Discussion on Mr. Egeler's Paper

Mr. Victor: Mr. Egeler, why is it that in yourcomparison you were not using the triple condensing system? Why didn't you use the meniscus and two plano-convex?

Mr. Egeler: The tests which were covered in this paper were conducted to obtain certain information regarding condenser lens systems now on the market used in the projection of motion pictures in theaters, and the lenses most widely used are the 4½-inch diameter prismatic and plano-convex in the 6½-inch and 7½-inch focal lengths; there appears to be no apparent standardization of the triple condenser lens systems in use. In other words, we were not investigating the possibilities of condenser design, but were making a comparison of the two most widely used types.

Mr. Victor: There has not been any attempt, in other words, during your test, to get maximum results out of the two types of condensing lens systems?

Mr. Egeler: Our purpose was to determine the merits of the plano-convex and prismatic types, but not to go into other combinations, such as triple combinations, or whatever number may be used to get better results.

Mr. Victor: As I take it, the whole thing sums up about this way: you have taken into consideration a type of condensing lens which is somewhat new, so far as practical application is concerned, to motion pictures, that is, the prismatic type, and the old style condensing lens system, which also lent itself to the projection of lantern slides, but the most efficient system, the triple condensing lens system, which can be used both for motion pictures and slide projection you have not dealt with.

Mr. Egeler: I agree with the suggestion you make there, that there are other systems which will probably give better results, but, as I say, for the purpose of the test we did not try to investigate all possibilities, but rather to deal with those two used most commonly in the past, with incandescent lamp theater equipments.

Mr. Victor: That is what I wanted to bring out.

Mr. Kroesen: One point that I want to ask Mr. Egeler about is if he accomplished all his focusing of the lamp forward and back by means of the small pin-hole in the douser. My reason for asking that is this: that we have a very elaborate method by which the lens, but in most cases in front. I might say the purpose of this test holes are actually perforated in the douser, but in the course of manufacture we find that it is absolutely impossible to get the perforation on the optical axis at all times, which will necessarily make a difference in the maximum amount of light obtained on the screen when using these perforations, and what I had in mind also was if there could not be a certain amount of error in Mr. Egeler's maximum amount of light obtained where the corrugated lenses were used, if he did his focusing on that basis.

The second point I want to ask Mr. Egeler is, could that same result be obtained in practice—that is, in a booth where the mechanism is at the present time, and what he would say is a permissible screen—that is, permissible even screen, evenly illuminated.

Mr. Egeler: With regard to the first point Mr. Kroeser has brought up, before the tests were run, determinations were made of duplications of settings of lamps and mirror reflectors by several focusing methods, and it was found that the most exact method which could be used was that which I mentioned, namely, the observation of images on a card placed in the optical system. For best definition of the image, this card may be in back of the objective was to find out the possibilities, and later see the results that might be obtained, so far as possible, in practice. We got the best images by this focusing on cards, so that method was selected as being the most exact.

The second question brought up was as to the possibility of obtaining these results in practice. The means which has been used in practice for focusing the mirrored reflector with the incandescent lamp has been the observation of the image on the fire shutter, produced by a pinhole placed in the douser.

We find that some variation is encountered by this method, and the degree of variation encountered depends on the condenser system. In fact, by this method, we find it impossible to duplicate the setting, with the plano-convex condensers. You might duplicate one in a dozen, but you could not duplicate them with regularity by the pinhole method, unless it was modified to, say, 4 pinholes, and the images observed on a card placed not at the fire-shutter, but some distance from it, and even that method leaves something to be desired. That is why the methods of reflector adjustment for the two condensers was discussed at considerable length in the paper, and the fact was emphasized that with the prismatic lens we found that the single pinhole image observation method can be duplicated, and that is an entirely practicable one in service and a very simple one to use.

Mr. Kroesen: My last question was, what would you deem to be a permissible screen.

