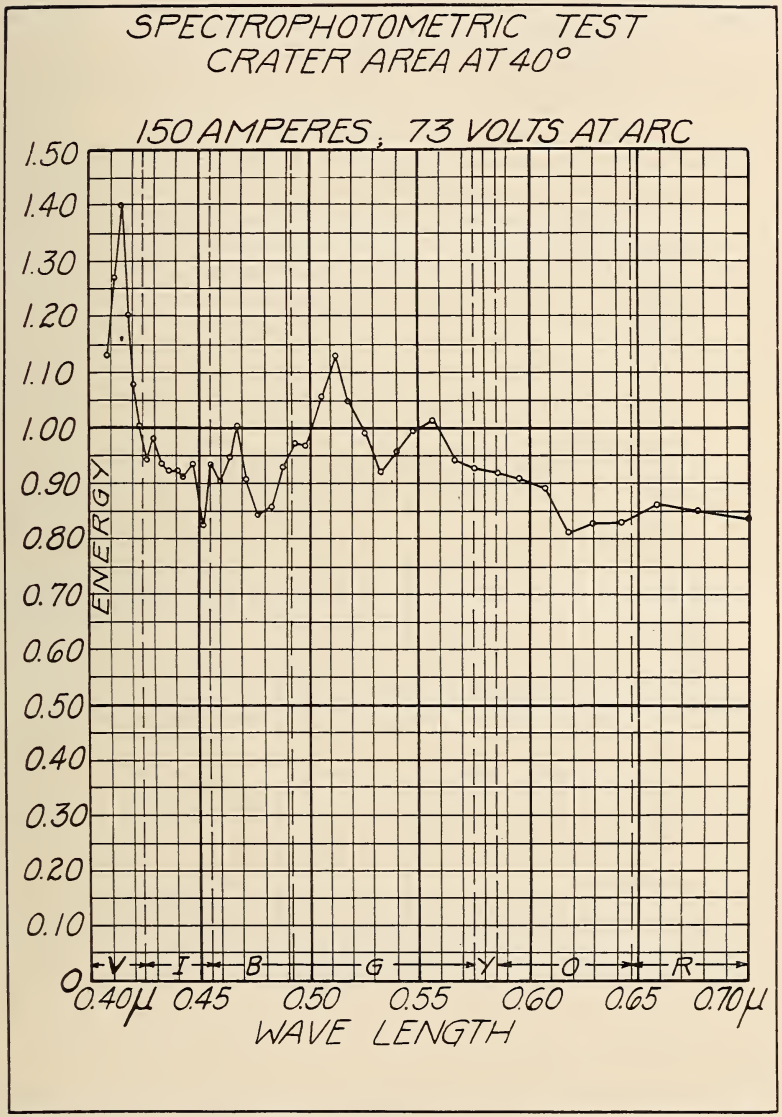


Fig. 16.—A typical spectrum analysis curve of the useful light of the bare arc.

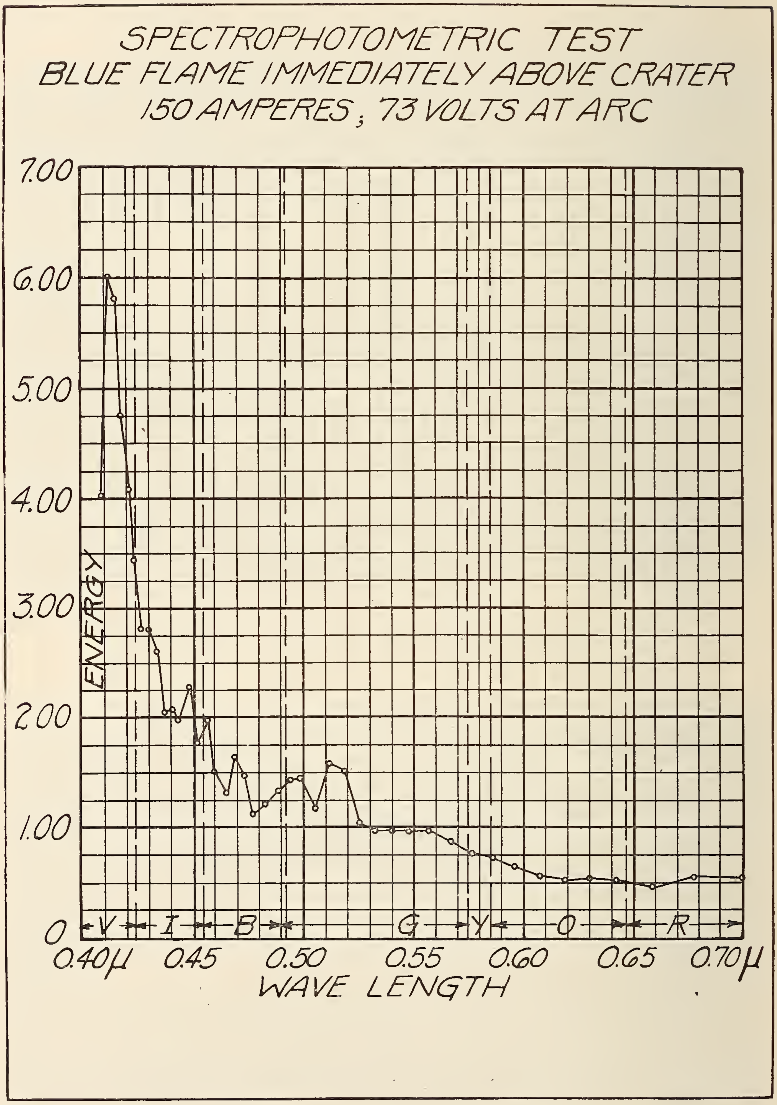


Fig. 17.—A spectrum analysis of the flame immediately above the crater. The great excess of violet is from the carbon gas of the arc stream.

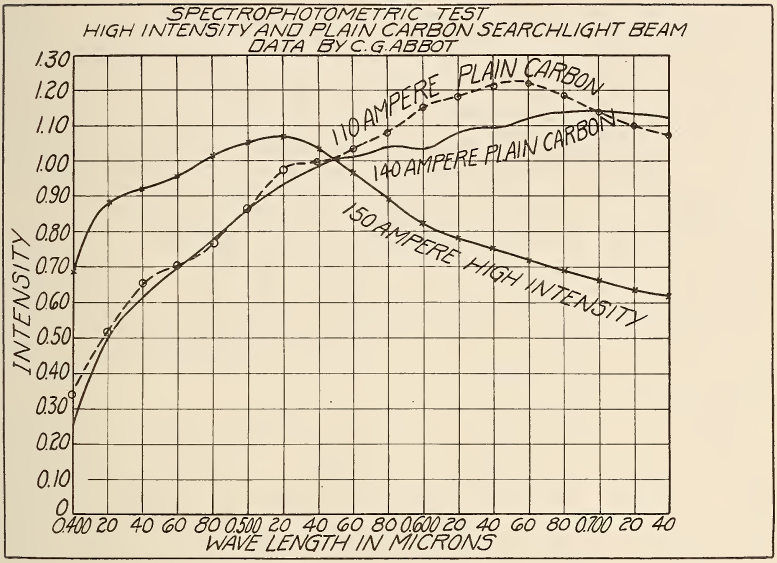


Fig. 18.—A spectrophotometric comparison of useful light from plain carbon and high intensity arcs. This analysis shows the influence of mirrors or lenses in absorbing the excess of violet.

DISCUSSION

Mr. Griffin: Will you outline for us what you have found with regard to the speed of rotation of the high intensity arc positive carbon? I ask this because we have taken over from the General Electric Company the manufacture of the high intensity arc for motion picture work; that is, the model they have formerly sold, and while we could formerly send all the complaints to the General Electric Company, we must stand on our own feet now. Some persons claim that if the speed is reduced to one-half that now used, much finer results are obtained. Our tests do not indicate that it is so serious, but the particular reason I have in mind for asking is that one of the lamps put out recently uses a lower speed of rotation.

Mr. Palmer: What is the proper arc voltage in a 150-ampere lamp, and can we be sure that we are operating the lamp at its highest efficiency if we hold the arc voltage at that amount?

Mr. Richardson: The principal objection to the high intensity arc has always been its harsh tone. May I ask what progress has been made, or what, if anything, has been accomplished in reducing the harshness of the light? Another objection to the high intensity and to the ordinary arc is condenser pitting and breakage. I have thought it was possible to air cool the condenser by a blast of air over the condenser lens, and I have brought the matter to the attention of the Nicholas Power Company and suggested that tests be made. I also have often wondered if it were not entirely possible to eliminate all fire hazard by a blast of air in front of the film.

Dr. Hickman: What constitutes a high intensity arc? If one takes an ordinary, plain carbon arc and increases the current four of five times, the crater area spreads four or five times without altering the intrinsic brilliancy. What is the mysterious thing in the high intensity arc which makes the four amperes sit contentedly in the space occupied by one before?

Then, I notice that cerium chloride and the rare earth fluorides were mentioned as being the light source. A spectrum photograph shows a gaseous emission and not the ordinary black body radiation. In incandescent mantle manufacture they are selected because of the emission in the solid state. I should like to know why they are chosen in gaseous emission. When the cerium fluoride volatilizes in air at high temperatures, the fluorine is driven off, and the brown oxides tumble down. Carbons are consumed at the rate of 10 inches an hour. The fluorine from this must act on the operator at some time or other.

What is the effect of increasing the voltage across the gap to allow a greater flux of light.

I should like to say to Mr. Richardson that when I was in Hamburg I saw a means of cooling the gate with a blast of air on it and know that it was very satisfactory.

Mr. Little: The curves would appear sufficiently close to black body radiation characteristics in order to express them in terms of approximate color temperature. Could Mr. Benford so express them in the manuscript before it is sent to the publisher?

Mr. Stark: Answering Mr. Richardson's question, in motion picture projection it is possible to overcome the harsh "high intensity" tone by the use of suitable filters. As a matter of fact, it is becoming an almost universal practice to tint positive film—usually yellow or amber—so that the blue light of the high intensity carbon arc is appreciably cut down to a semblance of white light.

Another method, more precise and more efficient, was presented to the Society by Dr. Kellner at the Ottawa meeting of 1923, in a paper entitled "Can the Efficiency of the present Condensing System be Increased?"

I should like to ask Mr. Benford why it was necessary in the original Beck high intensity arc lamp to "cool" the positive carbon by "heating" it in an alcohol flame; and why it is no longer necessary to do this in the present type of lamp?

Dr. Sheppard: Has Mr. Benford any data on the absolute amount of ultra-violet energy between 3000 and 3500 with the lens in position?

Mr. Powrie: What is the object in using a third electrode of copper in a high intensity arc?

Mr. Benford: Regarding the speed of the 150 ampere positive carbon, the speed of rotation was set at 16 revolutions per minute, and we never found that the light was very much influenced by changes of two or three revolutions a minute either way. I believe the 75-ampere arc runs at twelve revolutions a minute, and I must confess that I do not believe the quantity of light will be greatly changed by lowering the speed to, say, eight revolutions a minute.

In regard to the proper voltage of the 150 ampere arc, it is usually set between 75 and 80 volts at the arc. You may increase this and run the voltage up to 85 or 90, in which case there will be a small increase of light, but the arc becomes unstable. You can gain light and lose in stability, and it is an engineering choice as to where to stop, and the General Electric engineers think 75 to 80 volts is the best all around voltage.

Mr. Palmer: In maintaining the arc voltage, is a sufficient accuracy maintained or would you have to measure the amperage?

Mr. Benford: The automatic lamps are built to maintain current by means of changing the arc length. If you change the line rheostat the arc changes length. We selected this because the light is more sensitive to current than voltage, and we thought this would give the most uniform condition of light.

Mr. Richardson asked about contemplated changes in color. We have not done anything on this, and I don't think anything is under consideration. We feel that the most light is the best, and if the tone is not right, we can correct it by means of filters.

Mr. Richardson: Do you mean that it would be impossible to change the tone without decreasing the illumination value?

Mr. Benford: Almost that; we cannot be quite certain, but we have searched for the most light.

We have tried putting a blast of air over condensers, and as far as the arc is concerned it doesn't matter as long as air doesn't reach the arc; that would be serious.

With regard to the increase of current four times: If you do this, with plain carbons the crater area increases; the high intensity electrode is much harder than the ordinary and is a better conductor. Also, the gas given off by the core is a very good conductor, and it tends to concentrate the current in the center of the arc rather than allow it to spread around the edges of the electrode. When I started work on this arc I was warned to watch out for poisonous gases. It was suspected there would be harmful gases in the air which would attack the mirror, but in my experience I have never seen any direct evidence of the operator or the apparatus being attacked by the fumes. I have worked a number of times under extremely unfavorable conditions in a closed room which smoked up badly, and I have never suffered any ill effects, and I have never seen a mirror that was etched.

I believe Dr. Hickman also asked about increasing the arc length and I can answer that by saying that the arc becomes unstable if stretched too far.

With regard to labeling the curves with color temperature, this is pretty much of a guess. It is merely a convenience in speaking of the thing to say that it looks like black body radiation.

In answer to Mr. Stark, it is a fact when Mr. Beck first developed the electrodes that he could not get carbons of sufficiently high density to withstand the current density and his electrodes oxidized rapidly, so he surrounded the electrodes with a non-oxidizing alcohol flame. That apparently would add to the temperature but did not; the electrodes run cooler with the alcohol flame than without. If you exclude the air you eliminate the outside burning, which is a source of heat; with the alcohol flame the current density is not so high on account of the greater cross section of electrode, and there is less resistance drop in the electrode itself. After we took up the production of these lamps, the Army and Navy objected to the use of alcohol as being too fussy, and the tank had a habit of leaking, so that a new electrode was developed to resist oxidation better, and we found it possible to crowd the heads up towards the arc so that the oxidized length was not so great, and the use of alcohol was not so important.

A third electrode has been used to control the focal position. If the crater burns back with a third electrode, some current is carried off from the tip of the flame to operate the feeding mechanism. We don't use that method; we have used an optical system of throwing the optical image on the thermostat mechanism.

I have never measured the energy between 0.290μ and 0.330μ. The camera speed of the high intensity arc is about five times as great as plain carbon, so that the energy in that region is probably in the neighborhood of five times as great.

Mr. Griffin: While it is irrelevant to the discussion of the high intensity arc, with regard to the air blast, I think if Mr. Richardson will go back three or four Transactions, he will find that I built an apparatus in which the air blast was used satisfactorily in the aperture of the projector. This was developed by Targets, Limited, London, fifteen or sixteen years ago.

Mr. Kunzman: Has your laboratory analyzed the gases referred to in the high intensity arc?

Dr. Hickman: Why was cerium chosen rather than anything else?

Mr. Hubbard: What is the total beam candle power of the 150 ampere lamp using a 24″ mirror compared with the 60″ mirror?

Dr. Sheppard: What degree of constancy is obtained actually, and how constant could it be made with some refinement? I should like to know this because of the possibility of using the lamps in photo-chemical work.

Mr. Benford: I have never heard of an analysis being made of the gas.

With regard to the constancy, the arc is much more constant in its output than plain carbon; there is a flicker of 5 per cent going on, a fluctuation of short duration, but over long periods it is very constant because the current is constant, so that from hour to hour it is more constant than plain carbon.

The particular chemicals used in the carbons were chosen for the same reason that they were chosen for the Welsbach mantle. They were available to Mr. Beck when he started the job, and we have never found anything better.

About the candle power: We get into big figures. I have never tried this with a 24″ mirror because we never had a mirror which would stand such an arc. It should give about 150,000,000 candles. The 60″ mirror with a 150 ampere arc at the present time will test up to 725,000,000 candles, and it is theoretically possible to boost this over a billion, and work is being done at the present time on the re-design of the mirror.

Mr. Ziebarth: We are using air for cooling the film in our Filmo projectors, which enables us to stop the machine and show still pictures. A description of this may be found in our 1924 Transactions in a paper by J. H. McNabb.

Mr. Richardson: That is true, but so far no attempt has been made to lessen the fire hazard with the high intensity or the reflector type lamps.

Dr. Hickman: This method of cooling film with a blast of air has been patented and cross-patented any number of times in the last four or five years. I have seen many different modifications none of the patent claims of which are valid, and there are a number of continental machines fitted with the devices. All the various patents are chronicled in the Kodak Abstract Bulletin or the R.P.S. "Photographic Abstracts," and I make a plea for a subscription to some such abstract journal by everybody connected with the industry, since it would save cross-patenting and cross-designing of what other people have done.

Mr. Griffin: This explains very well why the manufacturers do not go into this. No one is looking for lawsuits, and the apparatus as used today is quite satisfactory. The building of compressed air apparatus is costly and takes up room in the projection room; it is subject to breakdown. I think it will be a long time before the manufacturers adopt such an apparatus.

Mr. Richardson: I don't believe any costly apparatus is necessary. I think the thing could be taken care of by a high speed electric fan with a proper air shoot. The reason I brought this up is that we have been using high power light sources and very hot spots in the last year or two.

RACK MARKS AND AIRBELL MARKINGS ON MOTION PICTURE FILM*

J. I. Crabtree and C. E. Ives

WHEN developing motion picture film by the rack and tank system it is very difficult to secure uniform development throughout the entire length of the film. Unless special precautions are taken, more development occurs at the top and bottom of the rack where the film passes over the end slats or bars than along the sides, so that bands of greater density occur at intervals corresponding with the height of the rack, which cause an objectionable flicker when the film is projected. These dark markings are termed "rack marks."

Another difficulty arises from the clinging of airbells to the film as the rack is immersed in the developer. These airbells prevent the accèss of developer to the film locally thus causing white spots.

Both the above defects can be overcome by correct manipulation, but their presence on much of the film shown in the present day theatre indicates a need for a better knowledge of the subject on the part of many laboratory workers.

It is the purpose of this article to explain the nature and cause of rack marks and airbell markings on motion picture film and to indicate methods for their prevention.

Rack Marks

When film is developed on the usual rack in a vertical tank, more development invariably occurs where the film passes over the top and bottom of the rack than along the sides, causing the film to appear as shown in Fig. 1. The marking where the film passes over the top of the rack is usually mottled and consists of a double line, while at the bottom only a single dark line is produced.

Cause of Rack Marks.—At various times rack marks have been wrongly attributed to causes such as a difference in temperature between the rack slats and the developer, which might cause an ac-

* Communication No. 250 from the Research Laboratory of the Eastman Kodak Company.

celeration or retardation of development at the point of contact of the film with the slat. Experiments have shown, however, that more development occurs where the film passes over the slats even when the rack is cooled below the temperature of the developer before immersion. It is now known that rack marks are caused by non-uniform development due to convection currents and retardation of development of the film along the sides of the rack by the developer exhaustion products.

