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FILM PRODUCTION TECHNIQUE

Alfred Hitchcock*

Read by Mr. Victor A. Peers to a joint meeting of the British Kinematograph Society and the Association of Cinema and Allied Technicians on Sept. 22, 1948.

The filming of each picture is a problem in itself. The solution to such a problem is an individual thing, not the application of a mass solution to all problems. Film production methods of yesterday may seem out of date today, and yet tomorrow’s problem may be best solved by using yesterday’s methods. The first rule of direction must be flexibility.

Nothing should be permitted to interfere with the story. The making of a picture is nothing but the telling of a story, and the story—it goes without saying—must be a good one. I do not try to put on to the screen what is called “a slice of life,” because people can get all the slices of life they want out of the kinema. On the other hand, total fantasy is not wanted, because people desire to connect themselves with what they see on the screen.

Those are all the restrictions I would place on the story. It must be believeable, and yet not ordinary. It must be dramatic, and yet lifelike.

Having decided upon our story, we must next develop our characters and the plot. When that is done, are we ready to go on the floor?

I maintain we are not, because our picture is going to need editing and cutting, and the time for this work is before shooting. The cuts should be made in the script itself, before a camera turns, and not in the film after the cameras have stopped turning.

Script Cutting

My objection to the more conventional method of cutting is twofold. First of all, it is wasteful. The tragedy of the actor whose entire part ends on the cutting-room floor is not entirely a personal one; his salary, the sets he acted in, the film on which his acting was recorded, all represent expenditure.

More important, if each scene is filmed as a separate entity, out of sequence, the director is forced to concentrate on each scene as a scene. There is then a danger that one such scene may be given too great a prominence in direction and acting, and its relation to the remaining scenes in the picture will be out of balance, or, again, that it may have been given insufficient value and when the scene becomes part of the whole, the film will be lacking in something.

*Transatlantic Pictures Corp.
The "extra shots" made after the regular schedule is completed are necessitated because, in the shooting of the scenes, story points were missed. The extra expository shots are generally identified by an audience for what they are: artificial devices to cover what had been overlooked in the preparation of the film.

How can this be avoided? I think it can best be avoided if a shooting script is edited before shooting starts. In this way, nothing extra is shot, and, most important, story points will be made naturally, within the action itself.

If we do not edit before we shoot, we may be faced, in the cutting room, with one of the most difficult of all editorial problems—the unexplained lapse of time. The passage of time may be essential to the plot, but it may not have been made clear in the sequences that have been shot. There was a time—long since passed—when one would simply have photographed the words "One Week Later" in transparency and caused them to appear on the screen in mid-air during the second scene.

The lapse of time can easily be indicated by the simple method of shooting one scene as a day scene and the next as a night scene, or one scene with leaves on the trees and the next one with snow on the ground. These are obvious examples, but they serve to point the need for editing before production commences.

Camera Movement

A director tries never to go on the floor without a complete shooting script. But for one reason or another, one often has to start with what is really an incomplete script.

The most glaring omission in the conventional script, I believe, is camera movement. The director may decide on the floor how he is going to film

Fig. 1. The set used for "Rope." The sliding walls are demonstrated for Mr. Hitchcock's benefit.
a sequence. But I maintain the time for such a decision is in the preparation of the script.

Here we encounter once again the fact that the tendency today is to shoot scenes and sequences, and not to shoot pictures. The angle from which a scene is to be shot ought to flow logically from the preceding shot, and it ought to be so designed that it will fit smoothly into whatever follows it. Actually, if all the shooting is planned and incorporated into the script, one will never think about shooting a scene, but merely about shooting a picture of which the scene in question is a part.

Shooting in Sequence

The object of these remarks is to emphasise that I favour shooting pictures in sequence. The film is seen in sequence by an audience, and the nearer a director gets to an audience's point of view, the more easily he will be able to satisfy the audience.

The satisfaction of an audience has been deprecated as an aim of picture making, and I think that is a very grave mistake. There has been a tendency to sneer at audiences, to regard them as a tasteless mass to whose ignorance phenomenal concessions must be made by producers and directors. Why is this? One reason is that a director hears comments about his work constantly, and these comments come, for the most part, from people associated with the industry. It is laudable to seek the applause and approbation of one's co-workers, but once one begins making pictures for their satisfaction, it is only a short step to condemning lay audiences for their lack of appreciation of kinema craft.

This is a dangerous point of view. Of course, it is a fine thing to make a picture whose technique excites admiration from people who understand technique. But these are not the people who pay the costs of production.
Fig. 3. The camera comes in to a close-up as the revolver is fired.

Audience Groups

A picture-maker need not try to please everyone. It is important to decide at what audience one is aiming, and then to keep one’s eye on that target. But it is obviously uneconomic to shoot for a small audience, and a motion picture costing some hundreds of thousands of pounds, which has taken the efforts of one hundred or perhaps two hundred men, cannot direct its appeal towards people with a special knowledge of filmmaking or to a certain section of the community.

To approach a cinema audience with contempt invites contempt in response. The great playwrights, Barrie and Pinero, for example, rendered more than lip service in their respect for their audiences. They wrote every line with a consciousness that it was designed to entertain adult human beings, and every line they wrote shows it. By the reasoning of those who maintain that intelligent drama cannot obtain a mass audience, their plays should all have been artistic successes and financial failures. But we know that they were well received, that many of them were terrific hits, and we should profit by that knowledge. A good film can have a financial success.

Filming Technique

I turn now to the actual techniques of picture-making. I have a liking, for instance, for a roving camera, because I believe, as do many other directors, that a moving picture should really move. I have definite ideas about the use of cuts and fade-outs which, improperly handled, can remind the audience of the unreality of our medium and take them away from the plot.

But those are personal prejudices of mine. I do not try to bend the plot to fit technique; I adapt technique to the plot. A particular camera angle may give a cameraman—or even a director—a particularly satisfying effect. The question is, dramatically, is it the best way of telling whatever part of the story it is trying to tell? If not, it should not be used.

The motion picture is not an arena for the display of techniques. It is, rather, a method of telling a story in which techniques, beauty, the virtuosity of the camera, everything must be sacrificed or compromised when it detracts from the story itself.

An audience is never going to think to itself: “What magnificent work with the boom!” or “That dolly is very nicely handled!” It is interested in what the characters on the screen are doing, and it is a director’s job to keep the audience interested in that. Technique that attracts the audience’s attention is poor technique. The mark of good technique is that it is unnoticed.
Maintaining Interest

Even within a single picture, techniques should vary, although the over-all method of handling the story, the style, must remain constant. It is, for instance, obvious that audience concentration is higher at the beginning of a picture than at the end. The act of sitting in one place must eventually induce a certain lassitude. In order that that lassitude should not be translated into boredom or impatience, it is often necessary to accelerate the progress of the story towards the end, particularly of a long picture. This means more action and less dialogue, or, if dialogue is essential, speeches ought to be short, and a little louder and more forceful than they would be if the same scene were played earlier in the picture.

It is sometimes necessary to encourage artistes to over-act. It takes a certain amount of tact, of course, to induce a good actor to do so, and this is another argument in favour of shooting pictures more or less in sequence, because, once one has edged an actor into over-acting, it is, sadly enough, entirely impossible to edge him back-again.

Direction is, of course, a matter of decisions. The important thing, is that the director should make his decisions when the need for them arises, and operate with as few rules as possible.

Following the paper the last two reels of Mr. Hitchcock’s film “Rope” were projected.

DISCUSSION

Mr. Charles Frend: How much of the dialogue was generally post-synced in the two reels we have seen?

The Author: Not more than about 20%. Only when there was movement through a door from one room to another was post-syncing necessary. After each take a full sound take was done.

Mr. Ridley: What are the reactions of the actors to this new technique and is there more rehearsal?

The Author: The actors ran through the whole movement with rough lines, and while the lighting men were at work I would go off to another stage where there was a dummy set, and rehearse the cast completely. Every movement had to be perfect. First we went through the lines and then went over to the physical side and did that. Then we would go back to the real set, but I was always ready long before the lighting was ready.

Mr. Thorold Dickinson: After playing a reel for seven or eight minutes, how do you decide what to cut and when?

The Author: It is not an arbitrary cut, it is a dramatic cut.

Mr. Walter Lassally: When making a film by this new technique, do you find yourself bound to stick to the long take technique all through, or do you find yourself free to inter-cut short scenes?

The Author: No. In my present picture I mix techniques.

Mr. Gordon Hales: In the last two reels of “Rope” how were the dialogue and effects done? Was it built up of several pieces of dialogue track?

The Author: I had the street scene written as a dialogue scene. We went out on the back lot and put a mike up about six storeys high and played the scene on the back lot. The recording of the police car siren was started one and a half miles away. Sound tracks were made on the actual location of this eleventh storey apartment in New York in the hours during the actual time it was being played.

Miss Kay Mander: In these long scenes, the camera is presumably not on tracks but on a free dolly.

The Author: That is so.

Miss Mander: How are the camera crew cued, and do the actors have to pay any attention to the camera?

The Author: When the first rehearsal takes place, the camera crew have their rehearsal period. In “Rope” there was a 10-day period of camera rehearsal only. We had a spotlight underneath the lens hitting the floor and when the camera hit the position, that spot was marked on the floor with a number for position. Also, there was a backmark for the dolly itself. So there were two sets of marks, one for the dolly position and one for the front lens, because of the swing of the arm. All the shots were marked out on a plan in squares, and this made re-takes easy. We re-took five reels because of colour problems.

Miss Mander: How were the cues given?

The Author: The continuity girl on the back of the dolly did the dolly cueing by tapping the operator on the shoulder when he was in position. A man with a
pointer pointed to the next spot, so that the man swinging the arm would know where to go.

Mr. Tanner: What is the work of the editor?

The Author: The editor works on the script ahead of shooting. My present picture was laid out in the rough and the editor made his comments after the cameramen. He now works on paper, not on the film.

Mr. Peter Hoyle: Has the boom operator opportunity for rehearsal?

The Author: He gets more opportunities for rehearsal this way.

Mr. Ridley: The preparation of your detailed script reminded me very much of the Independent Frame process. What are your re-actions to Independent Frame?

The Author: I know nothing about it. I gather that it is as though you had made a picture and took all the cuts apart and set them up individually. It feels to me as though there is a restriction of movement.

Mr. J. Adkins: If you could have attached to your camera a television system showing the picture all the time, do you think it would be advantageous?

The Author: Definitely. This is television. There is a great similarity in technique.

Mr. Charles Frend: What is the time saved on the over-all schedule?

The Author: The time saved is about 25%. "Rope" ran for 7,200 feet and was shot in 36 days, including 10 days' rehearsal and five reels of re-take. It was a short picture, but the present picture I am doing will end up about 55 days.

Mr. Frend: What about comparative budget costs?

The Author: When you shoot ahead of schedule, you have merely a saving of time. In "Spellbound" the schedule was 57 days and the picture was completed in 48 days. Although 20% of the time was saved, there was only a saving of 10% of the cost. The cost of the story and salaries of the stars, and the director, were the same.

A Visitor: Is there no saving in set construction?

The Author: About 20%.

Mr. M. Harvey: Do you feel you will be limited in the type of story you can handle by this method?

The Author: No. If you have a story with a number of sequences, you can take each sequence and treat it in this way. You can also mix your technique. Certain sequences you can shoot in continuous takes and others you can cut.

Mr. Kenneth Annakin: Do you feel that it is possible to get a complete conception of the film on paper?

The Author: I have a complete conception of the film in the mind and not on paper. It has to be built.

A Visitor: The opening of the film of the chest in "Rope," broke my continuity. Was there some purpose in doing so?

The Author: That was the end of a set-up. We were limited to the amount of film in the camera.

Mr. Pearce: Do your actors have to give a little more than in normal technique?

The Author: That is not strictly so. In movies we have been awfully lazy and we have just staged the scene to pick up the actor's face wherever it may be. By letting the actor move around he tends to help us more.

Mr. J. Mills: Can the system be adapted to a small studio? It seems rather necessary to be able to rehearse outside the stage in which you are shooting.

The Author: You want a large stage to get outside the confines of the set, but I have rehearsed in a scene dock.

Mr. Ridley: Have you ever filmed large crowd scenes by this method?

The Author: Yes, but the scene was not longer than about two minutes, because there was a dramatic reason for breaking it up. You rehearse the crowd independently of camera movement.

A Visitor: Do the long takes necessitate better equipment than we have in this country?

The Author: An electric dolly is needed, because it is more mobile and more sensitive.

A Visitor: How does the longer take affect the still cameraman?

The Author: The still man has a take all for himself. We are now doing stills in action. We play the film just the same and the still man goes through and takes instantaneous pictures and the result is quite astounding.

A Visitor: Does the dolly run on the normal studio floor?

The Author: In each case we have had to lay a special floor. At present we have an asphalt floor covering the whole studio. In "Rope" a wooden floor was placed on top of the one in the studio.

A Visitor: In the early part of "Rope," which we have not seen, do we ever see the fourth wall of the room?

The Author: Yes. The camera goes right round and shows one corner of the fourth wall.

A Visitor: Has the lighting cameraman any restrictions?

[Continued on page 16]
NITRATE AND SAFETY FILM BASE CHARACTERISTICS

G. J. Craig, O.B.E., M.B.K.S.*

Read to the British Kinematograph Society on October 6th, 1948.

ANY here will be familiar with the fact that prints made on a new Eastman Safety Film are being run on general release in London. More elaborate trials of the same character have already been made in the United States, and we may hope to see the gradual adoption of safety film in all phases of motion picture work within the next few years.

The immense advantages in reduction of fire hazard to be gained by elimination of nitrate film are too obvious to need mention, but so far the safety films offered as alternatives have shown poorer wearing qualities, and a tendency to become brittle after a few projections. This evening I hope to show that in most properties the new safety film comes close to matching nitrate, and is notably superior in respect of shrinkage characteristics.

I. MANUFACTURE

In the manufacture of film base, cellulose is the principal ingredient. It is usually obtained from raw cotton.

Various acids will react with cellulose to form organic compounds identified by the generic term “ester.” Esters of particular interest in film base manufacture are those produced by the actions of nitric, acetic, propionic, and butyric acids. They are known as cellulose nitrate, acetate, propionate and butyrate respectively.

The characteristics of these esters may be varied by controlling the degree of esterification, or acid action. For instance, cellulose mono-acetates, di-acetates or triacetates can be obtained in this way.

Also, mixed esters may be produced by the action of mixed acids, for example, acetate-propionates and acetate-butyrates. Use of these various esters yields film bases differing in character, and naturally the special qualities called for in the particular process for which the film base is to be used are borne in mind when deciding which base shall be employed. (For instance, aerial photography calls for a film with exceptionally regular and low shrinkage characteristics, while kinematograph projection requires a material capable of withstanding much wear and tear.) Mixed esters used in film base manufacture are acetate-propionate and acetate-butyrate.

The earliest “Kodak” safety base was a cellulose acetate of 40% acetyl content. In 1937 an improved cellulose acetate-propionate material replaced this: its composition was approximately 30% acetyl and 14% propionyl. The latest material now introduced is a cellulose acetate with the high acetyl content of approximately 43%. This approaches the maximum possible acetyl content for a cellulose triacetate, which is 44.8%. For convenience, these three types of film will be referred to as Early Safety, Old Safety and New Safety respectively. (Fig. 1.)

Casting the Base

After the cellulose ester has been prepared, it is dissolved in a suitable mixture of solvents (e.g., for nitrate an alcohol-acetone-amyl acetate mixture) to which plasticiser (for nitrate: camphor) is added to give flexibility. This “dope,” which has the appearance of clear honey, is applied in a thin layer to the surface of a highly polished slowly rotating drum. Evaporation of solvent before the drum has completed one revolution enables the base to be stripped

*Kodak, Ltd,
away as a thin film. This then passes through further heated "curing" chambers where more solvent evaporates, and the film attains its final form.

In passing through the curing chambers the film has to be pulled along to some extent. As a consequence, a certain amount of orientation of the cellulose ester molecules takes place. The practical effect of this later is to cause differential ester shrinkage across the film and along its length, so that we usually find when measuring a processed film that the percentage of shrinkage in width rather exceeds the lengthwise shrinkage.

II. MECHANICAL AND PHYSICAL CHARACTERISTICS

The final evaluation on the quality of a film base is, of course, its behaviour under practical working conditions. However, a very good estimate of its properties can be made from a study of certain mechanical and physical characteristics which are capable of measurement with considerable accuracy.

Mechanical Characteristics

From this aspect there are four mechanical characteristics we will consider: tensile strength, which is a guide to the ability of the film to withstand hard wear; the modulus of elasticity, indicating its stiffness and rigidity; the folding endurance, which determines flexibility; and the tear value, showing the ability of the film to withstand stresses of that character.

Tensile Strength.—If a strip of film is secured at one end and a tension applied to the other, it will stretch. As the tension is increased it will stretch further, and at first the amount of stretch will be constant for a given increase in tension. However, after a certain limit has been reached the degree of stretch will become very much greater, and the point at which this occurs is known as the yield point. If the tension continues to increase the film will finally snap. The tension at which this occurs is a measure of the tensile strength.

Modulus of Elasticity is the ratio of tension to stretch within the first part of the curve, and is indicative of the stiffness and rigidity of the support. This is of importance in resisting curl and buckle in the gate during projection.

Folding Endurance is measured by the number of times the material can be rapidly flexed back and forth without breaking. Good flexibility is obviously of importance for film which must travel devious paths in camera, printer and projector.

Tear Value is measured by the energy required to continue a tear which has been started by hand.

All these measurements will vary according to the temperature and the
R.H. of the air with which the film base is in equilibrium. Therefore, these factors must be held constant if truly comparative values are to be obtained.

Physical Characteristics

The most important physical characteristic of film base is that connected with swelling and shrinkage. In discussing this question, a clear distinction must be made between two forms:

(a) Temporary, or reversible shrinkage.
(b) Permanent, or irreversible shrinkage.

Temporary stretch or shrinkage may be caused through variations in the moisture content of the film, or through changes in temperature:

(i) Moisture: Film base swells when it absorbs moisture and shrinks when it gives it up. Consequently, the dimensions of a film will vary according to the R.H. of the air with which the base is in equilibrium. The degree of change in dimension along the film ranges between 0.05% and 0.12% per 10° change in R.H.

(ii) Heat: Like most other materials, film base expands if heated and shrinks if cooled. The change is of the order of 0.05% per 10° F. at normal temperatures.

Since in average handling conditions humidity varies over a wider range than temperature, and the change per 1% R.H. is usually greater than that per degree F., the effect of moisture on dimensional changes predominates. Because of this, film frequently is found to shrink when exposed to a warm atmosphere, because raising the temperature is usually accompanied by a fall in R.H.

Permanent shrinkage is caused principally through evaporation of residual solvent and plasticiser from the base. It is commercially impossible to remove all traces of solvent in manufacture, so that some evaporation later is inevitable. Shrinkage characteristics are, however, purposely controlled to some extent by the amount of residual solvent left in the base.

Another important characteristic is the viscosity degradation of the base. If a film base deteriorates chemically on keeping, then when a sample is dissolved in a suitable solvent the solution will have a lowered viscosity as compared with one prepared with a fresh film sample. This viscosity degradation is a measure of the chemical stability of the base.

Accelerated Aging

The mechanical and physical characteristics just described are used as a yardstick in assessing the quality of a film base: but obviously it is of great importance to know, not only how freshly made base measures up, but also
how these values will change with age of the film. If progress is to be reasonably rapid, the manufacturer cannot afford to wait years to see how his product behaves on keeping. Therefore, the film base is subjected to "accelerated aging."

In this form of test, the film is kept at an elevated temperature for a short period of time, on the assumption that this will simulate storage for a much longer time at normal temperatures. It cannot be said with certainty that this follows on all occasions, but accelerated aging provides a useful basis from which to predict behaviour of the film.

**Comparative Values on Safety and Nitrate Base**

Having discussed the various characteristics which will be considered in comparing safety and nitrate film bases, we will now examine the results of such tests, summarised in Table I. The films to be compared will be nitrate, and those safety bases shown in Fig. 1.

*Tensile Strength and Modulus of Elasticity.*—The tensile strength of the new safety base is considerably improved over the older types, and approaches that of nitrate. Young’s modulus is appreciably higher for the new film, but in this respect the material is still somewhat inferior to nitrate.

*Folding Endurance and Tear Strength.*—Folding endurance is in the same range for all products with the exception of the earliest type of safety base, which was much inferior in this respect, a fact which probably had something to do with the reputation for brittleness which is still regarded as a characteristic of safety motion picture film. Tear values for the new film are somewhat below those of nitrate or the previous safety materials, and might be the cause of some concern if this property should prove important.

*Retention of Tear Strength at 100° C.*—As seen in Fig. 2, the safety films show practically no change in values for tear strength on accelerated aging tests up to 30 days. Nitrate film, on the other hand, deteriorates rapidly, and after 48 hours shatters when subjected to the test.

*Retention of Flexibility at 100° C.*—As with tear strength, very little deterioration is apparent with safety films. Nitrate film, however, became completely brittle after ten days (Fig. 3).

*Viscosity Degradation at 100° C.*—Under accelerated aging, nitrate film base, as indicated in Fig. 4, shows serious degradation, which is anticipated from previous experience with this material. Up to 30 days, change in the safety base is negligible.

*Rate of Swell in Water and Rate of Shrinkage on Drying.*—Compared with nitrate, the degree of swell of safety film is high, although the new safety is superior in this respect to the old. The factor of importance, however, is the rate of swell and shrink, rather than the ultimate values, since sudden changes in dimension may
II. PRACTICAL TESTS

Following on these measurements of characteristics, which are of more particular interest to the manufacturer than the user, a series of practical tests was conducted in the U.S.A., in which the safety films were compared directly with nitrate film.

Laboratory Measurements

First the behaviour of the films as regards swell and shrink during processing was measured, together with the curl characteristics. It will be seen from Table II that the degree of curl encountered at any stage was very small, and can be ignored for all practical purposes. As regards swell and shrinkage, the new safety film acquires an increase in length of 0.28% on leaving the fixing solution, as against 0.14% for nitrate and 0.42% for the old safety. Final shrinkage or stretch immediately after processing is observed to be —0.02% for the new safety, —0.06% for the nitrate, and +0.02% for the old safety—all perfectly satisfactory values. On tests at commercial processing laboratories, no troubles have been reported in handling the new film.

Next the wearing properties of the film on projection were found in a preliminary manner by projecting short lengths of film over and over until breakdown. On this test, the results of which are set out in Table IV, nitrate film displayed slightly superior wearing qualities, as was to be expected from a study of the mechanical properties of the various film bases.

Following this, films were projected in the normal way and studied for
sharpness, steadiness and tendency to embossing, first with a projection arc of 65 amps. (when all films were satisfactory) and then at 175 amps. with an Aklo No. 3806 heat absorbing filter, when as indicated in Table III, the old safety film showed up poorly against the new safety and nitrate.

**TABLE I.**
MECHANICAL PROPERTIES OF EASTMAN MOTION PICTURE POSITIVE FILM BASE
70° F., 50% R.H.

<table>
<thead>
<tr>
<th>Material</th>
<th>Machine Direction</th>
<th>Tensile Strength lbs./sq. in.</th>
<th>Young's Modulus 10⁵ lbs./sq. in.</th>
<th>Cold* Flow, %</th>
<th>Flexibility (Schopper) Folds</th>
<th>Tear Strength (Thwing), gms.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetate Safety Base</td>
<td>Length 11,000</td>
<td>11,000</td>
<td>—</td>
<td>7</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Width 11,000</td>
<td>11,000</td>
<td>—</td>
<td>7</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>Acetate Propionate Safety Base before 1937</td>
<td>Length 11,900</td>
<td>11,900</td>
<td>4.42</td>
<td>0.62</td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Width 10,400</td>
<td>10,400</td>
<td>4.02</td>
<td>0.83</td>
<td>16</td>
<td>57</td>
</tr>
<tr>
<td>High Acetyl Safety Base</td>
<td>Length 14,500</td>
<td>14,500</td>
<td>5.54</td>
<td>0.51</td>
<td>14</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Width 13,000</td>
<td>13,000</td>
<td>5.00</td>
<td>0.63</td>
<td>15</td>
<td>46</td>
</tr>
<tr>
<td>Nitrate Base</td>
<td>Length 15,800</td>
<td>15,800</td>
<td>6.99</td>
<td>0.42</td>
<td>15</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>Width 13,400</td>
<td>13,400</td>
<td>6.05</td>
<td>0.58</td>
<td>16</td>
<td>66</td>
</tr>
</tbody>
</table>

*Load = 3,000 p.s.i.; time loaded, 7 days; recovery time, 24 hours.