Mr. Egeler: In the tests as they evolved, it was shown that for the plano-convex condensers the amount of light obtainable on the screen depended on what unevenness of the screen illumination is permissible. As we increased the distance between the condenser and the light source the screen became uneven, but on the other hand more light passed through the aperture, since the image became smaller. Therefore, we had to determine what was permissible unevenness. That was done by having a number of observers give their opinion as to whether the screen as used had that unevenness which would be noticeable in a theater during the projection of a light density film, or the projection of animated cartoons, in which unevenness of screen would be most noticeable, and we took those settings which gave just that amount of light where we thought the layman would begin to notice it.

Mr. Richardson: There is one element in the matter of screen

Now, your distance from the aperature plate to the projecting lens is so large as compared to the dimensions of the condenser that your objective does not take as much light as it would if your condenser were further back. In addition to that, we have, of course, the immaterial, possibly, 10% loss in the additional lens, which is entirely a dead loss with the 3-condenser system.

Now, I should be delighted to make a test of any lens which you will furnish us. I have made that offer—it is absolutely open to anybody, whether they believe the results of it or not. We should like very much indeed to try it out. (Laughter.)

Mr. Victor: Dr. Story, I am very glad you brought that up, because before I stood up because I couldn't stand it any longer, I looked around to see if anybody would help me, and I had taken that into consideration, but we are dealing with very small diameter condensing lens, and therefore your light beam at its widest is not as large as when you use your large diameter lens.

Mr. Richardson: You have 4% less service.

Mr. Victor: You have a very wide light beam here (indicating). It crosses somewhere here (indicating). Here is your film aperture (indicating). It crosses here, bringing this to a focus on the film element. Now then, on the other side we get, of course, a light beam which is very wide, but when you narrow this down to a very small condenser lens—we will put it up here—which is no larger than the film, or no larger than to comfortably cover the film element, this is really what happens: you get that (indicating) effect, and at no time is your light beam of a great diameter, so we find that we can use the smallest objective that is ordinarily used and amply take in the entire cone, even with a 5-inch focus objective.

Mr. Victor: If we take the next largest objective, we can take care of a 6- and 7-inch focus.

Mr. Story: May I have the benefit of the blackboard for just a minute? I think Mr. Victor, that perhaps we disagree in your assumption of this point source of light. If we consider simply the light from a point source, it is perfectly true that with such a system of lenses, making them small, putting this point light close to them, you can get exactly as much light through your condenser as with any large system.

Now, unfortunately, we have no point source of light. If we had, we would illuminate the world.

If you consider this as your source ((illustrating by means of blackboard); if you put in here a condenser of any sort—I am going to represent that as a line simply—whether you call it two or three, or any number of lenses, in that condenser. If now, over here, you have your aperture plate and beyond here you have your objective, represented in this way—I don't care what kind that is—now, your light; obviously the light from the center of this comes up to the top of the condenser and so through the center of this. If that be focused at this point, it goes through the center here, but the light from the beam, a beam of this sort, going through there makes a corresponding angle on this side, and so comes out at some such line as that, being stopped there.

for motion pictures. Am I right in that, if motion pictures and slides, stereopticon slides, were operated from the same light source?

Mr. Egeler: Determinations were first made as to the working distance which would give the maximum amount of light for motion picture projection, as being the criterion, and it was then determined what these settings were. As to slide projection, if you refer to the plano-convex settings as given on page 7, of advance copy, you will not that in the case of the No. 2 lens, we found one setting the 8 and 3½-inch for 6½and 7½-inch condensers which gave greater light for motion picture projection, but if the plano-convex system is to be used for both, motion picture and slide projection, then the 9 and 3¾-inch working distance for 6½ and 7½-inch condensers is best. In the other cases, the maximum amount of light would be projected for motion pictures and still slides could be projected with the same working distances.

The only thing that stops us, gentlemen, from getting maximum efficiency out of condensing lens systems is the use of the lamp. Now that is your first important point in this whole reasoning. I am going to show you very simply why that is so. You project a lantern slide and you use for the purpose of concentrating the light on the slide and to the objective, a condensing lens. Different forms have been used, from the very simple bi-convex to two plano-convex, the triple lens system, and so forth.