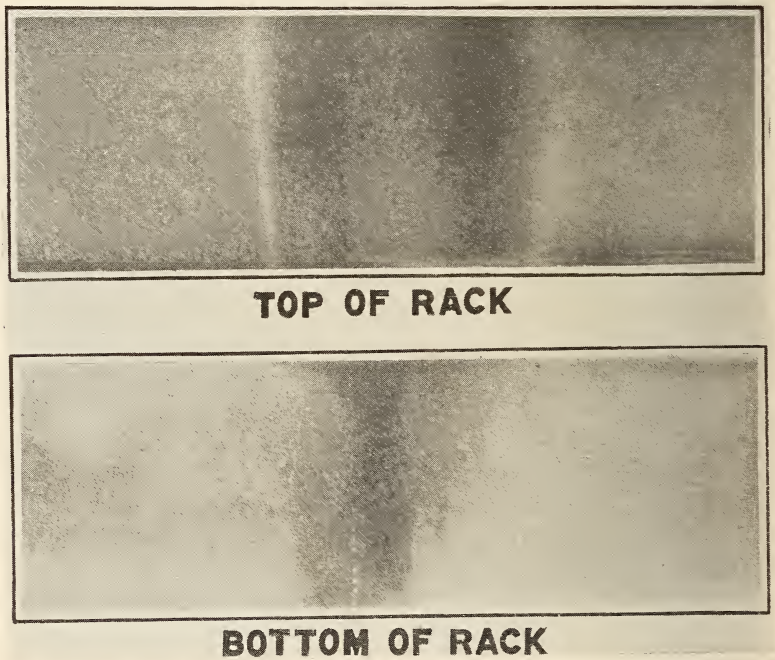


Fig. 1. Typical Development Rack Marks on Motion Picture Film

In order to demonstrate the non-uniformity of development at the top and bottom of the rack a length of motion picture film was given a uniform exposure and developed for the normal time, five minutes, at 65° F., the rack being kept stationary. The density of the developed film was measured in several places at the top, middle, and bottom of the rack and the average measurements were found to be as follows:

Top of Rack	Middle of Rack	Bottom of Rack
1.32	1.15	1.02

This grading of density from top to bottom of the rack is due to the fact that wherever development occurs reaction products consisting of oxidized developer and sodium bromide are formed. These substances are strong restrainers of development and have a greater density or specific gravity than the fresh developer and therefore tend to flow downward, while developer flows from above to take its place. As the developer flows down the vertical film it becomes gradually more and more exhausted because it has assisted in developing the upper portions. This results in a gradual diminution in the degree of development of the film from top to bottom of the rack.

The actual existence of convection currents in a vertical developing tank has been shown by Bullock,[1] who placed paper fibres in the

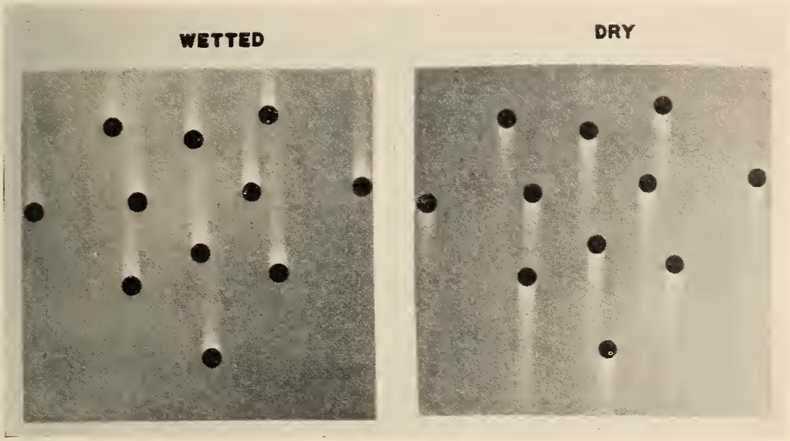


FIG. 2. Streaks caused by the Restraining Action of the Products of Development

solution. During development the fibres were observed to travel downwards along the film and then upwards at the side of the tank.

The restraining effect of the reaction products of development may be very clearly demonstrated by exposing a strip of film through a metal plate punched with a number of holes, slightly flashing the whole film to light and then placing the film vertically in the developer without agitation. Immediately below each black circle which develops up, a white tail is produced as shown in Fig. 2 caused

[1] "On the Convention Effects in Photographic Bathing Operations in the Absence of Agitation," by E. R. Bullock, B. J. Phot., Feb. 1922, p. 110.

by the restraining effect of the reaction products from the development of the circles, which reaction products gravitate downwards. If the film is wetted before being placed in the developer the white tails appear above the circles (Fig. 2) because the reaction products diluted with the water absorbed by the film have a lower specific gravity than the developer and, therefore, travel upwards.

The probable direction of the convection currents occurring in a vertical motion picture developer tank is shown in Fig. 3.

The main currents *ABFE* and *CDHG* flow parallel with each side of the rack. At the bottom of the rack small eddy currents

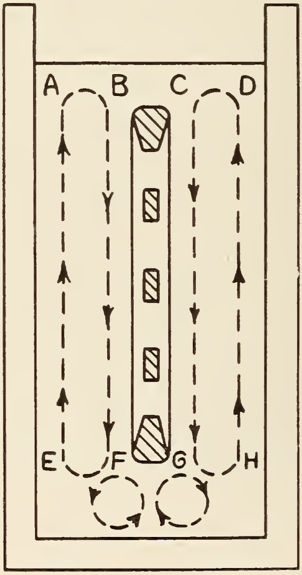


Fig. 3. Diagram Illistrating the Probable Direction of the Convection Currents in a Motion Picture Developing Tank

probably exist, while across the top of the rack the developer remains relatively stationary.

At the points *B* and *C* the developer is continually renewed, while between these points the reaction products of the developer remain stationary and development is restrained so that a double rack mark is produced as shown in Fig. 1*A*. At the points *F* and *G*, development is restrained by the reaction products flowing down the film, while between these points the developer is being continuously renewed by virtue of the eddy currents, so that only a single rack mark results as shown in Fig. 1*B*.

Negative rack marks appear as light bands on the positive print. The positive film may therefore contain both negative (light bands) and positive (dark bands) rack marks at varying intervals but separated by a distance not greater than the height of the rack. Only in rare instances do the positive and negative rack markings coincide.

Methods of Preventing Rack Marks.—Since rack marks are caused by non-uniform development, the remedy is somewhat obvious, but it is very difficult in tank work to ensure that each portion of the film develops at exactly the same rate. To attain this end the developer must be renewed at each point at the same rate, and this can be partly effected in the following ways:

1. *By agitation of the developer with the rack remaining stationary.* This can be accomplished by means of a pump or mechanical stirrer, but in the case of a deep tank it is almost impossible to so agitate the developer that the rate of renewal of the developer at the surface of the film is constant throughout its entire length. The experiment was tried of injecting a stream of nitrogen gas (so as not to oxidize the developer) at the bottom of the tank, but unless an even stream of the gas passed up each side of the rack uneven development resulted. In view of the expense involved and the difficulty of securing uniform agitation, this method was abandoned.

2. *By agitation of the rack.* The rack can be agitated in the following ways:

(a) By lifting the rack vertically out of the developer and re-immersing. This is the only method of agitation possible if the tank is fitted with rack guides. The rack is normally held down under the solution by a suitable fastener but on releasing this, the rack tends to float and usually protrudes about halfway out of the tank. If the rack is again submerged this will produce sufficient agitation to replace the reaction products of development at the surface of the film with fresh developer and mix the developer as a whole so as to be more nearly homogeneous.

The question arises as to how often agitation is necessary. The process of lifting and re-immersing the rack in a vertical direction causes a strong current of developer to strike against the lower slat, which tends to produce more development at that point and accentuate the rack marks. Experience has shown that agitation of the rack by allowing it to rise out of the developer and immediately re-immersing once every minute produces an effective degree of agitation of the developer.

(b) By leaving the rack fully immersed and imparting to it a "square motion"; that is, the rack is moved horizontally across the tank away from the operator, then vertically downwards, then across the tank towards the operator, and then vertically upwards. This manipulation may be termed the "square motion" and is only possible if the tank does not contain rack guides and if the depth of the liquid is somewhat greater than the height of the rack. Experience has shown that the rack must be agitated almost continuously in this manner in order to produce effective agitation, but this is not practical, and in case the film is developed by time it is difficult to duplicate the degree of agitation.

3. By moving the film along the rack during development. This can be effected in two ways:

(a) By winding the film on a roller rack previously described,[2] which consists essentially of a regulation rack with the end slats replaced by rollers. By attaching the film at each end to the rollers by means of rubber bands and turning the upper roller during development, the film is progressed along the rack spirally, and any unevenness of development at the roller end is distributed over the film for a length of two or three feet, and rack marks are therefore effectively prevented. When using such a rack it is desirable to agitate the developer by lifting the rack out and re-immersing once every two minutes. Owing to its relatively higher cost and the extra time required to load such a rack, it has not been generally adopted, though as a means of preventing rack marks it is highly effective.

(b) By progressing the film along the rack manually. This is accomplished by attaching the film at each end by means of a long rubber band capable of being stretched two or three feet. The same procedure is then followed as when tightening the film after winding on the rack, although this is carried out while the rack is completely immersed under the developer. By advancing the film spirally in this way every two minutes fairly even development is obtained.

This procedure requires the undivided attention of the operator and is otherwise objectionable but is the only alternative manipulation to the roller rack method for completely eliminating rack marks.

[2] "The Development of Motion Picture Film by the Reel and Tank Systems," by J. I. Crabtree, Trans. S.M.P.E., Vol. 16, p. 163.

4. By making the end slats of the rack as broad as possible and with a curved surface. This has the double effect of producing better stirring of the developer on agitation of the rack and of broadening out the rack marks. Experience has shown that a broad rack mark which grades off gradually at each side is less objectionable on projection than an extremely narrow one produced by a V-shaped end slat. It has been found that cylindrical end slats having a diameter of about two inches as shown in Fig. 4 are the most satisfactory and practical.

The following experiment was also tried. Strips of wood two inches wide were attached by means of clips across each end of the regulation narrow slat rack to provide an efficient means of stirring

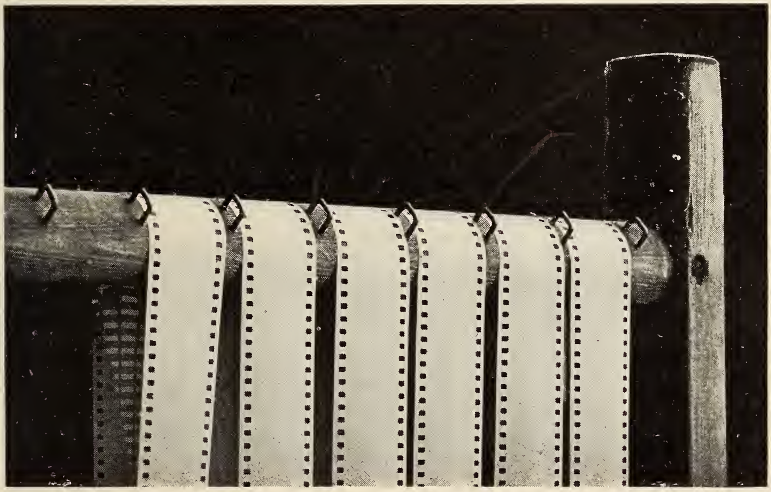


FIG. 4. Film Developing Rack with Offset Spacing Pins

and to protect the ends of the rack from an excessive flow of developer when the rack was agitated. Though moderately effective in diminishing the intensity of the rack marks, better results were obtained with the cylindrical slats.

5. By developing as far as possible to completion. As explained above, since rack marks are produced by virtue of one portion of the film receiving more development than another, it follows that the propensity for rack marks to be produced is greater when the film is developed to a low degree of contrast than when the limiting contrast is attained. In other words, with a fully exposed positive, printed from a contrasty negative, which must be developed in a weak developer for a short time, there will be a greater propensity for rack marks to be produced than in the case of a print from a flat negative which must be developed to the limit. The matter of the degree of development of any rack of film is, of course, determined by the requirements of photographic quality. Special care, however, must be taken when developing to a low degree of contrast.

Practical Instructions for Preventing Rack Marks

By employing racks with cylindrical slats of approximately two inches in diameter as shown in Fig. 4, allowing the rack to emerge from the developer and immediately re-immersing once every minute during the course of development, both negative and positive rack marks are so effectually eliminated as to be practically invisible on the screen.

For precision work, when more absolute uniformity of development is desired, either the roller rack should be employed and the rack agitated once every minute, or the film should be progressed along the rack manually as explained above.

It should also be remembered that full development of the positive or negative tends to eliminate rack marks, and although the degree of development is determined by the requirements of photographic quality, it is desirable not to over-develop the negative in order to eliminate the necessity for giving an extremely short development of the positive, which is necessary with a contrasty negative.

Fixing Bath Rack Marks

Rack marks may be produced independently in the fixing bath if the rack is not agitated, especially during the first few minutes of fixation. Owing to the fact that the film is saturated with developer when immersed in the fixing bath, the film continues to be developed, especially in a fixing bath which is weakly acid, until all the alkali in the developer is neutralized by the acid in the fixing bath. If the rack is not agitated, the rate of neutralization of the developer takes place more slowly at the top and bottom of the rack because of vertical convection currents along the sides of the rack as outlined above under "development," so that the film continues to develop locally, causing rack marks. To prevent this, the rack should be agitated several times on first immersing in the fixing bath so as to ensure complete neutralization of the alkali in the developer, thus arresting development.

Toning Rack Marks

When toning film on a rack in a single solution toner such as a uranium or iron toning bath, it is extremely difficult to obtain uniform toning especially if only a weak tone is desired. In the case of sulphide toning, when the bleaching and sulphiding processes are carried to completion no difficulty is encountered, but with the above toning solutions toning is progressive with time and for the same reason as outlined under development, there is less tendency for rack marks to form the nearer the degree of toning is carried to completion. Any rack mark already present due to development will also be intensified in toning and unless guarded against, new rack marks will be produced during toning. It has been found that the procedure of raising the rack out of the solution every minute is not sufficient to prevent toning rack marks. In addition, it is necessary either to use a roller rack or progress the film along the rack manually. The following procedure is recommended:

a. Use a roller rack or one with two inch cylindrical slats as for development.

b. Attach the ends of the film by means of rubber bands sufficiently long to give and take through a distance equal to about three-fourths of the rack height.

c. After immersion, stretch the band at one end and feed the film back spirally from the other end in steps of four to six inches every two minutes in a manner as outlined under development.

Even with the above procedure, slight toning for a short time is not possible. Toning should be carried out for at least one quarter of the time required for toning to the limit.

In view of the fact that both the uranium and iron toned images are partly soluble in alkali, if the water is at all alkaline, uneven washing may cause local reduction of the toned image, which results in unevenness. This may be prevented either by progressing the film along the rack during washing or by washing by means of successive soakings in water weakly acidified with acetic acid.

When developing on a reel, barmarks or slat marks are invariably produced at or near the point where the film passes over the slat or bar. This is because the slats act as paddles to agitate the developer, and the impact of the developer against the film is greatest at or near the slats, so that the developer is renewed most rapidly at these points, resulting in an increased rate of development.

Curved markings, as shown clearly in Fig. 5, are also produced as a result of curling of the film between the bars, which causes the developer to flow more or less in specific channels.

Reel bar marks may be minimized by using a reel with as many slats as possible so that the cross section approximates to a circle, by avoiding rapid rotation of the reel, and by reversing the direction of rotation of the reel at intervals.

Airbell Markings

When a strip of motion picture film is immersed in a developer or other solution, there is always a tendency for more or less air to be carried along with the film under the solution, where it immediately tends to assume a spherical shape resulting in a so-called airbell, see

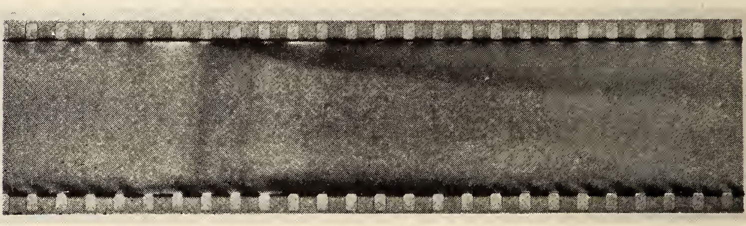


Fig. 5. Bar Markings Produced when Developing Film on a Reel

Fig. 6. The bubble of air usually clings to the film throughout the course of development unless for some reason it is dislodged, and it prevents access of the developer so that on subsequent fixation a clear spot or airbell marking remains. Sometimes the airbell persists throughout fixation or is formed again on immersion of the film in the fixing bath, so that after washing a spot of unfixed-out emulsion remains.

Clear airbell markings produced on negative film appear as dark spots on the positive, and in view of the present practice of developing negative film on racks and positive film on processing machines, which do not have so great a tendency to give airbells, most airbell markings seen on the screen at the present time are dark spots caused by airbells on the negative.

At the moment of formation the airbell is usually hemispherical and has a relatively large area of contact with the film, but owing to the tendency of the airbell to assume a spherical shape the area of contact with the film tends to become very much smaller. As the area of the circle of contact diminishes due to this change in shape, the emulsion previously protected becomes partially developed, which results in a clear spot corresponding in size to the area of contact of the final airbell, surrounded by a dark ring of lighter density than the surrounding area.

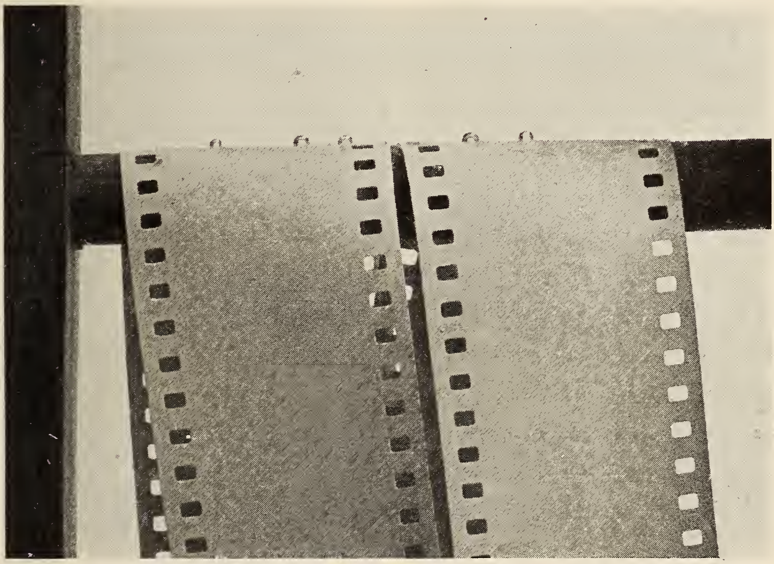


Fig. 6. Air Bubbles Clinging to Motion Picture Film

If the airbell forms on the film along the sides of the rack, owing to the tendency of the air to rise to the surface, the airbell frequently becomes elongated so that the area of contact is not circular but oval. The tendency for distortion is greater with the larger airbells, which explains why the larger airbell markings are rarely circular, while the small markings are invariably circular. A typical group of circular and irregular airbell markings is shown in Fig. 7.

