Discussion

Note: Chairman Larsen requested that discussion on the two preceding papers be held until after the Large-Screen Television Demonstration. Therefore, the following discussion concerns both papers.

MR. J. I. CRABTREE: Does the aspherical lens need cleaning very often? If so, being plastic, do you not impair the optical properties in cleaning it?

MR. I. G. MALOFF: Not especially in the large-screen projector. If it is cleaned with the antistatic compound, we do not have to clean it very often. In the home-projection receiver, we make a hood that protects it from collecting dust. The normal cleaning with a soft cloth does not spoil it, because we use the hardest available plastic.

DR. E. W. KELLOGG: I should imagine the audience might be interested if Mr. Maloff would give us the figures of the optical speed or effective *f* number that is attainable in the Schmidt system, and also the field size in degrees so that they might compare it with what is possible with camera lenses or projection lenses.

MR. MALOFF: The *f* number as such loses its meaning at, I would say, about *f*/1.4. So the best figure is the efficiency of the lens. By defining efficiency as the ratio of the number of lumens delivered to the screen, to the lumens produced by the tube, we arrive at a figure between 30 and 40 per cent with the reflective optics, with a very large magnification. The figures for the *f*/2 lens, for the same magnification, run close to 4 or 5 per cent. I cannot tell you the field angles, offhand.

CAPTAIN A. G. D. WEST: How many lumens do you project in this projector and how many do you expect to project in the new 42-inch mirror projector?

MR. MALOFF: Suppose we turn the answers to your question around. The prewar projector gave us high-light brightness somewhere between 1 and 2 foot-lamberts. That brightness was found in a number of theaters around the country by the Committee on Screen Brightness of the Society of Motion Picture Engineers, which report was published around 1936 or 1937. The size of our screen in the New Yorker theater in 1940 was 15 × 20 feet. The screen gain was 2. By gain of a screen, we mean the ratio of brightness normal to the screen, to the incident illumination; that is, how many foot-lamberts' brightness are obtained for 1 foot-candle illumination or 1 lumen per square foot.

What we are doing now is this: We went to a 15-inch tube and increased the area of the emitter four times, roughly. Then we increased the voltage somewhat, and we used an aluminum-backed screen. Before the war we also used an aluminum-backed screen, but it was of an amorphous type, which did not have a mirror reflecting the light that was going back toward the gun. It was an absorber of that light. We put it on only to maintain the luminescent material at the second-anode voltage. There is such a phenomenon known as "sticking" of the luminescent material. That means it does not quite reach the voltage put on the second anode, never rising above the "sticking potential."

This gives us a gain of approximately eight times. There are a few other small gains, for example, in higher light output from the phosphor.

This would give us, with a perfectly diffusing screen having a gain of 1, a net gain of four times the prewar screen brightness.

We do not propose to use, with theater television, screens that illuminate ceiling and floor. We want the light to fall where the people are. Therefore, we propose to build screens that will throw the light only where the audience is. We have done this to a certain extent with the home projection receivers. We hope to do so with the theater projection receivers. The screen in the home projection receiver has a gain of 6. I doubt if we can get that kind of gain for a theater, but we ought to be able to get a gain between 3 and 4, and we are working hard at it.

CAPTAIN WEST: As to the answer about how many lumens, I believe the pre-war, that is, 1941, projector gave about 200 or 300 lumens.

MR. MALOFF: On the New Yorker installation we ran close to 500 microamperes, average beam current. That gives us a peak, say, of 2 milliamperes. At 70 kilovolts, it is 140 watts. Now, 140 watts at 2 candle power per watt gives you 280 candle power. Assuming that we emit from the face of the cathode-ray tube according to Lambert's law, we multiply that by 3. That gives us somewhere in the neighborhood of 600 or 700 lumens. The same arithmetic applies again now, except that we are getting between 4 and 5 candle power per watt from the luminescent screen, this new aluminized screen. The new screen has mirror aluminum; it is not amorphous aluminum. We coat the screen with organic material. We fill all the little holes, the little depressions in the luminescent material, and the coating leaves a shiny surface. Then we evaporate aluminum on that shiny surface, and by baking and evacuating with pumps, we exhaust all the organic material. So we have left a shiny aluminum surface over the luminescent material. In this way we more than double the efficiency of the luminescent material.

CAPTAIN WEST: That is our practice, of course. However, I think we expect to get 1000 lumens from our 40-inch projector. You remember I mentioned about Dr. Zworkin's being in Paris. After he returned from that visit, I heard that he was achieving 12,000 lumens and 40 foot-lamberts on that size screen. So that rather depressed Professor Fisher, who was working on the other system.