Now, then, what would you think of a man today who designed, say, a 4-inch lantern slide and a 10-inch condensing lens for it, and set the slide about 10 inches away from the condensing lens? Why, it is absurd, but that is exactly what we are doing in motion picture projection today.

Now, if in lantern slide projection we use a condensing lens which is just large enough to cover the slide, why do we not use in motion picture projection a condensing lens just large enough to cover the picture element?

That gives us a small, inexpensive condensing lens, very thin, very accurate, but we cannot put our light source as close to the back wall of the back lens as we should.

Mr. Richardson: Why can't you with that kind of a lens?

Mr. Victor: You can and obtain pictures about 15 foot diameter with a candle-foot and a half, but that is your limit, but you can do that now, and it is being done, and none of you gentlemen have mentioned that is possible.

You do that by means of three lenses; the back one is a meniscus, and 2 plano-convex, and a very small incandescent lamp. We have a T-10 in our work; others use a T-8.

So far as I know, in motion pictures, this system was first employed commercially by the Pathés.

Dr. Story: May I say just one word? In regard to this 3-lens condenser, it seems to me that the principal reason why the 3-lens condenser offers any particular advantage over the 2-lens condenser is because in using a very small source, when you put that source to your condenser, you get a widely divergent beam on the other (illustrating by means of blackboard) side of the condenser.

Now, your distance from the aperature plate to the projecting lens is so large as compared to the dimensions of the condenser that your objective does not take as much light as it would if your condenser were further back. In addition to that, we have, of course, the immaterial, possibly, 10% loss in the additional lens, which is entirely a dead loss with the 3-condenser system.

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If, now, to bring this whole business up to a small condenser here, with your light source there—suppose that is the same angle—then, when this comes up here, that misses out on your objective down here.

Mr. Victor: It is a matter of getting close enough with your light source to the condenser so as not to have the rays cross before they reach the picture element.

Dr. Story: All right; suppose you focus out here. You mean focus at this point?

Mr. Victor: At the equivalent focal point.

Dr. Story: That means that either you use a large source here, or else you bring this very close to that, does it not?

Mr. Egeler: I wish to call attention to one point which does not always happen in service, and that is the fact that the focal or image point of the condenser is not always, and with Mazda lamps is never, at the aperture, and therefore in service we have complications due to spherical distortion at various points in the beam. Putting the image purposely far away from the aperture with the result that we have there does not always apply in practice, because—

Dr. Story (interposing): There is no such thing with any of these lenses as strict images. You get an image with a part of the ring of the condenser, extending on out further and further as you get nearer to the center of the condenser, but if you mean by the image of the condenser the point of maximum concentration, then it doesn't give you a uniform illumination if you use the plano-convex condenser, but it does give you practically uniformity if you use the prismatic condenser properly set.

Mr. Egeler: With the prismatic there are several conjugate focal points for the different rings.

Dr. Story: The different rings are put in their right place; the images are put in the right place to fall upon the gaps.

Mr. Victor: Is it possible with a large light source to get a parallel beam of light in the margins of the rays from the condensing lens?

Dr. Story: What do you mean by "parallel beam of light"?

Mr. Victor: We assume that we have a single lens. We will use a bi-convex, and have a 1-point light source. It will be possible to get our rays about parallel after they merge?

Dr. Story: Yes.

Mr. Victor: Can that be done with a large surface?

Dr. Story: No.

A Member: How about spherical correction?

Dr. Story: A small amount of spherical aberration does no real harm. Let me draw another diagram. Here is your aperture out here (illustrating). The light from this point comes up there. Suppose it is focused out here on this plate. In a projecting lens, then, the light from this point is lost, over here, because it is stopped by the diaphragm.