**Field Tests**
Finally, full scale tests were run on releases to commercial theatres, in which mixed reels of nitrate and safety film were used. The results, shown in Table V, confirmed that wearing qualities of the safety film were slightly inferior to nitrate, but there was an outstanding improvement in shrinkage characteristics.

**TABLE II.**
PROCESSING OF 35MM. MOTION PICTURE POSITIVE FILM.

<table>
<thead>
<tr>
<th>Curl</th>
<th>Before Processing</th>
<th>After Development</th>
<th>After Fix</th>
<th>Max. Negative Curl in Drying</th>
<th>Curl Change in Min.</th>
<th>Curl Leaving Dryer</th>
<th>At Rewind</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Acetyl Safety</td>
<td>.00°</td>
<td>.00°</td>
<td>+.03°</td>
<td>-.04°</td>
<td>2.8</td>
<td>+.16°</td>
<td>+.03°</td>
</tr>
<tr>
<td>Acetate Propionate</td>
<td>.00°</td>
<td>.00°</td>
<td>+.03°</td>
<td>-.04°</td>
<td>1.8</td>
<td>+.11°</td>
<td>+.08°</td>
</tr>
<tr>
<td>Nitrate</td>
<td>.00°</td>
<td>.00°</td>
<td>.00°</td>
<td>-.02°</td>
<td>2.9</td>
<td>+.12°</td>
<td>+.04°</td>
</tr>
</tbody>
</table>

| Shrinkage             |                   |                   |           |                               |                     |                   |           |
| High Acetyl Safety    | .00%              |                   | +.28%     |                               |                     |                   | -.02%     |
| Acetate Propionate    | .00%              |                   | +.42%     |                               |                     |                   | +.02%     |
| Nitrate               | .00%              |                   | +.14%     |                               |                     |                   | -.06%     |

Processing Conditions: Speed, 60 ft./m.n.; Drying Air, Temp. 81° F.; R.H. 35%; Velocity, 950 ft./min.; Flow, 44 cu. ft./in.
The commercial projection tests now running in this country appear to confirm these results, although the tests are not so comprehensive. During three weeks' release run in London the films have worn well, and no troubles have been encountered in processing.

TABLE III.
LABORATORY PROJECTION QUALITY OF MOTION PICTURE POSITIVE FILM
Arc Intensity: 175 Amps.

<table>
<thead>
<tr>
<th>Description</th>
<th>Acetate Propionate 5302</th>
<th>High Acetyl 5302</th>
<th>Nitrate 1302</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Screen Quality</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Original Sharpness and Definition</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Focus Drift</td>
<td>Excessive</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>Tendency to Image Flutter</td>
<td>Slight</td>
<td>Slight</td>
<td>Slight</td>
</tr>
<tr>
<td>Tendency to In-and-Out of Focus</td>
<td>Excessive</td>
<td>Slight</td>
<td>Slight</td>
</tr>
<tr>
<td><strong>Film Appearance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frame Embossing</td>
<td>Appreciable</td>
<td>Very Slight</td>
<td>Slight</td>
</tr>
<tr>
<td>Image Embossing</td>
<td>Appreciable</td>
<td>Very Slight</td>
<td>Very Slight</td>
</tr>
</tbody>
</table>

Splicing Difficulties
There was some difficulty at two or three theatres over splicing. This was rather to be expected, since splicing of the new film is more critical than

TABLE IV.
WEARING QUALITY OF MOTION PICTURE POSITIVE FILM.

<table>
<thead>
<tr>
<th>Times Projected</th>
<th>High Acetyl Acetate, 5302</th>
<th>Acetate Propionate 5302</th>
<th>Nitrate, 1302</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>A</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>200</td>
<td>B</td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>300</td>
<td>C</td>
<td>D</td>
<td>B</td>
</tr>
<tr>
<td>400</td>
<td>D</td>
<td>Failure (380)</td>
<td>C</td>
</tr>
<tr>
<td>500</td>
<td>D</td>
<td></td>
<td>D</td>
</tr>
<tr>
<td>600</td>
<td>Failure (520)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>Failure (644)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Condition of Film:
A—No Perforation Damage.
B—Damage in one perforation in a frame.
C—Damage in two perforations in a frame.
D—Damage in three perforations in a frame.
with nitrate, and projectionists who have been accustomed to the wider tolerances of the nitrate procedure may require a little experience on the new film. However, most of the projectionists had no complaints.

<table>
<thead>
<tr>
<th>No. of Prints</th>
<th>Picture</th>
<th>Average Bookings</th>
<th>Humidity Card, inches</th>
<th>K.H. 50% R.H.</th>
<th>Tear Strength 50% R.H. gms.</th>
<th>Acme. Thickness (O)</th>
<th>Perforation Condition (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2</td>
<td>34</td>
<td>+0.68</td>
<td>-0.02</td>
<td>44</td>
<td>0.033</td>
<td>A to B</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>35</td>
<td>+0.07</td>
<td>-0.02</td>
<td>44</td>
<td>0.034</td>
<td>B</td>
</tr>
<tr>
<td>C</td>
<td>9</td>
<td>22</td>
<td>+0.10</td>
<td>-0.02</td>
<td>56</td>
<td>0.030</td>
<td>A to B</td>
</tr>
<tr>
<td>D</td>
<td>9</td>
<td>24</td>
<td>+0.08</td>
<td>-0.02</td>
<td>49</td>
<td>0.026</td>
<td>B to C</td>
</tr>
</tbody>
</table>

(1) Britteness Tests: Measures indicate distance between two closing jaws at time film breaks.
(2) Perforation Condition: A. Few Light Fractures; B. More Numerous Light and some Heavy Fractures; C. Frequent Heavy Fractures.
The new safety base is less readily attacked by the solvents used in film cements, and therefore it is the more important that the cement be given full access to the base by complete removal of the clear gelatin sub-coat, which lies beneath the emulsion. Of course, if the splice is properly scraped, this factor will automatically be taken care of. Slight roughening of the base on the other half of the splice also assists in ensuring a good weld.

IV. CONCLUSION

To summarise, we appear to have in this new safety film base a material much improved in comparison with earlier safety types, and which compares well with nitrate in most mechanical qualities, although still not quite so good. But against the slight disadvantages account must be taken of the film’s slow burning qualities, the better retention of mechanical and chemical characteristics under severe aging tests, and its exceptionally low permanent shrinkage.

We may well hope that following the introduction of this new base, safety film will soon establish itself as the standard material for all forms of professional motion picture work.

The information contained in the above paper is based on data supplied by the Eastman Kodak Company in the United States, and especially on a paper by Dr. C. R. Fordyce recently presented before the Society of Motion Picture Engineers.

DISCUSSION

Mr. L. Knopp: In 1939, the Secretary of State set up a Royal Commission under Lord Stonehaven to enquire whether the old safety film could be regarded as inflammable within the meaning of the Cinematograph Act and the Celluloid and Cinematograph Films Act. In its report, the Royal Commission stated that in its view the then slow-burning film was outside the scope of the Cinematograph Act.

This new safety-film has slow-burning characteristics far superior to that of the early kind. A curious position is likely to arise when the cinematograph industry uses this new film base exclusively, because as the law now stands, licences will not be required. I doubt, however, whether this position would obtain for very long because there are many considerations of public safety which are far removed from the use of inflammable film.

Mr. H. S. Hind: Have any laboratory life tests been carried out, using slightly differently designed sprockets?

The Author: In the U.S. the diameter of the standard intermittent sprocket has been changed in view of the lower shrinkage characteristics of the material. The previous diameter of 0.935 in. was in 1947 modified to 0.943 in. and incorporated as an American Standard. The earlier sprocket was calculated on the assumption of a 1.2% film shrinkage, which was very high.

Mr. B. C. Sewell: Will the new film base be used for all types of negative material?

The Author: It is intended that this new material shall eventually be used for all types of motion picture film.

Mr. Brown: What is embossing? Can you say something about the relative transparency of the two bases?

The Author: Embossing refers to a deformation of the base which appears as a local curl, and is due to differential heat absorption by the film according to its density. Frame line embossing has little influence on picture quality, but can interfere with reproduction of the sound: image embossing affects the focus of the picture.

There is no difference in the transparency of the base of safety and nitrate films.

Mr. Sewell: On the question of hardness of the film, has it a tendency towards scratching?

The Author: Scratching qualities are associated with tensile strength and elasticity, which on the safety base is a little inferior to nitrate, so there may be a slightly greater tendency towards scratching of this base, although on practical tests this has not been observed.

Mr. N. Leevers: What happens when you join ordinary safety film and nitrate base?

The Author: Safety cement will serve for joining safety and nitrate bases, but in America an alternative cement is employed which incorporates solvents specially suited to the new safety base. Tests are still going on to find the best formula.

[Continued overleaf]
Mr. Ernest Jackson: Is there any effect on the processing solutions?

The Author: No.

Mr. R. H. Cricks: Chloroform has been recommended for cement. Would you agree?

The Author: Chloroform has been used in cement for an acetate-butyrate base, but I do not think it would have any particular advantage for the triacetate type.

Mr. Gunn: Are the factors limiting the production of the new base economic, or technical only?

The Author: Chiefly technical. The technical aspect means switching production from one type of film base to another whilst maintaining an adequate supply of the nitrate base. The changeover of plant involves a considerable building programme, and this takes time.

Mr. Brewer: Does this new base affect the photographic characteristics of the emulsion?

The Author: To the best of my knowledge, no.

Mr. Gunn: Is it more or less susceptible to electrostatic effects?

The Author: The main factor controlling electrostatic effects is the relative humidity of the atmosphere. So far as I am aware there is no large difference between the two materials.

"EXPOSURE TECHNIQUE FOR REVERSAL MATERIALS"

The Editor, 
BRITISH KINEMATOGRAPHY, 
53, New Oxford Street, 

Dear Sir,

My attention has been drawn to the fact that in the above paper, published in the November issue of BRITISH KINEMATOGRAPHY, the information given for converting integrating photo-electric meters into incident light meters might unwittingly be used to infringe the 12-year old British Patent 475,590, held by Smethurst Highlight, Limited. This fact should, of course, have been mentioned and I apologise for its omission.

I should like to take this opportunity of adding (as was done when the original paper was presented) my full acknowledgments to Mr. P. C. Smethurst for his pioneer work in connection with high-light exposure estimation for reversal materials. It is my earnest hope that anything I may have added will only serve to spread his original "gospel" since it is, I contend, proven beyond doubt, that his basic system (which, of course, formed the foundation of much of my own work on the exposure of reversal materials) is far sounder than any measurement of the integrated light from the subject can ever be.

Yours faithfully,

J. F. Dunn.

I. Deneway,
Bramhall,
Cheshire.

11th December, 1948.

SOUTH EAST ESSEX TECHNICAL COLLEGE

A series of special lectures on "The Applications of Optics to Industry" for advanced students in Engineering, Chemistry and Physics will be held during the Spring Term on Tuesday evenings at 7.0 p.m., commencing Tuesday, January 11th, 1949. The lectures will be given by members of the staff of the Hilger Division of Messrs. Hilger & Watts, Ltd. Equipment will be available for inspection during the lectures.

FILM PRODUCTION TECHNIQUE—continued from page 6

The Author: With all the restrictions, we are getting excellent results on our present picture.

A Visitor: Do you think the new technique will be applied to all your future films?

The Author: Where it is useful, and within a given sequence, this new technique will be applied to my other films. If you have a sequence that is an objective one you obviously must cross-cut.

Mr. Ridley: Does it take time to train technicians in the new technique?

The Author: It adds to the cost only of the first week.

A Visitor: Can you show on the script your camera movements?

The Author: You show your main positions and you indicate the movement from that particular set-up to the next one—a series of punctuations.
COLOURED AND DIRECTIONAL LIGHTING AS APPLIED TO THE STAGE

L. G. Applebee, F.I.E.S., M.B.K.S.*

Report of a paper read to the B.K.S. Theatre Division on Sept. 19, 1948

Mr. APPLEBEE commenced his paper with reference to the introduction of the cyclorama at the beginning of the century, early installations being at the Scala, Milan and the Charlottenberg Opera House. At the latter the cyclorama was constructed of plaster on a movable metal frame. It was illuminated by magnetically-fed arc lamps, the light being coloured by glass filters controlled by tracker wires.

After 1918 the gas-filled incandescent lamp was introduced for stage work. Since, owing to its high temperature, it could not be lacquered, the compartment or magazine batten was introduced, each lamp being contained in a compartment with a reflector of correct curvature.

Projection Lamps

The next advance was the introduction of the incandescent projection lamp. It created a revolution in theatre lighting. Since such spotlights did not need to be attended they could be placed in positions more advantageous for lighting the stage than they had been hitherto. Furthermore, their intensity could be varied by dimming.

Due to this development the spotlight became the most important unit of stage lighting. By its aid flat scenery could be made to look three-dimensional and artistes approaching the footlights could be correctly lit. The correct position of spotlights was of importance. Spotlights were frequently found at the front of the first circle in American theatres as the circles were placed

*Strand Electric & Engineering Co., Ltd.
degrees, thus, most lanterns used in England were placed on the second circle.

In order to provide colour changes, remotely controlled spotlights were developed, the filters being actuated by solenoids, or, more recently, by small motors, either controlled from the stage switchboard. (Fig. 2.)

A still later development was the mirror type spotlight, in which a sharply defined beam was obtained by means of an optical system similar to that of a slide lantern, a variable mask being provided to define the shape of the beam. (Fig. 1.)

Directional Lighting

For downward lighting a lantern was used, comprising 1,000-watt incandescent lamp with optical silvered glass reflector and spill rings.

The discharge lamp had so far been found unsatisfactory for stage lighting because of the large source size, the impossibility of dimming, and the delay in striking. Later developments might lend themselves to stage work.

For brightness control the reactance dimmer had many advantages, notably its flexibility and its ability to take different loads, but a serious objection was its high cost.

Mr. Applebee then turned to the applications of lighting, stressing always the need for avoiding flood lighting effects. He illustrated, for example, two methods of lighting a crowd scene, one with flat lighting from the auditorium, the other with downward lighting from the stage, the persons downstage appearing in silhouette. The second method gave greater depth to the scene and made the crowd look more numerous.

Applying Colour

When lighting a back-cloth floodlights should be mounted high so that actors would not cast shadows. An important point in any coloured lighting was that the colour of the light should resemble the colour of the material upon which it shone. The most suitable colour for tableau curtains was mouse grey, upon which any colour could be used.

To illustrate the effect of incorrect lighting Mr. Applebee made himself
up with red grease-paint which under a green spotlight gave him the appearance of a negro, but under a red spotlight he appeared normal. This, he said, was the basis of the Samoiloff system.

Mr. Applebee concluded his paper by describing, with lantern slides, the equipment of many of the leading theatres of the world.

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KINEMA TELEVISION DEMONSTRATED

The kinema television equipment described by Mr. A. G. D. West, M.A., B.Sc., Hon.F.B.K.S., in last month’s issue of British Kinematography, was demonstrated on December 21st last at the Palais-de-Luxe, Bromley, Kent.

The “Cintel” television projector was installed about 40 ft. from the 16 ft. screen, and controlled from racks at the rear of the theatre. The B.B.C. transmissions from Alexandra Palace were received on the normal 45 Mc/s channel, while specially relayed transmissions were received on 480 Mc/s.

The demonstration opened with a normal B.B.C. programme item, “Teen Ages.” While the quality of the picture was quite acceptable, it was at times marred by shadowing, and the scanning lines were occasionally noticeable.

Mr. West then explained that a programme was being specially staged for the occasion at the works of Cinema-Television, Ltd., at Lower Sydenham, and was being relayed to the Crystal Palace, whence it was being relayed by a micro-wave radio link to Bromley. A special camera had, he said, been developed, and was now demonstrated for the first time.

The technical quality of this transmission was extraordinarily high, and indeed practically indistinguishable from normal film projection. Picture quality was superior to that of the B.B.C.—due no doubt to the improved camera—scanning lines were rarely visible, and interference was markedly less than on the B.B.C. transmissions.

In course of this programme, Mr. West picked up a telephone and spoke to the two artists, who on the screen could be seen and heard answering his call.

Mr. West outlined the proposed system which it was hoped to inaugurate, whereby programmes originating from the Crystal Palace, Pinewood Studios, or London Theatres, in addition to the B.B.C. programmes from Alexandra Palace, could be beamed to a number of West End kinemas. The equipment was, he added, 100% British.

The programme concluded with a section of a B.B.C. outside broadcast. R. H. C.
B.S.I. COMMITTEES ON KINEMATOGRAPHY

In accordance with the usual procedure of the British Standards Institution, the following draft British Standards have been prepared and circulated for comment:

Draft British Standard for Spools for 35mm. release prints in 2,000 ft. lengths.

Draft British Standard for Electrical connectors for stage use.

Draft British Standard for 16mm. release prints.

Draft Revision of British Standard 677—Motion Picture Films.

Work is actively in hand on the following projects:

Technical Committee CME/2—Revision of BS.677.

Technical Committee CME/3—Spools for 35mm. films, 16mm. release prints.

Technical Committee CME/4—Spot-lights for kinema studios, ripple content in electricity supplies to kinematograph studio lamps, auditorium safety-lighting and safety-signs, electrical filters, photo-electric cells.

Technical Committee CME/10—Magnetic sound-on-film, magnetic sound-on-tape and discs, magnetic sound-on-wire; materials for magnetic sound-recording.

Technical Committee CME/11—Screen brightness in the projection of 35 and 16mm. film.

Technical Committee CME/13—16mm. kinematograph projectors; film life, performance, spools and containers, other aspects arising from installation and maintenance. Spools and containers for 8mm. film.

Technical Committee CME/14—Mechanical and dimensional aspects of 35mm. projectors, projection rooms for 35mm. projectors, theatre projection screens.

Technical Committee CME/16—Lenses for 35mm. projectors, method of determining resolving power of 35mm. projector lenses.

Technical Committee CME/18—Lenses for 16mm. projectors, method of determining resolving power of 16mm. projector lenses.

In addition, a draft British Standard for the photometric calibration of lenses (determination of T-number) has been prepared under the Photographic Section of the B.S.I. and will shortly be circulated.

BRITISH STANDARDS

B.S. 1479 : 1948—Use of Sound Level Meters.—The sound level meter consists of a microphone combined with an amplifier, detector, and meter, designed to give r.m.s. indication, adjusted to the equal-loudness curve of the ear. Precautions in the use of the meter and limitations to its accuracy are set out.

1488 : 1948—Test-films for 16mm. kinematograph projectors.—Six types of film are specified: buzz-track, sound-focusing, picture-unsteadiness, multi-frequency, 3,000-cycle flutter, and a sound-and-picture test-film.

Revision

935 : 1948—Photographic exposure tables.—This British Standard provides data for calculating out-door daylight exposures for black-and-white negative material and for black-and-white and colour reversal material.

AMERICAN STANDARDS

The following American Standards have been issued recently and are reproduced in the November issue of the J. Soc. Mot. Pic. Eng.:

Z22.57—1947 : Buzz-Track Test Film for 36mm. Motion Picture Sound Reproducers.
Z22.60—1948 : Theatre Sound Test Film for 35mm. Motion Picture Sound Reproducing System.
Z22.62—1948 : Sound Focusing Test Film for 35mm. Motion Picture Sound Reproducers (Laboratory Type).
Z22.65—1948 : Scanning-Beam Uniformity Test Film for 35mm. Motion Picture Sound Reproducers (Service Type).
Z22.66—1948 : Scanning Beam Uniformity Test film for 35mm. Motion Picture Sound Reproducers (Laboratory Type).
Z22.67—1948 : 1,000-Cycle Balancing Test Film for 35mm. Motion Picture Sound Reproducers.
Z22.70—1948 : Sound Records and Scanning Area of Double Width Push-Pull Sound Prints, Offset Centreline Type.
TECHNICAL ABSTRACTS

Most of the periodicals here abstracted may be seen in the Society’s Library

MONO-CHROMOGENOUS POSITIVE DEVELOPMENT.
It is possible to obtain uni-coloured positive images on diapositives and development papers by developing them by the well-known colour coupling methods of colour photography. A short history of these methods is given. Formulae are listed (after Tull) for six couplers to produce yellow, brown, red, blue, blue-green and green images with a diethyl (or dimethyl)-p-phenylene diamine developer; other colours can be obtained by mixing the basic couplers. The colours obtained are blackish because the dye is adsorbed on the black silver image, but pure colours can be achieved by dissolving the silver with the aid of Farmer’s reducer. These “mono-chromogeneous” developing methods are not suitable for silver chloride emulsions, but for silver bromide papers, silver chloro-bromide papers and most diapositive emulsions. The baths must not be acid. Images developed by normal methods can be dyed afterwards by bleaching and chromogeneous re-developing; this method is also useful for silver chloride papers, for re-toning and for influencing the gradation.
R. S. S.

BRIGHTNESS AND ILLUMINATION REQUIREMENTS.
This paper gives valuable and hitherto unrecorded data on the lighting of motion picture auditoria. Consideration has been given to the great advances in recent years of degree of screen illumination, and photometric measurements of screen brightness with various classes of films are given. Those concerned with the correct relationship between screen brightness and degree of auditorium illumination will find much of interest and a wealth of useful data which, modified to suit technique in this country, will afford considerable help toward the final solution of the problems involved.
R. P.

AIR CONDITIONING OF KINEMAS.
A survey of the ventilating requirements of French kinemas. The earlier paper discusses general principles, the second gives more precise data of requirements and of equipment.
R. H. C.

AUDITORIUM ACOUSTICS.
A restatement of the principal factors affecting the acoustical properties of cinema auditoria.
L. K.

QUIETING AND NOISE ISOLATION.
A generalised summary of the causes of extraneous noise that may be present in cinema auditoria and of the remedial action that may be taken.
L. K.

BEHAVIOUR OF ACOUSTIC MATERIALS.
A brief review of acoustic materials, an inadequate description of a technique for the measurement of absorption of co-efficient, and an incomplete review of the effects of paint upon sound absorbent surfaces.
L. K.

TELEVISION TRANSCRIPTION BY MOTION PICTURE FILM.

TELEVISION RECORDING CAMERA.
These two papers both relate to the work done by the co-operation of Eastman Kodak and Du Mont Laboratories to produce film record of television programmes.
The first paper covers the technique of photographing television pictures on cathode ray tubes and discusses the application of such film records.
The second paper is mostly concerned with the timing cycle and problems of reducing 30 television pictures per second to 24 film frames per second and has mathematical appendices on the design of the intermittent gears with short pull-down times.
T. M. C. L.
THE COUNCIL

Meeting of December 1st, 1948

Present: Messrs. W. M. Harcourt (President), A. W. Watkins (Vice-President), I. D. Watten (Past President), L. Knopp (Deputy Vice-President), R. B. Hartley, A. G. D. West, B. Honri, R. E. Pulman, R. H. Cricks (Technical Consultant), and W. L. Bevir (Secretary).

Fellowship Committee.—The conferment of the Fellowship upon Mr. Norman Leewers was unanimously agreed. The offer of Mr. Watten and Mr. Watkins to defray the cost of having the Fellowship Certificates re-printed was accepted with thanks.