Unless the surface of the emulsion is locally greasy or burnished, the points of attachment of the airbells are determined merely by chance. However, there is usually a greater propensity for the airbells to become attached where the film passes over the ends of the rack, so that rack marks are usually accompanied by airbell markings (see Fig. 8).

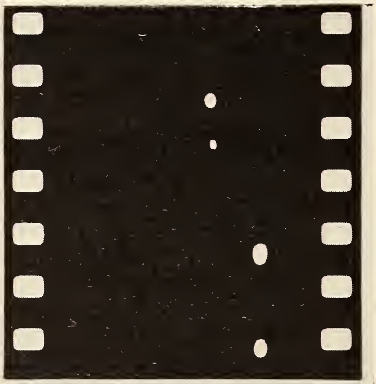


Fig. 7. Group of Circular and Irregular Shaped Airbell Markings

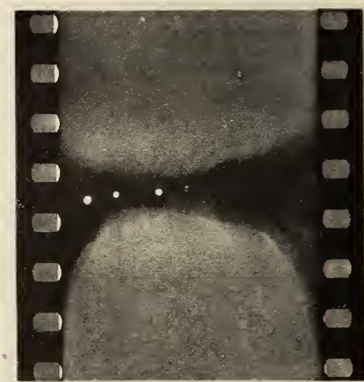


Fig. 8. Airbell Markings Coincident with a Rack Mark

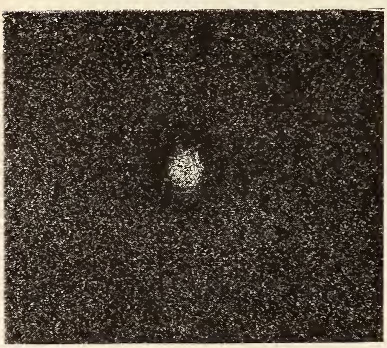


Fig. 9. Airbell Marking—Clear Spot Surrounded by a Dark Ring

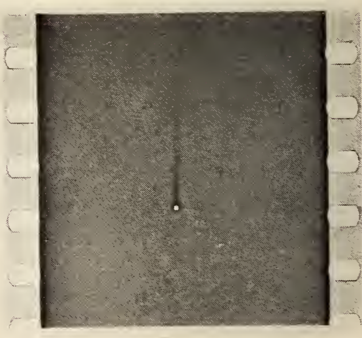


Fig. 10. Airbell Marking—Clear Spot Surrounded by a Dark Ring Accompanied by a Tail

Classification of Airbell Markings

Airbell markings may be of the following types:

1. *Clear white spots.* These may be either circular or irregular in shapê, as explained above. (See Fig. 7). The clear cut edges of the

spots indicate that the area of contact of the airbells did not materially alter during the course of development.

2. Gray spots. These are similar in shape to those illustrated in Fig. 5 but are not perfectly clear and contain more or less silver grains. They are caused by the airbell breaking or becoming dislodged during development so that the spot was protected for only a part of the total time of development.

3. Clear spots surrounded by a dark ring. (see Fig. 9). The dark ring is probably a result of developer oxidation fog caused by local oxidation of the developer by the airbell. This type of marking occurs only rarely and with freshly mixed developers which are susceptible

Fig. 11. Airbell Marking—Clear Spot Surrounded by a Gray Ring

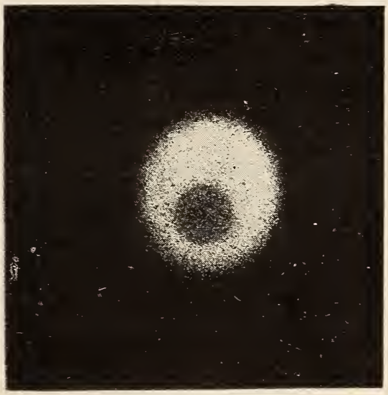


Fig. 12. Airbell Marking—Clear Spot with Central Dark Ring

to aerial oxidation fog. In such a case if the film remains stationary during development the oxidation products of the developer flow down the film and frequently produce a fog streak or tail as shown in Fig. 10.

4. Clear spots surrounded by a gray ring. (see Fig. 11). The gray ring is probably caused by a diminution in the area of contact of the airbell with the film due to a change in shape during development as explained above.

5. Clear spots with a dark central ring. (see Fig. 12). Examination of the dark nuclear ring showed that this consisted largely of silver. The exact method of formation of such markings is not known, though they could be formed by bursting of the airbell just before the film was removed from the developer so that the whole airbell area became saturated with developer, and the reforming of a smaller central bubble when the film was immersed in the fixing bath. This second bubble would prevent the access of the fixing bath and permit of development of the image underneath by the developer absorbed by the film after the bursting of the first bubble.

Such a marking could also result from the printing of a positive image from a negative containing airbell markings similar to those described under "3" above; namely, "clear spots surrounded by a dark ring."

6. Clear spots with a nucleus of silver halide. The appearance of these spots by transmitted light is essentially the same as those shown in Fig. 12, although the dark central ring consists largely of silver halide instead of metallic silver. The method of formation of such spots is probably as follows: During development the airbell prevents access of the developer to the emulsion and persists until the film is removed from the developer. On re-immersion in the fixing bath a small airbell forms where the larger bell previously existed, thus protecting the emulsion from fixation.

The difference between the spots indicated under 5 and 6 is, therefore, merely a result of slight wetting of the previously protected airbell area with developer immediately before fixing. A nucleus of silver halide is produced in one case and a mixture of silver and silver halide in the other.

Factors Affecting the Number of Airbells Formed.—The quantity of airbells which may accumulate on the film is determined by the following factors:

1. The manipulation of the rack. This determines:

a. The rate of immersion of the film. If the film is immersed rapidly there is a much greater tendency for it to carry down airbells than when immersed slowly. It is important therefore to immerse the rack slowly, especially when the end slat touches the surface of the developer, because most airbells usually accumulate along the end slats.

Rapid immersion is also apt to cause foam on the surface of the developer, and the small air bubbles constituting the foam attach themselves to the film causing airbells.

b. The time of soaking before removing from the developer. Experience has shown that if the film is immersed quickly in the developer, allowed to remain submerged for only a few seconds, and is then lifted completely out of the developer and resubmerged, a much larger quantity of airbells will be formed than when the film was originally immersed.

Short immersion of the film in the developer followed by exposure to the air leaves the film in a partially swollen state, and in this condition it has a much greater propensity to carry along airbells with it on subsequent immersion than the dry or completely swollen film. It is usually necessary to allow the film to soak for at least twenty to thirty seconds after the first immersion in order to remove this tendency.

c. The degree of agitation of the rack. In many cases airbells can be dislodged after the film has been thoroughly soaked by rapid agitation of the rack or by slapping the end slat against the surface of the developer, though when developing by time it is necessary to duplicate the rack agitation precisely and too much rack manipulation is not practical. It is preferable to remove the airbells manually as described below.

2. *The quantity of grease on the film.*—A very slight trace of grease or oil on the film will so affect the surface of the emulsion that it has a greatly increased tendency to attract airbells. Any appreciable quantity of oil or grease will also act as a resist and prevent the access of the developer. Preliminary soaking of the film in a solution of sodium carbonate will often overcome this tendency (see below).

3. *The condition of the developer.*—Experiments have shown that old developer which frequently tends to foam badly has a greater tendency to give airbells than new developer. This foaming is the result of the presence of decomposed gelatin produced by the action of the alkali in the developer on the small particles of emulsion removed from the film by abrasion. The effect of the addition of ethyl alcohol to such a foaming developer was tried, but no beneficial effect was observed by the addition of increasing quantities of the alcohol up to 10%.

Methods of Preventing the Formation of Airbells.—The formation of airbells may be prevented as follows:

1. *By soaking the film in water or a solution of sodium carbonate (about 2%) before development.* This has the effect of thoroughly soaking the gelatin, in which condition the propensity for airbells to form is a minimum, while the carbonate solution tends to remove traces of grease which would otherwise cause airbells and prevent

access of the developer. The carbonate treatment, however, will not remove splashes of mineral oil.

Any airbells which cling to the film during the soaking process can be removed manually by passing a soft camel's hair brush along the top slat, reversing the rack in the tank and repeating the process.

After soaking the film it is very necessary to thoroughly agitate the rack for the first minute after immersing in the developer, otherwise the liquid carried over by the film will still adhere and cause development streaks.

Soaking is objectionable insofar as it involves an extra operation and is really not necessary if the manipulation outlined below is followed.

2. *By taking care not to use developer which is too old and which foams badly,* by immersing the rack slowly, and by allowing the film to remain under the surface of the developer for at least 30 seconds before lifting out of the developer for any reason whatever.

3. *By removing the airbells mechanically.*—Experience has shown that even when the above precautions are taken some airbells may still cling to the film, and especially at those parts where the film passes over the end slats. The only way to be absolutely certain of the absence of airbells at these points is to remove the airbells by passing the hand or a soft camel's hair brush along the upper and lower slats during the course of development. If this is done with reasonable care the film emulsion will not be damaged or scratched in any way although no trace of hypo must be present on the fingers or brush, otherwise streakiness will result.

With the usual rack it is not possible to pass the hand across the slat owing to interference by the separating pins. This difficulty may be overcome by offsetting the pins at an angle of 45° as shown in Fig. 4 or by omitting the pins on the slats and placing a bar fitted with spacing pins slightly below the end slats.

Practical Instructions for Preventing Rack Marks and Airbell Markings.—Both rack marks and airbell markings may be largely prevented by adhering to the following manipulative procedure which should be applied when developing both negative and positive film.

1. Use racks with cylindrical end slats approximately two inches in diameter with the spacing pins offset at approximately 45° so as to permit of passing the hand or brush along the length of the slats so as to dislodge any airbells.

2. Lower the rack slowly and carefully into the solution, and when the lower slat is just below the surface pass the hand quickly along its entire length so as to dislodge any airbells. Then completely submerge the rack, and in a similar manner quickly pass the hand across the upper slat and allow the rack to remain submerged for thirty seconds. Then allow the rack to float, resubmerge immediately, and repeat this operation once every minute during the period of development.

3. In case this treatment does not entirely prevent airbells, the film should be soaked in water or a 2 percent solution of sodium carbonate for three or four minutes before development, and after placing in the developer the rack should be moved continuously during the first thirty seconds while submerged in order to prevent streakiness.

Rochester, N. Y.
September 22, 1925.

DISCUSSION

Mr. Chanier: Has Mr. Crabtree tried to avoid rack marks by circulating the developer; for example, pumping it out at the bottom and putting it back at the top of the tank?

Mr. Briefer: Mr. Crabtree omitted to include the theory of airbells running up the sides of the film, but he recommends a remedy for it in that the rack must be dropped slowly into the tank. Our experience is that the airbells attach themselves between the perforations and they then come out and attach themselves to the side.

Also, we get effects such as Mr. Crabtree has shown when the top of the rack is near the top of the developer level. When there is plenty of developer above the rack, the markings are very infrequent. We have found a good deal of trouble due to the top of the developing tank and the bottom being at different temperatures. Manipulation of the rack is the only practical way for the operator to prevent irregularities.

Mr. Ziebarth: Has Mr. Crabtree found that rack marks show from the hypo bath if the film is placed in water for a minute between the developer and hypo? We have found that the hypo rack marks were eliminated in this way.

Mr. Richardson: We have a good many complaints concerning new film which will not stay in focus during projection. The picture will be alternately in and out of focus on the screen. The only explanation I have been able to get from laboratory men concerning this fault is that it is caused by forced drying, and the fact that in forced drying the edge dries quicker, setting up internal stress which causes buckling over the aperture during projection. The reason has been advanced that it is due to high power light sources used in the first run of film when it contained a great deal of moisture. I should like to know if you can throw any light on this subject?

Mr. Crabtree: In reply to Mr. Chanier, I don't know of any method of circulating the developer so that you would get equal rate of renewal at all points of the rack. We have tried this but it was worse than no circulation at all; it has the same effect as agitation of the developer with gas. Unless the flow of gas is equal at every point, you get uneven development.

In regard to Mr. Briefer's remarks: Certainly air is trapped as the rack is dropped in the developer, but as it is released, it rises and usually does not encroach much on the picture area. Usually the airbells are fairly large ones, and once they get started on their movement, they are not likely to cling to the film. It is the small airbells and particularly those across the top and bottom of the rack that cause the trouble. The small airbells which attach themselves haphazardly are not of serious moment. The fact that you get more rack marks when there is little solution above the top of the film may be due, I think, to the fact that the developer tends to oxidize more rapidly at the surface and produces more fog. Also, where the temperature of the room is greater than that of the developer, so that the temperature of the solution at the top would be greater than at the middle of the tank, more development takes place at the top of the rack causing uneveness.

In reply to Mr. Ziebarth, a rinse in water will tend to remove the developer, although you have to rinse for two or three minutes to prevent fixing bath rack marks entirely. Many laboratories do not rinse at all between developing and fixing, in which case agitation in the fixing bath is necessary.

In reply to Mr. Richardson, the "in and out of focus" effect is due to the buckling of imperfectly dried film under the heat of the projector. In the case of film which is rapidly dried at too high a temperature, only the outer skin on the gelatin coating is dried, and when the film is later subjected to the heat of the projector it buckles slightly in the gate causing the effect in question.

A HIGH POWER SPOTLIGHT USING A MAZDA LAMP AS A LIGHT SOURCE

L. C. PORTER AND A. C. ROY*

MODERN theatrical performances are being lighted largely by projected light. For this work, many types and sizes of incandescent lamps, spotlights, and floodlights have been developed. These same types of projectors also find wide application for the lighting of pageants, dance halls, and many other similar institutions. The one unit, however, where the arc lamp spot has reigned supreme has been in the high power spot. Where a long throw is used, and a small intense spot of uniform distribution is required, the Mazda lamp has been unable to compete with the arc. This has been due to several reasons, primarily the greater concentration of light source obtained with the crater of the carbon arc, its high brilliancy, and the lack of a lens system especially adapted to the incandescent lamp.

About a year ago, the authors set out to overcome these conditions and build a spotlight using a Mazda lamp as a light source that could successfully compete with the arc; especially the D.C. arc. In order to find out what we were trying to compete with, we secured a number of the best spotlights on the market and made photometric distribution curves of their beams, concentrated to the smallest spots, and also spread out to the maximum floods. D.C. spots were used, as the A.C. ones gave much lower beam candlepower than D.C. for the same current consumption. A summary of those tests shows the following results:

Light Source	Condenser		Beam Candlepower			
			Spot		Flood	
	Lens	Focus	C. P.	Spread	C. P.	Spread
25 Amp. D.C.arc	6"	10½"	80,000	11°	11,000	30°
50 " " " "	"	12"	750,000	4°	25,000	"
70 " " " "	"	"	950,000	6°	35,000	43°
400 W 115 V.Mazda	5"	8½"	13,000	10°	5,000	20°
1000 " " " "	"	"	47,500	8°	6,000	30°

Experience has shown that the light of the Mazda lamp lies more nearly in that portion of the spectrum to which the eye is most

* Commercial Engineering Department of Edison Lamp Works, Harrison, New Jersey.

sensitive (yellow-green) than that of the arc. This, together with the steadiness of the illumination from the Mazda lamps, gives an apparent equal intensity value for the two illuminants when the actual foot candle intensity of the incandescent lamp is appreciably lower than that of the arc. It seemed probable, therefore, that if an incandescent lamp spot could be built that would produce a spot of uniform intensity, and of about five or six hundred thousand candlepower, it would better any arc spotlight and be fully as effective as D.C. spots up to 50 ampere capacity.

In attempting to build such a spot, we realized that the ordinary coiled wire filament light source was unsuitable. A lamp of this nature, when placed at the focal point of a lens system to obtain the maximum beam candlepower, threw an enlarged image of the filament coils in the spot, giving it a streaky appearance. To overcome this, we used a tungsten ribbon as a light source. In order to increase the brilliancy of the ribbon to a maximum, it was crimped, so that by cross reflection between the crimps the apparent brilliancy of the source is increased.

A ribbon of this type has a rather low resistance and, therefore, consumes a high current. The area from which a lens system collects light is small; this means a fairly short filament is all that can be utilized. In other words, a low voltage, high amperage lamp. Various sizes and shapes of light source were experimented with, but the one that has been finally chosen as most satisfactory is an 11 volt, 140 ampere lamp in a T-24 bulb; $13\frac{1}{2}''$ overall length, $3''$ diameter, $7\frac{1}{2}''$ light center length having a special two prong base, No. 1838. This base is necessitated by the high current which is too great to be carried by the common mogul screw base. Two lamps are used so that, in case one fails during a performance, the other may be immediately turned into position (Fig. 1).

Lamps of this capacity can be most readily operated from transformers, a standard 120 to 11 volt, 1500 watt sign lighting transformer being well suited to the purpose.

A starting resistance is necessary with these high current lamps to prevent the "overshooting" of the current burning out the filament. A "no-voltage" release A.C. motor starting box is provided for this purpose and is mounted upon the base of the spotlight.

Study of the spotlights on the market showed at once that they used condensers of relatively long focal length, which would pick up but a small percentage of the available light flux from a Mazda lamp.

We therefore adopted the short focus aspheric condensers which had been developed for use with Mazda lamps in motion picture projectors. In order to pick up all of the light that these condensers were able to collect, we used an 8″ diameter, 15″ focus plano convex lens in the end of the spotlight housing. The special lens system was fitted into a standard housing of a well known make.

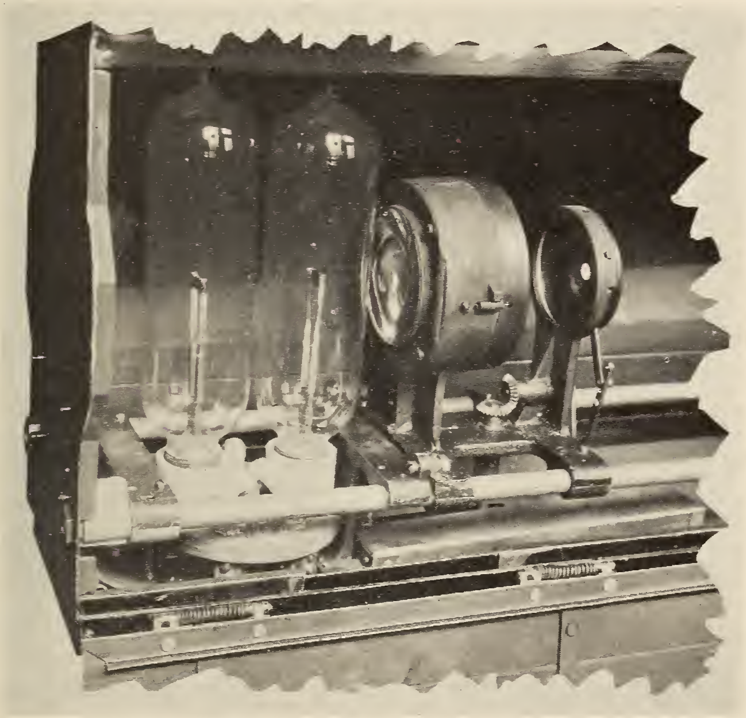


Fig. 1.