Now, a certain amount of spherical aberration will simply bend —oh, I had better draw the other one, too—the other one comes down here, and goes through the aperture. A small amount of spherical aberration, then, will simply bend this light beam down. Now, eventually this piece will be lost out here, but there will be light supplied by increasing the angle here. A certain amount of spherical aberration will do no real harm.

Mr. Richardson: Isn't it a fact that the magnification of the light source will be equal to distance from the center of the condenser to the aperture—divided by the center of the condenser to the light source?

Dr. Story: It will be in that proportion.

Mr. Richardson: You cannot get that amount of magnification, it seems to me.

Dr. Story: You can get this quantity of it—this quantity of magnification.

Mr. Richardson: You are showing magnification to cover the whole aperture and considerably more. I don't see how you can do that with Mazda projection.

Dr. Story: This is 6½ inches, the way it is ordinarily run with that condenser. This (indicating) is 2½ inches.

Dr. Richardson: That would be three.

Dr. Story: In other words, it is carried up almost three times. That is, the diameter of this, or any similar line would be one and a half, across any particular line, which is more than enough, even assuming spherical aberration. Of course, Dr. Gage can tell you more about that than I can, but, as a matter of fact, it takes up most of the spherical aberration.

Mr. Cook: In all your diagrams you have shown a distance from the condenser lens to the aperture, which is very much greater than the lens combination Mr. Victor is describing. I think we are discussing two entirely different problems. You say you have a distance from condenser to aperture that is very nearly the diameter of the lens.

In the system Mr. Victor speaks of, and which is also used by our concern, and has been for many years, the condenser element is close to the aperture, and the light is almost a parallel beam. As a matter of fact, the spot is almost the identical size of the aperture and every bit of light goes through there.

Mr. Richardson: That is where you are very close to it?

Mr. Cook: Yes, but Dr. Story is describing the existing system, instead of what Mr. Victor brought out for discussion, a different type.

In the miniature the condenser projector is 36 millimeters in diameter and the aperture is about two-thirds of it, so that there is practically no light lost.

The image of the filament is sharp from a distance of a little beyond the equivalent focus of the objective lens, clear on to infinity.

Mr. Richardson: And you have very little spherical aberration?

Mr. Cook: Very little. All you have to do is take your objective lens out and move the light source back and forth until you get a perfectly sharp screen image of your light filament. You use a small source here with about a 72° angle, and the condenser is within a half-inch of the film, so there is no loss of light there.

Aren't we sticking to the old system simply on account of the lantern slide necessity, rather than adopting a thearetically correct system if it is applied only to motion picture projection? •

Mr. Egeler: Mr. Cook brought out a point there about the very excellent utilization one gets if his condenser is nearly the same size as the aperture, but there is a limitation. The reason that design has been along the line of large condensers is from the necessary consideration of heat and radiated energy, and limitations in the light output of the source itself; in projection with condensers near the size of the aperture, you cannot make a lamp that will give you the large amount of light you want.

Mr. Cook: Not yet, but we are approaching it.

Mr. Egeler: Some day that may be done, but not yet.

Mr. Richardson: Here is a thing. Some of you already know about it, some do not. Something like four years ago I was called upon to go up somewhere in New York to look at what was known as a "Boy light concentrator." I was told two years ago that that was impractical. It is not; I saw it done about three weeks ago. I saw one of the most beautifully illuminated pictures I have ever looked at, and there wasn't a sign of a "ghost" on the screen, and it is the coming thing in Mazda, I believe.

The thing was made just like this (illustrating on blackboard).

The light source was here, and the aperture here, 16 18 inches, and your direct rays came here. Your light comes forward like this—through all these different zones, and here this way.

Dr. Story: I want to take that as a beautiful example of just the thing I mean. Here he has a reflecting surface. If you could get a small spot of light there, a mathematical point, you could get every speck of light from this whole outfit through that screen.

Mr. Richardson: We did it without the point source. It was a small automobile lamp, and it made a 15-foot picture bright with no "ghosts."