Library Committee.—Mr. Rex B. Hartley reported that there were now 400 books and 55 different periodicals in the Library.

Film Mutilation.—Mr. Watten reported that the first Film Mutilation Brochure had been completed and passed to Mr. Knopp, and that the others would be finished shortly.

The resignation of Mr. Harry Waxman as Council Representative of the Film Production Division was received with regret.

EXECUTIVE COMMITTEE

Meeting of December 1st, 1948

Present: Messrs. W. M. Harcourt (President), A. W. Watkins (Vice-President), L. Knopp (Deputy Vice-President), I. D. Watten (Past President), and W. L. Bevir (Secretary).

Elections.—The following were elected:

Matthew Raymond (Member), M.G.M. British Studios.
Ivor John Willis (Member), Kodak, Ltd.
Eric Reginald Aurban Hazell (Associate), Denham Laboratories, Ltd.
Nigel Knocker (Student), Murphy Radio Course.
Norman James Godden (Associate), W. Vinten, Ltd.
John William Harland (Associate), Pathéscope, Ltd.
Philip Thomas Hastings (Associate), Photographer.
Edwin Slater (Associate), Pavilion Cinema, Rossendale.
Transfer.—From Associate to Member: Edward Charles Brunger.
Death.—The death of Mr. C. Cabirol was noted with much regret.
Expulsions.—14 Student Members who were two or more years in arrears, were expelled from the Society.

PERSONAL NEWS of MEMBERS

Members are urged to keep their fellow members conversant with their activities through the medium of British Kinematography.

C. E. Andrews has left Warner Bros. and is now attached to the News and Information Bureau (Film Section), of the National Film Board of Australia.

David Hawkins is engaged upon the picture "L'Ultima Cine," at the Industrie Cinematografiche Teatrals Studios.

Rex B. Hartley will in future be G.E.C. film studio representative for all classes of equipment and materials.

Rudall Hayward is returning to New Zealand, where he is to direct some films of Maori life. His film "The Last Stand," is soon to be released.

L. Mannix of Leeds, has been nominated the next vice-president of the Society of Cinema Managers.

J. G. Nowell has left the Tatler News Theatre, Manchester, and joined the C.W.S. Film Unit as a camera operator.

Geoffrey Park, Hon. Consulting Editor of British Kinematography, has retired as Managing Editor of Electronic Engineering since his appointment as Technical Director of Messrs. Chapman & Hall, publishers.

David Robson has just returned from a visit to Egypt on behalf of A.K.C.

Tore B. Thoresen has been working on location at the Canary Islands.

Eric Williams has been elected a F.R.S.A.

THOMAS STARK

Died December 13th, 1948

Mr. Stark had been a Circuit Engineer with the Gaumont-British Picture Corporation, Limited, in the Midlands, since 1939. He had had a varied career, and after serving as a mechanical and electrical engineer with Messrs. Dorman Long & Co. was with one of the Canadian Power Supply Under-takings for some years. On returning from Canada he joined the North of England Cinemas, which were eventually transferred to Gaumont-British.

In 1945 Mr. Stark was elected an Associate of the Institute of Electrical Engineers. He was an extremely capable mechanic and electrical engineer and was very popular with all with whom he came in contact. He will be very much missed by a wide circle of friends.

S. H.

Small announcements will be accepted from Members and Associates. Rate, 4d. per word, plus 2s. for Box No. If required (except for Situations Wanted). Trade advertisements, other than Situations Vacant, not accepted.
Unmentioned in the credit titles, it nevertheless plays an important part in the screen-play's success. It's the vehicle for the superb technique of directors, producers, players, technicians. It brings their work brilliantly to the screen. It is—and has long been—the industry's overwhelming choice...
LECTURE PROGRAMME

February, 1949

Meetings to be held at the Gaumont-British Theatre, Film House, Wardour Street, London, W.1, commencing at 7.15 p.m. Sub-Standard meetings in the G.-B. Small Theatre.

S—Sub-Standard Film Division.

F—Film-Production Division.


MANCHESTER SECTION.

Meeting to be held at the Lecture Theatre of the Manchester Geographical Society, 14 St. Mary’s Gate, Parsonage, Manchester, commencing at 10.30 a.m.

Feb. 1 "Time Base, its Implications," by J. C. EVANS.

LEEDS SECTION.

Meeting to be held at the Y.W.C.A., Cookridge Street, Leeds 1, commencing at 10.30 a.m.


NEWCASTLE-ON-TYNE SECTION.

Meeting to be held at the Lecture Theatre, Newe House, Pilgrim Street, Newcastle-on-Tyne, I, commencing at 10.30 a.m.

Feb. 1 "Developments in Discharge Tube Lighting," by G. KINGSLEY LARK.
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BRITISH PROGRESS IN KINEMATOGRAPH ENGINEERING

W. M. Harcourt, F.B.K.S., F.R.P.S., F.R.S.A.*

Read to the British Kinematograph Society on December 3, 1948.

My remarks tonight are something of an eulogy on those in our industry who have been actively engaged in the renaissance of the British Motion Picture Industry. I refer now not to the makers of the actual pictures, but mainly to the "back-room boys," who have designed and built tools with which the making and presentation of the product has been so improved.

War is always a horrible thing, but in its throes and immediately after such a debacle, industries in some way or another reap benefits. We in the film industry, however, were not a militant part of the great war machine; few of the tools we use had any direct potential value towards the final victory.

Before the war, the general attitude was if anything was good it had to come from overseas. Today one sees certain types of pre-war designed equipment of British manufacture hailed as being far superior in performance and technical exactness to the apparatus once lauded to the heavens. Whether this is because a younger generation of technicians is taking over, which is more intelligent than the older generation, I cannot say; I do know, however, that the new batch of technicians are rediscovering much previously rejected technical machinery, little knowing that it has been in existence for years.

Nevertheless, during the war years, certain types of motion picture machinery were urgently required for the armed forces, and some of our manufacturers were commissioned to make copies of existing types. I believe that the experience gained has proved of great worth to our manufacturers.

Progress in Kinema Equipment

In the field of projection equipment we are striding ahead in no uncertain manner. Our designers realised that machinery in itself can be streamlined and made to look attractive. Unit construction was adopted, and with other advances has led to the production of equipment that makes it possible

*Denham Laboratories, Ltd.
to project a good quality print with the full range of tonal values as it should be. Slowly but very surely our theatres are being re-equipped with these new machines, with the result that many millions of kinema-goers are virtually seeing and hearing their films as they have never seen or heard them before.

Great strides have been made in electrical supply gear for the arc. The lens manufacturer has leapt ahead, and such improvements have been made in the quality of glass that the perfectly controlled properties in relation to high refractive indices have made it possible to produce lenses working at f/1.6 with perfect correction. It has been forecast that very soon projection lenses working at f/1.4 will be on the market. All these lenses are bloomed.

The sound engineers have not been idle, and sound reproduction in our theatres is improving daily. Much research is going on by the screen manufacturers, all to enable the patron to see his picture more clearly.

The Sub-Standard Film

In the sub-standard field, a serious effort is being made to lift the 16mm. standard out of the amateur status. In sponsored films, educationalists, etc., the production side of the industry is using the medium of 16mm. to an increasing extent. Professional cameras, such as the Mitchell, are either being used or about to be used. Apart from the already well-known printing machines made in this country, we now have the Bell and Howell Model "J" contact printer.

Major laboratories are now carrying out 16mm. negative processing on the same sensitometric control lines as for 35mm., with rushes service almost as quick. One at least has installed an optical printer for carrying out all the trick work usually demanded only for production on 35mm., such as dissolves, montage sequences, and trick wipes. No less progress has been made with the new types of projectors.

Photographic Equipment

In the sphere of photography, we have the new Everest camera, designed and built by that well-known firm of Vinten. The advantage of direct vision without parallax problems is fully appreciated by the camera operator. The camera is silent and easy to handle and is proving very popular with all who have had the opportunity of using it. The same company have carried out enormous research on the problems of high-speed photography for scientific purposes, and Vinten high-speed cameras played an important part in many of the discoveries made during the war.

The high precision engineers, Messrs. Newall of Peterborough, were given the task of making a studio camera of orthodox design, and have succeeded nobly. All who have tested the Newall camera say that it equals anything anywhere. This same company, whose reputation is well known throughout the world for high precision work, has also been entrusted with the manufacture of a series of Technicolor cameras.

In the news-reel and documentary field the Newman-Sinclair 200 ft. clockwork-driven camera still holds first place. Due to its precision movement, a full 200ft. roll will go through at any temperature with one wind of the springs.

Our photographic lenses still lead the world: 90% of the lenses used in Hollywood Studios are of British manufacture. The principle of coating lenses, today of such importance, was definitely invented by a British scientist.

Some of the new machinery for projection purposes in the studios has necessitated the design of completely new types of lenses, of massive appearance, available in various focal lengths to satisfy completely the demands of the producer and his technicians.
Studio Illuminants

One of the biggest steps forward is that of the illuminating engineer, who has designed and perfected new types of lamps with completely new light sources. We all remember the discharge lamp that was used many years ago in all studios; derived from this we now have the mercury-cadmium compact-source discharge lamp, constructed in 2kw. and 5kw. sizes. The colour emission has proved suitable for colour film. The problems of striking these arcs and of "simmering" them to avoid delay in re-striking have been overcome. Their silence is an important factor in the studio.

Another important advance is the introduction of the three-electrode arc, which again reduces noise considerably and cuts down electricity consumption. High power arcs are being built in this country with a light output which was altogether undreamed of in the years before the war. The cameraman’s difficulty of avoiding multiple shadows in what are supposed to be sunlight shots is now a thing of the past; he has at his disposal arcs of such power that all his general lighting is easily overcome to give that one single shadow.

Lenses for studio lamps now leave little to be desired in evenness of illumination and concentration of beam without spill light.

Much is being done by individual studios in designing and constructing camera accessories such as cranes and velocilators, trucks and other accessories. The science of electronics is playing a big part in all these designs, and knowledge gathered during the war is being widely incorporated.

"Independent Frame"

A new form of production technique has been introduced which for want of a better title has been called "Independent Frame." It is a method of making pictures in which it is absolutely essential that a great deal of time be given to script preparation, at all times desirable. Back projection, both moving and static, plays an important part, and it was necessary to design and plan completely all new types of projectors for the static as well as the moving plate. High and even illumination is necessary, and many problems had to be overcome. Our engineers and designers were able to provide the necessary equipment.

Special movable rostrums were planned so that complete sets could be moved in front of the scene. Mobile screen holders and mobile spot rails were to be used so that complete spots could be moved by one man. Time was the element that had to be defeated.

A picture has been made by this method. I saw the rushes and I could not distinguish at any time static back projection from the real set. Only in moving back projection could one detect the build up of grain particles moving around. In one scene, an artist moved back from the camera and picked up a chair which was standing with a table and three other chairs; actually the table and other three chairs were in the projected background, but it was impossible to detect this fact.

This means that a still photographer can be sent to any point with his equipment. Using static plates it is possible to dispense with an enormous amount of building. This is quite an advance on anything that was done before, and it has been made possible solely by the design of new mechanical equipment.

Laboratory Improvements

The Newall Engineering Co. are manufacturing the Bell & Howell Model "E" fully automatic printer. In this printer one negative is loaded up and runs backwards and forwards, and all that is needed is to load positive
film into it. A master controlling band and light diaphragm is necessary, which passes across the light source at a relative speed of 4 to 1. Such machines make it very easy to produce a large footage.

We have experience in spray processing machinery, and in my own laboratories a spray machine has been in use for nearly a year, with astonishing results. Speeds attainable are very extraordinary, so much so that although the machine is capable of running at 500 feet a minute it is throttled back to 350. We have discovered that with spray development and spray washing and spray hypo, developing times are cut down by 50 per cent. A normal developing solution in a spray machine will cut the time by half. Given correct chemical analysis, over two weeks we can arrive at a boost rate which will overcome any oxidation which takes place. By replenishment at 80 litres an hour we obtain control without throwing the bath away.

The advantages can be seen only when compared with ordinary deep tank development. The prints from the deep tank machine with which we were practically satisfied look flat and "bunged up" when compared with the print from the spray machine. There is no directional or Eberhardt effect, and the definition is clearer and cleaner in the picture characteristics. With spray washing, the percentage of residual hypo is so low that it passes any test for the storage of historic films.

The Colour Film.

The introduction of colour is progressing rapidly. Several British companies are working furiously to perfect their systems, and we shall soon see these results on our screens. One laboratory is now equipped for any type of integral tripack colour and is going into production with Ansco Color right away. In this direction one can expect developments from the various stock manufacturers; some we know are very near the final result; others are maintaining a secrecy which we all hope means that present standards are being dismissed as not good enough, and that we can expect striking advances.

Our thanks are due to the new leaders of the industry who have made it possible for our manufacturers to see a future ahead, to plan for research and design with the full knowledge that there is a commercial reward at the end of it.

Following his address, the President presented certificates of Hon. Fellowship, Fellowship, and Hon. Membership (see the December, 1948 issue of this journal.)

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**BRITISH STANDARDS**

B.S. 935: 1948.—Photographic Exposure Tables. Two sets of tables provide between them index figures relating to latitude, month, time of day, condition of sky and type of scene. In conjunction with the speed numbers of negative materials, given in B.S. 1380, Table 3 indicates the exposure required.

B.S. 1496: 1948.—Photographic Safelight Screens and Housings. Specifies dimensional standards only for safelights and housings.

The following draft specifications have been circulated for comment:

CK(CME) 848.—Draft revision of B.S. 677. The original specification, which included dimensional standards for 35mm., 16mm. and 8mm. films, and for 35mm. and 16mm. cores, has been amended to bring it into line with American standards, and has been supplemented in various respects.

CK(CME) 1207.—Draft British Standard for Kinematograph Projection Screens. This draft lays down dimensions for screen sizes ranging from 8ft. × 6ft. to 30ft. × 23ft., for reinforcing border and position of eyelets, and also specifies the overlap of masking into the projected picture, and the radii of corners.

LENS MANUFACTURE AND DESIGN


Read to the British Kinematograph Society on November 3, 1948.

CAMERA and projection lenses are made of optical elements, concave or convex in form according to the design which has been arrived at mathematically by the lens computer, and in various types of optical glass. These different optical glasses possess characteristic physical properties but are quite indistinguishable one from another to the unaided eye.

The properties in which the optical designer is particularly interested are refractive index and dispersive power. It is necessary to have available a great variety of types of optical glass to enable the designer to reduce to a minimum the aberrations peculiar to the particular lens system he is designing.

I. GLASS MANUFACTURE

There are few makers of optical glass in the world, and in Great Britain we are dependent upon Messrs. Chance Bros. of Smethwick, for our supplies.

The properties required to be known by the lens designer are characteristic not only of the type of glass but of each melt of glass, and are dependent on the chemical composition of the glass. Optical glass consists mainly of silica—that is, sand—together with sodium and potassium carbonates and other metallic salts which impart particular properties. The art of making good optical glass lies in the melting together of the chemicals to produce a glass which is free from colour and inclusions, uniform in chemical and physical characteristics, whilst possessing a high degree of stability.

With the aid of slides the speaker described the manufacture of optical glass\(^1\) based on processes carried out at Chance Bros.

II. LENS MANUFACTURE

When reasonable quantities of lenses are to be made it is usual to commence with mouldings approximating to the shape of the finished elements. When small quantity production has to be carried out, the blanks are cut roughly to shape from slab glass, using a diamond loaded saw. It will be appreciated that it is less economical to cut from slab glass than to start from a moulded shape.

Each melting of a particular type of glass has its own physical characteristics, and the optical designer must know them to great accuracy. There are various instruments for measuring the refractive index and dispersive power; the Ross Autocollimating Goniometer is one of the most rapid and accurate instruments devised for this purpose. Samples of each melting are tested as received from the glass manufacturers and the constants found are recorded for use in subsequent lens calculations.

The lens data, specifying the melts of glass to be used, diameters, radii of curvature, and thicknesses of the various elements, are passed to the works from the design department. For small quantity production the surfaces of the blanks are roughed to curvature by hand. The operator rubs the blank against the surface of a rotating spherical tool made of brass or cast iron whilst feeding on coarse carborundum and water as abrasive. For larger quantity production, the blanks are spherically milled with diamond loaded milling tools.

Lens Grinding

Lens elements have a spherical surface on both sides, and each surface has to be processed separately. One side is rough ground, smooth ground, then

*Ross, Ltd.
polished. This is then repeated on the other side, bringing the centre thickness of the element to its computed value, and the element is then edge ground to the diameter specified.

The abrasive used for rough grinding is quite coarse, say just passing through an 80-mesh sieve. For smooth grinding a range of fine abrasives is used until a very smooth surface is finally obtained. The action of polishing is to smooth out the fine pits left by the grinding, the surface of the glass actually flowing. It is convenient to perform this smooth grinding and polishing with the lens blanks stuck with pitch on so-called runners, so that as many as convenient can be processed at one time; they then form

what is called a block of lenses. The number of lenses that can be accommodated on a block will depend on the diameter and radius of curvature.

The blanks are sometimes roughed singly and stuck into a block, or sometimes the blanks are roughed as a block by being cemented into recesses in a machined runner. The roughed block of lenses is then screwed on to the spindle of a smoothing machine for smooth grinding. The size of the machine used will depend on the radius of curvature of the block, but the principle is always the same. The block is rotated on a vertical spindle and the grinding tool moved in an oscillatory motion over the surface of the lenses. Emery and water is used as abrasive, and the lapping is continued with successively finer grades of abrasive until the surface is of a sufficiently fine greyness for polishing. The same type of machine is used for polishing, the polishing tool being similar to the grinding tool, but having a layer of

Fig. 1. Ross Autocollimating Goniometer.
about 1/16in. of pitch on the surface. The polishing tool moves over the
ground surface of the lenses, lubricated by rouge or other metallic oxides and
water.
Polishing
Quite a high degree of polish is obtained after 30 minutes, and it is then
that the operator commences to take an interest in the figure of the surface.
By figure is meant the shape of the surface being produced. The lens surface
must be perfectly spherical and must also comply accurately with the designed
radius of curvature. The surface is tested by means of a glass plate which is
of opposite curvature to the surface being produced. Interference fringes,
known as Newton's rings, are obtained between the surface and the test
plate; by means of these fringes the departure from radius of curvature and
spHERicity of the surface under test can be obtained to great accuracy.
After several hours' polishing, the block will be fully polished and also
acceptable for curvature. The making of the test plates is a very skilful
task, involving much checking by interference fringes and for radius of
curvature by the spherometer.
The highest quality grinding and polishing is still performed by hand, by
highly skilled craftsmen. With large lenses and prisms, it is very difficult
to produce the glass perfectly homogeneous. If the interferometer indicates
inhomogeneity of the glass then one surface of the lens or prism is rubbed by
a small polisher to deform the surface so as to neutralise the effect; only a
few wave-lengths of glass would be so removed.
The removal of the lenses from the pitch is facilitated by putting the
blocks of lenses into a refrigerator. The pitch contracts at a different rate
to the lenses and the lenses can easily be removed quite clean.
Edge Grinding and Assembly
Lenses after being polished on both surfaces have to be edge ground so
that the optical axis is true with the edge. To do this, the lens is stuck with
wax on to a chuck. The lens is warmed and moved on the chuck until
reflected images seen in the lens surfaces are perfectly steady. The spindle
together with the lens is then transferred to a mechanical edge grinding
machine and the lens edged to the correct diameter. For work of the highest
accuracy, the lenses are edge ground by hand, the operator checking the
concentricity of the lens continually. Chamfers are produced at the same
time as edging.
Lenses which have to be cemented are now stuck together with Canada
balsam, and set up concentric on a chuck as if setting up for edging. The
lenses are now ready for mounting and are bezelled into their cells. The
cells are assembled into the lens bodies and the completed lenses are ready
for test.
Anti-Reflection Coating
When visible light passes through an optical system, one or two per cent.
is absorbed per centimetre of glass. At each air/glass or glass/air transmitting
surface between four and eight per cent. is lost by reflection, dependent on
the refractive index of the glass. The reflected light which is lost suffers
multiple reflection between the lens surfaces, and finally makes its presence
felt as a general background of illumination in the image, whether photo-
graphic or projected, causing a reduction in contrast. In bad cases, flare
spots are present also.
By means of surface coating, very nearly all the reflected light is eliminated,
and passes through the system to increase the brightness of the image. The
prime advantages of surface coating are therefore increased transmission and
improved contrast. The film is only a few millionths of an inch in thickness, and is produced in high vacuum plants.

The surface treatment of lenses has opened the way to more complicated lens systems, since the necessity of keeping the number of elements to a minimum has been largely removed. The large aperture projection lenses employed resemble photographic anastigmat lenses more and more in their construction. The separation of the various elements is critical, and if dismantled the lens has to be very carefully re-assembled; such lenses should therefore be sealed.

Transmission Calibration

To quote an example of the increase in transmission caused by blooming, Ross Xpres /3.5 lenses have a transmission of 70% prior to blooming and 91% after blooming; this is equivalent to an increase in speed to the photographer of about one degree Scheiner. The transmission difference between various makes of lens, bloomed and unbloomed, when set to the same aperture value, has become serious in the case of taking lenses for colour films, and it has been proposed to mark photographic lenses with a transmission scale. The scale will take into consideration the light transmitting power of the lens, so that all lenses of whatever make, bloomed or unbloomed, would transmit exactly the same amount of light when set to the same f number.

III. TESTING

There are mechanical and optical tests to be applied to the finished lenses, and from an optical point of view the focal length and resolution will be the important criteria.

Photographic lenses were formerly tested by photographing a test chart to ascertain that the resolution was satisfactory over the area to be covered

Fig. 2. Nodal Slide Test Bench
by the lens. The testing of long focus lenses in this way is costly, as the plates are very big, also much storage room is required to keep the records of lenses which have been manufactured. A method of test was devised, therefore, which enables the equivalent focal length of the lens to be ascertained, and at the same time test visual and photographic resolution.

**Nodal Slide**

The instrument used is called a nodal slide. The lens under test is arranged by trial so that a pivoting point on the lower carriage passes through the back nodal point. In front of the lens is a collimator with a resolution graticule. The image of this resolution graticule, called a Cobb type test object, is focused by the microscope and the visual resolution as the lens is swung through any angle can be examined. The photographic resolution on any type of emulsion can be determined by removing the microscope and putting a 2½in. × 3½in. plate into the repeating back of the instrument. A series of resolution photographs is made with the lens rotated through various angles, then further sets of photographs are made in and out of the visual focus position.

![Fig. 3. Principle of Nodal Slide.](image-url)

In this way, the resolution data for any focal length lens can be obtained on a very small plate. The equivalent focal length of the lens is shown on a scale, and is the distance between the pivoting point and the focal plane.

Projection lenses are tested usually for resolution and focal length on a small nodal slide, and then finally in an ordinary projector, using a piece of transparent quartz-bearing a multitude of fine detail as the test object.

A foco-collimator is used for the precise determination of the equivalent focal length of short focus lenses. Special test benches are used for testing enlarging and process lenses, also for testing such lenses as wide-angle survey and gauge projection lenses, for which freedom from image distortion is the important criterion.

**Future Developments**

The standardisation of a transmission scale is one of a number of optical matters at present receiving consideration by the British Standards Institution. Another example is a recent draft specification for 35mm. projector lenses which makes provision for a barrel diameter of 80mm., permitting a range of lenses working at f/1.4. This indicates the trend of new design.
The popular projection lens barrel diameter size in the past was 52.4mm, but more recently with the introduction of f/1.9 collecting systems and lenses to match, the 70.65mm diameter jacket has become almost universal. There are, however, certain mechanical restrictions in some projectors which do not permit the use of this larger diameter jacket in all focal lengths. Modern projection lenses are surface treated and hermetically sealed, the inner optical surfaces are thus always clean, and the projectionist need only wipe over the external surfaces.

Development work on optical matters is constantly in progress by British manufacturers. During the war a number of new types of optical glass were envolved and this has enabled further improvements to be made in taking and projection lenses.