With this combination we obtained a nice smooth spot of uniform intensity and about 700,000 beam candlepower. We thought the problem was solved. The spot, however, being really an enlarged image of the ribbon filament, was somewhat elliptical instead of round. Test of the spotlight in a theatre developed the fact that the high priced artists objected to appearing in an elliptical spot. They preferred a round spot. In order to obtain this round spot, and also to provide an easier method of control of the size of the spot, an iris diaphragm was added in front of the aspheric condenser. The lamp, aspheric condenser, and iris diaphragm were mounted as one unit on a carriage that could be moved forward and back, thus varying the

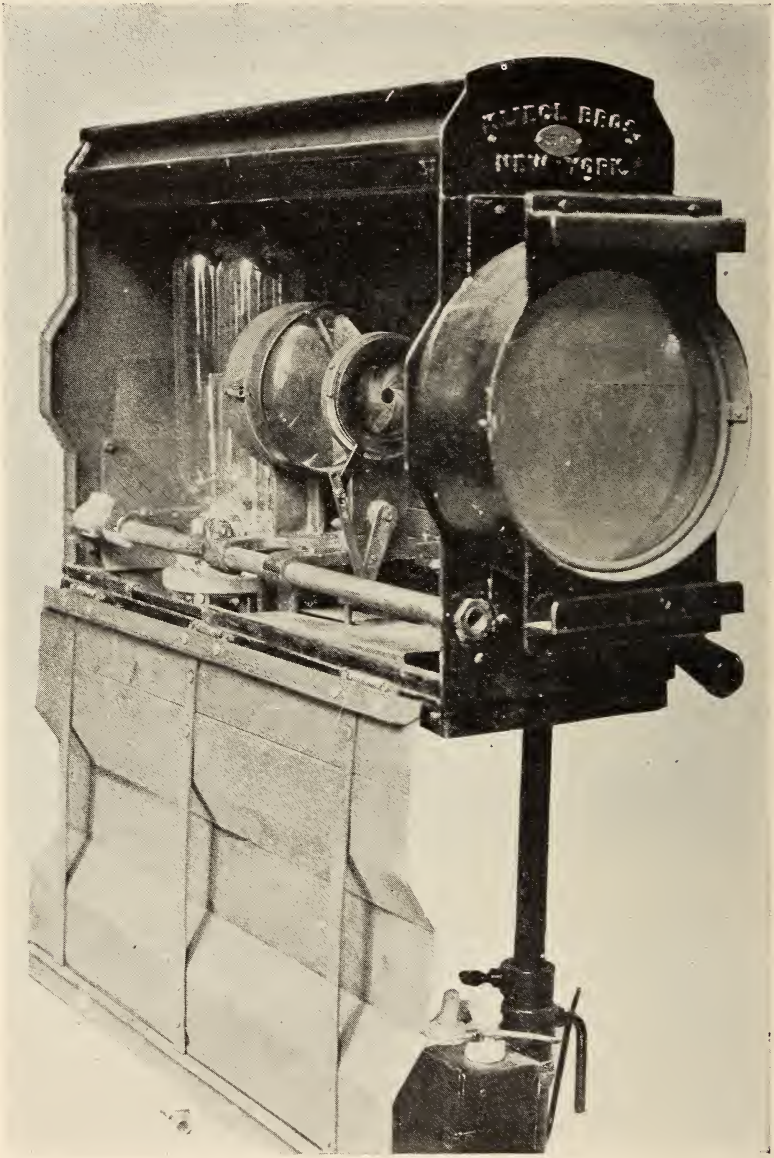


Fig. 2.

distance between the plano lens in the end of the spotlight, and the light source (Fig. 2 and Fig. 4).

This diaphragm cuts down the intensity of the spot a little, the average being 575,000 candlepower for the concentrated spot of 2° spread, and 45,000 for the flood of 14° spread. The diaphragm produces a clean cut, round spot which is free from the usual red color

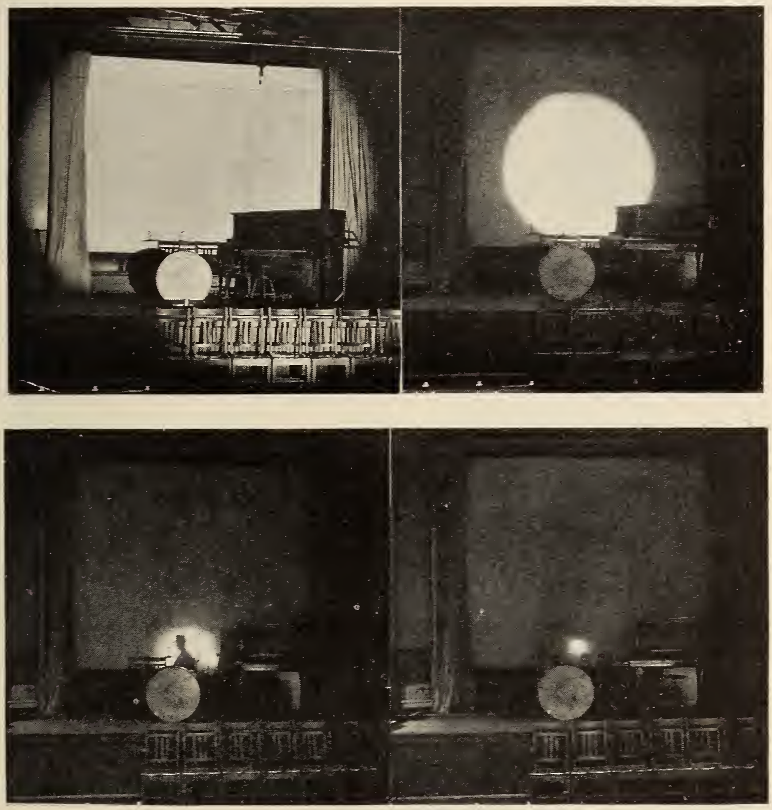


Fig. 3.—Illustrating variation in size of spot obtainable with the incandescent spotlight.

fringe around the edge. This spot can even be concentrated to such an extent as to be just the size of a person's head at 150′, something that is not possible with the arc spots now on the market (Fig. 3).

Operation

The operation of this spotlight is extremely simple. After closing the switch, the handle of the starting box is moved from starting to running position, and the lamp is ready for use.

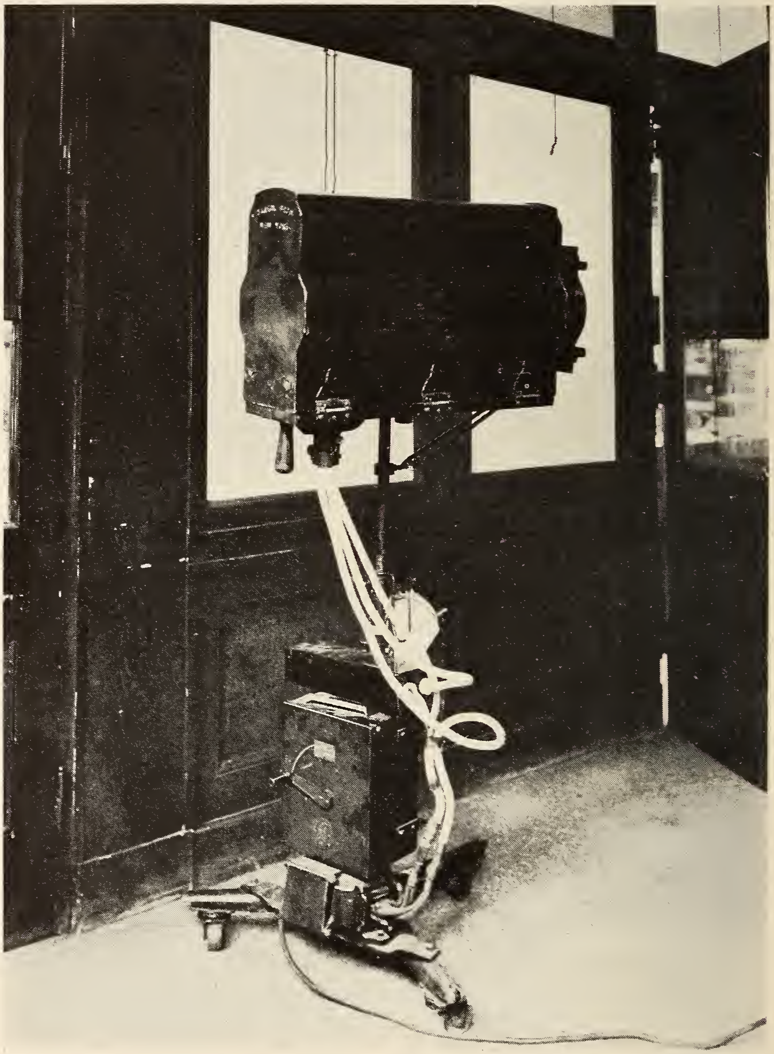


Fig. 4—The completed spotlight.

There are no carbons to adjust, no sputtering and fussing, nor time spent waiting for a crater to form on the positive carbon.

By simply turning a small knob attached by bevel gears to the diaphragm, the size of the spot of light upon the stage is varied from a small head spot to about one half the width of the usual stage. For flooding, a slight forward movement of the "lamp carriage" is necessary to cover the full width of the stage. Contrast this with the continual shifting of the arc lamp in order to accomplish the same result. Once lighted, the Mazda lamp requires no further attention, while the arc lamp must be watched and adjusted continually.

Economy of Current Consumption

The 50 ampere arc, when operated from a 120 volt line with the usual resistance units, consumes about 6000 watts.

If a motor generator set is employed, a potential of about 70 volts is generated, and after passing through the necessary resistance units, about 3500 watts are consumed.

The Mazda lamp requires but 1500 watts for the same apparent effect.

Quality and Quantity of Light Produced by the Mazda Outfit

The color of the spot of light produced by the Mazda lamp is soft and pleasing, and is not harsh and cold like that of the carbon arc.

This spot, therefore, offers all the inherent convenience of an incandescent lamp, such as cleanliness, reliability, steadiness, ease of control, and economy of operation. It should be a great boon in theatrical work, and for places where lighting lines are already too heavily loaded to permit of the addition of a 5 or 6 kilowatt arc spotlight.

DISCUSSION

Mr. Richardson: Mr. Porter, you have a low voltage, high amperage proposition there, and any slight change in voltage would enormously affect the amperage. How do you handle that? I noticed apparently in two slides that your collector lens was longer than the converging lens; apparently, you have a two lens condenser. Why is that if it is true? In the last slide, in your light distribution on the medium and small spots—could we have that slide put on again?—(slide projected). As I understand this, while you get an amazingly even distribution on a floodlight, you get a bright center with a relatively dim edge in the spot. Another thing I noticed was that you say, for instance, seven hundred thousand beam candle power.

Do you mean the candle power of the entire beam and, if so, why is the flood so much less? I would say that in theatrical work it has always been my impression, and I should like to hear from Mr. Denison on this, that the spotlight with a sharp edge is not desirable; it gives the impression of a hole cut in the slide. I believe the diffused edge is better.

Mr. Crabtree: What is the relative value of the ribbon compared with the cylindrical filament?

Dr. Hickman: There seems to be a tendency at the present time for all forms of searchlights to converge in two widely different directions. There is the mirror arc projector, the mirror spotlight, and the automobile head lamp, which have unanimously come to the use of a simple mirror or collecting lens and nothing else, of parabolic surface, and these give a reasonably sharp spot. On the other hand, there are the complicated condensing systems which work with a diaphragm and a second set of lenses. The effective light is only the small cone collected in front of the source and everything else is wasted, and the photographic candle power is cut down by the many glasses that the light has to penetrate. I should like to ask the lecturer if he could give us some idea of why the complicated system has been adopted and why the simple mirror arc has been displaced.

Mr. Beggs: What is the average life of the lamps?

Mr. Powrie: Has any use been made of the lamp for photographic work in the studio? It might be particularly adapted for color motion pictures.

Mr. Porter: In regard to the variation in voltage on the lamps, it is true that a change in voltage affects the candle power in the same way as it does ordinary incandescent lamps, but most of the city lines are held within 1 per cent or 2 per cent, and the c.p. variations caused by this small fluctuation is scarcely noticeable on the screen. A variation of 2 per cent does not materially reduce the life of the lamp.

With regard to the double lens condenser system, we use this to pick up a greater solid angle of light.

In regard to the distribution curves showing a bright center, it is true that the center is higher than the edge. This is true with any spotlight unless it is out of focus. As to where the edge is, this is difficult to determine. The edge of the spot is not absolutely sharp; you can't lay a pencil point on it and say, "That is the edge." If it is desirable to have it fade off even more gradually, that is easy to accomplish.

With regard to the life of the lamps, the ribbon filament lamps have a life of about 60 hours. That is along the general life policy of incandescent projection lamps in which we strive for intrinsic brilliancy rather than life.

Answering Dr. Hickman as to why single mirrors are used in the large searchlights and parabolic reflectors and not in spotlights, the answer is that in the spotlight you must have a unit which can be changed rapidly from a concentrated beam to a wide spread flood, and you can't do this with the single mirror.

With regard to the use of a spherical mirror behind the lamp; that is practical with the wire type filament, but with the ribbon you don't gain much with the mirror. By reflecting the image back onto the ribbon itself, the temperature of the ribbon is increased, and you only save a very little energy. It would be possible to make an apparent larger light source by reflecting the image just above the filament, but this seems scarcely worth while for this type of lamp. Mirrors deteriorate fairly rapidly, and it doesn't seem worth while to fuss with them.

In regard to the use of the spotlight in studios, we have not tried it. We are not in the spotlight business, don't manufacture them, and don't intend to, but we wanted to find out whether an incandescent lamp can be applied to high power spotlight work. We hope some one will build spots along this line, and we should be glad to assist anyone who wants to do it.

Dr. Hickman: The reason I raised the question was that I was shown a large number of spotlights in the U.F.A. studios in Berlin. They were using sizes from two to six feet in diameter with small plane mirror units about three inches square arranged within a parabolic metal cage so that the entire assembly formed a parabolic mirror with linear facets. One got an enormous light flux spot with a brilliant center and soft fading away at the edges. I believe they got very efficient lighting by the invention, though I am not sure that they were exploiting it. I think they were simply using it themselves, and I wondered whether any experimenting had been done here along that line.

Mr. Porter: We have experimented with the lamps for searchlight work but have not tried them with long focus mirrors for spotlight work.

THE EFFECT OF SCRATCHES AND CUTS ON THE STRENGTH OF MOTION PICTURE FILM

S. E. Sheppard and S. S. Sweet

In an earlier paper on this subject[1] the effect of scratches on the strength of film support, not coated with emulsion or processed, was discussed. It was concluded from the measurements that the "principal effect of a scratch is due to its depth" reducing the effective thickness, and "the idea sometimes expressed that the mechanical strength of such materials as support and similar plastics is greatly dependent upon superficial scratches, and a surface skin does not hold for motion picture film support." In the discussion the point was raised whether the age of the film and its brittleness would not change the matter, so that scratches would have relatively more effect. A further study has now been made on processed film brought to equilibrium with an atmosphere of definite temperature and humidity.

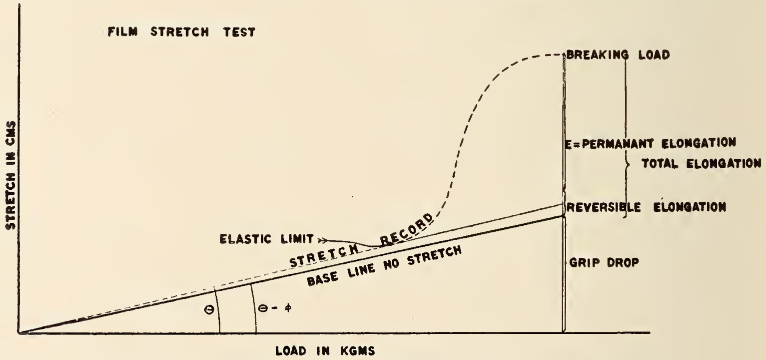


Fig. 1.—Diagram of stress—strain curve of film support.

In order to understand the values tabulated it is necessary to reproduce the diagrammatic representation of the characteristic stress-strain curve for film. (Fig. 1). The meaning of the total and permanent e ongation at the breaking load will be clear. The strength measurements were made with a pendulum tester fitted with an automatic recording device so that the stretch-load curve could be plotted at any convenient speed of loading. (Fig. 2).

[1] Trans. S.M.P.E., May, 1924, p. 102.

Scratches were made by an apparatus designed to draw the film at constant rate under a point bearing a fixed load.

Experimental Results.—In the first series processed positive motion picture film was conditioned at 30, 50, and 80 per cent relative humidity at 70° F., scratched under different loads, the scratch extending from edge to edge, on the support side.

Fig. 2.—Stress and elongation testing machine.

Nitrate Base Film 35 mm.

Scratch Load	*30 per cent R.H. Breaking Load*	*50 per cent R.H. Breaking Load*	*80 per cent R.H. Breaking Load*
0 gms	11.6 kg	12.35 kg	9.1 kg
100	11.5	12.25	9.0
500	12.1	11.81	9.0
900	11.3	10.25	8.9
1270	11.3	11.30	8.5

Acetate Base Film 35 mm.

Scratch Load	*30 per cent R.H. Breaking Load*	*50 per cent R.H. Breaking Load*	*80 per cent R.H. Breaking Load*
0 gms	12.35 kg	13.0 kg	8.5 kg
100	12.20	12.3	8.0
500	12.80	11.5	8.2
900	12.50	11.5	7.5
1270	11.00	11.4	7.1

In these tests scratches began to be visible at about 100 gms load. Up to 500 gms load the break did not necessarily ocurr at the scratched place. This corresponds with the fact that these films showed little weakening by scratches until loads of 900 gms or more were applied.

These results on emulsion coated processed film, some months old, show to an even greater degree than the former ones with raw film support, that only very deep scratches seriously affect the strength. Folding tests showed a similar behavior, although the effect of increasing scratch load was somewhat more marked.

Processed Nitrate Film

Scratch Load	*30 per cent R.H. No. of Folds*	*50 per cent R.H. No. of Folds*	*80 per cent R.H. No. of Folds*
0 gms	44	47	38
100	41	45	38
500	37	30	35
900	25	29	26
1270	15	21	18

Processed Acetate Film

Scratch Load	*30 per cent R.H. No. of Folds*	*50 per cent R.H. No. of Folds*	*80 per cent R.H. No. of Folds*
0 gms	33	24	27
100	31	24	26
500	28	25	28
900	21	25	20
1270	15	19	17

This increased effect of scratches as shown by the decrease in number of folds with scratch load was, however, only observed when the scratch crossed the perforations. When the scratch was made between the perforations, not touching them, there was practically no effect on the folds within the limits of the experimental conditions.

The folding tester used was a new one designed in this laboratory; the folds do not necessarily correspond with the Schopper folds, although they agree relatively with hand folding tests.