I should have liked to bring a projector here to compare with the one used in the large-screen television demonstration, but it was not possible. However, in London we are projecting on a larger screen. It is very difficult to make a comparison, but, first of all, I should say my impressions of the picture are exceedingly good. My first impression is an impression of the color. It is a better color than we are having at the moment for a larger screen. I like the blue white and the bluish white in the home receiver.

Second, there seems to be good interlacing, which we do not have at home. The contrast range was very good. Was the center part film transmission?

MR. LITTLE: I believe certain portions of that program were from film.

CAPTAIN WEST: The transmission of the British Broadcasting Corporation suffers from a good deal of shading. Generally speaking, I am very favorably impressed. I think it is a very good picture, indeed.

DR. K. PESTRECOV: I think we need a committee on standardization of screen terminology. Recently we heard a report on screen-brightness measurements. At that time the ratio of foot-lamberts to foot-candles on the screen was called efficiency of the screen. As I remember, the efficiency would run from about 50 per cent to about 90 per cent. I believe Mr. Maloff prefers the term "gain." If it is really the same quantity, then a gain of 2 would correspond, as was defined a day or two ago, to an efficiency of 200 per cent. That is the first question.

Second, if television engineers can design a screen, or hope to design a screen, with a gain of 2, or an efficiency of 200 per cent, the screen also should be suitable for general motion picture projection. Perhaps, it will be a real advance so far as obtaining brighter pictures in general, because for theater television you are not inclined to use one screen and another screen for motion pictures.

MR. MALOFF: The first question is on efficiency and gain. There has not been any standardization in that field, so far, except among ourselves. Television engineers have a clear distinction between the two terms.

The one term, efficiency of the screen, is simply determined by putting a photometer on the other side and determining how much light at all angles gets through that screen. I am mostly talking about transmission screens, but the same applies to reflective screens. However, when we talk about gain, we measure this by comparing the light with what would come from a perfectly diffusing screen according to Lambert's law. We concentrate the returned light into a narrow pyramid, more or less. Horizontally it is wide. What we are trying to do is to get 60 degrees width from the screen, completely uniformly, with a sharp cutoff beyond that. Vertically, we are trying to get a 20-degree spread.

Theoretically, you can get close to a gain of 12 if you collect light that went to various places before. However, you can never get efficiency of the screen of over 100 per cent, because you absorb some light.

Before very long, we shall all have to get together and straighten out this matter, at least among us television engineers. Then we might have either conversion factors to translate to motion picture practice, or perhaps we can adopt the same terminology and the same definitions. Such is the case of resolution right now. When we talk about resolution in television, we say "500 lines." When an optical man looks at it, he will say it is only "250 lines," because we count every line, white and black, whereas he is counting only the black lines.

As to the second question, whether such screens as we are using now in the television industry are suitable for motion picture projection, we have various reflective screens. One concern is putting in a reflective screen with a gain of just about 6. It was demonstrated in New York and in other cities. Screens with a gain of 12 were demonstrated. That particular screen, however, has too narrow a vertical angle, and they have put in one with a lower value of gain.

So, all screens, both of the translucent type and the reflective type, could be used in theater projection of motion pictures. However, in some of the theaters the angles are so wide that you cannot use a directional screen; that is, where there is a second and third balcony. That is why we could not use a very high-gain screen in the New Yorker theater before the war.

In an auditorium like this one we should use a curved type of screen. There is an exhibit right outside the door of a curved screen, which definitely can give you a different directional distribution, vertically and horizontally. However, the problem is not so acute for the motion picture engineers as it is for television engineers. You start with such high values of light that you can waste it. If you can put a few extra seats here and there, you do so. The light goes down, but you still hold within your standard; that is, if it drops from 10 to 7 foot-lamberts, you do not mind that very much if you have a few extra seats.

We barely reach sufficient brightness. We cannot waste it, and we might have to waste a few seats in the theaters in order to show theater television.

DR. PESTRECOV: Thank you, Mr. Maloff. I purposely meant to provoke the discussion, because I have had discussions with Mr. Maloff before, and I more or less knew what he was talking about when he mentioned the term "gain." However, I believe that perhaps many people here do not know that term. As a matter of fact, I did not know it about two years ago, and many people in the optical industry and the motion picture industry still do not know that term. The point is that you get gain when you narrow the angle of reflection; is that correct?

MR. MALOFF: That is correct.

DR. PESTRECOV: So, perhaps, it really might be better to employ that term, make it standard, and then we shall not talk so much about the efficiency of the screen. As to the committee that reported on the brightness of the screen, what the committee actually measured at that time was the brightness of the screen in a certain direction. They did not measure the total light reflected, I believe. Perhaps some time in the future we can introduce that term and really talk about gain of the screen. In this particular case probably it does not have much meaning, but when we start to talk about television screens in the motion picture industry, then we have to use that term, and I think it should be more or less explained. Maybe if you explain it when you write this paper for publication, I think it would be very useful; at least, we shall have a definite and authoritative reference.