REFERENCES


DISCUSSION

Mr. W. Braby: To what light does the quarter wave-length refer? Is the transmission selection according to the wave-length of light?

The Author: We generally coat the surfaces to have a maximum transmission and minimum reflectivity in the apple-green part of the spectrum at about 5,500Å. Away from that minimum position, you do get a certain amount of light reflected.

Mr. W. Braby: If you coated for a particular wave-length, what percentage gain would you expect for a particular monochromatic light?

The Author: There is a condition that the refractive index of the film should be the square root of the refractive index of the glass. It is not possible to obtain that condition precisely, because there are not many minerals of a suitable type for evaporating on to the glass surface. We have to use magnesium fluoride.

Mr. W. Buckstone: How does the reflectivity curve continue into the infrared? At 12,000Å would there be any improvement with coated lenses?

The Author: Yes, there would still be a considerable improvement. It is possible by evaporating successive layers of different minerals to attain an achromatic effect.

Mr. A. Duery: Is it likely that faster aperture lenses than are now available will come into use soon? If that is so, it will mean re-designing the collecting system of the arc lamp.

The Author: The case is really that the light collecting end of the system is lagging behind the projection lens. The wider the angle of pick-up the greater the trouble with heating.

Mr. R. H. Cricks: Regarding the desirability of matching apertures from the mirror to the lens, recent papers in American journals have suggested that the illumination at the edges of the picture is improved if the projection lens is of wider aperture than the mirror. What are Mr. Antis's views on this subject?

The Author: I think that one American writer was endeavouring rather to point out that certain American projection lenses gave some cut-off of light due to their improper design.

Mr. Oram: You have that case in some American projectors using f/1.9 lenses giving only f/1.9 at the centre. If you are free to increase the diameter, you will get f/1.9 at the margin.

Mr. F. G. Gunn: What do you consider is a natural basis for the calibration of lenses in transmission values?

The Author: The old basis was the relation of the diameter of the lens to the focal length. This gave the f value. That does not take into consideration the transmission of the lens. If one imagines a lens of 100% efficiency, that is the theoretical basis of the f system.

Mr. J. Hill: Am I right in thinking that the coating is not permanent? The f number of a lens is permanent, but the f scale would vary in time.

The Author: Modern coatings are hard and substantial. Over a number of years the transmission would not vary appreciably.

Mr. C. F. Knott: How is an aspherical surface produced?

The Author: They cannot be produced in the manner as for ordinary lens surfaces. The grinding and polishing tools when producing spherical surfaces oscillate in a free motion over the top of the lens. In making aspherical surfaces, one has usually to depend on some kind of a formula or link mechanism for producing the curvature mathematically.
THE LABORATORY AND 16mm. COLOUR


Read to the B.K.S. Sub-Standard Film Division by Mr. Coote on October 13, 1948.

In this country at the present time there are only three processes by which 16mm. three-colour prints may be obtained in commercial quantities, they are, Dufaycolor, Kodachrome and Technicolor.

Dufaycolor, by reason of its réseau, suffers increasingly as the size of both picture and sound track images is reduced, and little attempt has been made to apply the process to 16mm. printing for this reason. This is a matter for real regret, as there certainly never has been, and probably never will be, a simpler colour process for the laboratory.

Agfacolor, Ansco Color, and presumably Gevacolor, could all be applied to sub-standard work if the materials were available over here, while Cine-color and the new Trucolor—the latter apparently intended to replace Magnacolor, in due course—are American two-colour processes which can be used for 16mm. printing when suitable printing and processing equipment is available.

All of these processes, whether they can or cannot be operated in this country at present, are receiving some mention in this survey, in an attempt to place them in proper perspective and thereby present a more complete picture of the field of 16mm. commercial colour kinematography.

1. KODACHROME

It is quite often forgotten that 16mm. Kodachrome film has been available for some 13 years—although duplicating facilities are of a more recent origin. In America, four types of Kodachrome stock are now available. They are:

- EK 5265. Duplicating (Tungsten). Not available in Gt. Britain.
- EK 5262. Commercial (Soft Gradation Camera Film). Not available in Gt. Britain.

Speed of Camera Films

Some estimate of the speed of the camera materials may be gained from the fact that both Type A Kodachrome and the Commercial Film will require 650 foot candles when exposed at 24 frames per second at an aperture of f/2.8.

While some photographers regularly employ either Kodachrome Regular in artificial light with a blue correction filter on the camera lens, or Kodachrome Type A in daylight with an orange filter, the manufacturers of stock have often pointed out that the correction filters were originally supplied to enable short ends of one type of Kodachrome to be exposed under a different form of illumination from that originally intended. It was not intended that either type of stock should be used with filters as an "all purpose" camera film.

Processing

All Kodachrome film is processed in the laboratories of the manufacturer, and although simplifications were introduced in 1942 (up to that time there were no less than 30 separate stages of processing involved) the procedure remains sufficiently complex to render it extremely unlikely that other laboratories will ever handle the job.

*Dufay-Chromex, Ltd.
Duplicates

When duplicate Kodachrome prints are required, they can be—but strictly speaking ought not to be—printed on Type A Kodachrome. In America, the material which is used for duplicating is E.K.5265, which is balanced for exposure to a tungsten source after appropriate colour correction. In fact, in America it has become common practice for commercial laboratories to prepare and print 16mm. duplicates on E.K.5265 material, afterwards sending the exposed film to one or other of the several Eastman Kodak laboratories for processing. In England, it is more usual for both the printing and the processing to be placed in the hands of Kodak at Harrow, although at least one independent organisation is printing dupes on Type A material.

It is certain that the practice of duplicating Kodachrome will extend in this country, as soon as both the Commercial and Duplicating films are made available. By the time it does become general for our laboratories to carry out the printing stage of the Kodachrome duplicating procedure much useful information will have become available from the experience now being gained in the American laboratories.

Commercial Kodachrome film is designed to provide a low contrast colour original from which colour release prints of good quality may be obtained on Kodachrome Duplicating stock.

As already stated, only Regular and Type A Kodachrome have been available in England up to the present, and both of these materials are primarily intended to produce the best possible colour positive for projection—a result which is by no means the same as the most suitable positive from which to obtain duplicates. In view of this, some of the results which are being achieved are all the more remarkable.

Commercial Kodachrome (E.K.5262), is not intended for projection. Besides having a softer gradation than Regular or Type A stock, scenes shot on it may show a definite colour cast, because the rendering of the neutrals may depart from grey in order to facilitate the task of obtaining optimum reproduction in the duplicates.

This point will need some clarification, as it may not be easy to understand how the colour quality of a duplicate can be improved by having been made from an off-balance original.

Colour Accuracy in Duping

It is fairly well known that the principal difficulty encountered in the duplication of multi-layer colour originals is the loss of colour saturation and accuracy, which results in the duplicate copy. This difficulty can be traced to the fact that none of the available subtractive printing dyes is sufficiently close to theoretical requirements to absorb substantially the whole of one primary colour while transmitting the whole of the other two. Because of this difficulty in the subtractive colours, it is impossible for each component image to serve as a satisfactory separation positive, since it will always pass some of the colour it should completely absorb, while absorbing some of the colours it should freely transmit, and as a result, the duplicate usually looks what it is—a reproduction of a reproduction.

Now if the three component colour images, which are formed in the emulsion layers of a monopack film, do not have to be chosen because of their suitability for subtractive colour reproduction, but rather for their suitability for service as separation images, a wider range of colour couplers will become available, although an original comprising non-standard component colour images will certainly not, in itself, be a satisfactory colour reproduction. However, when the time comes to print from such a master, the chances of obtaining an accurate reproduction will be considerably greater than if either Regular or Type A materials had been used.
The exposure latitude of Commercial film is greater than that of the earlier types of Kodachrome, although the manufacturers point out that the longer scale of reproduction means that shadows are improved, and the extra latitude should not be used to absorb avoidable exposure errors.

**Straight Printing**

The most important factor in printing from a colour original on to another colour film is the control of the intensity and colour quality of the exposing light. Such control appears quite straightforward at first sight, but it is not always realised that a change of only five volts (at about 90 volts on a 110 volt lamp)—will result in a corresponding increase or decrease of more than 100 degrees Kelvin to the colour temperature of the light—a difference which would certainly be detectable as a colour shift in a duplicate. From this, it will be obvious that no form of resistance control must ever be used to modify the light output of a printer which is set up for the duplication of colour film.

It must also be remembered that the characteristics of new lamps change rapidly during the early stages of their life, and no lamp should be put into a printer until it has been "aged" sufficiently to ensure that the rapid changes have ceased.

**Printing Filters**

Assuming that a printer is being set up with a lamp having a colour temperature of 3000° K. at the working voltage, then the following filters are recommended by Kodak to effect the necessary correction of the light source for printing on E.K.5265 Duplicating stock.

They are:

1. Wratten 2A. (minus ultra-violet).
2. CC 45 (minus red).
3. CC 35 (minus green).
4. 3.2mm. Aklo glasses. (Heat absorbing)*.

The Aklo glasses should be placed nearest to the lamp, and if possible, should be cooled by a draught of air. The gelatine correction filters should be placed as far from the Aklo glasses and the lamp as is practicable.

Additional filters which may be required before a final correct colour balance is obtained are:

- CC 35, CC 34, CC 45 and CC 44.

The filters already named, together with the CC 23, CC 24 and CC 25 (minus blues) represent the range of colour compensating filters supplied by Eastman Kodak for Kodachrome duplicating.

Ideally, each of the three groups of correction filters would only absorb light in one third of the spectrum, and although this is substantially achieved with the minus blues, it is not true of either the minus greens or the minus reds.

**Exposure Level**

Having obtained light of approximately the correct colour quality, the level required can be ascertained by means of comparison exposure on black-and-white positive film.

With the filter set-up already described, an additional filter having a neutral density of 1.20 is added, and an exposure test is made on 5301 at the anticipated running speed. The exposed positive is then carefully

* Probably equivalent to the Chance ON. 13 glass.
developed in D.K.76 to a gamma of 1.20, and should finally result in a strip having a density of $1.65 \pm 0.05$. When the printer shutter or the speed of running have been adjusted to give the required result, the 1.20 neutral density should be removed from the filter pack, and the first trials can then be made on 5265 Duplicating stock.

Offenhauser, who has written a very comprehensive paper on the duplication of monopack film\(^2\), suggests that a test leader should be employed for frequent checking of both printer and stock. The test might include a few frames of each of the following:

1. A black-and-white material, preferably fine grain, exposed and processed to give a uniform density of about 1.0.
2. Clear (fixed out) positive film.
3. The 16mm. Kodak colour test chart.
4. Kodachrome printed through a sharp cut Blue filter (Wratten 49).
5. " " " " Green " (Wratten 61).
6. " " " " Red " (Wratten 29).
7. A resolving power test chart.

When such a test strip is available, it can be used for periodically checking a printer, for setting up a new printer, and for testing new batches of material.

**Photo-Electric Printer Meter**

Another method of ensuring that printer illumination remains constant in all respects, has recently been proposed by a technician from the processing laboratories of Eastman Kodak\(^3\). The idea is to utilise a photo electric cell to check the intensity and the colour balance of the illumination at the printing aperture.

The instrument required consists essentially of a photo-cell and a sensitive galvanometer arranged so that measurements can be made through red, green and blue filters in succession. Obviously these readings will vary if either the intensity or the colour quality of the light changes, and filter adjustments can then be made until the standard set of three readings is regained. The filters chosen for the meter are Wratten 47 (blue), 53 (green) and 29 (red). The cell galvanometer combination is said to be sufficiently sensitive to show a substantial change when the lightest colour compensating filters are either added to or withdrawn from the filter pack, or alternatively, when light intensity changes by an amount equivalent to a one-sixth stop difference in exposure.

**Suitable Printers**

Unfortunately, all the original Kodachrome requiring duplication will not be consistent in colour balance, and while it would not be too difficult to compensate for a colour shift in the original if that shift remained constant for at least the length of the roll, it is much more difficult to compensate for the random colour changes, which do, of course, occur in almost every edited production.

It rather seems that for the moment, in this country, an "average" colour balance is all that can be obtained when scenes vary throughout the roll, since so far as we have been able to ascertain, no 16mm. printer is in use over here which is capable of making automatic colour changes. However, it is obvious that such a printer must be used if Kodachrome, or any other multi-layer colour original, is to be printed satisfactorily and efficiently.

**Reeves Printer**

In America there has been more progress, and Art Reeves has made, and Acme Film Laboratories are using, a 16mm. contact picture printer, which
allows each scene of a colour original to be individually colour corrected. The control of the intensity and colour quality of the exposing light is effected by means of a disc which has slots of varying width cut in its periphery, and which is rotated sufficiently to bring a new slot into the light beam each time an operating solenoid is energised via a micro switch which in turn is operated by the film notch.

Colour correction of each scene is achieved by placing a transparent disc, upon which correction filters are mounted, behind the opaque exposure control disc. Both discs revolve in step, and thereby place the correct slot and the required correction filter in front of the light of each scene.

Depue Printer

It appears that the Eastman Kodak Laboratories in America employ printers made by Depue⁶, which are capable of printing combined sound and picture on to Kodachrome at 70 feet per minute, but whether these are designed to effect automatic colour changes we do not know. Certainly, at such high operating speeds, it would be quite impossible to read a light change card sufficiently quickly under the dim green safelight which must be used for Kodachrome, and we can therefore assume that any light changes which are required will be preset and not manually operated.

Earlier Colour Printing

It must not be thought that these American printers are the first which have been designed to meet the special requirements of colour printing.

A Dufaycolor printer was described to this Society by D. A. Geary in 1939⁷ and this printer, which is made for Dufay-Chromex, Ltd. by Vinten, Ltd., provides for eight changes of light intensity and six changes of colour quality—all of them automatically controlled by a separate light change band. The neutral density filters and the colour correction filters are moved into or out of the light path by means of a set of solenoids.

During the war, the German and French laboratories worked out methods and apparatus for the automatic printing of Agfacolor negatives. Usually Debrle printers were employed, and as an aperture band had already served to control the light intensity, it was relatively simple to attach any gelatine filter, or combination of filters to the paper band, and thereby control the colour quality of the exposing light⁷.

Grading Means

We now know from several published reports on the Agfacolor process, that a great deal of attention was also given to the colour grading of Agfacolor negatives before they were printed, and means were devised to print a series of single frames, so that each frame was exposed through a different filter combination.

The principle of making colour "Cinex strips," if we may be permitted to call them that, is now being used in the Acme Film Laboratories to grade 16mm. Kodachrome, which is subsequently printed on the Art Reeves colour printer. A 55-frame test strip is exposed through five filter combinations, each of which has eleven density steps.

Colour Masking

During the past few years, "masking" has become something of a catch phrase in colour photography, and it is probably true to say that the term is frequently used without any certainty of its meaning. The fact is, that even when special taking films such as E.K.5262 are employed, there will still be a rather serious loss of quality in any duplicates which are made from un-masked originals.

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In duplicating an integral tripack original, the possibility of obtaining an improvement, by the use of one or more masks, is very considerable. Generally two masks will be made, one to improve colour reproduction and control contrast, and the other to control the tone reproduction of the highlights.

Since a mask is simply a negative or a positive image which is either placed in contact with, or optically registered with, the colour original during the printing operation, it is obvious that a high degree of accuracy is required in the contact or optical printers which are to be used. Such a printer has been made by Irving Dyatt, and is now handled by Chroma-Tech Motion Picture Laboratories in Hollywood.

Although the Chroma-Tech printer appears to be capable of dealing with a great variety of optical work, its particular advantage in the duplication of Kodachrome lies in the fact that any mask can be run through one gate, while a colour original is running through the other gate in contact with the duplicating stock.

The Chroma-Tech Laboratories appear to be the only organisation claiming to make Kodachrome release prints via intermediate colour positives⁸, and although there is no direct evidence to support the supposition, it is probable that they are employing a positive mask which has itself been obtained by printing through what can be described as a "highlight mask."

When reproducing a transparency, the lightest parts of the image fall upon the toe of the characteristic curve and will therefore be considerably "compressed." This form of tone distortion can be counteracted by making a negative mask from the original transparency in such a way that the highlights alone are recorded on the mask—the exposure being insufficient to record either the middle or the shadow tones. This "highlight" mask is next combined in register with the original, while a second or "monochrome negative mask" is made from the pair⁹. The second mask will usually be made by exposure through a red filter so that very little additional density will be added to any blue or green areas of the original, while some density is added to the reds.

The reduction in contrast, due to the mask, can be regained when making the duplicates by using Type A material in place of Duplicating stock. Such a procedure would result in the increased saturation of all colours.

Whether the Kodachrome prints which are made by the comparatively elaborate procedure which seems to be employed by Chroma-Tech Laboratories are as good as, or better than, straight contact printer duplicates, we do not know, but it is certain that other advantages do result from the method. In the first place, the colour original is protected from risk of damage and, furthermore, many optical effects can be introduced during the making of the intermediate positive.

Kodachrome Sound

It would only be possible to hazard a guess at the procedure which is now followed by Kodak to procure a track image in silver iodide, silver sulphide, or metallic silver, and since the outside laboratory is never likely to be responsible for Kodachrome processing, it will be sufficient to say that whatever method is employed, it results in a satisfactory image which is either silver or some salt of silver, and which is principally located in the outermost—and therefore the sharpest—image layer.

Up to the present, sound has been printed on to Kodachrome from a positive, in order to comply with reversal processing, but it has recently been reported that Kodak have a patent which will allow the track to be printed from a negative¹⁰. The procedure is to print the track from a negative, and to develop the film to produce negative silver images in the picture.
area, with a positive track in the sound track area. The sound track only is then fixed—presumably by means of a roller application of the solution—and the whole film is then colour processed, all the silver images finally being bleached to a silver halide but not fixed. The whole film is then partially fixed for a time which is just sufficient to remove the yellow colloidal silver filter layer, and any fog in the sound track area. The sound track area only is then re-developed to silver—again probably with a coating roller—and the whole film finally fixed, washed and dried.

If and when this new procedure is employed, Kodak will obviously inform the users of Kodachrome, but until then positive image tracks will still be needed.

Most of the laboratories in America appear to prefer to print sound on to Kodachrome on a 1:1 optical printer, and one reason for this may be that, at least with variable area, a useful increase in contrast can be expected. The 16mm. positive track will usually have been re-recorded. In some cases sound is being re-recorded directly on to Kodachrome.

II. ANSCO COLOR

There is little evidence to suggest that 16mm. AnSCO Color is being widely used for commercial purposes in America, and this is the more surprising when it is remembered that there is a special 35mm. AnSCO Color material for making soft gradation master positives, as well as a duplicating material for prints.

Perhaps it is the problem of sound reproduction which is the cause of the delay, for the fact that the lowermost or cyan image is inevitably unsharp in any orthodox type of monopack means that a sound track which is printed and processed in the same manner as the picture area and, therefore, comprises a composite dye image, will produce poor quality sound with any normal cell because it will be the cyan image which is doing most of the work.

Image Resolution

Whilst on the subject of the resolving power of monopack materials, we must mention some very confusing evidence. Kodak claim 70 lines per mm. for Kodachrome, while others have reported only 40 lines per mm.11. One thing is certain, and that is that the resolution of the lowermost—red sensitive—emulsion is far worse than that of either the green or the blue record layers.

Since the sharpest record is the least easily seen yellow image, and the worst image is the important cyan component, it seems unlikely that on balance the resolving power of the material as a whole is up to black-and-white standards.

Sound Volume Range

Several interesting attempts have been made to improve the sound reproduction obtained from dye tracks. RCA technicians thought, for instance, that since the unsharp cyan image was likely to be largely responsible for the poor quality, an improvement might be expected if means were found to dispense with that image. The red sensitive lowermost emulsion layer was therefore "flashed" to red light in the sound track area, and the track itself obtained as a combined yellow and magenta image. The improvement obtained was only slight, and it was decided that the unsharp cyan image was not seriously affecting the blue-sensitive cell after all12.

Other tests were made using the outer blue-sensitive emulsion layer exclusively—in other words, producing a yellow track image. The results were not very successful, as the RCA 1P.37 blue-sensitive cell is sensitive to green as well as to blue, and the presence of a magenta image is necessary
in addition to the yellow, in order to secure a reasonable volume range. Nevertheless, it did prove advantageous when using blue-sensitive cells to expose multi-layer dye tracks through a pale yellow filter in order to increase the density due to the blue-sensitive layer.

III. ASSEMBLY PROCESSES

We must now consider one or two entirely different methods of producing 16mm. colour prints in commercial quantities.

Technicolor 16mm. Printing

The Technicolor process, whether it be applied to 35mm. or 16mm. printing, is always operated from three colour separation negatives, and by far the larger proportion of these negatives are obtained in the Technicolor beam-splitter camera. A few 35mm. releases have been printed from negatives obtained by enlargement from 16mm. Kodachrome originals, but there is no record of 16mm. Technicolor prints being made from 16mm. separation negatives, which in turn have been obtained from a 16mm. Kodachrome original.

It may not be well known that 16mm. Technicolor prints made in this country are actually printed upon 35mm. stock in the first place. The procedure apparently is to print the 16mm. sound track first—either by contact or 1:1 optical printing—and to develop this to black-and-white to provide a silver image track in the same manner as for 35mm. Technicolor. The inhibition stages of the process are carried out on the standard 35mm. transfer machine, the matrix and the print stock being registered by the 35mm. perforations, and only after the three 16mm. component images have been combined in register are the sub-standard perforations added and the 16mm. width slit from the larger film—two 9.5mm. edges being discarded. When 16mm. Technicolor prints display a "weaving" effect during projection, it is presumably due to slight variation in the final perforating or slitting stage.

The silver sound track of a Technicolor reduction print is usually similar in quality to that found on a good black-and-white 16mm. print, but the picture definition is not as good because of the fact that the degree of dye spread or "bleeding" associated with the dye-transfer process is constant regardless of image size and, therefore, appears more serious under normal 16mm. projection and viewing conditions.

Double-Sixteen

It is to be expected that when Technicolor expand their processing plant and undertake a greater proportion of 16mm. printing, they will build an inhibition machine which will either handle standard 16mm. film or some form of "double-sixteen" stock. A recent patent may in fact describe the procedure which will be followed.

The first laboratory to employ the idea of printing two or more sets of sub-standard images on a single 35mm. width, appears to have been Pathé in France, very soon after the first world war. Pathéscope in this country have used the method for some twenty years in the production of three 9.5mm. image sets on standard width stock, which has been perforated in a suitable manner before use.

There is an obvious saving in processing time when two 16mm. prints are obtained from one 35mm. band, although there is the disadvantage that special picture and sound printers must be used, and a film slitter is required. For processing, it is possible to employ normal 35mm. machines, after a
relatively simple change of sprockets, or friction drive machines without any change at all.

Cinecolor

Sixteen millimetre Cinecolor prints are made on 35mm. film with emulsion on both sides of the base, so first of all, a special double-sixteen negative has to be made on an optical printer. Both the negative and the positive stocks are received by Cinecolor without perforation, and are then given three sets of 16mm. perforation—one down the centre, and one along each edge.

The double-sixteen duplicate separation negatives from the optical printer are then used to expose the two sides of the positive at the same time, and for this a special contact printer has been built. On this printer it is possible to obtain up to twenty-one independent automatic light changes on each negative.

The exposed positive material is developed to black-and-white in a normal manner, and then treated so that orange-red dye toned images are formed on one side of the film, and blue-green (or cyan) iron toned images on the other. This differential processing usually involves what is known as a "floating" operation, during which the film is passed continuously over the surface of a treating bath so that one side only is affected.

The sound tracks are printed upon that side of the film which is toned blue-green—both tracks being printed at the same time on another special printer. Since Cinecolor sound track images consist of a metal salt—ferric ferrocyanide—they are satisfactorily reproduced by means of ordinary cells, but it is impossible to foretell just what would happen to them if blue-sensitive cells became standard.