Effect of Scratches on Elongation.—In an interesting paper presented at the Spring meeting of the Society in 1924 by Mr. M. Briefer,[2] it is remarked that "even a slight nick, so slight as to be imperceptible to the naked eye, wil' shorten the elongation curve fifty per cent and more. A very light scratch on the celluloid side, if it reaches the edges of the films, will have the same effect." Tests were made measuring the whole elastic curve after scratches had been applied.

Processed Nitrate Film 35 mm.
at 50 per cent R.H. and 70° F.

Scratch Load	*Breaking Load*	*Total Elongation cms*	*Permanent Elongation cms*
0 gms	11.0 gms	31 %=5.9	4.25
100	8.1	19 %=3.6	2.23
500	8.4	15 %=2.8	1.30
900	9.4	11.5%=2.2	0.90
1270	9.0	7.5%=1.4	0.00

Processed Acetate Film 35 mm.
at 50% R.H. and 70°F.

Scratch Load	*Breaking Load*	*Total Elongation cms*	*Permanent Elongation cms*
0 gms	12.0 kg.	(2.7 =15%)	1.3 cms
100	10.3	4.35=23%	2.8
500	10.8	3.5 =18%	1.7
900	10.0	2.4 =12%	0.7
1270	10.0	2.4 =12%	0.3

See also Fig. 3.

These results, and still more the original curves, some of which are shown in Fig. 3 bear out Mr. Briefer's statement, in so far as showing that the effect of scratches is much more marked on the elongation than on the breaking load or strength. That is, the effect of the scratch is first shown in the period of plastic deformation, so that the elongation is reduced, although the breaking load may not be affected.

In these experiments the scratches were made on the support side. The previous series had scratches made on both the support and gelatin side. No difference was observed in the breaking load in

[2] Trans. S.M.P.E., May, 1924, p. 177.

either case, but as this material did not show great sensitivity to scratches, it is possible that a difference might show in some cases.

Effect of Nicks in the Film.—Carefully selected processed film with smooth edges was nicked to different depths with a safety razor blade. Stock films processed several months past were used.

Depth of Nick *mm*	*ins.*	*Breaking Load*	*Total Elongation cms*	*Permanent Elongation cms*
0		12.8 kg	6.0 = 31 %	4.6
.05	.002	10.4	1.0 = 5.2%	0.0
.10	.004	10.2	1.1 = 5.8%	0.1
.20	.008	10.0	1.0 = 5.2%	0.0
.30	.012	9.6	0.7 = 3.5%	0.0

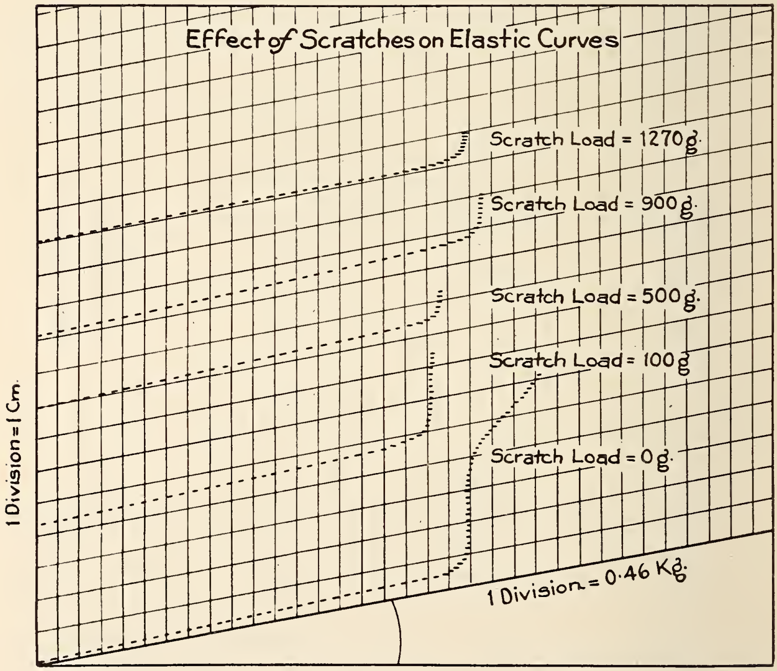


Fig. 3.—Effect of scratches on elongation and breaking load.

Nicks of the order of .002 inches are scarcely perceptible, but the effect on the elongation appears to be immediate and more marked than that of scratches.

Effect of Processing on Scratch Resistance of Film.—Some freshly coated unprocessed nitrate base film, 35 mm was given strength tests at various humidities.

R.H. per cent	*Breaking Load*	*Total Elongation*	*Permanent Elongation*	*Folds*
30	11.4 kg	2 cms. =10.5%	.5 cms	46
50	10.9	5.6 =29 %	4.4	40
80	8.3	4.0 =21 %	2.8	41

Scratch resistance tests on this raw film conditioned three days at 30 per cent R.H. at 70° F. showed very slight effect of scratches on either the breaking load or the elongation up to loads of 900 gms. This indifference of the elongation is not necessarily in contradiction with the previous results, because at this low relative humidity the elongation has already been very much reduced, and in this condition the material appears to be less susceptible to scratch damage.

Folding tests on this raw but well dried film three days at 30% R.H.) showed some effect of scratching but not very pronounced.

Scratch load	0	100	500	900	1270 gms
Folds	46	31	26	27	24

This film was then processed and tested at R.H. 50 per cent at 70° F. It was then stored at 150° F. for hours, and strength and folding tests made for different scratch loads.

	At R.H. 50 per cent	*Stoved at 150°F.*
Breaking load	12.5 kg	14.5 kg
Total elongation	3.9 cms =20.5	2.2 cms
Permanent elongation	2.2 cms	1.0 cms

Scratch Load	*Breaking Load*	*Total Elongation*	*Permanent Elongation*	*Folds*
0 gms	14.5 kg	2.2 cms	1.0 cms	17
100	14.2	2.6	1.2	18
500	14.3	1.8		14
900	14.2	2.7	1.25	15
1270	12.6	1.7	.4	10

This material was made relatively brittle by oven heating, as shown by a reduction of the folds from 40-46 down to 17, but did not appear to be very much affected by scratches until very high loads were reached.

Conclusions.—Examination of processed films has on the whole confirmed previous conclusions as to the effect of scratches. There appears to be little effect of scratches upon the strength until comparatively deep scratches are produced, and this indifference is increased rather than lessened, as the film becomes older and hardened. Films with a high elongation have this markedly reduced by even slight scratches, which do not much affect the breaking load, but when the elongation is reduced, as by heat, even this effect becomes much less apparent.

DISCUSSION

Mr. Denison: My experience with the effect of scratches on film both new and old is that we rarely, if ever, have to discard a print on account of scratches; that is, scratches in the film do not shorten the life of the print. Our only concern is to protect the perforations, for practically every print is discarded on account of mutilated perforations. We have marked brittle prints that had fractured perforations and kept them in service, and it was surprising how long these prints lasted. It appears that most prints fracture in a very short time, but in spite of this fact the fracture does not seem to get any worse. This is probably due to the drying or seasoning of the film. No doubt scratches in the region of the perforations such as are caused by emulsion depositing on the shoes of the projector will shorten the life of the film considerably, but we have yet to find that ordinary scratches affect the life of the print.

Mr. John Jones: Do I understand that the scratches were longitudinal and was not the film perforated?

Mr. Crabtree: I think it would be interesting to have measurements on the effect on the film strength of treating the scratched film with any of the various media supposed to eliminate scratches.

Mr. Richardson: I am not sure I quite understand just what the Doctor has in mind. I am unable to see how longitudinal scratching, which is to all intents and purposes the only kind encountered in practice, appreciably weakens the film stock. It is harmful because the scratches fill with dirt, become opaque, and cause what is termed "rain." From the viewpoint of projection, the only weakness of the film, provided it be film stock of normal thickness, is found in the sprocket holes. I cannot agree with Mr. Denison that sprocket hole fractures do not tend to get worse once they are made. I believe Mr. Denison did not give sufficient consideration to the fact that even though the initial fracture acts to impart a certain degree of "springiness" to the edge of the sprocket hole, still, if there be excessive tension at the aperture of the projector, as is too often the case, the tendency will be to increase the fracture, or, if the tension excess be sufficient, to tear away entirely the weakened division between two holes. Longitudinal scratches, I must insist, do not weaken the film stock appreciably, and traverse scratching to all intents and purposes does not exist.

Dr. Sheppard: Do you mean scratches across or along the length?

Mr. Denison: When I spoke of no appreciable increase in the fracture, I meant generally. We have had prints which went to pieces on the first six or seven runs, but generally this is not true. In most cases we are able to play out all the dates in the territory.

Dr. Hickman: It seems that the nicks in the edge of the film apparently have given contradictory results at various times according to Dr. Sheppard. I should like to know whether all his tests have concerned longitudinal strain, because a scratch will split suddenly with quite a slight side strain.

Dr. Sheppard: With regard to Mr. Denison's remarks, first of all, I am glad his experience is in agreement with our experimental results in that scratching does not affect the using quality of the film; that is, mechanically. I am not referring to the optical behavior of the film. I took up this work because statements had been made that the breaking of the film depended on quite small scratches on the exterior skin.

With regard to the perforation break, I think that couples up with the last remark made by Dr. Hickman. It will depend enormously on whether the film gets a twist to it, or whether the pull is directly on it. If the film breaks so, when we are looking at the perforation sideways like this (drawing), we shall get a small piece acting as a spring and affording take-up for the rest of the pull, and it may be that the seasoning effect is more connected with the formation of such a spring than with a change in the properties of the material. That is merely a possibility, and I do not say that seasoning does not take place.

Mr. Jones raised a question as to the direction of the scratches. I am sorry I did not make it clear that in this case all the scratches were made across the width of the film, from edge to edge, or between perforations. In the previous paper we dealt with scratches made longitudinally with the length of the film. We are dealing with the most extreme case—a scratch from edge to edge—and we found that scratches impinging on a perforation are likely to be dangerous, while those from edge to edge were not so.

As regards Mr. Crabtree's suggestion that the effect of covering solutions be taken up, I think some little work might be done on this, but I do not think that as such it will be very profitable. I started this work merely as an entering wedge. The question of scratches as such is beginning to exhaust its value; it appears that the practical man is in agreement with the laboratory, but whether covering solutions of this kind cover the behavior of edge injuries is, I think, worthy of experimental investigation.

Mr. Richardson's question with regard to longitudinal scratches is, I think, definitely answered.

Coming to Dr. Hickman's remarks, the question as to the direction of the stress applied with regard to the nick is unquestionably of great importance. In all the pull down tests the stress was applied transverse to the nick. In the case of the folding tests, probably twist occurs with any machine. That is worth following up.

Mr. Richardson: How is film going to get that kind of a scratch in practice?

Dr. Sheppard: You do have scratches in different directions. I took the worst possible. Formerly, we investigated scratches lying in different directions.

Mr. Richardson: The effect of such scratching would, I believe, to all intents and purposes be negligible as regards weakening the film.

Mr. Denison: I follow film conditions very closely, and I agree with Mr. Richardson that we don't get transverse folds that ever affect the film. In V-ing film it might occur occasionally. You are more apt to get it in rewinding, and if the projector is in fairly good condition, you don't get a twist sufficient to damage the film. At least, I am stating that on my past experience only.

Dr. Sheppard I am entirely open to suggestion and conviction on the matter of twist.

Mr. Richardson: In the projector you may or may not have a side pull between the upper magazine and the upper sprocket. There can be no side pull except where there are crookedly made splices after the film has left the upper sprocket, because thereafter everything is in perfect alignment, and that alignment cannot be changed. On one popular professional projector it is possible to get the upper sprocket and upper magazine out of alignment, in which case there would be some side pull, which might develop into a very hard pull under some conditions.

Dr. Sheppard: I was not considering only the projection machine. There are processing machines in which the film passes around a spiral so that there is twist produced on it, and the relation of twist to the liability of the film to become nicked is of probable importance. In all the film considered there was no twist. Mr. Denison's denial of the film reacting to scratches is all right, because I started the matter with an open mind; I didn't start with the belief that there is a great deal of trouble with scratches. I do not regret the work or consider it wasted because the result is largely negative.

THE IMPORTANCE OF PROPER SPLICING

Earl J. Denison[1]

DURING the past ten years the mechanical processes involved in the making of motion pictures have, for the most part, been subjected to critical analyses followed by changes and improvements which have resulted in increased efficiency. Processes of major importance, such as the perforation of the film, the taking of the pictures, and the making of positive prints, are now carried on by means of standardized machines and instruments, the use of which insures surpassingly fine artistic effects and a minimum of production cost. But some minor processes are of major importance, and these have received scant attention. The splicing of film is a case in point. This process has, until recently, been carried on by crude methods which have produced unsatisfactory results. A faulty splice may throw the picture out of frame, trespass upon the picture space, stiffen the film at the point of the splice, or give way altogether. And to the extent that it does any of these things, it makes impossible the production of the perfect motion picture.

A more intimate knowledge of motion picture film, the abuses it is subjected to in the theatres, together with the reasons for proper inspection, splicing, and handling, will lead those engaged in this particular branch of the industry to an understanding and appreciation of the necessity for perfect work.

Of primary importance among the mechanical processes is that of film perforation, because accuracy in this operation is the first requisite in the making of quality pictures; that is, since it is the initial operation, successful handling of the succeeding processes is only possible with the utmost accuracy in film perforation. The fact that the life of the film depends almost entirely on the physical and and mechanical condition of the perforations (sprocket holes) proves that the utmost care should be exercised to prevent the perforations from becoming damaged.

The matter of splices has never been confined to any one locality but constitutes a problem for all laboratories, exchanges, and theatres.

[1] Famous Players-Lasky Corp., New York City.

This problem presents features more complicated than the mere holding quality of the splice, and the recurrence of complaints shows clearly that a satisfactory means of splicing film to withstand the use to which the prints are subjected in the theatres has yet to be standardized.

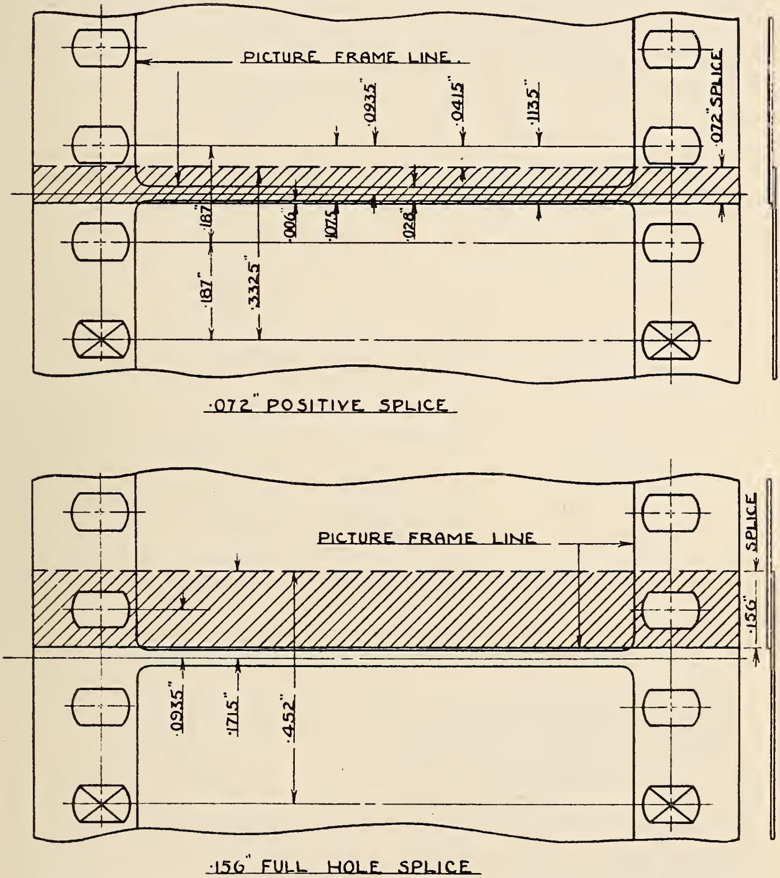


Fig. A.—Showing the comparative widths of the Bell and Howell splice 0.072″ and the Famous Players-Lasky standard positive splice—full hole 0.156″.

There is very little difference in the strength of the different types of positive splices, but there is considerable difference in uniformity, flatness, register, etc. It is an easy matter to obtain strength, but strength alone does not constitute a satisfactory splice. The comparative widths of the Bell and Howell and Famous Players standard positive splices are shown in Fig. A.

Projection is the ultimate test for the mechanical and physical qualities of the splice, as well as the film. A specially rigged projector used to test splices and perforations is shown in Fig. B. All tests

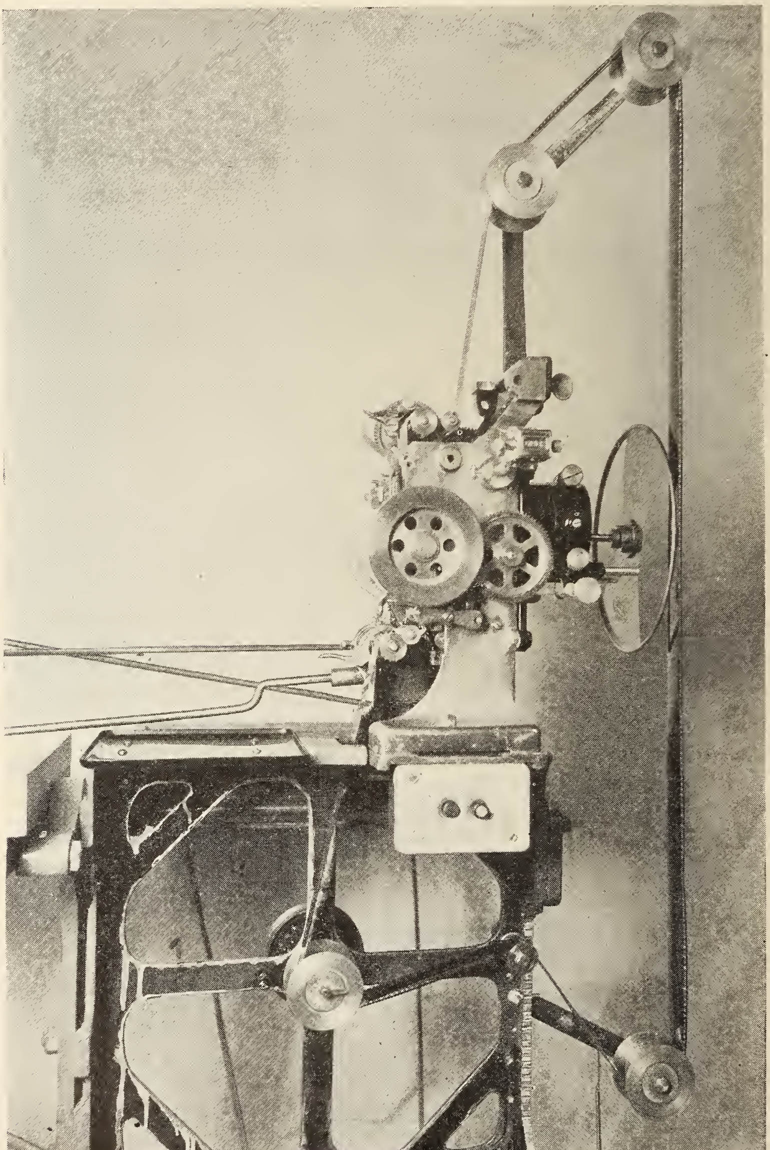


Fig. B.—A specially rigged projector used to test splices and perforations are made with 10 foot loops of film. While practically all film damage occurs in the theatres, about 50 per cent of the damage is traceable to improperly made splices for which there are six primary causes.