MR. LITTLE: Captain West might be able to answer a question on screens. In his paper he mentioned the lenticular screen which they were using in England, which gives a gain of 3. He also showed slides showing the distribution throughout the house, and that screen gave excellent coverage. Captain West, would you care to give us some explanation of the type of screen that you use?

CAPTAIN WEST: We are not using that screen at the moment. The one I referred to there under the heading of lenticular, which makes a large gain, was first demonstrated by Dr. Muller in Berlin at an exhibition. It consisted of a series of mirrors like a cat's eyes you see when you are driving on the road at night, looking out at you. It was very carefully arranged. I tested it very clearly on this television projector, which was similar to the one I illustrated on Tuesday night, of the pipe-shaped tube of the lens. I must say that if you were sitting at the end of the row and got out of your seat into the gangway, the picture vanished; and when you went back into your seat, it appeared again. The idea is that all the light was reflected back into the seats, and not all over the theater. That amount of light was conserved. It was always very expensive to make and had to be tailored for every theater.

There is an intermediate type of lenticular screen which we have been using. We have not used it so much as we wanted to, because of the shortage of metal and other materials. It is similar to what was described by Mr. Maloff for the home, except that it is a reflecting screen instead of a transparent one. I think that it corresponds to the screen in my diagram, which I referred to as a "stippled-metal screen." That gives a reflection factor right down the center of about $2^1/_2$ to 3 times.

One more question. I suppose you are getting a good show for one particular reason, in that it is all coming down from that little tower up there, is that right?

MR. LITTLE: Yes, that is correct. The program came from the Empire State Building, but I might add that the proximity really causes a great deal of difficulty. Tonight, about twenty minutes after seven, I would have said tonight's show was not going on, because we had a great deal of interference which apparently was cross modulation in the receiver between frequency-modulation and television signals. We were very much discouraged about putting on the show Some of the difficulty you did see in the picture during the show was caused in the receiver and not in the projection equipment. It was unforeseen, I assure you, and normally that type of interference is not present.

CAPTAIN WEST: That should please you very much, because we find that when everything goes wrong, before a demonstration, it is usually all right.

There is one other thing I would like to mention which helps very much, in presentation of television on the screen. That is the sound. We are doing experiments in theaters now which in the last eight years have had a little disturbance around them, not fit for the public to enter; in fact, all the seats had been taken out, parts of the roof were down, and that sort of thing. The sound is very bad in our television presentation. The sound was very good here tonight. I am absolutely certain that if you get good sound you get a much better picture.

MR. BEN SCHLANGER: If we can call this theater television a baby, I wonder if we are not making this baby run before it creeps. From what I can see, you are limited to a screen characteristic which throws the light back in a very narrow angle. Is it not better to take theater television and put it into shelters which are made for theater television? You are overstepping your bonds in trying to show television in existing theaters, where 50 per cent of the location will be inadequate and will not show the job off as well as it could be. The way you light the interior of the motion picture theater, there would be too much light in competition to the amount of light that you can get off the screen with television.

MR. LITTLE: I hasten to point out the remark during the paper, that the present equipment is the basis of an experimental program. We do not know what form television theaters will take, or what form television programming will take. We do not know what form television equipment, as such, will take. We are just embarking on this field, and we hope to get the answers. We certainly do not know them and as manufacturers we do not propose to give the answers to the industry. We are trying to help the industry find the answers. You gentlemen are part of the industry, and we expect the answers to come from you. We cannot give them. We can build you the equipment if you can tell us what you want.

MR. SCHLANGER: All the demonstrations and all the tests have been in existing theaters. It has never been given a really fair trial in a room that would really show it off the way it should.

MR. LITTLE: Maybe those limitations are inherent, but we do not believe so. We are certainly looking for an answer.

MR. R. B. AUSTRIAN: Mr. Maloff, in describing the screens and assigning the values to them which you did, I understood you to make a statement that there was no reason why they could not be used interchangeably for regular motion picture projection. Do I assume that the screens you worked with were nonporous; and if you had to perforate them for proper sound presentation as to be acceptable today, would that not change some of your reflection characteristics?

MR. MALOFF: Yes, very definitely, if you use directional screens. By the time you perforate it, you probably lose part of the effect that you gain. Maybe your sound effect will not be as good as you would like to have it. I do not think a perforated screen is an important item, but the industry probably thinks differently. If we perforate a directional screen, depending upon the percentage of the holes to the rest of the screen, we shall lose that much more light.