The difficulty of accurately focusing prints made on double coated or "duplex" stock is naturally greater in the case of 16mm. projection than with 35mm. film. Consequently, although the component color images of a Cinecolor print are not subject to dye-spread, and may be perfectly registered one with the other, it is difficult to focus the combined image on the screen.

Registration Printing

There is another way in which it should be possible to prepare excellent colour masters from which to make subsequent prints on multi-layer colour materials. The Bell & Howell 35mm. to 16mm. picture reduction printer has a 35mm. Unit I type gate in the projector head, and a 16mm. version of the same movement in the camera head. Naturally the register pins cannot be located across the width of the frame when 16mm. sound film is being printed, and instead there is a fully fitting pin placed below the frame being printed, and a second pin four frames above, which fits the perforation laterally but not vertically—to allow for shrinkage.

This printer could be used to expose a length of Kodachrome three times—once to each of the three separation positives through the appropriate tri-colour filter. During the making of the required positives, all optical effects would be introduced, while at the same time a good deal of density and colour balance adjustment could be made. The positives would certainly need to be quite soft in order to counteract the increase in contrast, which always results from optical printing, but it would not be very difficult to arrange this.

Naturally, all the preparatory work involved with such a procedure would only be warranted if reasonably large numbers of release copies are required. If only a few prints of very high quality were required, and the separation records were available, they could be made in the same way.
Separation Images

These registration printing proposals depend upon the existence of a set of colour separation negatives—easy when the subject matter is not alive, but not so easy when it is in action. Harsh and Friedman, of Ansco, have recently proposed an alternative procedure which could be applied to 16mm. printing on to multi-layer materials. They would commence with a soft gradation monopack original made on a film such as Ansco Color Type 735—or its equivalent, Commercial Kodachrome—and then make successive frame colour separations from the original on to a new black-and-white material known as Ansco One-strip Colour Separation Film, Type 155, the principal characteristic of which is to produce separation negatives having equal gammas after the same times of development.

The colour original is placed in the projector head of a suitable optical printer, while the "One-strip" stock is used in the camera head—an arrangement being made to shift the film in the projector only after each set of three colour exposures have been made in the camera—the latter being fitted with the usual type of rotating filter disc.

The successive frame negative which results is a master, and can include all the fades, lap dissolves, and other optical effects which are required. To convert this master negative into a colour print, it is necessary to "extract" each of the sets of colour separation records, so that they are on three bands of film. This is a straightforward skip printing job which can be carried out on the same printer.

The final step is to print the separation positives on to any suitable reversal colour material, which can be done in a standard contact printer, equipped with register pins, by printing the multi-layer colour material three times—each time through the appropriate positive and tricolour filter.

It may well be your opinion that all these roundabout procedures cannot really be worth while, and that it is easier to wait for improved monopack materials and simpler methods of handling them before getting mixed up in colour. Only time will show whether such a view is correct.

It is certain, however, that if the work is ever to be carried out in ordinary laboratories, means must be found to make and use a satisfactory intermediate colour film from which release prints can be obtained, before colour on 16mm. can be considered a complete commercial process.

The paper was illustrated by the following films: "Beauties of Britain" (Duofacyolor); Kodachrome original and dupe; "Insects" (Kodachrome dupe); a sequence from "Henry V" (Technicolor); "Hunting Season" (Cinecolor); "La Poulet Grise" (Kodachrome).

REFERENCES

1. Report No. 125. "Tentative Instructions for Making 16mm. Kodachrome Duplicates on Kodachrome Duplicating Film."
5. Amer. Cine., Vol. 29, No. 4, April, 1948, p. 129.
9. B.P. 570,498.
13. B.P. 569,426.

**DISCUSSION**

Dr. D. Ward: May I ask Mr. Coote what future developments are likely in this country?

Mr. Coote: What is most needed is material for making masters and dupes. It seems, too, that Monopack materials are even more important to 16mm. workers than to 35mm. workers, whilst generally speaking, a large number of 16mm. prints is not needed.

Mr. H. S. Hind: Do you think there is any general overall advantage in using film that is subsequently going to be slit? From the practical point of view of subsequent projection, it is not very satisfactory because the print is not made using the standard guiding edge.

Mr. Coote: I think the laboratory has to decide just what volume of business is going to be done in 16mm. Pathéscope did the obviously wise thing in printing 9.5mm. three up on 35mm.; it must have reduced their processing requirements enormously.

Dr. Ward: Do you think it would be possible in a process such as Kodachrome to leave a little silver in? I have often thought that Kodachrome prints would be improved by a slight silver image.

Mr. Coote: There are many conflicting views on that point. We have a good example in the key printers used for Technicolor, but it would not be possible to leave the silver just where it is required—in the shadows.

Mr. W. S. Bland: Could Mr. Coote tell us the reason for the laborious process by which a sound track is made from a negative in the case of Kodachrome?

Mr. Coote: I can only suppose that there are definite advantages in working from a negative. They will, of course, get a true silver image instead of silver iodide.

Mr. Bland: In regard to the use of dayight or artificial light stocks one of these films is, presumably, so to speak, the basic film, and the other is filtered in the film itself?

Mr. Coote: In the colour sensitivity and speed of the emulsion layers these are quite different.

**TECHNICAL ABSTRACTS**

**Most of the periodicals here abstracted may be seen in the Society’s Library**

**USE OF G.3 FILM PROCESSING TANK.**


Designed for use in the field, this developing tank processes up to 100ft. lengths of 16mm. or 35mm. film (negative or reversal), by winding it to and fro between two spools immersed in the processing solutions. The processing relies on solution entrapped between the coils, and times vary both with film length and winding rate. Any irregularities such as clips, punches or creases produce marks on the next coil. Full formulae and working instructions are given.

M. V. H.

**A NEW METHOD OF VARIABLE DENSITY SOUND RECORDING.**


A mercury vapour lamp containing a rare gas is of capillary form and is excited by a high frequency (4 Mc.), applied to external electrodes. The light output is modulated by modulating the high frequency. High brightness and long life are claimed for the lamp, whose inertia is negligible at audio frequencies. With a very simple optical system variable density recordings are made which have low distortion. Normal methods of noise reduction may be used.

M. V. H.

**OPTICAL SOUND-TRACK PRINTING.**


An improved design of optical printer is described in which the optical layout gives ample room between negative and positive to permit the use of conventional constant speed drives. The improved results compared with contact printing are illustrated by photographic enlargements and response curves.

N. L.
THE COUNCIL

Meeting of January 5th, 1949.

Present: Messrs. W. M. Harcourt (President), A. W. Watkins (Vice-President), L. Knopp (Deputy Vice-President), P. H. Bastie (Hon. Treasurer), I. D. Wratten (Past President), A. G. D. West, H. S. Hind, R. F. Pulman, R. B. Hartley, R. H. Cricks (Technical Consultant), W. L. Bevir (Secretary).

Finance Committee.—The Council requested that Mr. Foster, the accountant, prepare a Profit and Loss Account, and Balance Sheet, showing the Society's position in 1948. Messrs. Knopp and Hartley were empowered to make recommendations for the reduction of work to effect economy in the office.

Elections, 1949.—It was agreed that the ballot should be run as in previous years for the election of the four officers of the Society, who were due to retire, together with Messrs. Champion and Honri.

Proposed Section for Directors of Photography.—The President read a letter from Mr. F. Young, in which he stated that it had been decided that the proposed body should not be a part of the B.K.S.

Film Mutilation Brochure.—Mr. Wratten reported that the last brochure was being typed, after which a further meeting was to be called.

B.S.I.—Messrs. Leevers, Kolb and Voigt were appointed to represent the B.K.S. on the B.S.I. Acoustics Industry Committee, and it was agreed that there should be a representative on the Photographic Committee.

Film Production Division.—Mr. Watkins reported that Mr. G. Burgess had been appointed as Council representative in place of Mr. H. Waxman.

Honorary Member.—It was unanimously agreed that Mr. R. T. Dealey be made an Honorary Member in view of his past services to the Society.

F.I.T.A.C.—The President stated that as Chairman of a F.I.T.A.C. Committee, he could not involve himself over the question of employment in the industry of B.K.S. students.

EXECUTIVE COMMITTEE

Meeting of January 5th, 1949.

Present: Messrs. W. M. Harcourt (President), A. W. Watkins (Vice-President), L. Knopp (Deputy Vice-President), I. D. Wratten (Past President), W. L. Bevir (Secretary), and Miss S. M. Barlow (Assistant Secretary).

Elections.—The following were elected:—

John Frederick Wood, Jr. (Associate), Bedford Cinemas.
Albert Dennis Usher (Member), Western Electric Co., Ltd.
John Claude Tetard (Associate), Pathéscope, Ltd.
Donald Doo (Hon. Member), U.N.E.S.C.O. Film Fellowship.
Nils Muller (Hon. Member), U.N.E.S.C.O. Film Fellowship.
Kenneth Reginald Ilott (Member), R.A.F. Cinema Corp.
Maurice James Reardon (Member), R.A.F. Cinema Corp.
William John Moylan (Member), Hibernia Pictures, Ltd.
Kenneth Rouge (Member), Autotype Co., Ltd.
George Mark Lloyd (Member), Film Producer for British Govt.
Burton Magnus Munnings (Associate), Supreme Sound System, Australia.
John Aylin Sevse Bruce (Member), Commonwealth Film Labs, Pty., Ltd., Australia.
Philip Henry Budden (Member), Commonwealth Film Labs., Pty., Ltd., Australia.
Mervyn Ross Murphy (Member), Panachrome Processing Co., Australia.
George Montague Heath (Member), Ealing Studios, Australia.
James Alexander Scott Smith (Member), Odeon Theatres, Ltd.
James William Gislingham (Member), General Film Distributors, Ltd.
Harold Peasgood (Associate), Technicolor, Ltd.
Leonard George Applebee (Member), Strand Electric & Eng. Co., Ltd.
Arnold Graaff (Member).

Peter Parviz Shayan (Associate), British Acoustic Films, Ltd.
Harry Lambert (Member), C.M.A.

Expulsions.—Two members, eight Associates and two Students, who had failed to pay their subscriptions after repeated reminders, were expelled from the Society.

Resignations.—The resignations of five Members and six Associates were accepted with regret.

Death.—The death of Mr. Thomas Stark was noted with much regret.
He interprets with light...

This scene, from the moment of its conception, had dramatic possibilities. But it was the director of photography who made them more than possibilities.

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LECTURE PROGRAMME
March, 1949

Meetings to be held at the Gaumont-British Theatre, Film House, Wardour Street, London, W.1, commencing at 7.15 p.m.

T—Theatre Division.
A—Joint Meeting with A.C.T.


Mar. 20 "Films Not Generally Seen."
A. Mar. 23 "Independent Frame Production," by DAVID RAWNSLEY and MAURICE GORHAM.

MANCHESTER SECTION.

Meetings to be held at the Lecture Theatre of the Manchester Geographical Society, 14 St. Mary's Gate, Parsonage, Manchester, commencing at 10.30 a.m.

Mar. 1 "Cathode Glow Tube and Crater Arc," by Dr. J. A. DARBYSHIRE, M.S.Inst.P.

NEWCASTLE-ON-TYNE SECTION.

Meeting to be held at the Lecture Theatre, Newe House, Pilgrim Street, Newcastle-on-Tyne, 1, commencing at 10.30 a.m.

Mar. 2 "Television Picture Projection," by G. DOBSON.

LEEDS SECTION.

Meeting to be held at the Y.W.C.A., Cookridge Street, Leeds 1, commencing at 10.30 a.m.


*The third paper in the Modern Kinema Equipment series, the Ross RCA, has been postponed, but it will be given in next season's programme.

NEW ZEALAND STANDARDS

The New Zealand Standards Council has appointed technical committees on photography and kinematography. It has been decided that the Dominion can make no useful contribution on these subjects, and the function of the Committees will presumably be merely to decide on the adoption of British standards.

BOOK REVIEWS


As a professor of psychology, the author reviews the requirements of research to increase the effectiveness of instructional sound motion pictures from the psychological standpoint. Although marred by abstract terms and inconclusive statements, the report includes a number of subjects which the makers of educational films might well study to form a background to their work.

A. W.

PERSONAL NEWS of MEMBERS

Members are urged to keep their fellow members conversant with their activities through the medium of British Kinematography.

FRED W. CORDEN is retiring from the industry after spending 36 years in film processing laboratory work.

EDWARD C. DAVEY has been elected a F.R.S.A.

ERIC WILLIAMS, Studio Manager, Ealing Studios, Ltd., Australia, writes that the construction of the new Pagewood Studios, Sydney, N.S.W., is almost completed.

NIGEL RACINE JACQUES is working for Herr Julius Pinschewer, the Swiss film cartoonist, at Berne.

C. E. ANDREWS, chief projectionist at the Warner Bros. Theatre, Leicester Square, after 25 years in the film trade, goes to Sydney, Australia, this month, where he hopes to take up similar employment.

PERSONAL ANNOUNCEMENT.

FRED. W. CORDEN is retiring from the industry after 36 years in film processing laboratories. He will be pleased to hear from old and new friends at his Holiday Guest House at "Lowlands," Coverack, Near Helston, Cornwall.

Small announcements will be accepted from Members and Associates. Rate, 4d. per word, plus 2s. for Box No. If required (except for Situations Wanted). Trade advertisements, other than Situations Vacant, not accepted.
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THE CHEMICAL ECONOMICS OF SPRAY PROCESSING

Gerald I. P. Levenson, Ph.D., M.B.K.S.*

Communication No. 1240 from the Kodak Research Laboratories.

A PHOTOGRAPHIC developer contains reducing agents that are oxidisable not only by silver halides but also by oxygen. The developers that are almost exclusively used in the motion picture industry are alkaline solutions containing sodium sulphite, hydroquinone, and p-methylaminophenol sulphate (Elon). The main course of the oxidation by oxygen is well understood,¹ the ultimate products being sodium hydroxide, sodium sulphate and the sulphonates of Elon and hydroquinone. It has been shown² that when solutions of this type are oxidised by silver bromide a disproportionately small quantity of Elon is oxidised to the sulphonate, as the result of a mechanism by which the methylquinoneimine is partly reduced back to Elon by hydroquinone. The course of oxidation by oxygen (autoxidation) is similar to that of oxidation by silver bromide, and a similar mechanism may be assumed.

I. SYSTEMS OF DEVELOPER AGITATION

Because the rate at which oxygen attacks developers is appreciable, it is customary to protect them from exposure to the atmosphere as much as possible. However, in order to achieve uniformity of treatment of the film that is being developed, it is necessary to introduce considerable turbulence in the developer solution so as to change as frequently as possible the developer actually in contact with the sensitive emulsion. Mere circulation of the developer is not usually adequate to achieve this end and systems have been described, for example, in which the developer is projected at the surface of the film from submerged jets.

On the other hand, there has been a tendency in recent years to achieve the desired degree of agitation by methods that involve the free exposure of the developer to air. Machines have been described in which the developer is cascaded down the strands of film from a trough situated above the racks. Ives and Kunz,³ and Crabtree and Schwingel⁴ have shown that a developer can be suitably agitated by means of bubbles of air released from submerged jets and that, in spite of the aeration, the sensitometric properties of the developer can be maintained constant by proper replenishment.

Spray Development

The latest move in this direction has been to abandon altogether the idea

*Research Laboratories, Kodak, Ltd., Wealdstone, Harrow, Middlesex.
of immersing the film in a tank of developer and, instead, to apply the developer to the loops of film by spraying it on in mid-air. Several machines based upon this principle are in use in the United States and at the time of writing this paper, similar machines are coming into use in the United Kingdom.

In these machines the degree of aeration is extreme and, at first sight, one might suppose that the rate of loss of chemicals by aerial oxidation would be too severe for the idea to be practical. While it is generally understood in the industry that the chemical consumption is increased only slightly, if at all, no comparative figures have been published. To gain a closer insight into the economics of this method of processing, a study was made to compare the performance of a pilot spray developing cabinet with that of conventional systems, and the results of this work are set out below.

**Advantages of Spray Developing**

At the outset of this work it seemed that spray developing would offer several advantages:

(a) Better agitation, with greater prevention of directional effects, sprocket-hole modulation, etc.
(b) The cabinet would need to be only spray-proof as opposed to water-tight. The construction of the cabinet could be light because no great hydrostatic pressures are involved.
(c) By closing off the developer supply and opening the cabinet door the loops of film are readily accessible for threading up or for mending a break.
(d) Especially in the case of positive processing, the loops can be inspected through the transparent (glass, Perspex, etc.) cabinet.
(e) The bulk of developer required to serve the spray system could be much less than that required to fill a developing tank of equivalent processing capacity.

In carrying out the work described below, the validity of claims (a), (b), (c) and (d) was not questioned. However, it emerged from the experimental work that the volume of solution used in the spray developing system (e) has an important bearing on the cost of running. In the pilot machine that was the subject of most of the experiments, the volume of developer used was the minimum (6-7 litres) that would adequately serve the circulation system, although some experiments were made using the spray cabinet in conjunction with a large (130 litre) reservoir.

**II. THE PILOT MACHINE**

No special merit can be claimed for the design of the spray developing cabinet (Fig. 2) that was constructed to carry out this work, except that it could be made from the limited materials available at the time. However, cuprous metals were carefully avoided and, with the sole exception of the pump rotor chamber, which was made of cast iron covered as far as possible by a developer resistant chlorinated rubber paint, the developer came into contact only with inert materials: stainless steel (FMB Grade), Perspex, rubber and glass.

The cabinet was constructed of 1/4-inch Perspex sheets joined together by screwing from the inside into external wooden quartering. In this way a smooth interior was achieved as free as possible from corners. The screw-heads were countersunk and covered with a rubber cement, and the internal corners of the cabinet were sealed and rounded with the same material. The small developer reservoir was constructed similarly to the cabinet. The circulation piping is shown diagrammatically in Fig. 1. The developer was drawn from the reservoir at A and was sent, by the 1/6 H.P. pump into the three vertical manifolds B, C and D. Each manifold supplied six spray
tubes. The spray tubes fed by B and D sprayed horizontally inwards, whereas the central spray tubes fed from C sprayed horizontally in both directions. In order to make proper use of the pumping capacity, it was found necessary to avoid sharp bends in the piping, particularly where the manifolds divided.

Types of Jets

It is unfortunate that the term "spray" has come into common usage in connection with this mode of developing, because it is apt to convey the wrong impression. A spray of developer, consisting of a mist of droplets, would not be effective in scrubbing the surface of the emulsion free from used developer. For this purpose a high velocity jet of developer is required and "jet developing" would be a more apt term.

In some commercial spray-processing machines, a splayed, flat jet is used to throw a blade of liquid. In others a coned jet is used. However, in order to maintain a high jet velocity without having recourse to a large pump, a round, 1.0mm. diameter jet hole was adopted.

A row of 1.0mm. holes 1.0cm. apart was drilled along each of the single-sided spray tubes (on B and D), and two horizontally opposed rows of holes were drilled into each of the six central spray tubes (Fig. 3). When the spray tubes and the film transport bobbins had been located in the spray cabinet, a number of the holes were re-sealed, leaving open only those from which the jet of developer impinged on the film.

Circulatory System

The rate of circulation, on the one occasion that it was measured, was 43.5 litres per minute (570 gallons per hour). This figure agreed well with
sizes of the holes in the cork diaphragms were found by trial and error.

The spray cabinet and the reservoir were so constructed that air could not penetrate freely in and out, save at the orifices provided for the film to enter and leave. These holes were about $5 \times 1$ cm. in size and, when desired, they could be sealed by means of adhesive tape. No attempt was made to make the cabinet completely air-tight. These conditions were chosen because, while complete air-tightness would be troublesome to maintain in practice, it would not be inconvenient to prevent the free access of air, and one of the objects of this work was to study the changes in the enclosed air and to find whether the use of nitrogen gas would be necessary in order to reduce the rate of oxidation of the developing agents.

After making trial runs, it became obvious that the steps taken to prevent the free entry of air were being nullified because the turbulent developer, falling down the return pipe from the cabinet to the reservoir, carried with it a large volume of air which was, of course, replaced by air leaking into the cabinet. To avoid this defect, a wide return pipe was provided for the air to return from the reservoir to the cabinet. In the description given below of the experiments on the composition of the enclosed air, this device will be referred to as the "air return pipe."

III. OTHER SYSTEMS

Four other systems for holding and circulating the developer were examined in comparison with the spray cabinet used with a minimum quantity of developer. For convenience in referring to each, the system already described will be referred to as the S-R Spray (small reservoir) system to distinguish it from the first of the following:

L-R Spray (large reservoir).—In some commercial spray processing machines, the spray cabinet is used in conjunction with a bulk of developer about as large as that which would be required for a total immersion machine of the same processing capacity. By using the large bulk of solution, the ease of handling and mixing a small quantity of solution (advantage $e$ in the list above), is lost, but the developer is less susceptible to a rapid change in composition, and would thus be expected to show less tendency towards short-term deviations. For this reason, some of the experiments, revealed as more significant by runs on the S-R Spray system, were repeated, using a large earthenware crock as the reservoir, holding a 130 litre batch of developer. In these experiments no provision was made for returning the air carried down the developer return pipe. The L-R Spray system is shown in Fig. 4A.

Immersion Systems

The various methods of agitating and circulating the developer in an immersion system can be divided into three groups, and the following three systems studied in this work are fairly representative.

Quiet Circulation System.—For want of a better term, the description "quiet circulation" is applied to those systems, comparatively rare in
modern motion picture practice, in which bubbles of air are not trapped to any significant degree and carried below the surface into the bulk of the developer. Fig. 4b shows the arrangement used. It consisted of the large earthenware crock containing 130 litres of developer which were drawn out of the bottom and returned, below the surface so as not to entrap bubbles, at the top.

A system of this sort could, of course, be used with submerged jets without altering its characteristics towards aerial oxidation. The liquid-air interface was 16 sq. cm. per litre. It should be noted, however, that if the pump gland were to leak and admit air, or if film were to be run through the tank at high speeds, carrying down air in the perforation holes into the developer, the characteristics of the system would be entirely changed and it would become similar to the air-trapping circulation system described next.

**Air-trapping Circulation System.**—In most processing machines, a greater or less amount of air is trapped and carried, as bubbles, into the bulk of the developer. In many cases, this trapping of air is an inevitable consequence of the design of the system, particularly in those installations where the developer is pumped from one tank to another and then returns by over-flowing down an incompletely filled pipe, or a pipe that is so placed that air is sucked in unintentionally. In high-speed machines, the moving film carries a considerable amount of air below the surface of the developer. In any machine a leaky pump gland, or a leak on the induction side of the pump, will inject air into the developer in the form of very minute bubbles which aerate the developer very efficiently.

To simulate such conditions, the arrangement shown in Fig. 4c was used. The developer (130 litres) was pumped from the earthenware crock to a small elevated tank, and returned by passing down a 4ft. long, 1in. bore, rubber hose, carrying with it a considerable amount of air which was impelled into the bulk of the developer in the crock.

**Air Bubbling System.**—To represent an air-agitated bath, 130 litres of developer in the earthenware crock were agitated by a current of air injected from nine 4mm. diameter jets situated 56cm. below the surface of developer. This arrangement was achieved by blowing compressed air down nine tubes as shown in Fig. 4d. The air flow, which was maintained constant according to a differential manometer in a fixed position in the system, was approxi-
mately assessed by finding the time necessary to displace the water from a large flask when catching the bubbles from a single tube of the same internal cross section as the sum of the cross sections of the three manifold tubes. The rate of flow of the air was found to be nearly 27 litres per minute. The rate of flow of air through each jet was balanced to the same level and the general rate of flow was set at a level that, on the basis of general experience, seemed to provide a sufficient degree of turbulence for good processing.

However, this rate of air flow was less than a quarter of that which would have been required to supply Ives and Kunz injector grids, judging from the data (for a different shape tank) given in their paper. Thus, when considering the oxidation rates given below, it should be borne in mind that the air flow was comparatively low and higher rates might be met with in practice.