Cause No. 1. *Splice out of register* (sprocket holes not perfectly matched). Splices of this kind will jump while passing through the projector and probably damage the film.

Cause No. 2. *Splice too wide.* A splice is stiff and unbending, and if too wide will not seat properly on the sprocket wheels of the projector, causing a jump with probable damage.

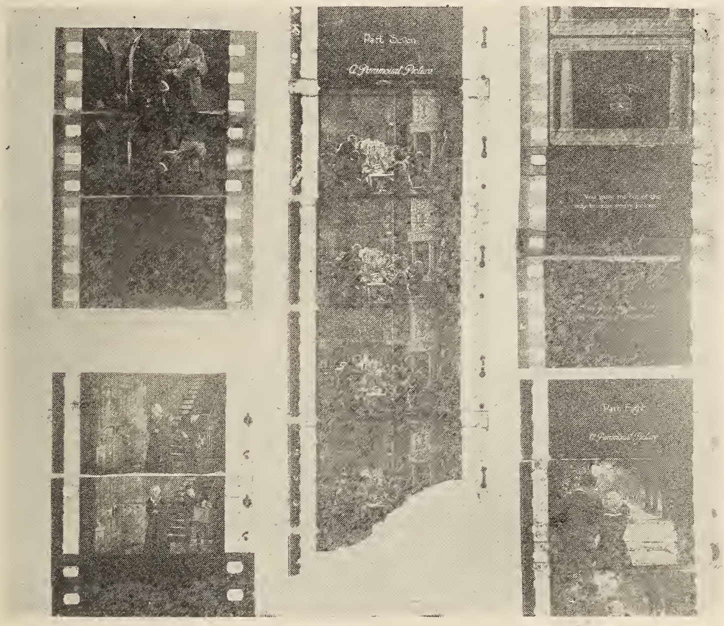


Fig. 1.—Several good examples of mis-matched splices. Note how perforations fail to register.

Cause No. 3. *Improperly scraped splices*: Due to the fact that film cement only acts upon the celluloid base of the film, it is necessary to entirely remove the emulsion in making the splice. Where there is a particle of emulsion, the cement will not hold, causing the splice to open and come apart.

Cause No. 4. *Too much or too strong a cement:* We say "splicing" the film, when it is more nearly correct to say "welding" the film. The cement attacks the celluloid base of the film, and when the

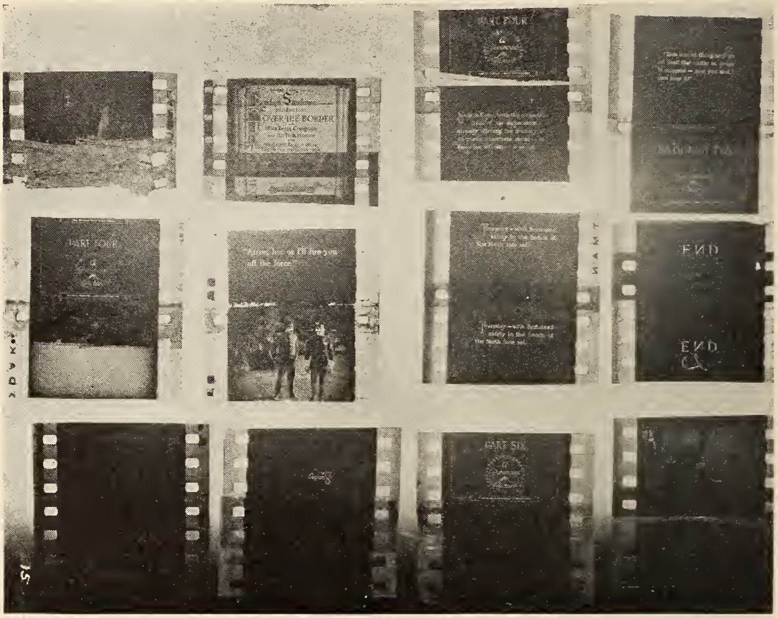


Fig. 2.—Examples of exceedingly wide splices and mismatched and poorly scraped splices.

Fig. 3.—Showing poor attempt at scraping and disregard for correct cutting and alignment.

pressure is quickly applied, the two pieces of film are welded together. When too much or too strong a cement is used, the whole celluloid base is softened instead of only the surface, causing the film to cup or buckle after drying.

Cause No. 5. *Not enough cement or cement in bad condition:* If too little cement is used, it will not soften the celluloid sufficiently to make the splice hold. Film cement evaporates rapidly if left uncorked and will cause the mixture to lose its proper proportions. Cement in this condition will not hold the splice.

Fig. 4.—*Cupped and buckled splices* the result of using too much or too strong a cement, excessive scraping of base or both. This kind of splice invariably causes damage.

Cause No. 6. *Uneven scraping:* It is necessary to remove every particle of emulsion to make a good splice, (See Cause No. 3). However, great care must be taken not to thin down the celluloid base for the reason stated in Case No. 4.

Improper tools, careless handling of the film, or dirty hands will also result in poor splices. Covered hands or taped fingers will not permit the best work.

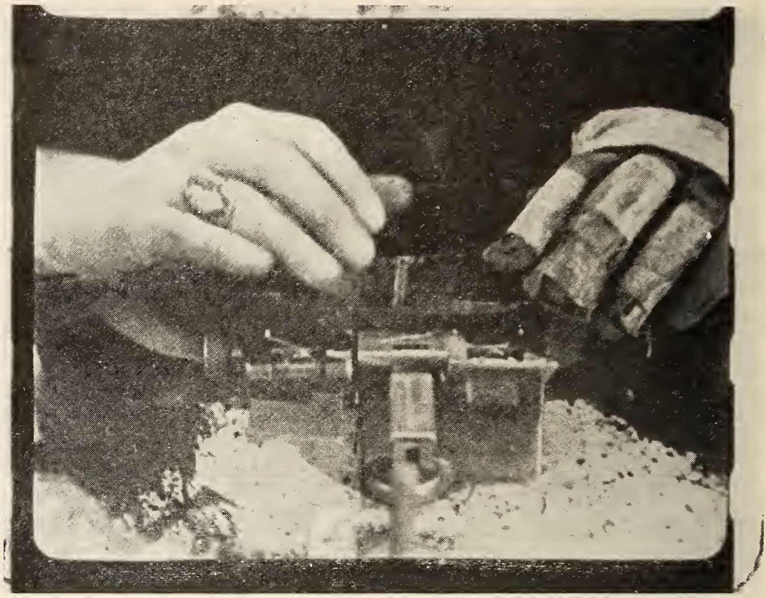


Fig. 5.—Showing fingers of operator covered with adhesive tape. This does not permit of accurate work.

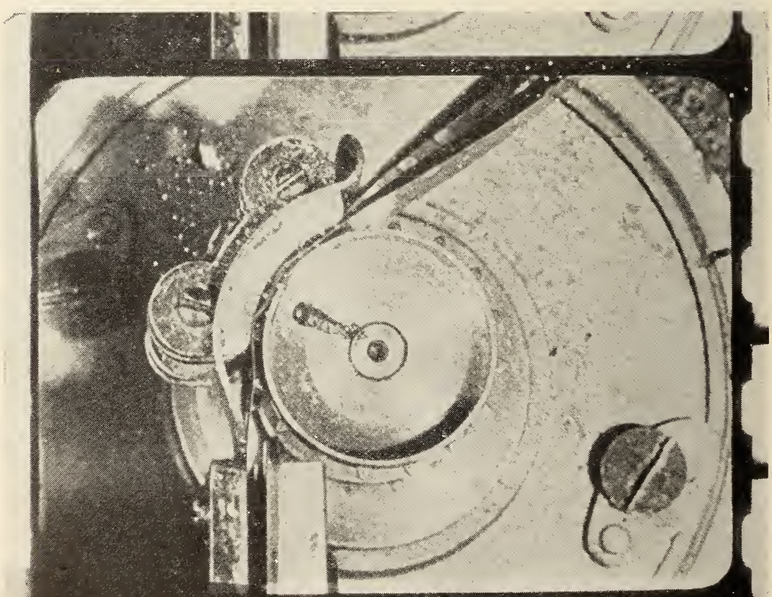


Fig. 6.—A wide splice at rest on the intermittent sprocket. Note how it fails to seat properly.

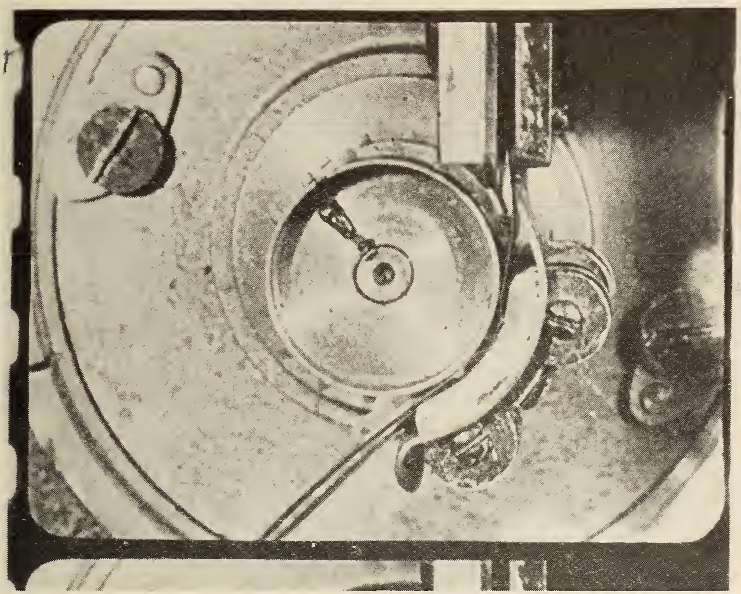


Fig. 7.—A cupped splice at rest on the intermittent sprocket of a Simplex Projector. The action is similar to that of a wide splice.

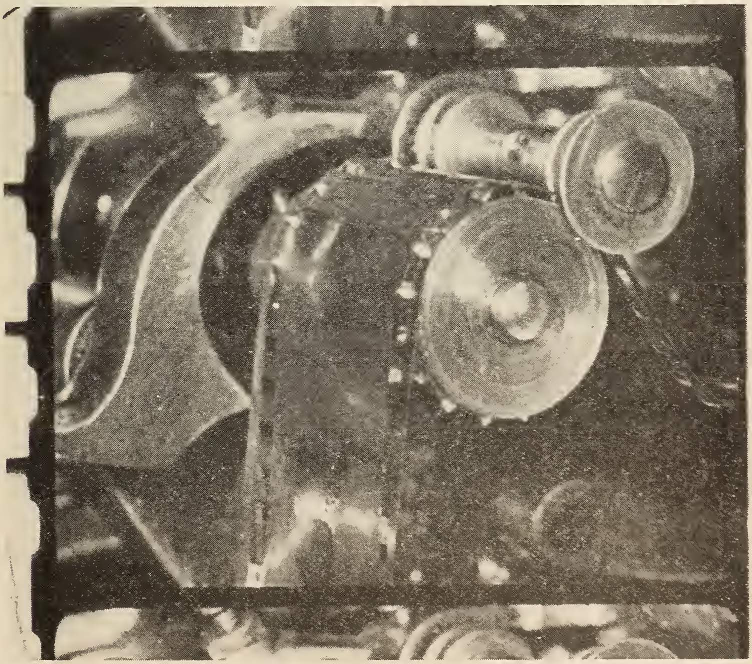


Fig. 8.—An excessively wide splice just starting to run off the take-up sprocket.

So far, this paper has dealt with hand-made splices. Now, let us examine some of the results of improperly made splices. The fact that every film passes through two or three different makes of projectors, and that each of the three most widely used machines threads differently from the others, it does not make any difference whether the splice is lapped left or right.

Certain tests show conclusively that the film invariably runs off at the take up sprocket, and ninety-nine times out of a hundred

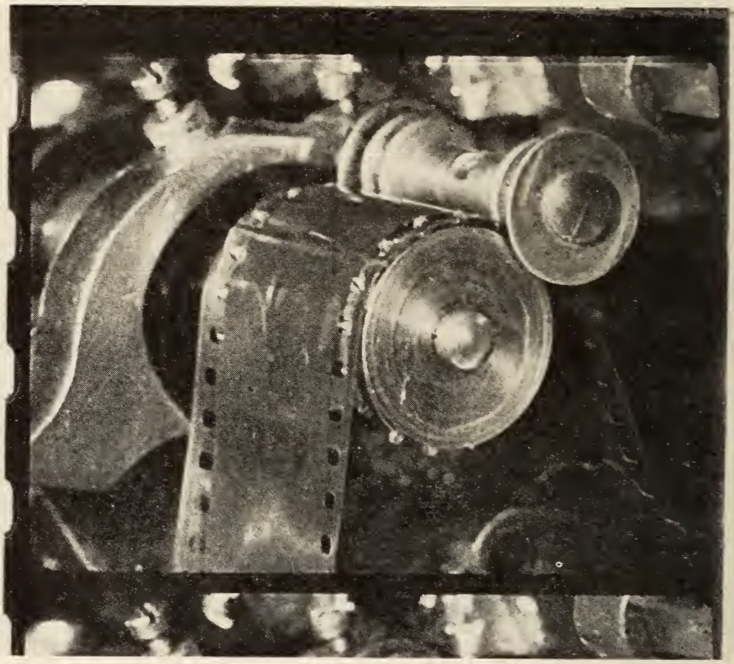
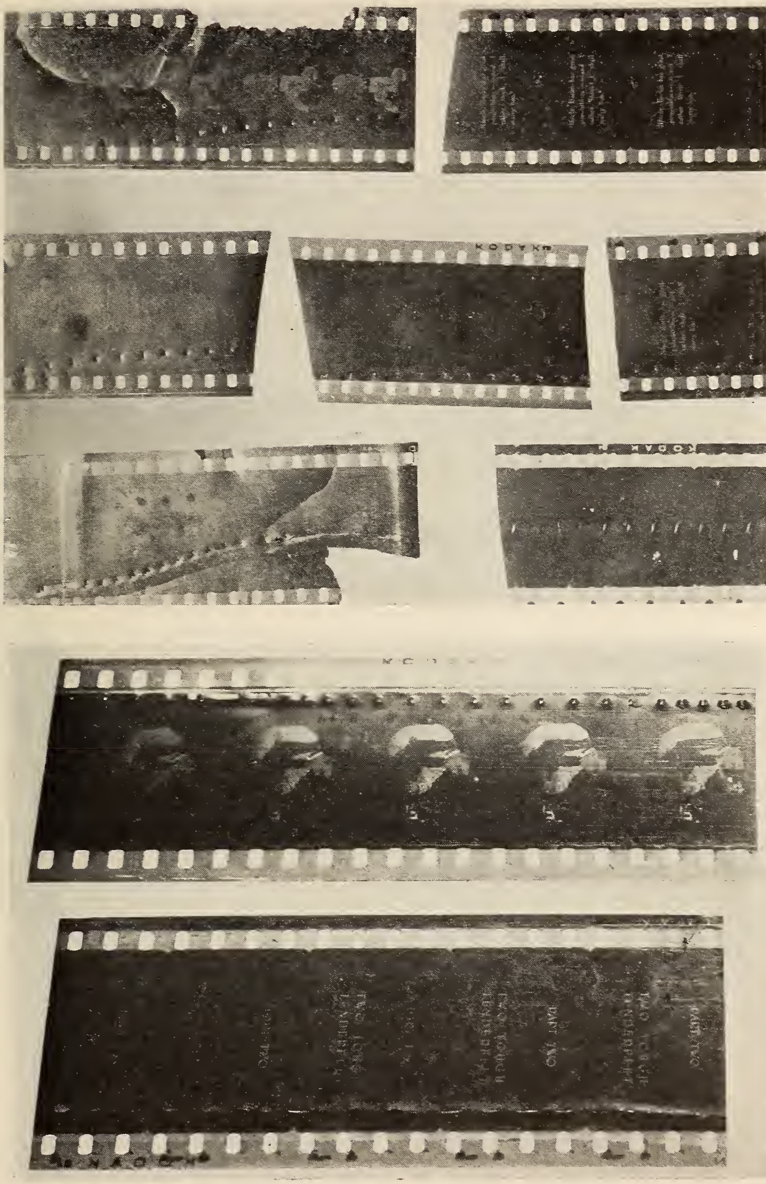


Fig. 9.—A cupped and buckled splice running off the take-up sprocket.

the run off is caused by a bad splice. The reason for this is that the film at the top sprocket is kept taut by the tension on the reel in the top magazine, and the film is kept taut at the intermittent by the tension at the aperture. The film feeds on to the bottom sprocket out of a loop that is constantly slapping back and forth, and a slight imperfection in a splice will cause the film to run off and become damaged. The condition of the film after running off the sprocket is shown in Figs. 10 and 11.



Figs. 10 and 11.—Showing *Sprocket Runs*.—This form of damage is very common. It generally starts at a bad splice and invariably happens at the take-up sprocket.

Very few projection rooms are properly equipped to splice film, but fairly good splices can be made by hand if sufficient time and pains are taken. However, most splices made in the theatres are made in a hurry, and the samples used in the accompanying cuts are fair examples of how film is spliced by the average projectionist.

Not only has a great deal of damage resulted from improperly made splices, but oft times the presentation of a picture is greatly marred. A bad splice also constitutes a fire hazard.

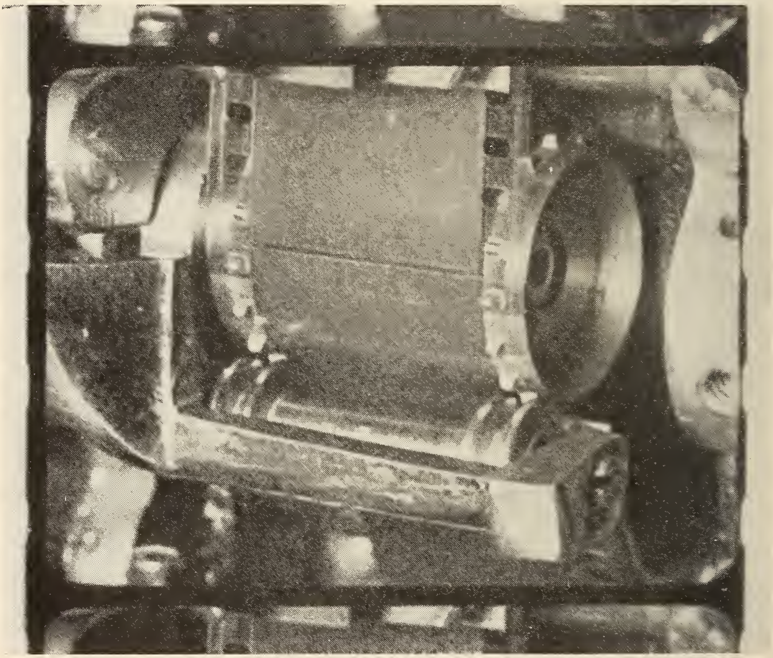


Fig. 12.—Illustrating how a poorly cemented or improperly scraped splice can come apart at the aperture. There is always danger of fire when this occurs.