Dr. Story: We have a light source—it is not mathematical—let us draw it in there, something like this. Now, the light from the center of that small source comes over to this point and from there is reflected back through the center of this point. The light from the bottom of that source comes up say to the same point on the mirror, and is there reflected back in the same general direction, but making the same angle here that those two lines make there. Accordingly, when this light comes back here, whether or not it comes inside that opening is going to depend on this distance and that angle.

Mr. Richardson: Doctor, we got, I should say, nine-tenths of the light within a half-inch circle.

Dr. Story: If you can get 90% of the light through the source it is fine.

Mr. Victor: Take an ordinary reflector, such as we use in combination with our triple condensing lens system. You remove the condensing lens, and you move your reflector forward, and you get a most marvelous illumination on the screen, but it is absolutely useless for projection on account of the large light source.

I gave up all my hopes of getting that wonderful illumination due to that fact.

As Dr. Story said, if we had a one-point light source, a special reflector could be made doing away with all condensing lenses, and it would take very little illumination at the source to give us a wonderful screen picture.

Mr. Richardson: Why do you say it is useless, even under that condition? Why it is useless, if you get the light to the screen? I don't quite get your point.

Mr. Victor: Well, I could explain it to you in time, but I think someone else could do it much quicker. I will cite as an example of the efficiency of the small diameter triple condensing lens system, the following: I have recently perfected a printing machine, an optical printing machine, for printing pictures from standard negatives to safety negative prints.

I first experimented with a 1,000-watt lamp in a large housing, and found I had difficulty, even then, with so much illumination, in printing dense negatives. Subsequently I substituted a 1,000-watt lamp for a 2 ampere 24-candle power, 9 volt, Ford automobile light, in conjunction with this precondensing lens system, and found I was burning up my prints, no matter how dense they were, so I had to reduce the illumination by means of a rheostat, and close my aperture down to 8½ in the lens I was printing with.

Now, that should be conclusive, and all this time you can take the lamp out, which contains this globe, which is not over 2½ inches in diameter, and hold it in your hand while you print, and you can also leave that negative indefinitely in the aperture with the full light on.

Mr. Richardson: Yes, but you haven't enough light for your projection.

Mr. Victor: I was stating a comparative condition between a 1,000-watt lamp and a light of a small candle-power used with the condensing system I have just mentioned.

Mr. Johnson: Mr. Victor, wasn't that a parabolic reflector you have reference to in all your experiments?

Mr. Victor: No.

Mr. Johnson: What did you use?

Mr. Victor: I used a type of reflector which I understand is not parabolic.

Mr. Johnson: What is it near, an elipsoid?

Mr. Victor: No; it would be a portion of a sphere.

Mr. Johnson: What Mr. Richardson is speaking about is a sort of an ellipsoid reflector, which is only possible to generate by the construction of special lapping tools, and as to the test he has reference to, I saw a 30-watt automobile light give to the eye as much illumination as the present 900-watt motion picture light, so that what he says has quite a bit of merit as a projection matter, but it is difficult to obtain, due to the generation of this special reflector, which was nearer an ellipsoid than the parabolic arrangement used by most people, and by being able to pull this light back through the hole in the back of the reflector, it was possible to get as near to one point source as it is commercially possible. I personally saw the demonstration and am convinced there is a great deal of merit to this if you have the proper tools and they are able to generate this ellipsoid thoroughly.

Mr. Porter: I would like to ask Mr. Johnson if at that demonstration he actually saw a film projected with that outfit, or if he simply saw the screen illumination. I would also like to ask him if he knows at what temperature the lamp was run.

Mr. Johnson: Answering the first question, I did see a piece of film projected, and as to the second, the lamp was run at what the manufacturers recommended it to be run at. There was no occasion to strain it, or do any running other than what the lamp called for.

I think the results derived from simply making it possible to cast and design this special tool, so that we could generate it, and lap it over, and not have any break-up in the occular system, is a perfectly wonderful piece of mechanical work, and that is why you get those results.