Experimental Conditions

The object of these experiments was to find the initial rates of oxidation of the Elon and hydroquinone from the unexhausted developer. In a continuously replenished system, the Elon and hydroquinone are maintained at a steady concentration, and the rates of oxidation are reflected in the extra quantities of the developing agents needed in the replenisher. Because of the repeated and extended runs that would have been required to establish the correct replenishment rate in each case, the simpler course was followed of installing a fresh bath and measuring the initial rates of oxidation.

In all the runs on all five systems and in the small-scale oxidation experiments to be described later, the temperature was maintained at 20°, within $\pm\frac{1}{4}$C. No account was taken of the barometric pressure because the accuracy to be expected in work of this nature was not sufficiently high to merit doing so.

The Elon and hydroquinone analyses were carried out along the lines described elsewhere. Sulphite analyses were done using Stott’s method. The pH values were determined using an ordinary glass electrode and a high-salt buffer as described in a previous paper. Analyses of the air in the spray cabinet were made by drawing off a 50ml sample of air and absorbing the oxygen in alkaline pyrogalol in a Hempel pipette. The air was sampled through a cock fitted in the back panel of the spray cabinet about 9in. from the bottom.

Ordinary photographic grade "Kodak Tested" chemicals were used, and tap water was employed in all the runs involving a large volume of solution.

At the outset the survey was based on D76d, as a typical negative developer, and the following positive developer:

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elon</td>
<td>1.72g</td>
</tr>
<tr>
<td>Hydroquinone</td>
<td>3.30</td>
</tr>
<tr>
<td>Sodium sulphite</td>
<td>37.8</td>
</tr>
<tr>
<td>Sodium carbonate</td>
<td>21.2</td>
</tr>
<tr>
<td>Water to</td>
<td>1 litre</td>
</tr>
</tbody>
</table>

In a number of makings the pH of the D76d varied between 8.6 and 8.8. The pH of the positive developer was adjusted with sodium hydroxide to $10.5 \pm 0.05$. This somewhat high level was deliberately chosen so as to extend the pH range covered. Later, in the light of the results obtained, it was thought necessary to repeat some of the more significant runs with the positive developer adjusted with bisulphite to pH 10.0.

Oxidation Rates in the Five Systems

Since it was thought possible that the presence of colloidal silver might
influence the rate of oxidation, most of the runs were repeated after adding about 0.014gm. of colloidal silver suspended in a gelatin sol, per litre of developer. When, as will be discussed later, it was established that it did not affect the rate of oxidation, its use was discontinued. Figs. 5, 6 and 7 illustrate typical exhaustion runs and give some idea of the fair degree of reproducibility that was obtained in the rates of oxidation. The runs with colloidal silver may be taken as duplicates of those without. For lack of space, full plots of all the runs will not be given; instead, the initial rates of oxidation in terms of grams per litre per hour are given in Table I. Because of its apparent lack of effect, a number of the runs shown in Table I have no counterpart with colloidal silver.

Before discussing the results in detail, it is necessary to comment upon the rather wide deviations that are shown in Table I in the initial concentrations of Elon and hydroquinone. These deviations, which do not materially affect the results, arose from the fact that, in order to expedite this somewhat lengthy work, the baths were made up slightly overstrength, with respect to the developing agents, to allow for some oxidation in mixing and for some dilution by water remaining in the systems from the washing after the previous run. After installing the bath in any one of the systems, it was circulated for a few minutes to ensure uniformity, the pH was checked, and then the first sample was drawn for analysis. The run commenced immediately, since most of them were of long duration, and were well advanced before the first analysis was complete. Thus there was no convenient opportunity to adjust each bath to exactly the same initial concentrations of Elon and hydroquinone before starting the run.

Whereas in the first runs the volume of developer used in the S-R Spray system was 6.3 litres, it was found convenient later to use 7 litres of developer.

Fig. 6. Change of composition of the positive developer at pH 10.5 in two runs in the S-R Spray system.

Fig. 7. Change of composition of the positive developer at pH 10.5 in the Air-bubbling system.
III. EXPERIMENTAL RESULTS

Table II shows the rates of loss of Elon and hydroquinone in grams per hour from each system after the figures have been adjusted to relate to standardised conditions of initial volume and developing agent concentration. The standard volumes are taken as 7.0 and 130 litres and the rates are adjusted (to 2.0g. Elon, 5.0g. H.Q. and 1.72g. Elon, 3.30g. H.Q.) on the assumption that they should be proportional to the initial concentration, the \( \text{pH} \) being constant.

Running Cost

In order to illustrate the relative cost in developing agents of running the various systems, without processing film, the values from Table II are shown pictorially in Fig. 8, 1.0g. of Elon being taken as equal in cost to 2.0g. of hydroquinone.

At \( \text{pH} \) 8.7, in the case of D76d, the loss of developing agent is negligible in the quiet circulation system. The cost of running the S-R Spray system is about 1/3 of that for the air-trapping and about 1/4 of that for the air-bubbling system. The cost of running the L-R Spray system is far greater than any of the others.

At \( \text{pH} \) 10.5 both the spray systems are more costly to run than the other systems. The quiet circulation system loses an insignificant quantity of developing agent. The air-trapping and air-bubbling systems cost about

<table>
<thead>
<tr>
<th>Developer</th>
<th>System</th>
<th>Vol. of Initial Conc. Rate of Oxidation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Elon</td>
</tr>
<tr>
<td>D76d</td>
<td>S-R Spray</td>
<td>7.2</td>
</tr>
<tr>
<td>L-R Spray</td>
<td>121</td>
<td>1.95</td>
</tr>
<tr>
<td>Quiet</td>
<td>130</td>
<td>2.01</td>
</tr>
<tr>
<td>Air-trapping</td>
<td>130</td>
<td>2.24</td>
</tr>
<tr>
<td>Air-bubbling</td>
<td>130</td>
<td>2.06</td>
</tr>
<tr>
<td>D76d</td>
<td>S-R Spray</td>
<td>7.2</td>
</tr>
<tr>
<td>L-R Spray</td>
<td>123</td>
<td>2.06</td>
</tr>
<tr>
<td>Quiet</td>
<td>130</td>
<td>2.06</td>
</tr>
<tr>
<td>Air-trapping</td>
<td>130</td>
<td>1.92</td>
</tr>
<tr>
<td>Air-bubbling</td>
<td>130</td>
<td>2.06</td>
</tr>
<tr>
<td>Positive</td>
<td>S-R Spray</td>
<td>7.2</td>
</tr>
<tr>
<td>Developer</td>
<td>L-R Spray</td>
<td>130</td>
</tr>
<tr>
<td>pH 10.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>S-R Spray</td>
<td>6.3</td>
</tr>
<tr>
<td>Developer</td>
<td>L-R Spray</td>
<td>118</td>
</tr>
<tr>
<td>pH 10.5</td>
<td>Quiet</td>
<td>130</td>
</tr>
<tr>
<td>Air-trapping</td>
<td>130</td>
<td>2.15</td>
</tr>
<tr>
<td>Air-bubbling</td>
<td>130</td>
<td>1.77</td>
</tr>
<tr>
<td>Positive</td>
<td>S-R Spray</td>
<td>6.3</td>
</tr>
<tr>
<td>Developer</td>
<td>L-R Spray</td>
<td>130</td>
</tr>
<tr>
<td>pH 10.5</td>
<td>Quiet</td>
<td>130</td>
</tr>
<tr>
<td>Air-trapping</td>
<td>130</td>
<td>1.79</td>
</tr>
</tbody>
</table>
2/3 as much as the S-R Spray system, and about 1/6 as much as the L-R Spray system.

At pH 10.0 the cost of running the two Spray systems is roughly 2/3 of the cost at pH 10.5.

The presence of colloidal silver made no significant difference to the cost of running, and in the diagram the best value for a particular system is probably the mean between the figures shown for the rates with and without the colloidal silver.

The minimum cost of running a bath depends upon the amount of silver that is to be reduced to form the image. R. M. Evans\(^8\) quotes figures for the silver content of 1,000ft. of motion picture positive image; an average (for fine-grain positive), taken on the basis of his estimates, would be 10g. The reduction of this quantity of silver would require about 5 grams of hydroquinone. Any of the systems studied in this work would process nearly 1,000ft. of motion picture positive film per hour, so the minimum average rate of loss of hydroquinone would be 5g. per hour. However, experience has shown that most systems require at least 5 litres of bromide-free replenisher per 1,000ft. in order to keep the soluble bromide concentration of the bath down to a reasonable level of about 2g. of KBr per litre.

### TABLE II
**Rates Corrected to Standard Volumes and Concentrations**

<table>
<thead>
<tr>
<th>Developer</th>
<th>System</th>
<th>Standard Volume (Litres)</th>
<th>Rate of Loss of Dev. agent from the system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Elon</td>
</tr>
<tr>
<td>D76d</td>
<td>S-R Spray</td>
<td>7.0</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>L-R Spray</td>
<td>130</td>
<td>14.3</td>
</tr>
<tr>
<td></td>
<td>Quiet</td>
<td>130</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Air-trapping</td>
<td>130</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td>Air-bubbling</td>
<td>130</td>
<td>4.3</td>
</tr>
<tr>
<td>D76d + Ag.</td>
<td>S-R Spray</td>
<td>7.0</td>
<td>.8</td>
</tr>
<tr>
<td></td>
<td>L-R Spray</td>
<td>130</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Quiet</td>
<td>130</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Air-trapping</td>
<td>130</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td>Air-bubbling</td>
<td>130</td>
<td>4.1</td>
</tr>
<tr>
<td>Positive</td>
<td>S-R Spray</td>
<td>7.0</td>
<td>.6</td>
</tr>
<tr>
<td>Developer</td>
<td>L-R Spray</td>
<td>130</td>
<td>1.8</td>
</tr>
<tr>
<td>pH 10.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>S-R Spray</td>
<td>7.0</td>
<td>.6</td>
</tr>
<tr>
<td>Developer</td>
<td>L-R Spray</td>
<td>130</td>
<td>1.3</td>
</tr>
<tr>
<td>pH 10.5</td>
<td>Quiet</td>
<td>130</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Air-trapping</td>
<td>130</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Air-bubbling</td>
<td>130</td>
<td>0</td>
</tr>
<tr>
<td>Positive</td>
<td>S-R Spray</td>
<td>7.0</td>
<td>.5</td>
</tr>
<tr>
<td>Developer</td>
<td>L-R Spray</td>
<td>130</td>
<td>—</td>
</tr>
<tr>
<td>pH 10.5</td>
<td>Quiet</td>
<td>130</td>
<td>0</td>
</tr>
<tr>
<td>+ Ag.</td>
<td>Air-bubbling</td>
<td>130</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard concentrations</th>
<th>(\text{Elon})</th>
<th>(\text{Hydroquinone})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative developer</td>
<td>2.00g</td>
<td>5.00g</td>
</tr>
<tr>
<td>Positive developer</td>
<td>1.72g</td>
<td>3.30g</td>
</tr>
</tbody>
</table>
This quantity of replenisher is sufficient to replace the carry-over of developer and to occasion some overflow, or "bleed."

Thus in practice, excluding loss by aerial oxidation, each of the five systems might be expected to cost (in grams H.Q.):

\[
\text{Concentration} \quad \text{Cost (in g. of H.Q.)}
\]

\[
\begin{align*}
\text{Elon} \quad &\quad 1.72 \quad 5 \times 2 \times 1.72 = 17.2 \text{g.} \\
\text{Hydroquinone} \quad &\quad 3.30 \quad 5 \times 3.30 = 16.5 \text{g.}
\end{align*}
\]

plus

\[
\text{Cost of developing the image} \quad = 5 \text{g.}
\]

\[
\text{TOTAL} \quad = 38.7 \text{g.}
\]

or in round numbers, about 40g. of developing agent in terms of hydroquinone equivalents, when processing positives. For negatives the figure would be somewhat greater:

\[
5 \left(2 \times 2.0 + 5.0\right) + 2.5 = 47.5
\]

or in round numbers, 50g. of developing agent in terms of hydroquinone equivalents if it is assumed that the average weight of image silver per 1,000ft. of negative film is half of that found on prints.

If these figures of 40 and 50g. hydroquinone equivalents per hour are compared with the autoxidation figures in Fig. 8, it will be seen that in most cases the appropriate autoxidation loss is less than half of them. Only the L-R Spray system shows autoxidation losses which are equal to, or greater than, the development loss figure.

**Effect of Colloidal Silver on Autoxidation Rates**

No definite change in the rate of oxidation of developing agents in the runs on the five systems could be associated with the addition of colloidal silver.

Volmer observed that the addition of colloidal silver accelerated the darkening of alkaline developing agent solutions on aeration. Weissberger and Thomas examined the effect of colloidal silver on the rate of absorption of oxygen by sulphite-free solutions of developing agents. Their experiments on Elon and hydroquinone, made at rather low \( \rho H \) levels (between \( \rho H 7 \)
Fig. 9. Course of autoxidation when 1 litre samples of the positive developer at pH 10.5 were aerated together, one containing colloidal silver.

Fig. 10. The course of the oxygen depletion in the spray cabinet. The broken lines refer to runs in which the air-return pipe was closed.

and 8), showed that colloidal silver slightly accelerated the absorption of oxygen by hydroquinone. Colloidal silver had almost no effect on the initial rate of absorption by Elon, but the partially oxidised Elon solution absorbed oxygen much more slowly in its presence. An experiment on p-aminophenol at pH 9.2, a level closer to those used in the present work, showed a marked increase in the initial autoxidation rate when colloidal silver was added, though, as in the case of Elon, the partially oxidised solution absorbed oxygen much more slowly in the presence of the silver.

To check the influence of colloidal silver on the rate of autoxidation of developers more precisely than it was possible to do on the pilot systems, experiments were made on 1 litre samples of the positive developer (pH 10.5). Compressed air, at a constant rate of flow, was moistened and then bubbled through two 1-litre cylinders arranged in tandem, separated by an empty flask which acted as a spray trap. One litre of developer was placed in each cylinder and 0.02g. of colloidal silver was added to one of them. To ensure uniformity of treatment, the air flow was set at a high rate so that its composition would be but little changed on emerging from the first developer cylinder, and the two cylinders were interchanged every 15 minutes. The cylinders were stood during the run in a tank of water at 20°C.

The results, in Fig. 9, show that colloidal silver had no effect on the rate of autoxidation of hydroquinone, or on the almost zero rate of autoxidation of the Elon while hydroquinone was present in appreciable quantity. However, when the hydroquinone was almost entirely oxidised, the rate of oxidation of the Elon was inhibited by the presence of colloidal silver. The results agree with those of Thomas and Weissberger.

Composition of Air in Spray Cabinet

Using D76d developer, tests were made to find whether reducing the oxygen content of the air in the cabinet would have a marked influence on the rate of autoxidation. On circulating D76d in the S-R Spray system, with the air return tube in position, it was found that the oxygen content of the air did not deviate much from that of normal air (top curve, Fig. 10). On
flushing the cabinet with cylinder nitrogen the oxygen content of the air was reduced from the normal 20% to 4% and maintained at this level by a nitrogen flow of 2 litres per minute. The rate of autoxidation of the developing agents was the same at this low oxygen level as it was in normal air. The reason for this emerged later, and will be described below.

In carrying out runs with the positive developers, the solutions were replenished, because of their much more rapid rate of autoxidation, in order to maintain them at substantially constant composition, especially in respect of developing agent concentration and pH. Fig. 10 shows the change in oxygen content of the air in 3-hour runs. When the air return tube was in position, the oxygen content fell towards equilibrium at about 15% at pH 10.0. At pH 10.5 the oxygen content reached 10%, and was still descending rapidly. When the air-return tube was closed the reduction in oxygen content was much less. At pH 10 the equilibrium value would appear to be at about 18%, and perhaps 17% at pH 10.5.

These values would be markedly affected in practice, if a compressed-air knife were used in the developing cabinet to prevent carry-over of developer. The imperfect correlation between the relative rates of developer oxidation and rates of oxygen depletion, probably due to changes in the degree of closure of the cabinet, makes it necessary to regard the curves in Fig. 10 as being of illustrative significance only.

Influence of Degree of Aeration on Rate of Autoxidation

On considering the fact that, in view of the high degree of aeration produced in the spray cabinet, some of the rates of loss of developing agents are lower than might be expected, and the fact that reducing the oxygen content of the air to 4% had no influence on the rate of autoxidation of D76d, it seemed likely that the degree of aeration involved was sufficient to supply the developer with oxygen faster than the oxygen could be removed by reaction with the reducing agents. Thus, under the conditions of spray processing, the rate-determining factor would no longer be the degree of exposure of the solution to air. This hypothesis was checked experimentally and was found to be in keeping with the experimental results.

50ml. of the developer under test was placed in a tube 52cm. long and of 2.0cm. internal diameter. Compressed air, metered by a Rotameter flowmeter, was moistened by bubbling it through a flask of water packed with marble chips, and was injected at the bottom of the oxidation tube through a 0.71mm. diameter jet. The pressure of the air at the flowmeter was measured by a mercury manometer. The oxidation tube was stood in a water jacket which was set at 20° before each run. Unless otherwise stated, each sample of developer was aerated for 30 mins. Only the hydroquinone content of the developer was determined, since the relation between the rates of Elon and hydroquinone oxidation, at a given pH, did not seem likely to vary with the general rate of oxidation.

The results for the negative and positive developers are shown in Fig. 11. They are not corrected for the change in pressure of the air (7.5cm. Hg. at 2,000cc. per min.) at the measuring point. At pH 8.7 the rate of autoxidation of hydroquinone reached a maximum at an air-flow rate of less than 250cc. per minute. Increasing the air flow up to 2,000cc. per minute produced no increase in the rate of loss of hydroquinone. The addition of tolusafranine (1 drop of a 1% solution in 50ml. of developer) was made in another run, the dye being used as a substitute for the sensitising dyes, likely to be picked up by a negative developer, which might affect the rate of oxidation. The results, shown by the broken line, indicated no significant change. Neither did the addition of one drop of a 1% copper (sulphate) solution affect the results.
At pH 10.0 (9.97 in Fig. 11) the positive developer showed what was substantially the same mode of behaviour, the practical limit to the rate of oxidation of hydroquinone being reached at an air flow of about 1,500cc. per minute, although very little further increase in autooxidation rate occurred beyond the 1,000cc. per minute stage. At pH 10.5 (10.45 in Fig. 11), however, the rate of autooxidation appeared to reach no limit within practical rates of air flow and increased steadily up to the maximum measurable air-flow rate of 2,000cc. per minute. On increasing the rate of air flow to the maximum that could be tolerated without blowing the developer out of the oxidation tube (about 5,000cc. per minute), it was found that the hydroquinone was completely oxidised in the 30 minutes run. The experiment was repeated, this time reducing the time of aeration to 10 minutes, and the results, after multiplying the actual hydroquinone losses by 3, are shown by the broken line and agree very well with the results obtained previously.

From these results it may be concluded that at pH levels up to 10.0 (at 20° C) the rate of oxidation of the developing agents will increase on increasing the degree of aeration until the concentration of oxygen in solution is sufficiently high to ensure that the autooxidation of the developing agents can take place at the maximum rate permissible under the given conditions of temperature, pH, and sulphite concentration. Increasing the degree of aeration beyond this point has no further influence on the autooxidation rate.

Factors influencing Autooxidation

Further study of this point might show that the factor setting the level of the maximum rate of autooxidation is the solubility of oxygen in the developer, the maximum being reached at the degree of aeration that is sufficient to maintain the developer saturated with oxygen. Some experiments were made in the hope that this point might readily be cleared up, but the results were ambiguous. Briefly, it was found that adding quantities of potassium chloride up to 200g. per litre to the following developer:

- Elon ............... 2.0g.
- Hydroquinone ...... 5.0
- Sodium sulphite, anhyd. ........ 20.0
- Borax ............... 2.0
- Water to .............. 1 litre

pH adjusted with sodium bisulphite to ........ 8.7

reduced the percentage of hydroquinone oxidised in a fifteen minute run from 5% to 4% (air flow of 1,250cc. per minute). This evidence tended to favour the oxygen saturation theory. On the other hand, additions of potassium chloride to the following developer:

- Elon ............... 1.72g.
- Hydroquinone ...... 3.3
- Sodium sulphite, anhyd. ........ 20.0
- Sodium carbonate .... 21.2
- Water to .............. 1 litre
- pH adjusted to ........ 10.0

were found to have no effect.
up to 100g. per litre seemed to cause an initial increase in the rate of autoxidation of the hydroquinone. Increasing the potassium chloride concentration up to 200g. per litre caused the autoxidation rate to fall back to its initial value. Similar results were obtained when potassium nitrate was used to load the developer. If it is assumed that loading the developer in this way does reduce the solubility of oxygen, then these results for the positive type developers favour the view that under these circumstances it is not the solubility of oxygen but some other factor that sets the maximum rate of autoxidation on increasing the degree of aeration. To deal with this matter satisfactorily it will be necessary to measure the solubility of oxygen in the developer solutions.

The fact that, at pH 10.5, no maximum rate of autoxidation was found on increasing the degree of aeration, and the fact that the slope of the curve is much steeper than it is at pH levels up to 10.0, indicate that the pH of the developer should not be raised above 10.0 in systems involving considerable aeration.

**Influence of Sulphite Concentration on Rate of Oxidation**

The effect of varying the sulphite concentration was studied in the case of the positive developer at pH 10. No special study of the negative developers was made in this connection because a very high sulphite concentration is maintained in them for reasons other than the prevention of autoxidation. However, it will be seen from the results in the previous section that, at an air-flow of 1,250cc. per minute, 5% of the hydroquinone was oxidised in 30 minutes when the sulphite concentration was 100g. per litre. The same percentage loss of hydroquinone occurred in 15 minutes when the sulphite concentration was 20g. per-litre. Thus the rate of oxidation was halved on increasing the sulphite concentration from 20 to 100g. per-litre.

To examine the effect of varying the sulphite concentration at pH 10.0, a range of solutions was prepared by mixing solutions A and B in varying proportions:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydroquinone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium sulphite, hydrated, A.R.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium carbonate, anhydrous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water to make</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>pH adjusted to</th>
<th>Ordinary electrode</th>
<th>10.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkali electrode</td>
<td>9.94</td>
<td>9.98</td>
</tr>
</tbody>
</table>

Because of the wide range in sodium ion concentration, it was deemed unsafe to level the pH values using the ordinary glass electrode. Solution B was brought to pH 10.00 using the ordinary glass electrode; the pH value of the solution as given by an ALKI (High pH) electrode was 9.98. The pH of solution A and the pH values of the intermediate solutions were then measured with the ALKI electrode. All the pH readings fell within the range 9.94-10.00, which may be taken to mean that the pH's of the intermediate solutions were probably intermediate between those of the extreme solutions.

50ml. samples of these solutions were aerated at 20° C., using an air-flow of 1,250cc. per minute. The percentage losses of hydroquinone are plotted in Fig. 12. They agree with those of James and Weissberger, who found that the initial rate of autoxidation of hydroquinone was inversely proportional to the sulphite concentration. The log/log plot, inset in figure
12, shows a reasonably linear relationship over a sulphite concentration range of 20:1.

The conclusion to be drawn from these results is that 40gm. per litre of sulphite is about the optimum concentration for positive developers in highly aerated systems. To halve this rate of loss of developing agents by autoxidation it would be necessary to raise the sulphite concentration to about 100g. per litre, a concentration that would probably cause considerable development fog and decrease the maximum gamma obtainable. Whether or not any economy can be effected by increasing the sulphite to this level depends, of course, upon the relative cost of sulphite and hydroquinone. The ratio between the prices of these products fluctuates from time to time and varies considerably from one country to another. To illustrate this problem, the case of the L-R Spray system will be considered, with the developer at pH 10.