Exhaustive experiments and research have proven conclusively that the best splices cannot be made by hand. In order to prepare a good splice the following conditions must be fulfilled:

First: The splice must be narrow enough in width to conform to the periphery of the sprocket wheels.

Second: The film must be uniformly scraped.

Third: The perforations must be in perfect register.

Fourth: The cement must be quickly and evenly applied.

Fifth: Uniform pressure must be quickly applied after cementing.

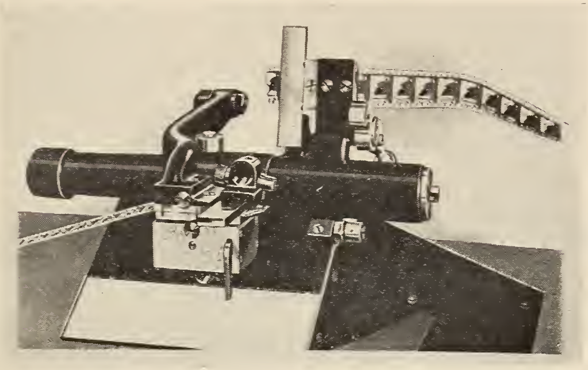


Fig. 13.—Splicing mechanism of Automatic Positive Splicing Machine.

Fig. 14.—Type of splice made on Bell and Howell Machine. Note perfect registry, width, neatness and equal division of film margin on both sides of splice.

The answer to this is, to splice film properly, splicing must be done automatically.

The Famous Players-Lasky Corporation have equipped all of their exchanges and laboratories with the Bell and Howell automatic positive splicing machine. This machine automatically cuts and scrapes film and applies even pressure to the splice. The plates on which the splices are made are heated to about 120°F. The heat not only acts as a binder to the cement but makes it quick drying.

It certainly is the duty of exchanges to properly inspect and splice the film served to the theatres. It is also the duty of the pro-

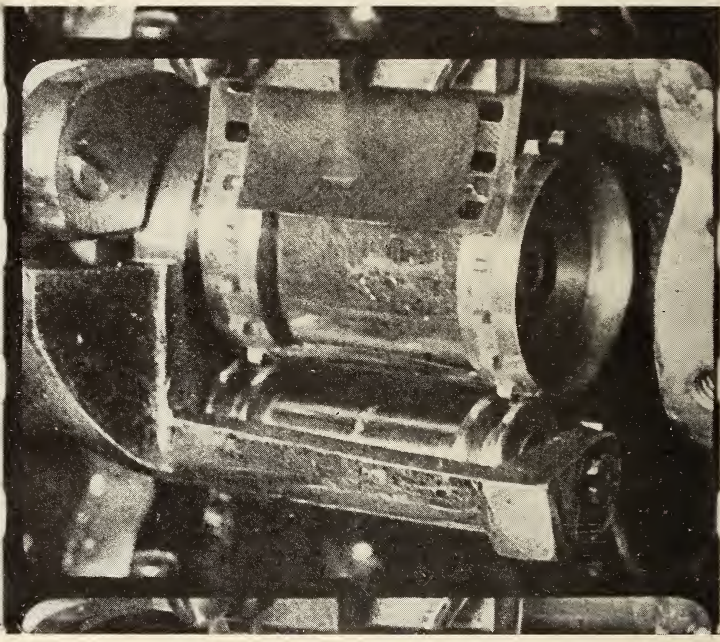


Fig. 15.—A splice made on the Bell and Howell Machine at rest on the Powers intermittent sprocket.

jectionist to make as good splices as possible, and a little more thought and pains on the part of the projectionist in making splices will greatly add to the life of the film and react in better service from the exchanges.

All film and splices used in these illustrations were taken from prints in daily use in theatres throughout the United States. All illustrations of film in projectors are enlargements made from slow motion pictures of projectors in actual operation.

Famous Players-Lasky Corporation,
485 Fifth Avenue,
New York City.

DISCUSSION

MR. RICHARDSON: Mr. Denison has, both in this and some other work he has done, performed enormously valuable service. It is something I have wanted to do for a long time but lacked the facilities. It shows the man in the best possible way the effect of wrong procedure. Those pictures are of enormous value.

DR. HICKMAN: A great many people have the idea that a curved splice gives greater strength if the film has to pass through a great deal of machinery.

MR. CRABTREE: I notice that the width of the Famous splice is greater than that of the Bell and Howell standard splice. Am I correct in assuming that the Famous Players Company have adopted this in compromise to the operators since they always cut out the Bell and Howell splice, because it doesn't look like their own hand-made splice while the Famous splice does, and therefore they leave it alone? Has Mr. Denison tested the relative wearing qualities of the various width splices; that is to say, does the Famous splice wear better than the Bell and Howell splice?

MR. RICHARDSON: The narrow splice has proved highly unsatisfactory to the great majority of projectionists and machine operators. They all object to it.

MR. DENISON: Replying to Dr. Hickman, what do you mean by a curved splice?

DR. HICKMAN: May I draw it here? (Drawing) Just curving the edges so that there is no chance of it breaking.

MR. DENISON: I have seen only a few like this, and they were very poor.

With regard to Mr. Crabtree's question and Mr. Richardson's statement about widths, I will say this: splicing film consists of scraping, cutting, and cementing. The quality of the cement, the amount, and manner in which it is applied to the film is very important. There is little difference in the holding quality of splices of different widths. Technicolor is using a splice somewhat narrower than the Bell and Howell standard. We adopted the full hole splice because it was the first type used for projection work, and the average projectionist does not think that a narrow splice is strong enough. We used the Bell and Howell for a while and the films came back in terrible shape, so we give them the full hole splice mainly so that the users will leave them alone. We are better equipped for making splices than the projectionist.

Mr. Richardson: Another reason for preferring the full hole splice is that the great majority of men in projection rooms make their splices by hand. This they should not do, but just the same they do do it, and when you try to make a narrow splice by hand it is very difficult. The full hole splice is much easier to make; and usually is much the better of the two when made by hand.

Mr. Ziebarth: We have found by running a roll of film through a projector (containing the same number of 0.030″ (beveled), 0.078″ and 0.156″ splices), the 0.030″ would run longer before breaking than the wider splices. The reason for this is that since the 0.030″ splice is considerably more pliable, it will take the curvature of the sprocket better.

Mr. Denison: Where did you make the test? In the field or the factory?

Mr. Ziebarth: In the factory.

Mr. Denison: That is different.

Mr. Ziebarth: The wide splices seem to be more practical. More care is required to make a good narrow splice, but it is the stronger when properly made.

THE PATHEX CAMERA AND PROJECTOR

By W. R. Daniel

EVER since moving pictures became part of the social life of the people of the United States the need has been felt for that more intimate touch which the amateur motion picture camera and projector would bring to the home. Most people are "movie fans," and even those who disdain the silver screen would become its ardent supporters if the appeal were made personal.

Whilst the moving picture shown to thousands in a large hall is perhaps the cheapest form of entertainment, brought into the home for the use of a few it becomes the most expensive.

The problem of popularizing the amateur outfit is, therefore, largely one of expense. To minimize expense the size of film must be decreased and the complexity of the apparatus reduced, and both steps must be taken without reducing the "quality" of the finished picture below that generally accepted as pleasing.

Of the many miniature motion picture machines which have from time to time been placed on the market, the baby cameras and projectors now introduced under the name of "Pathex" are claimed by their manufacturers, the Pathé Company, to represent the most advanced compromise between design and selling price.

The camera, which in size measures $4\frac{1}{4} \times 4\frac{1}{4} \times 1\frac{3}{4}$ inches, has a capacity of 30 feet or 1200 pictures at one loading, equivalent to 75 feet of standard film.

The lens is an F/3.5 anastigmat of 20 mm focal length possessing such depth of field that it functions perfectly at a fixed focus except for portraits, for which a simple attachment is marketed.

The finder is of the wire frame and sighting hole type which has the advantage of simplicity, accuracy, and the fact that it affords a full size picture.

The camera is fitted with a film footage counter and can be equipped, as an extra, with a home "tilting" device. A tripod completes the taking requirements. The projector is a little machine $12\frac{1}{2}$ inches high by $7\frac{1}{2}$ inches wide at its widest part, and is capable of accommodating 60 feet, or two reels, of film, from which it will throw a picture 30 by 40 inches at a distance of 12 feet. Standard electrical equipment enables it to be connected to an ordinary lamp socket. By a mechanical contrivance the film can be kept stationary for a few seconds whilst showing, even though the projector is operated continuously, allowing titles to be projected without using more than a "frame" or two of film. The working procedure with the outfit is simple in the extreme. The film magazine is slipped into the camera; an operation taking less than a minute. The counter is set at zero, the camera mounted on the tripod and the subject brought into line with the view finder. The appropriate stop is found by reference to the exposure tables, after which the picture is taken by cranking steadily at 2 revolutions a second.

When the film is run through, the magazine is removed, and sent to the makers, who return the film developed and reversed to a positive, together with a critical analysis of any faults in taking, after which it is available for use in the projector.

The threading of the projector is accomplished by snapping the lamp house to and fro once. The film is projected by hand cranking. A simple rewind operation completes the cycle.

In conclusion it must be emphasized that the design and construction of these little machines is such that they can be acquired by persons of modest means. It is now possible to record, with a permanency running into decades, many of the precious but hitherto fleeting moments of family life and outdoor enjoyments. For the sportsman these miniature cameras will record moments of adventure; for the golfer, tennis player and games enthusiast; not only will they secure a record of prowess, but afford a ready means of correcting faults in style.

COLOR PHOTOGRAPHY PATENTS (*cont.*)

Wm. V. D. Kelley*

CLASS 2—COATED ON ONE SIDE OF A BASE

Division A—Where two images are imprinted at the same time, and the two images developed at the same time, and then by fractional toning, each is made a different color.

Leopold D. Mannes, U. S. No. 1,516,824. Nov. 25, 1924

Claim 4: The method of producing a color photograph in two colors comprising forming in layers of emulsion sensitized respectively to record different color values, two superimposed latent images of different color sensations, simultaneously developing and then fixing said two images and then coloring each of said images with that color whose values are recorded by the other image.

Division B—Where the two images are produced by two developments on one face of the base by re-emulsifying.

Gustave Selle, No. 654,766. July 31, 1900

Claim 1: The process of production of multicolored paper photographs consisting in covering the paper with a waterproof layer, then with a sensitive layer, exposing and developing the latter for one color, again covering same with a waterproof layer, then with a sensitive layer, exposing and developing the latter for another color, and repeating the operations of waterproofiing, sensitizing, exposure, and development for each additional color.

Wm. F. Fox, No. 1,166,122. Dec. 28, 1915

Specification, page 4, lines 43 to 49: If single emulsion stock be used, the emulsioned surface of the projection positive is first protected by means of a suitable substance (for example a celluloid solution), after which that surface is re-emulsioned to adapt it to receive the correcting image.

T. A. Mills, No. 1,172,621. Feb. 22, 1916

Specification, page 2, lines 101–120: "Recoating or resensitizing between the printings is in accord with the usages and methods well understood by photographers, a waterproof and chemical

* Kelley Color Laboratory Inc., Palisade, New Jersey.

proof stratum being interposed when necessary, just as is done between the strata in the case of the Lumière Autochrome plates."

This patent was filed Dec. 3, 1912.

Claim 1: Process of producing a color cinematographic picture film for projection without the aid of color screens or filters which consists in making each complete picture of said picture film a composite helichrome, more or less simulating the colors of nature by taking a single original or negative band exposed through recurring color filters, printing on a light sensitive surface from said negative band, treating such surface so that each of the positive images thereon will appear in color complementary to the color of the filter used in taking the corresponding negative image, *printing on a fresh light sensitive surface* from said negative band, said negative band being stepwise shifted in relation to the previous printing, and treating such fresh surface so that each of the second series of positive images thereupon will appear in color complementary to the color of the filter used in taking the corresponding negative image, each positive image in color of the above recited first printing and the above cited first color treatment forming one element of a composite helichrome and each positive image in color of the above recited second printing and the above recited second color treatment forming the other element or another element of a composite helichrome, *a single transparent base* being the final support for all the light sensitive surfaces.

Wm. Francis Fox, No. 1,187,421. June 13, 1916

Specification, page 4, lines 83–91: "The originally emulsioned surface of the positive film having been utilized as above pointed out, it is desirable to form a new emulsioned surface thereon, and this may be done either by applying the emulsion to the reverse side of the film or, if preferred, by varnishing the previously emulsioned surface and then re-emulsioning that surface over the varnish."

R. Fischer, U. S. No. 1,055,155. March 4, 1913

Division C—Where the images are printed in black and white on a single coated film and color added by hand painting, stenciling, or imbibition.

C. Sciamengo, U. S. No. 1,036, 730. Aug. 27, 1912

A. Wykoff and Max Handschlegl, U. S. No. 1,303,836. May 13, 1919

Claim 2: The process of coloring cinematograph films comprising uniformly blocking out with an opaque medium all those portions on a positive print which portions it is desired to color, making a negative from such positive, rendering insoluble all those portions of the negative surface exposed to light in making the negative, applying coloring matter to the portions which have not been exposed to light, and transferring such applied coloring matter to the film to be colored.

A. Wyckoff and Max Handschlegl, U. S. No. 1,303,837. May 13, 1919

Claim 17: In a method of coloring films by subjecting the film to be colored to a pressurable contact with a similar film carrying coloring matter, continuously moving the films, exerting a tension upon a portion of each of the films, and adjusting the tensions separately to bring the films to registering dimensions, and bringing the said film portions together in pressurable contact while under tension.

Max Handschlegl, U. S. No. 1,316,791. Sept. 23, 1919

Claim 2: A process of making colored moving picture films which consists of taking a smooth negative, applying transfer dye to the negative, taking a smooth positive of the negative, softening the coating of the positive, dye toning the positive, placing the positive and negative together face to face, and applying yielding pressure to transfer the dye from the negative to the positive.

Max Handschlegl, U. S. No. 1,295,028. Feb. 18, 1919

Claim 4: An impression drum, means for feeding two films to the impression drum one on top of the other, there being windows through the drum to allow the light to shine through the films to show the registration of one film upon the other.

Frank Wordsworth Donisthrope, U. S. No. 1,517,200. Nov. 25, 1924. Filed Aug. 18, 1920

Claim 1: A process of dye transfer printing from photographic negatives, which consists in immersing the negative in a preparing bath containing acid and then in a dye bath, controlling the penetration of the dyes or dye into the prepared negative by varying the proportion or quantity of said acid contained in said preparing bath, and transferring the dye or dyes from the negative to a printing medium by direct surface contact.

Robert John, U. S. No. 1,374,853. April 12, 1921. Filed May 6, 1916

Claim 26: The process of forming a photographic record of lights and shades capable of use as a transfer printing plate, which comprises hardening portions of emulsion adjacent to the light sensitive content of a photographic emulsion mounted on and exposed through a transparent carrier to lights and shades of a photographic negative, by treating said emulsion with an agent adapted to harden said emulsion by reaction with the light affected sensitive content of the emulsion, and with a neutralizing agent for said hardening agent, the relative proportions of said hardening and neutralizing agents being such as to control selectively the effective area of influence of the hardening agent but to an extent less than the complete neutralization of said hardening agent, removing the unhardened portions of emulsion, coloring said hardened portions, and placing said colored portions in contact with a substance adapted to take the coloring matter from said hardened portions.

Robert John, U. S. No. 1,453,258. April 24, 1923. Filed Oct. 23, 1919

Shepherd and Bartlett, U. S. No. 728, 310. May 19, 1903

William V. D.Kelley, U. S. No. 1,505,787. Aug. 19, 1924

Claim 1: A transparent carrier coated with gelatine having a reduced silver image and a dye impressed color representation of the reds in the original subject.

Loren E. Taylor, U. S. No. 1,518,945. Dec. 9, 1924

Claim 1: The process of coloring motion picture films comprising taking a positive print from an original negative by printing with their emulsion sides in contact, projecting successive views of said positive each on to a mat of non-actinic color in sequence, the emulsion side of said positives being towards the projecting light, making drawings on said mats in actinic colors.

On the areas of said views it is desired to tint with one color, thence exposing successive portions of an unexposed negative film to each of said mats so the successive drawings will be impressed thereon in the sequence in which they were produced, developing said negative and making a positive print therefrom by printing with the celluloid side of the positive in contact with the emulsion side of the negative, developing said positive and treating it so the emulsion over the areas thereon corresponding to those of the drawings will absorb moisture and the remaining areas will be impervious thereto, applying dye to said absorbent areas, thence subjecting said positive to a pressurable contact with the original positive while in register therewith and with their emulsion side in contact.

Loren E. Taylor, U. S. No. 1,518,946. Dec. 9, 1924

Claim 1: The process of coloring motion picture films comprising producing a negative by exposure of a film predominantly sensitive to certain colors and predominantly insensitive to colors complementary thereto, taking a positive print therefrom, etching out those portions of the sensitized coating of the negative containing the silver affected by exposure to light, applying coloring matter to said etched negative so that it is absorbed by those portions of its gelatinous coating not removed by etching, said color being complementary to the color to which the negative was predominantly sensitive, and transferring said coloring matter to the positive film by bringing it into pressurable facial contact therewith.

F. E. Ives, U. S. No. 1,121,187. Dec. 15, 1914. Filed July 12, 1912

Claim 3: The process of photographic imbibition printing comprising the dyeing of a dye member with an acid dye and thereafter transferring the dye image so formed by imbibition to a gelatine coated print member charged with a mordant of a character capable of converting such dye into an insoluble lake.

Division D—Where two images are produced by two developments without recoating. First, one image is printed and colored or rendered capable of coloring, the film dried without fixing, a second picture printed in the original coating, developed, and colored.

Wm. Francis Fox, U. S. No. 1,166,123. Dec. 28, 1915. Filed Feb. 3, 1913

Claim 1: A photographic process involving the production of a negative of two images from one of which certain color-sensations have been omitted and from the other of which certain other complementary color-sensations have been omitted, imprinting one of said images upon transparent or translucent sensitized material, imprinting the other of said images upon said material in registry with the first image imprinted thereon, coloring one of said images with a color corresponding to the sensations omitted from the corresponding negative, and coloring the other of said images by the use of a basic dye to a color corresponding to the sensations omitted from the corresponding negative, substantially as set forth.

Claim 2: A photographic process involving the production of an image upon transparent or translucent sensitized material, treating the same with vanadium chloride and potassium ferricyanide, and coloring the same by means of a basic dye, substantially as set forth.