Hydroquinone/Sulphite Rates

It is assumed, as before, that this machine will process 1,000ft. of film per hour. The autoxidation cost in terms of hydroquinonone is shown by Fig. 8 to be 41g. per hour. In this time, 5 litres of replenisher would be required and this replenisher would contain the extra 41g. of developing agent plus, among other things, the sulphite. Analysis showed that in the system in question, the loss of sulphite was roughly equal to the two moles per mole of hydroquinone that theory, based on the evidence of Tausch, would require. Thus the concentration of the sulphite in the developer, by influencing the rate of autoxidation of the developing agent, affects, in turn, its own rate of loss.

Using the linear relationship between the sulphite concentration and the rate of loss of developing agent given in Fig. 12, the total cost, in arbitrary units, of sulphite and developing agent per hour, is shown in Fig. 13 for four different hydroquinone/sulphite price ratios. The absolute levels of these curves will depend upon the absolute prices of these chemicals. It will be seen that increasing the sulphite concentration in the bath from 38g. to
100g. per litre, to halve the rate of loss of developing agents, would only save money if the hydroquinone/sulphite price ratio is 40 : 1 or more. At a ratio of 30 : 1 the most economical sulphite concentration would be reached at 80g. per litre. At a ratio of 20 : 1 the most economical sulphite concentration in the bath would be 60g. per litre. At a ratio of 10 : 1 the most economical concentration of sulphite would be 45g. per litre.

Although the numerical values in the above example were chosen to illustrate the case of the L-R Spray machine, the shape of the curves and the general conclusion is probably valid for any case involving the aerial oxidation of an Elon-hydroquinone developer at pH 10 and at 20°C. When the hydroquinone/Elon ratio is sufficiently high for the hydroquinone to be predominantly lost.

IV. CONCLUSION

Practical experience by the motion picture processing laboratories shows that a spray or jet-applied developer can be maintained over a considerable period by suitable replenishment. The present work indicates that the cost of the chemicals wasted by aerial oxidation depends upon the volume of developer used in the installation. If the minimum volume of developer is used, e.g., about 1/20th of the volume that would be required in a normal total immersion system of the same production capacity, then it is cheaper to use a spray system with a negative developer at pH 9. This arises from the fact, now presented, that the autoxidation rate in a developer of this type reaches a maximum value at a comparatively low degree of aeration. When the volume of the developer in a spray system is about 1/6 of the volume in an equivalent total immersion machine, having a fair degree of aeration, the two systems will cost about the same to replenish. At equal volumes, aerial oxidation in the spray system will waste 3 to 4 times as much developing agent and sulphite as in any normal system.

At the other end of the range, at pH 10.5, a spray developing machine will cost at least twice as much in developing agent and sulphite wastage as any normal machine, and, at equal volumes, it can cost over six times as much.

An interesting point emerging from this work is the very small, or negligible, rate of aerial oxidation in a system where, in spite of a vigorous stirring of the solution, no bubbles of air were carried below the surface.

The figures quoted so far relate to the relative wastages by aerial oxidation. Put in another way, it may be said that in the case of negative developers the use of a small-reservoir spray system may result in some saving of chemicals, while a large-reservoir spray would just about double the total cost of developing agent consumed. In the case of positive developers at pH 10 the use of a small-reservoir system might increase the total cost of developing agent consumption by about 10%, whereas the large-reservoir system might increase the cost by about 70%. Thus the possibility of making economical use of spray processing would seem to depend upon the extent to which the volume of circulating developer can be reduced without losing control over the rate of change of the composition of the bath. The theoretically ideal condition would be that in which the volume of circulating developer is reduced to zero, for in this case the "replenisher" itself (presumably of constant composition) is sprayed on to the film and then runs to waste. This advance awaits only a suitable application technique.

In the case of negative developers, there is little to be gained by using nitrogen or an air-tight system, unless the oxygen content of the air can be brought much lower than 4%. If nitrogen were used, the cost of doing this would be prohibitive. Although reducing the oxygen content of the air, especially in the case of positive developers, could be achieved by making the
cabinet air-tight, the trouble of doing this and the instability that would be introduced on opening the cabinet doors and admitting oxygen makes the device scarcely worth while.

Some advantage might be gained in a spray system using a large reservoir of developer, if the air-bubbles trapped in the returning developer could be separated before they are carried back into the bulk of the solution in the reservoir. This separation could, perhaps, be coupled with a removal of dissolved gelatin by allowing the foam to be removed from the system at this point.

The author would like to acknowledge the assistance rendered by Miss S. J. Moorcraft, and Messrs. A. F. C. Hirst and J. Smith in constructing the apparatus and carrying out the many hundreds of analyses involved.

REFERENCES


BOOK REVIEW

FROM SCRIPT TO SCREEN, by Bruce Woodhouse (Winchester Publications, Ltd., 12s. 6d.).

Mr. Woodhouse in this book takes the layman behind the scenes of film production and gives him some idea of the preparation necessary before, during, and after the actual shooting of a film. It is unfortunate that several errors have been allowed to remain, which, to say the least, are misleading. For example, the average technician will be surprised to learn that "the cutting copy is used to shoot a new negative for the finished film"—that "the recordist is in charge of the sound department"—that the only colour process is Technicolor—and that the purpose of the clappers is, apparently, only to annoy the artistes!

The author is, however, on firmer ground in the later chapters, particularly in matters of publicity, and gives undoubted value with a fine collection of photographs.

Geo. E. Burgess.

BRITISH SOCIETY OF CINEMATOGRAPHERS

The inaugural luncheon of the above Society was held on Saturday, January 29th, at the Orchard Hotel, Ruislip.

Mr. Freddy Young, F.B.K.S., President, said in a short speech that he was very happy to see the Society officially born and looked forward to the future with great interest; he felt that the Society filled a need that had been apparent for some years amongst kinematographers.

The inaugural officers are as follows: Mr. Freddy Young (President); Mr. Guy Green (Vice-President); Board of Governors: Mr. Desmond Dickinson, Mr. Jack Cardiff, Mr. Lovat Cave-Chinn, Mr. Derick Williams; Mr. Bert Easey (Hon. Secretary and Treasurer).

The rules provide that applications for membership shall be restricted to Directors of Photography who have been employed on "feature" films. The Board of Governors is, however, empowered to invite for membership persons closely allied with Motion Picture Photography.
FILMING THE OLYMPIC GAMES

Castleton Knight*

Summary of a paper read to a joint meeting of the British Kinematograph Society and the Association of Cine-Technicians on November 24, 1948.

Due to the success of other actualities filmed in colour, I suggested to Mr. Rank that a feature film of the 1948 Olympic Games in colour might be a good opportunity to make film history, especially if the film could be produced and released within a few weeks of the conclusion of the Games. Therefore, speed became the keynote of our production plan.

Willing co-operation was essential and we received it wholeheartedly from the A.C.T. The Technicolor Organisation also gave us full support, although it meant the disruption of the greater part of the latter's plant and plans.

Colour Provisions

We knew that few Technicolor cameras would be available, but I had seen experiments of the Technichrome process which can be used in the ordinary Mitchell type cameras, with only slight, but important, attachments and adjustments. It was decided to use this process for the filming of the actual Games, where the use of a large number of cameras was imperative.

Three different colour processes were used in the film. The Winter Games in Switzerland were filmed in Monopack, the opening and closing ceremonies at Wembley in three-strip Technicolor, and the Torch ceremony and the actual Games at Wembley, Henley, Herne Hill, Torquay, and Windsor, in Technichrome.

I think it is remarkable that not one of the many thousands of press notices even hinted that there had been more than one colour process used, although we used several devices in order that the public would not notice the changes. For instance, we cut from the wonderful scene at Wembley on the opening day, where the grass was a really beautiful shade of green, to a close-up of the discus-thrower, on whom attention was immediately concentrated, and not on the grass, which looked as though it had been burnt up during the previous day's heat wave.

Camera Equipment

Cameramen, cameras and equipment were the top priority need, so an Olympic Games Camera Committee was formed under the chairmanship of George Hill. At least fifteen Mitchell type cameras were required, and eventually it was arranged that we should have seven from Gainsborough, four from Denham, one from the Gate Studios, one from Ealing and three from Technicolor. In some cases the cameras were brand new, and this meant that there were certain teething troubles to overcome. Each camera had to be adjusted and attachments made. This work was carried out by the maintenance engineers of the supplying studios.

A large number of batteries was required and as a safeguard, almost every camera position in Wembley Stadium had three-phase alternating current laid on for the cameras and 110-volts supply for the slow-motion cameras. Thousands of yards of cable were laid under the running track to supply the towers and sunken pit positions in the centre of the arena. A complete charging plant was installed for re-charging the batteries, and for the mobile electric camera trolleys.

Some 40 bi-pack magazines, costing nearly £5,000, had to be made and tested. Sorbo-lined, waterproof and dustproof carrying cases had to be

*Gaumont-British Distributors, Ltd.
made to lower the magazines from heights to the ground, large changing bags were made for units on other locations, and handtrucks were necessary for the transport of heavy equipment around the arena.

Production Facilities
A special type of rostrum had to be designed for the centre of Wembley arena, 25ft. high, as light as possible, and so mobile that it could be moved by three people without disturbing the camera crew or camera. Smaller rostrums were designed, for each end of the arena, which could be moved by hand according to a timetable arranged with arena control. Altogether 130 camera stands and rostrums were erected in connection with the Games, and in most cases care had to be taken in placing them to avoid interfering with the view of the spectators. Use was also made of stands built for the Press.

Noiseless camera electric trucks were built to operate from the arena, but an aluminium bridge was insisted upon by the Arena Controller for use in crossing the running track. The running track was such a good one, however, that the trolley wheels did not harm it.

Filming the swimming and diving events in the Empire Pool was a problem, as the lighting had to comply with the regulations of the Sports Associations. Direction and volume of lighting had to be kept down, there could be no reflection on the water, and it had in no way to worry or confuse the competitors. For colour films reliance had to be placed on daylight, and in order to get as much light as possible into the Pool, a gang of men spent ten days scraping the paint off the huge glass roof.

Working Centre
Our headquarters were established in the grounds of the dilapidated Civic Hall at Wembley. Several air-raid shelters were adapted into loading
rooms and storage rooms for film and camera equipment. The ceilings, walls and floors of the shelters were treated with a dust-proof solution, and in the loading rooms double light-lock doors were fitted with special ventilation and lighting arrangements. The colour equipment was felt to be safer in the shelters in the event of fire in the Civic Hall.

A loud-speaker system linked up the offices, workshops and canteen, which were established in the Hall, and three television sets kept the staff au fait with the progress of the games. Besides a fleet of cars, a Corgi motor-cycle was used for the delivery of magazines around the arena, and the various departments coped with the daily supply of film stock (which had to be kept at the correct temperature), weather reports, programmes and report sheets.

**Shooting Script**

A 70-page shooting script for the black-and-white newsreels and the colour film was completed a week before the Games started and given to every cameraman. It included details of every event, its venue, time, camera positions, units, names of camera personnel engaged, lenses to be used, coverage required from each camera, the continuity of filming in correct sequence, and the main requirements of coverage.

Each day the camera crews received details of their assignment on forms compiled from the script, and altered in accordance with any change of circumstance. Special camera crew log sheets, giving six duplicate copies, supplied technical information required by each department.

A “Film Control” centre was established under the Royal Box on the edge of the running track, linked by special telephone to each camera position. Instructions could be given for particular shots of any event, and any sort of breakdown at any position was immediately known and another camera assigned to cover the shot.

Cameramen and assistants were assembled at Wembley ten days before the opening of the Games for tests of cameras, camera lenses and other equipment.

**Editing and Sound**

Over 350,000ft. of film was exposed, and the cutter, Roy Drew, used a tremendous amount of imagination in selecting material from the black-and-white prints, as there was no time for colour pilots. Cutting started the day after the Games began, and between ten and twenty thousand feet had to be dealt with daily. In less than a month 20,000ft. had been finally edited.

The film was eventually commentated in a number of languages, but priority was given to the British, American and Dutch versions. Commentary on these three versions started simultaneously a day after the Games started, and it was difficult to obtain the services of the commentators, who were acting for their own countries' radio stations, at the same time. Only by working each Sunday and many nights, was it completed in time.

Effects were recorded by studio type sound recording equipment built in a control room at the back of the scoreboard at Wembley. A wild track, made by placing microphones at various points around the arena, was carefully used in the re-recording. There were only eight days in which to do this work by the time the re-recording stage was reached, and during that time the dubbing crews, projectionists and cutting room staff worked continuously with very few hours sleep.

The music was composed and recorded before the Games started, and had either to be adapted to the film, or the picture cut to suit the music.

*The hammer throwing and marathon race sequences were projected to illustrate the use of music in these ways.*
DISCUSSION

Mr. George Gunn, Technicolor; Mr. George Hill, in charge Camera Dept.; Mr. Roy Drew, editor; Mr. Bishop, Production Dept.; and Mr. Ron Abbott, Dubbing Recordist, joined Mr. Castleton Knight in answering questions.

Mr. R. H. Cricks: Is it possible that Technichrome will produce better green later?

Mr. Geo. Gunn: No, frankly, I do not think so. I think that is just about what we can expect from a two-colour process.

A Visitor: Did Technicolor alter the camera gates for Technichrome or did you?

Mr. Geo. Hill: The alteration of the gate is made by installing another pressure pad. These pads were made by Newall for Technicolor, as were the magazines. The actual alteration referred to and fitting damping rollers, suitable belts, etc., special motors to contend with load variation, were all done centrally at the Shepherd's Bush Studios camera shop.

Mr. Yates: The Monopack scenes were of excellent quality. Was the processing done here or in Hollywood?

Mr. Geo. Gunn: Monopack film that was actually exposed in the camera was developed in Hollywood and returned to us. We made the necessary separation of dupe negatives and finally the colour prints.

Mr. Leon Isaacs: Can you tell me relative emulsion speed between the three emulsions?

Mr. Geo. Gunn: In very general terms, yes. Monopack and Technichrome are about equal to each other and they are probably twice as fast as three-strip.

Mr. A. W. Watkins: What editorial difficulties were encountered?

Mr. Roy Drew: The only way I could tackle this job was to deal with the material at once, day by day. Immediately footage arrived it was viewed. Taking say 1,000 feet, a decision on a rough cut would be made; then came whittling down to a presentable shape.

Mr. Mercer: Did Mr. Drew find any restrictions in his work due to the use of colour?

Mr. Roy Drew: No, I would not say that. Cutting on Technicolor's black-and-white pilot copy gave a very good indication.

BRITISH STANDARDS

B.S. 1492: 1948.—35mm. Cinematograph Release Prints. This specification details requirements for the 2,000ft. reel, covering leaders, cues, and trailers; it also makes recommendations on the protection of prints and the avoidance of emulsion pick-up.

The specification is substantially in accordance with American standards, except that, at the suggestion of the B.K.S. Sub-standard Film Division, an additional sound synchronising mark is provided for use when reduction prints are made to 16mm.; this additional mark takes the form of a circle imposed upon a transverse line, 26 frames from the picture start mark. The maximum length of reel is fixed at 2,050ft.

It is recommended that a protective band (e.g., of tough paper) be provided around every reel, and where transit spools are not provided, that a hardwood core shall be used.

Canadian Standards

The Canadian Standards Association, in their current Quarterly Bulletin, announce the unification of screw thread standards between themselves, the B.S.I., and the Inter-departmental Screw Thread Committee of the U.S.A. Replies to a questionnaire on a proposed standard for 16 mm. sound projectors were considered by a sub-committee of the C.S.A. on 16 mm. Projection Equipment.
PRODUCING INDUSTRIAL NEWSREELS.

S. Boyle, F.R.P.S.,* and N. Beese*

Summary of a paper read by Mr. J. Sheppard to the B.K.S. Sub-Standard Film Division on November 10, 1948.

The films of the "Just Billingham" series represent an attempt to use the motion picture camera and the microphone as the means of conveying to thousands of employees in a large, heavy-chemical factory, information on a wide variety of subjects affecting their welfare and interests in their daily job of work.

During the past two-and-a-half years, the sound-film has been one of the media by means of which this problem of creating a well-informed factory population has been attacked, and, on the basis of this experience, there appears a definite place for the use of film in organisations of a size and pattern comparable to Billingham.

"Just Billingham"

Originally conceived as the factory equivalent of the commercial newsreel of the kinemas, the early films succeeded in achieving topicality on a number of occasions. However, the emphasis soon changed to subjects of a "cine-magazine" type, although the treatment always remained on a newsreel basis.

A serial story of the organisation and activities of the Billingham factory was begun, and the main processes were described in subsequent productions.

Production Principles

The people responsible for the production of these films believe that they have established certain principles in the use of sound-film in an industrial setting, which may be of interest to others. They are:—

1. Entertainment value is the priority requirement of this type of film. Documentary subjects should be treated to create interest in the personal human element, the story, dramatic aspects of daily jobs, and be built up, where possible, to a climax.

2. Integration of picture and commentary is essential in the interests of intelligibility and effective presentation.

3. A simplification of treatment is preferable to running the risk of talking beyond the scope of the audience.

4. Topicality should be introduced wherever possible.

5. While factory audiences are quick to detect insincerity, or information not in their own and the company's interests, they accept readily factual statements, the objective presentation of a problem, and like to feel that they belong to a great and important organisation.

Films of these types should be made by people who know the organisation concerned as employees. Given the confidence of the management and freedom from interference in subject treatment, an internal team can work on a more modest budget than would be possible for outsiders.

Technical Requirements

The camera used in making the "Just Billingham" films was a Kodak "Special" with 200ft. magazine and five lenses. As 16mm. film could not be obtained in 200ft. lengths, the large magazine was a disadvantage in use. When mobility was necessary a light Vinten stand was used, but where possible, a heavy metal ex-R.A.F. tripod was preferred. Both had friction heads.

* I.C.I., Billingham.
An animating bench consisted of a vertical rod carrying a cradle for the camera, driven by an electric motor at a non-variable speed. Apparent variations were achieved by adjustment of film speed. The easel could move up and down and across the frame by means of screwed rods, and celluloid, 5/1000in. thick, was used for the drawings. Eight Photoflood lamps illuminated the easel and a "Variac" auto-transformer enabled fades to be made when the shutter fades could not be used. A series-parallel switch allowed the lamps to be dimmed when changing celluloids. The general lighting equipment consisted of ten 2KW and two 5KW spot-lights, and two 2KW broadsides, with two six-way spiders wired for series operation of the 115-volt lamps.

Black-and-white reversal film was used exclusively and processed by the makers. A cutting copy was not used, in order to effect reduction in the time needed for editing. This meant cutting points had to be selected irrevocably.

Lack of "optical" facilities in 16mm. work caused profound dissatisfaction; in most other respects 16mm. could no longer be regarded as "sub-standard," as it was capable of serious application.

Commentaries

Commentaries were generally made by direct recording, but disc recording with transfer to film had been used. Satisfactory synchronisation could be obtained with only clockwork camera drive by frequent angle changes. The studio was equipped with a three-channel disc play-back system, feeding into the sound-film recorder. The complete sound-track was recorded to the picture and the commentary, and other elements of the track mixed in synchronism with picture by detailed rehearsal during the recording session. Subsequent careful adjustment of sound and picture perfected the final married print.

Prints were rather light in general density to overcome some of the handicaps of projection in canteens and rooms where black-out facilities were limited. Even under ideal projection conditions, however, most 16mm. projectors provided insufficient light output for a good quality reversal print on ten-foot screens.

**A.F.I.T.E.C. HONOURS PIONEERS**

Pioneers of the kinematograph trade were made Honorary Members of the Association Française des Ingénieurs et Techniciens du Cinéma at a meeting last November. The names announced by the President, M. L. Didiére, were: MM. Louis Lumière, Léon Gaumont, Charles Jourjon Clément Lair, Georges Laudet, Lucien Bull, André Debrè, François Lallement, Léopold Lobel, Georges Mareschal, Jacques Marette, J. Comandon, Félix Mesguish, Charles Pathé, and Georges Zelger.

**PHYSICAL SOCIETY EXHIBITION**

The 33rd Annual Exhibition of the Society is to be held at the Imperial College of Science, South Kensington, in April. Dates and times of admission are:

- Tuesday, April 5th, 2—9
- Thursday, April 7th, 10—1 and 2—7
- Wednesday, April 6th, 10—1 and 2—9.
- Friday, April 8th, 10—1 and 2—7.

A limited number of tickets for admission are available from the B.K.S. In applying, please state day and time it is wished to attend.

**THE LIBRARY**

Members who have attended recent meetings of the Society in London will have seen the Library Appeal Film, and, where possible, the film will be shown at provincial branch meetings. The Chairman of the Library Committee makes an earnest appeal for members to support the Library, not only with contributions of books, but by using the many facilities which it offers. A suggestion box is available through which members may express their own views on the running of the Library. Every member should have received the recently published Library Catalogue, listing books available for loan and periodicals for reference. R. B. H.
A NEW FILM STUDIO.
The new studios of the Soc. Fr. de Studios Ciné at Joinville de Pont are described by the
architects. The studios are specially designed for work in colour, and the authors describe
the design features intended to ensure comfort and efficiency.

M. V. H.

INCREASING THE EFFECTIVENESS OF MOTION PICTURE PRESENTATION.
The author considers increasing the effectiveness of film presentation by an enlarged screen and the use of a vignette to diminish screen illumination in degrees from the acting area to the screen perimeter; masking is unnecessary, the screen surround and wall surfaces being arranged to merge into the picture.

H. L.

THE FRACTURE OF CONDENSER LENSES AND MIRRORS.
Glass being a poor conductor of heat, large temperature differences are easily set up in it. If the expansion exceeds the limits of elastic strength fracture occurs. Cures are to arrange for even heating, if necessary by using greenish glass, to use glasses of low expansion or high strength, and to prevent marginal cooling by a heat resistant collar.

M. V. H.

ADVANCEMENT OF MOTION PICTURE THEATRE DESIGN.
The author surveys the progress made in kinema design in the past 20 years, and refers in detail to the importance of paying due attention to sight lines, seating positions and floor levels in order to secure optimum conditions of viewing.

Means of minimising distraction from the screen by suitable decoration and maintained lighting layout are considered and suggestions for future progress made.

H. L.

GENERAL THEATRE CONSTRUCTION.
The author deals with the essentials of kinema construction and design to provide satisfactory conditions of comfort, vision and sound and makes suggestions of material suitable for the structure and decoration of different grades of kinemas.

H. L.

INFLUENCE OF WEST COAST DESIGNERS ON THE MODERN THEATRE.
The film studio’s influence on the architecture of the modern West Coast designed kinema is considered, and the features of some are described.

H. L.

FOREIGN THEATRE OPERATION.
The author describes the design and amenities of some Australian theatres, and refers briefly to kinema construction and design in Egypt and Latin America.

H. L.

DYNAMIC LUMINOUS COLOR FOR FILM PRESENTATION.
The paper deals with colour mixing lighting controllers and refers in detail to dynamic coloured lighting used in auditoria, and as a surround to the screen for the enhancement of picture presentation.

H. L.

THREE-DIMENSIONAL SCREENS FOR TELEVISION AND THE KINEMA.
A screen for the presentation of parallax stereograms consists of a polished metal sheet engraved or embossed with sets of concentric semi-circles, one such set of semi-circles for each file of observers. The grooves are considered as equivalent to a number of concave mirrors, and function in a similar manner.

R. H. C.
THE COUNCIL

Meeting of February 2, 1949.

Present: Messrs. A. W. Watkins (Vice-President), L. Knopp (Deputy Vice-President), L. D. Wratten (Past President), E. Oram (Hon. Secretary), P. H. Bastie (Hon. Treasurer), R. B. Hartley, R. E. Pulman, H. S. Hind, G. E. Burgess, B. Honri, and W. L. Bevir (Secretary).

Economy.—Messrs. Knopp and Hartley were thanked for their helpful suggestions in cutting down the expense of office work.

Library Film.—Mr. Rex Hartley reported that through the generosity of Messrs. M.G.M. at Elstree, there was no cost to the Society for the production of the sound version of the Library Film.