Claim 2: A photographic process involving the production of an image upon transparent or translucent sensitized material, treating the same with vanadium chloride and potassium ferricyanide, and coloring the same by means of a basic dye, substantially as set forth.

F. E. Ives, U. S. No. 1,170,540. Feb. 8, 1916. Filed July 1, 1914

W. F. Fox, U. S. No. 1,207,527. Dec. 5, 1916. Filed June 23, 1924

F. E. Ives, U. S. No. 1,278,668. Sept. 10, 1918. Filed Oct. 9, 1917

Claim 4: A color photograph or film comprising a layer of colloid material containing a red copper-toned and mordant-dyed silver image blended with a blue-to-green image.

F. E. Ives, U. S. No. 1,499,930. July 1, 1924. Filed Oct. 25, 1923

Claim 4: The conversion of a photographic silver print in a colloid layer containing also silver bromide to a pigment blue print and silver bromide, by treatment in a bath containing in combination the necessary ingredients for producing the blue image and a bromide and a chloride followed by exposure and development to produce a second image in the same colloid layer.

F. E. Ives, U. S. No. 1,538,816. May 19, 1925. Filed Feb. 15, 1923

Claim 1: In photographic color print making, the production of a silver image which is converted in part to silver ferrocyanide, followed by reconverting the silver ferrocyanide to silver bromide, and then exposed to light under another negative, and developing a second silver print which is subsequently converted into a color print.

CLASS 3

Division A—Methods of producing dye images by means of mordants.

Arthur Traube, U. S. No. 1,093,503. Apr. 14, 1914. Filed May 15, 1907

Claim: The process of converting silver prints into pure color prints, which consists in converting the material of which the picture is composed into substances capable of being colored directly and soluble in fixing compounds, then coloring the pictures with basic dyes, and treating the colored pictures with a mixture including substances which dissolve the silver salts and also containing substances which produce insoluble lakes with the dyes used for coloring the prints.

Auguste Jean Baptiste Tauleigne and Eline Mazo, U. S. No. 1,059,917. Filed Mar. 23, 1910

Claim 1: The herein described steps in a process for the production of colored photographs from ordinary silver positives, which consists in the treatment of the positive with bichloride of copper, subsequently treating it with iodide of potassium, immersing it in an aniline dye bath, washing with water, fixing the color by immersion in a solution of tannin, washing to eliminate excess of tannin, fixing the print, and finally washing to eliminate the fixing reagent.

Wm. Francis Fox, U. S. No. 1,166,123. Dec. 28, 1915

Vanadium ferrocyanide forms the mordant for basic dyes, (See Class 2).

Hoyt Miller, U. S. No. 1,214,940. Feb. 6, 1917. Filed Feb. 26, 1915

Claim 10: The herein described method, comprising bleaching a photographic image by treatment with iodine and iodide, treating the bleached image with sodium bisulphite to clear the same of iodine, washing out the bisulphite, treating the image with a dye of the desired color, and then washing out the excess dye.

P. D. Brewster, U. S. No. 1,537,524. May 12, 1925. Filed Dec. 6, 1918

Improvement on Hoyt Miller, above.

Jesse M. Blaney, U. S. No. 1,331,092. Feb. 17, 1920. Filed May 22, 1918

Claim 3: The method of producing photographic images which consists in substituting for the silver forming the initial photographic image a salt of tin, removing the silver forming the initial image and treating the tin image forming material with a dye of the desired color to produce a colored image.

Leon F. Douglass, U. S. No. 1,450, 412. Apr. 3, 1923. Filed Oct. 16, 1919

Claim: The process of making a colored photographic image from a black silver image, which consists in replacing the black silver image with an iron blue toned image, treating said converted image with a basic dye, and subsequently causing said image to mordant basic dyes by treating it with an alkaline solution.

J. Lewisohn, U. S. No. 1,126,495. Jan. 26, 1915. Filed Apr. 3, 1914

Claim 3: A method for producing prints having a plurality of color effects, which consists in forming a blue print, substituting for the blue of the image a different color, coating the so-formed image with a blue print sensitizer, making another blue print, substituting for the blue of the image a color different from the blue and first different color used, coating the so-formed image with a blue print sensitizer and forming a blue image thereon.

J. Lewisohn, U. S. No. 1,071,559. Aug. 26, 1913

J. I. Crabtree, U. S. No. 1,305,962. Filed Jan. 25, 1917

Claim: The method of producing a color photographic image consisting in copper-toning a silver image and subjecting it to a bath of soluble dye capable of being selectively mordanted by the copper image.

F. E. Ives, U. S. No. 1,300,616. Filed Feb. 20, 1917

Similar claim to above for copper mordanting.

CLASS 3

Division B—Methods of producing dye images by treating the gelatine so that it will absorb dyes selectively.

John G. Capstaff, U. S. No. 1,315,464. Sept. 9, 1919. Filed Feb. 14, 1918

Claim 2: The method of preparing for a dyeing operation a gelatine light-sensitive film, which contains a photographic image, which consists in bleaching the silver image and rendering the gelatine differentially permeable to dye, according to the light gradations recorded in the film, the more permeable portions being immediately adjacent the light affected portions of the image.

John G. Capstaff, U. S. No. 1,525,766. Feb. 10, 1925. Filed July 12, 1922

Claim 3: The process of making a colored image that comprises exposing a colloid layer containing a sensitive silver salt to light, developing in said layer a silver image by the agency of a developer that does not render the colloid insoluble, and developing the hitherto undeveloped portions by the agency of a developer that renders the gelatine insoluble, washing off the soluble gelatine, thus leaving a relief image, and dyeing the relief image.

Leonard T. Troland, U. S. No. 1,535,700. Apr. 28, 1925. Filed Sept. 13, 1922

Page 1, lines 9 to 20: This invention relates to the selective treatment of the exposed and unexposed portions of light sensitive films by which one of the portions, for example the exposed portion, is made harder than the other portion, whereby the two portions react differently to subsequent treatment, as for example a hot water etch in which the relative soft portion is dissolved off leaving the other portion in relief, or a dye bath in which the dye is absorbed predominantly by one portion.

Claim 18: The art of treating light sensitive film having exposed and relatively unexposed portions which comprises mixing with pyrogallic acid, sodium hydroxide, and ammonium chloride, thereby to form sodium chloride and ammonium hydroxide, and hardening said exposed portions with the mixture.

Frederick E. Ives, U. S. No. 980,962. Jan. 10, 1911. Filed April 28, 1910

Page 1, lines 75 to 80: I sometimes incorporate a non-actinic dye with the sensitizing solution, *to limit the penetration of light*, this dye being preferably acid, so that it may be discharged by an alkaline developer.

Claim 2: The within described improvement in the process of making colored photographic prints in graduated relief, the same consisting in incorporating a non-actinic coloring medium in the sensitized colloid coating, exposing said sensitized coating to light, developing the print, discharging the coloring medium, treating the developed relief print with a hardening and mordanting agent such as chromic acid, and then dyeing the print.

Jens Herman Christensen, U. S. No. 1,517,049. Nov. 25, 1924. Filed Sept. 6, 1919

Claim 3: A sensitized photographic element comprising a film containing a silver halide and a substantial amount of dye which will be bleached catalytically by reducing agents on places on the said film which after developing will contain silver.

Gustav Kogel and H. Neuenhaus, U. S. No. 1,444,469. Feb. 6, 1923. Filed Sept. 12, 1922

Claim 1: Process for producing layers sensitive to light on a suitable base, consisting in covering the base with diazoanhydrides, bleached on exposure to light.

R. Fischer, U. S. No. 1,055,155. Mar. 4, 1913. Filed July 1, 1912

Claim 1: The herein described process of making colored photographs consisting in producing the various primary colors on an exposed halogen silver film by developing such film by means of such substances as are oxidized by exposed halogen-silver, to colored substances soluble with difficulty.

Rudolph Fischer, U. S. No. 1,102,028. June 30, 1914. Filed Jan. 27, 1913

Claim 1: A process of making colored photographic pictures, consisting in developing pictures on halogen silver films with a developer that contains a substance which in connection with the oxidation product of the developer forms a colored body soluble with difficulty.

DISCUSSION

MR. KELLEY: We have had with us this week the granddaddy of all this work, Mr. F. E. Ives. I am very proud he is here and can help us in it. He has worked in the development of color photography for fifty or sixty years and is still at work.

MR. IVES: Since the subject of color cinematography patents is now being discussed, I wish to call attention to one source of confusion due to quoting patent dates with the implication that they reveal the status of different claimants with respect to substantially the same invention. In England, the date of a provisional patent specification is the first date of record and also the date of the patent finally issued. In the United States, the date when an inventor demonstrates his invention and communicates it to his patent attorneys and business associates corresponds practically to the date of a provisional patent specification in England, though he may not file his application in the patent office until six months later, and his patent may not be (and seldom is) issued and dated until one or more years after that. Six months' delay in filing the application in this country (although unwise) does not invalidate an inventor's claims, else he would file without such delay.

The significance of all this is illustrated in the matter of my U. S. Patent No. 1,170,540, dated February 8, 1916. Cox, in England, disclosed a similar process in a provisional specification July 1, 1914, which thus became the date of his patent, making its date a year and a half in advance of my own; but my communication to my patent attorneys and business associates, which in this country corresponds legally to Cox's provisional specification, anticipates Cox by five months. I was saved from an interference in the patent office by the fact that my complete patent specification was signed and mailed to the patent office on the same day that Cox filed his provisional specification in England.

This is the first patent taken out on placing the two images on ordinary single coated cine film, and that is the direction in which every one is working today. The results shown by Mr. Kelley last night were on single coated film, and it is the direction in which I have worked from the start, and the reason more has not been heard of it is that I wouldn't put out a process until it was working smoothly and properly, and it takes time to perfect the details in these processes.

There are two or three other interesting points. Fox took out two patents at about the same time that I took out the patent on single coated film in which he suggested putting the images on one film. One of Fox's patent specifications was filed about one week before my application went in, so that it gave Fox a certain advantage in the Patent Office. The Patent Office should have declared an interference, because we made claims that interfered, and the Office issued patents to both of us. That was where Fox suggested vanadium chloride as a mordant for the dye image, and it didn't work because he used a toning solution which was iron and vanadium and put a red dye image in afterward. Almost immediately he discovered it would not work because when he put the red image on the top of the green image, the vanadium in the green image took up the red dye as well as the other image, so that he got a black and red image. Since his claim was for the red and green image which he could not produce, it would not work, and he didn't then prosecute the application but filed another some months after in which he showed how to overcome that difficulty by making a blue image instead of a green one, so that there is some confusion there. I call attention to this question because of the confusion which arises in the law with respect to dates. Here is a case in which an apparently parent patent is not really a parent patent.

With respect to the transfer processes, the Technicolor people have been using such a process, and it is interesting in that the original dye transfer process from relief prints a process of Bartlett and Sanger-Shepherd, made prints on paper which had the defect that the dye color spread in the gelatin to which the dye was transferred. They specified in the patent that pure, clear gelatin should be used to receive the transfers, the theory being that the gelatin of the relief print was hard, and dye could only be got out by having the gelatin on the paper soft. The dye spreads in the soft gelatin, not enough to prevent good color prints on paper, where sharp definition is not needed, but they are never sharp enough for cinematography. The dye going into the gelatin should be changed immediately to an insoluble compound or lake, and I took out a patent for making these transfers in gelatin containing a mordant, and got prints microscopically sharp. Technicolor and all using a dye process are now using a mordant. I have a master patent on this which I sold to the Eastman Kodak Company. The Technicolor have been making the prints not only with the dye transfer process incorporating a mordant in the film, but they are cementing two films together. I took out a patent on doing that, but I specified that they be cemented face to face, so that the film on both sides should protect the image and not scratch the pictures. If the films are cemented back to back, the pictures are exposed to abrasion, and if you make a scratch on one side, the color on the other side shows through. Technicolor are cementing the films together back to back because I hold the patent for cementing face to face. In the British patent, they specifically mention cementing face to face. They are also coating with celluloid varnish, and I took out a patent on that as applied to paper prints. I have taken out about twenty patents in connection with this problem. I simply make these statements in order to keep the history straight.

I am glad Mr. Kelley is trying to get this matter of history straightened out. The transfer processes all involve making a relief print, dyeing it, and transferring to the mordanted film. You cannot get the relief process image low enough without a yellow dye, and I took out a patent on this.

Mr. Kelley: I should like to add that we are extremely fortunate in having Mr. Ives here. He has covered every angle of this art and is probably one of the best authorities in the world on the subjects we are listing in the form of patents.

Mr. Ives: I doubt the wisdom of spreading out all this information; it is so complicated and involved, and I think Mr. Kelley is really going about as far as necessary when he takes care of the patent applications. I don't want to start any controversies, but I would like to have the facts known as they stand.

Mr. Kelley: We can't settle them, but we can put them on record. Have I the patent numbers of all the cases you refer to here?

Mr. Ives: I don't know. I have no memory for patent numbers or dates, and I am obliged to go over the list when I want to look them over. I find I have patented things I have forgotten all about when I do go over the list.

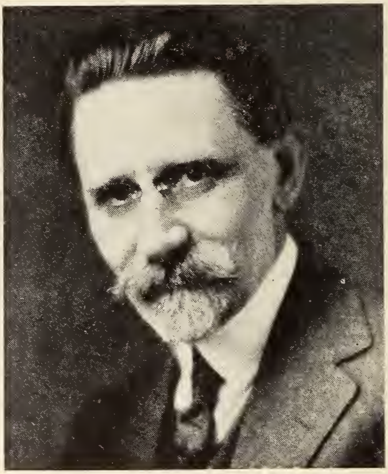
Mr. Kelley: One more point: I don't know whether Mr. Ives is aware of it. The gluing of the films together by the Technicolor Company before development is really the ingenious point in their system.

Mr. Ives: It is a wonderful achievement, but I think it is labor lost because I think it is too expensive in competition with the processes they will have pretty soon.

Dr. G. A. Herman Kellner, organizer and head of the Scientific Bureau of the Bausch & Lomb Optical Co., died at his home in Rochester, Thursday, Jan. 28, after an extended illness.

His death deprives the optical industry of America of one of its outstanding personalities for Dr. Kellner was universally recognized as one of the highest authorities in the field of lens and instrument design. Born July 30, 1873, Dr. Kellner studied at the universities of Berlin and Jena, receiving his doctorate from the latter in 1899. Endowed with a marvelous memory and an extraordinary quickness of perception, he was able, in his early years, to master the entire classical literature of geometrical optics. During the latter part of his course at the University of Jena, and afterwards, he was associated with the Optical Works of Carl Zeiss.

Dr. Kellner brought to America an extraordinary natural ability and a rare training in scientific optics. His influence upon the optical industry here was most conspicuous in the case of the microscope, which was always his favorite instrument. The excellence of the American microscope today is due largely to his efforts. He participated in the development of practically all of the modern fire-control instruments now used by the U. S. Navy. In later years he devoted much time and effort to the development of motion picture projection apparatus.



DR. G. A. HERMAN KELLNER

He was a prominent figure at the meetings of the Society of Motion Picture Engineers. He joined the Society within the first few months of its existence and served it as a member of its Board of Governors, as Vice-President and by his labors on several of its committees.

He contributed the following papers to the Transactions:

The Function of the Condenser in the Projection Apparatus—Vol. 7, Nov. 1918, p. 44.

Absorption and Reflection Losses in Motion Picture Objectives—Vol. 11, Oct. 1920, p. 74.

Some Uses of Aspherical Lenses in Motion Picture Projection—Vol. 14, May 1922, p. 85.

A Motion Analyzer—Vol. 15, Oct. 1922, p. 47.

Can the Efficiency of Condensers be Increased?—Vol. 17, Oct. 1923, p. 133.

Stereoscopy and its Possibilities in Projection—Vol. 18, May 1924, p. 54.

Results Obtained with the Relay Condensing System—Vol. 18, May 1924, p. 143.

He was a charter member of the Optical Society of America, and was the first editor of its journal.

Dr. Kellner was married in 1906 to Miss Marguerite Goetze, who died about a year ago. He leaves three daughters. His mother, two sisters and a brother in Germany also survive him.

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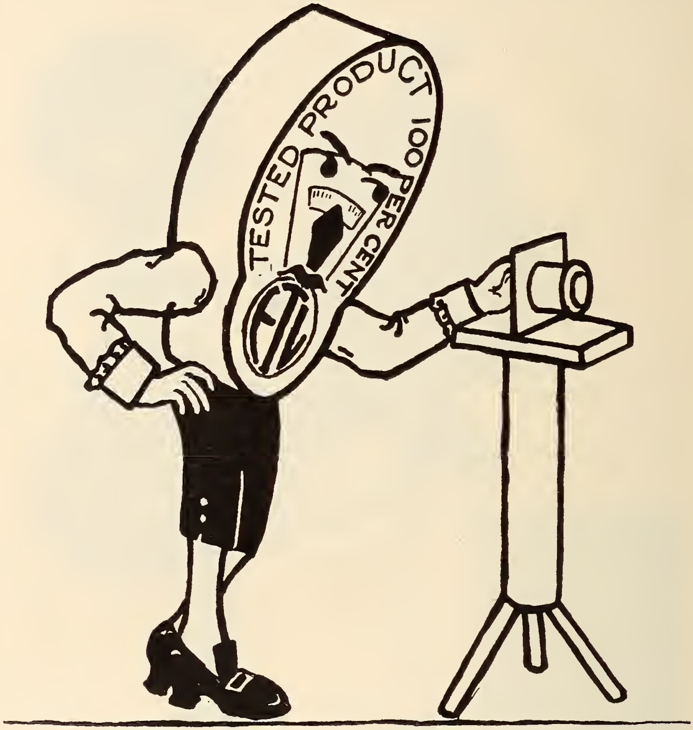

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He is vitally interested. He wants to know about the improvements that are being made by motion picture engineers.

He is ambitious. He wants better theatres. He wants better projection. He wants more comfort for his patrons. He wants better pictures. He is on the alert for improved equipment—for advice on how to get better results from the equipment he is already provided with.

To meet this demand, Exhibitors Herald, the leading weekly motion picture trade paper, prints every fourth week a "Better Theatres" section under its own cover. It contains from 40 to 50 pages, unlike anything else offered the motion picture theatre owner. In two years, "Better Theatres" has become recognized as the one magazine theatre owners look to for advice and information on the construction, equipment and maintenance of theatres.

Here then is an appreciative audience for you, and the ideal medium through which to reach it. We want you to contribute to our editorial columns articles on the rapid strides which are being made in motion picture engineering. We would suggest that the theatre owner is not a "technical" man and should be given facts in such a way that they are clear to the lay mind.

If you have a product to sell, we offer you a complete, sustained advertising campaign more effective and at lower cost than you can obtain in any other medium of the motion picture industry.

If you are not familiar with "Better Theatres," you do not realize what a forward step in motion picture trade journalism has been taken. A note to Martin J. Quigley, Exhibitors Herald, 407 South Dearborn Street, Chicago, will bring you the latest copy.

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