Film Mutilation Brochure.—Mr. Wratten reported that a final meeting of the committee would be held next week when the three Brochures would be presented for approval.

1951 Exhibition.—It was decided that Mr. Knopp should pursue the matter of the Society taking part in the Exhibition.

EXECUTIVE COMMITTEE

Meeting of February 2, 1949.

Present: Messrs. L. Knopp (Deputy Vice-President), P. H. Bastie (Hon. Treasurer), E. Oram (Hon. Secretary), W. L. Bevir (Secretary), and Miss S. M. Barlow (Assistant Secretary).

Elections.—The following were elected:—

James Henry Freedy (Member), Ilford, Ltd.
Patrick William Davis (Associate), Leicester Square Theatre.
Manuel Henry Fortun (Associate), Victoria Station News Theatre.
Derry A. Leather (Student), Pinewood Studios.
Samuel Alfred Shawcroft (Member), A.B.P.C., Ltd., Elstree.
David Leonard Deutsch (Student), Gainsborough Pictures, Ltd.
Jack Chambers (Member) Nucleus Film Unit.
Charles Harold Close (Associate), Surveyor.
William Algernon Reed (Associate), Classic Cinema, Chelsea.
Arthur Alfred Reed (Associate), Radion Cinema, Laindon.
Arthur Frederick James Frost (Associate), Old Kent Road Picture House.
Cecil Norman Taylor (Associate), Cinetechnic, Ltd.
Harry Walsh (Associate), Greengates Cinema, Nt. Bradford.
Albert Leonard Truman (Associate), Troughton & Young, Ltd.
T. A. Svendsen (Hon. Member), U.N.E.S.C.O. Scholarship Holder.

Hon. Membership.—In view of his past services to the Society, Mr. R. T. Dealey was elected an Hon. Member.

Transfers.—From Studentship to Associateship: John Hadland, Ronald Nuttall.

Resignations.—The following resignations were accepted with regret:—

Eric Humphries (Associate).
Philip Garnett (Associate).
Sydney Wilson (Member).

Death.—The death of Mr. Frank Robert Kennedy was noted with regret.

THEATRE DIVISION COMMITTEE

Meeting of February 24, 1949

The Ross-R.C.A. Demonstration, the third in the series of Modern Kinema Equipment lectures, was postponed and in its place "Films Not Generally Seen" were to be shown on March 20th. Four Members and eleven Associates were enrolled in the Division.

FILM PRODUCTION DIVISION COMMITTEE

Meeting of February 23, 1949

In thanking Mr. W. Norris, Studio Manager of Nettlefolds Studios, for the poster display case which he had made for B.K.S. publicity, it was decided to request 24 copies of the blue print for distribution to other studio representatives. Consideration of Draft B.S. "Photometric Calibration of Lenses" was deferred for a subsequent meeting. Mr. Young raised the matter of the proportion of camera aperture masked off in projection. Twelve Members, six Associates, and two Students were enrolled in the Division.
PERSONAL NEWS of MEMBERS

Members are urged to keep their fellow members conversant with their activities through the medium of British Kinematography.

J. P. J. CHAPMAN is producing a 16mm, astronomical film in co-operation with H. Percy Wilkins, F.R.A.S., and the Mount Wilson Observatory of California.

W. F. GARLING has been elected a director of R.C.A Photophone, Ltd.

KEN MATTHEWS thanks all those who have enquired after him in his recent illness and states that he is very near final recovery.

FRANK ROBERT KENNEDY

Mr. Kennedy had been with Associated British Cinemas, Ltd., for the past 16 years. He served as an engineer mainly in the London area until he left the Regal Cinema, Staines, three and a half years ago, to become area engineer at Cardiff. He was 41 years of age and leaves a widow and two children.

Mr. Fielding, M.B.K.S., Chief Engineer of A.B.C., pays tribute to a "loyal servant of the Company, an efficient worker, a good colleague and friend, and a charming personality."

PERSONAL ANNOUNCEMENTS

Nationally known TELEVISION LABORATORIES announce a vacancy for experienced CINE-TECHNICIAN to work on the development of special apparatus. Applicant must be conversant with film processing technique, maintenance and repair of picture and sound cameras, projectors, etc. A good working knowledge of photographic optics and electronics is essential, and familiarity with the fundamentals of television would be highly desirable. This post is concerned entirely with experimental work in a new field, and only those with an interest in the design of new equipment, rather than routine maintenance, need apply. The prospects of advancement for the right man are considerable. Write stating qualifications and salary required to Box 23, B.K.S., 53, NEW OXFORD STREET, W.C.1.

WANTED. Back copies of the Journal of the B.K.S. as follows:—Vol. 1 No. 2, Vol. 2 No. 1, Vol. 3 Nos. 1 and 3. Anyone willing to dispose of copies as above, please write to: PURCHASING DEPT., D. & P. STUDIOS, LTD., Denham, Uxbridge, Middlesex.

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LECTURE PROGRAMME
April, 1949

Meetings to be held at the Gaumont-British Theatre, Film House, Wardour Street, London, W.1, at 7.15 p.m. (Sundays 11 a.m.).

T—Theatre Division.  S—Sub-Standard Film Division.  F—Film Production Division.

Apr. 6 “MAGNETIC SOUND RECORDING”—A symposium by E. W. BERTH-JONES, B.Sc., NORMAN LEEVERS, B.Sc., A.C.G.I., F.B.K.S., and A. TUTCHINGS.

S  Apr. 13 Annual General Meeting (6.30 p.m.). Review of New Apparatus. (Joint meeting with the Royal Photographic Society and the Scientific Film Association.)


F  Apr. 27 Annual General Meeting (7.15 p.m.).

MANCHESTER SECTION
Meetings to be held at the Lecture Theatre of the Manchester Geographical Society, 14 St. Mary’s Gate, Parsonage, Manchester, commencing at 10.30 a.m.

Apr. 5 “Glass in Projection Systems,” by Dr. WILLOTTS.

NEWCASTLE-ON-TYNE SECTION
Meeting to be held at the Lecture Theatre, Newe House, Pilgrim Street, Newcastle-on-Tyne, I, commencing at 10.30 a.m.

Apr. 5 “Reflectors, Types and their Uses,” by F. F. TRELIVING.

LEEDS SECTION
Meeting to be held at the Y.W.C.A., Cookridge Street, Leeds I, commencing at 10.30 a.m.

Apr. 2 “Film Projectors for Television,” by A. BUCKLEY.

BRITISH FILM ACADEMY
Meeting open to all technicians to be held at the Hammer Theatre, Wardour Street, W.1, at 8.30 p.m.

Apr. 12 “Editing—A lost art?” Principal Speakers: REGINALD BECK and ERNEST LINDGREN. Chairman: THOROLD DICKINSON.

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- Ni-Hard versus Abrasion: 108

**KINEMA INDUSTRY**
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**MINING AND PETROLEUM INDUSTRIES**
- Ni-Hard versus Abrasion: 108
- Metallurgical Methods for Combating Corrosion in the Petroleum Industry: 207

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- R.M.S. Queen Elizabeth — Role of Nickel-Containing Materials: 134

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TRANSMISSION CALIBRATION OF PHOTOGRAPHIC LENSES

A. Warmisham, M.Sc., M.B.K.S.*

Read to a Joint Meeting of the British Kinematograph Society and Royal Photographic Society on January 5, 1949.

THE twenty-year period just completed has seen the mature development of two revolutionary processes. First it has seen the magnificent achievement of Technicolor, which has revolutionised the motion picture industry. Second it has seen the equally revolutionary process of sound-on-film. These two processes have in common the factor that they both demand more exact control of exposure and processing than was usual in practice at the beginning of the period. Knowledge of the theory of the photographic process has been extended enormously, and to a large extent the previous empirical controls have been displaced by more exact controls based on the new knowledge.

I. NEED FOR UNIFORMITY OF LENS CALIBRATION

Within a few years of these two major events there has been a general development in the optical equipment. Primarily this development is not concerned with lens definition and optical correction per se, but rather it is a technical operation to digest a series of empirical developments which will ultimately improve the uniformity of the product. During the course of the operation it has been demonstrated that lenses can be made more uniform in transmission than the current product, and at no serious increase in cost. Cameramen will find that with the new system the probability of achieving the best results is increased, because the improved uniformity in transmission will increase the exactness of control of exposure. It is now proposed that this improved product shall become the standard equipment of the industry.

The immediate purpose of the proposal is not to improve the performance of the present objectives, but rather to produce them to a higher standard of uniformity of transmission. That in itself is certainly worthwhile, but I foresee that the new technique will provoke further new developments, and I propose to use my present opportunity to bring to your notice a short review of the difficult questions which I believe we must face.

*Taylor, Taylor & Hobson, Ltd., Leicester.
The conditions which led to the demand for the present operation are the inevitable results of the gradual development in optical technique. In the early thirties the optical equipment in the majority of studios consisted of two main types of objectives: the old f/3.5 lens, and the newer f/2 lens. These days were before reflection reduction coating was in use, and the f/3.5 lens had a transmission of about 70%, the f/2 lens about 60%.

Lens Blooming
In the later thirties the first attempts were made to apply reflection reduction coatings. The optical manufacturers, ourselves included, adopted a conservative view, and decided not to introduce at that time an obviously immature process. Outsiders with nothing to lose stepped in, and many small shops in Hollywood and elsewhere undertook to apply the coatings.

The early results were not satisfactory. Especially unsatisfactory were most of the attempts to coat old objectives. These early experiments were a natural, and indeed, a necessary step in evolution, and we know now the reasons for their relative failure. The rather drastic cleaning operations which are necessary to ensure a hard and efficient coat on the glass surfaces are altogether impossible with the lens components already mounted in their cells. Also the early vacuum apparatus was not comparable in efficiency with the present equipment. On the whole it may be fairly concluded that the early experiments on coating resulted in increasing the overall spread of transmission factors.

Variations in Lens Transmission
Lens users became quite vocal on the subject. During the period 1941—1947 there were nine papers published in the *Journal of the S.M.P.E.* describing methods and means for calibrating lens transmission. It was felt both widely and strongly that in order to provide the increased accurate control of exposure required not only in colour photography but also in many applications of black-and-white, some measure of standardisation was necessary. The demand crystallised that we should eliminate the variations in the transmission of all objectives of nominally similar aperture. This means that when a photographer sets his iris diaphragm to t/2.8 on any lens of any focal length, he must have the same exposure on his film.

In order to determine the best means to ensure this result the S.M.P.E. Committee on Standards appointed, early in 1947, a Sub-Committee on Lens Transmission Calibration, under the Chairmanship of Dr. Kingslake, formerly of South Kensington, now of Rochester.

Implications of Uniformity
In the optical industry we were well aware of the problem and of all that it implied. In order to solve the problem we had to establish under the difficult conditions of the post-war régime a number of new techniques.

The first in importance was to mature the present coating processes. It is plain that to meet the requirements of any method of standardisation of transmission we had to produce not merely an efficient coating, but in addition, the coating must be hard enough to withstand cleaning and still remain efficient. After that problem was solved we had to install the plant necessary to carry out the operation on a sufficiently large scale. It is probably not realised outside the optical industry how formidable has been the development work required to evolve the current technique of hard coating processes.

The next problem was to design and build the apparatus necessary to make the measurements of transmission. On account of the import licence difficulty we decided that we had to restrict our apparatus to components then readily available in this country, and therefore this development had to start *de novo*.
S.M.P.E. Report

Dr. Kingslake’s Sub-Committee issued its final report on April 6th, 1948, after eighteen months’ work. The report is a masterpiece, and it will be of great and lasting service both to the optical industry and to the studios. Precise definitions are given of all the physical quantities involved, and the necessary engraving on the lens is laid down. Two somewhat different methods suitable for making transmission measurements are described, but neither is recommended to the exclusion of the other. There is also no recommendation about the instrument to be used. This is exactly as it should be. The system can be of general use, only if it is based on a formula which can be interpreted by technicians, either lens manufacturers or lens users, in exactly the same way. The standard proposed in the report can be interpreted in one way only.

Other necessary features in the system are that it must permit the use by cameramen of existing exposure meters or exposure data, and again, it must permit the use of depth-of-field tables or data. Again, it is obviously desirable that the t-marking on the iris scale should take complete account of any random variations of efficiency of the coatings and of the operative area of the iris aperture, and of all variations in the equivalent focal lengths of the objectives.

The S.M.P.E. Sub-Committee had in mind mainly the studio 35 mm. film lenses, and it was decided that for the present, lens speeds for distant objects only should be considered and that the corresponding problem for objectives intended for use at short conjugates should be postponed for a later discussion. With this simplifying limitation, the definition of the term “t-number” was agreed as the f-number of an open circular hole which would give the same central image illumination as the actual objective at the specified stop opening, assuming a very distant object.

To realise the meaning of the definition, consider an objective of focal length $f$ and of aperture $t/2$ placed at one entrance port of an integrating sphere, and at a second entrance port a circular aperture of diameter one-half of $f$; it is required that from the same distant source each of these ports shall receive the same flux of light. An alternative statement of this definition of t-number is that it is the f-number of a fictitious lens having 100% transmission and which gives the same central image illumination for a distant object.

II. THEORETICAL BASIS OF TRANSMISSION CALIBRATION

The theoretical basis of the transmission calibration system may be summarised as follows:

$$E = \frac{\pi y^2}{f^2} \frac{TB}{(f \text{ number})^2} = \frac{\pi B}{(t \text{ number})^2}$$

$$t \text{ number} = \sqrt{\text{transmittance}}$$

$E$ Illumination of image—Lumens per sq. mm.
$B$ Brightness of Object—Candles per sq. mm.
$y$ Radius of Effective Front Aperture of Objective.
$T$ Transmittance Ratio:

Light transmitted by objective
Light transmitted by hole diameter of $2y$

Measurement of transmittance over a large number of coated lenses of recent production shows an average value of about 87% for objectives with four components. In such lenses, therefore, $t/2$ would be $f/1.88$. 
The report lays down the sequence of whole number stops shown in Fig. 1. The interval is the square root of 2 rounded off to the second decimal place.

The report recommends that f-numbers be omitted from the engraving on lenses calibrated photometrically, and it is defined that in setting the f-stop the diaphragm ring shall always be turned in the closing direction and not in the opening direction. Regarding the accuracy of marking the f-stop scale, since one-third of a stop represents a variation in exposure of 26%, manufacturers should mark the f-stops within an accuracy of 1/10 stop, corresponding to about 7% in illumination.

Corner-to-Centre Ratio

In the definition of f-number the words were used: "f-number is the f-number of an open circular hole giving the same central image illumination, assuming a distant object." The report defines the term "centre of the field" explicitly for the purpose of f-stop measurement, to mean a circle not more than 3 mm. diameter for objectives for the 35 mm. film.

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<th>2.00</th>
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<td>14.2</td>
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<td>28</td>
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</table>

\[
\text{T STOP INTERVAL RATIO} = \sqrt{2} \\
\text{TRANSMISSION RATIO} = 2 \\
\text{LOG TRANSMISSION RATIO} = 0.3 \\
\text{SUB STOP TRANSMISSION RATIO} = \frac{3}{\sqrt{2}} = 1.26 \\
\text{LOG SUB STOP TRANSMISSION RATIO} = 1
\]

Fig. 1. Sequence of whole number stops.

Dr. Kingslake's Committee must be congratulated on this particular decision. In effect it is a decision not to include the effects of lens vignetting in the f-stop calibration. The Committee recommends that vignetting should be measured separately as the ratio of corner-to-centre illumination. The measurement is to be made first with the 3 mm. hole central and then with the hole moved so that its rim is touching the top and side edges of the camera gate. With the transmission measuring equipment we have now provided, the corner-to-centre ratio can be measured quite accurately.

Transmission Measurement

Further definitions were proposed by the Committee. First, the light used in measuring the transmission should be white, and the sensitivity of the photo-electric receiver should approximate to that of the ordinary panchromatic emulsion. It is considered that neither of these factors is very critical and that any closer specification is unnecessary. Secondly, the incident light should fill an angular field not exceeding that admitted by the ordinary matte box of a motion picture camera. Thirdly, measurements
are to be made with the light going through the lens in the same direction as in normal photographic use. These recommendations are made to ensure that the calibration measurements are to be carried out under conditions as closely similar as possible to user conditions.

One thing further: the Committee mentioned that the system adopted should permit the continued use by cameramen of their existing depth-of-field data. Because we cannot at the present make coatings to give an average transmission greater than 85%-87%, the f-number will be on the average some 7% smaller than the corresponding f-number, according to the system proposed. No cameraman would consider that such a difference would be of any real significance in depth calculations.

III. METHODS OF TRANSMISSION CALIBRATION

We have now to turn to the methods and apparatus to be used for f-scale calibration. Two main types of apparatus have been discussed, namely, the extended source type and the collimated source type. Our own experience is limited to the collimated source instrument. The S.M.P.E. Committee report contains a description of the extended source method in their Appendix I and detailed accounts have been published by Sachtleben\(^1\) and by Gardner\(^2\).

The collimated source type of instrument is the subject of Appendix II of the report, and I shall confine myself to further consideration of this type only. Dr. Daily of Paramount published one of the outstanding contributions to the subject\(^3\), in which he described a collimated source type of instrument. Fig. 2 is largely self-explanatory.

Collimation Type Instrument

On the left is a projection lamp A which is focused by the condenser lens on a diffusion disc in the plane of the stop. Close behind the diffusion disc is a chopping wheel. The collimating lens C is focused on the diffusion disc and the parallel beam of light emerging from the collimator is thrown towards the aperture D in the integrating sphere. In the path of the collimated beam can be placed either a standard hole of known diameter or the lens to be calibrated.

It is necessary in this apparatus to have a uniform flux of light per unit area of the collimated beam through the fixed stop, and an operator can make a routine check by moving a small hole across a diameter of the beam in the plane of the fixed stop: if the output is constant for all positions of the hole, the instrument is ready for use. The next step is to verify that on inserting a series of standard holes the corresponding output is related to the area of the hole by a constant factor.
Suppose we have to examine the calibration of a 2 in. $t/2$ lens. We first measure the focal length, and to check the full aperture we have to compare the output through the lens with that through a standard hole of diameter equal to half the measured focal length. If the calibration is correct the two readings should be equal. To check the $t/4$ stop, we close down the iris until the output is the same as that through a standard hole of diameter equal to one-quarter of the focal length.

It is clear that with this apparatus the only satisfactory way to take into account the variations in focal length which occur in manufacture is to provide sets of standard holes at intervals of say 1% in diameter. This consideration led Townsley to propose an alternative method and my own company has more recently proposed still another.

Reproducibility of Scaling

Daily's purpose was to provide a method and equipment which would give repeatable results in any laboratory. In order to test this point he sent us a description of his apparatus via the Bell & Howell Company, who proposed that we should make a trial batch of twenty lenses covering the whole normal range of focal lengths for the 35 mm. camera, and that we should calibrate them and send them to the United States for comparison on their apparatus. We could not duplicate the Daily instrument in the time available, but we devised an alternative instrument, and graduated the objectives with $t$-scales. The measurements were repeated by Townsley of the Bell & Howell Company, and the results are reproduced in Fig. 3.

It should be pointed out that at the time this experiment was made there was a proposal by Berlant that a suitable limit of maximum acceptable error should be $\pm 1/10$ stop. In Fig. 3 the points indicate the percentage transmission of our marked $t$-stops against the corresponding standard holes as re-measured on the Bell & Howell apparatus. Therefore if we had produced a calibration with no measurable error all the points would lie along the line 1.0; in fact one point only lies outside the limit of $\pm 1/4$ stop. The result of this experiment supports Dr. Daily's claim that his system affords the possibility of independent reproducibility. Taking due account of the limited electrical sensitivity of our primitive instrument, we regard the Committee's present proposal of $\pm 1/10$ stop as not unreasonable.

Null Balance Method

Fig. 4 shows the Bell & Howell instrument developed by Townsley to provide the advantages of Daily's method in combination with a null balance. Townsley claims that his apparatus is both stable and sufficiently sensitive to calibrate accurately stops as small as $1/32$ in. diameter. The lamp $A$ is imaged at the small aperture $B$ which is collimated by lens $C$. The opening $D$ into the integrating sphere carries a fixture into which a series of discs perforated with standard holes can be inserted, or, alternatively, the objective
$P$ under test can be mounted so that all the light transmitted by it is received into the sphere. $F$ is an electron multiplier photo-cell.

So far the system is similar to Daily's. In order to provide the null method, Townsley's apparatus picks up a beam of light from the rear side of the lamp $A$ and by means of the mirrors and condensers forms a second image of the filaments at $G$, in the same plane as $B$ and about 6 ins. distant from $B$. The chopper $H$ is arranged so that the two beams are transmitted alternately. Lens $J$ images the aperture $G$ on the opal screen $K$, and is provided with a series of circular aperture plates, the successive diameters being in the ratio $\sqrt{2}$, and corresponding to the iris diaphragms for $t/2$, $t/2.8$, and so on to $t/32$. The lens $M$ images the screen $K$ via a mirror directly into the photo-cell $F$. The lens $M$ has a wedge-shaped diaphragm $N$ sliding in front of the slit $O$; this is the adjustment to provide correction for off-standard focal lengths. The current from the photo-cell $F$, after amplification, is passed into a cathode-ray oscilloscope, which is used as the null detector.

To perform a calibration, the slit $O$ is adjusted according to the measured focal length of the objective, the appropriate standard hole is inserted at $J$, and the objective is mounted at $P$. The iris diaphragm of the objective is closed down until a balance is obtained.

Townsley's instrument is more complicated than Daily's. I am uncertain about Townsley's present view of the relation between the two instruments. But we had no hesitation in selecting a type more simple than either, partly because we were pressed for time, but also because we wanted to know whether a less intricate instrument would serve the purpose.

**Taylor-Hobson Instrument**

In designing our instrument we had in mind that it was to be a tool for the use of mechanics in our assembly department. The electrical systems in Daily's instrument and more especially in Townsley's seem to us to be better adapted for use in a research laboratory than in a workshop.

Fig. 5 shows our present transmission apparatus. The illuminating system
and the integrating sphere are fixed on the optical axis of the system, \( A \) is the objective to be calibrated, \( B \) is a neutral density, \( C \) is the standard hole with which the objective is to be matched, and \( D_1D_2 \) is a variable neutral density. \( A \) and \( B \) are mounted at the same station on a turret whose axis is parallel to the optical axis of the objective, and \( C, D \) are mounted at an adjacent station on the turret, so that a simple rotation of the turret head replaces the one system by the other on the optical axis. The turret is represented diagrammatically in Fig. 5 by the long rectangle.

The variable neutral density \( D_1D_2 \) comprises two density wedges having the same slope, but mounted in opposite directions, so that by sliding one across the other the composite density can be varied between the limits 80\% to 125\% of the mean value, and the mean value of the density is identical with that of the simple member \( B \). The output of the photo-electric cell is passed into a simple D.C. amplifier and thence to the galvanometer.

Suppose now we have to calibrate a 2 in. \( l/2 \) lens on this instrument. The first operation is to check the focal length of the objective. This measurement is made on an auxiliary optical bench called a focometer. This auxiliary operation of checking accurately the equivalent focal length of objectives is always necessary in calibration by any collimated source type of instrument.

First suppose that the focal length is exactly 2 in.: this requires the wedge \( D \) to be set in its mean position, giving the same transmission factor as \( B \). To calibrate \( l/2 \) on this lens, we mount at \( C \) a standard hole 1 in. diameter. \( C \) \( D \) is then turned into the optical axis and the galvanometer reading is taken. Then \( A \) \( B \) is moved into the optical axis and the iris diaphragm of the objective is closed down to the position where the same galvanometer reading is obtained. The point on the iris ring opposite the zero index is then marked. Next, the standard hole \( C \) is changed from \( l/2 \) to \( l/2.8 \), and the process repeated for all the stops required.

**Discrepancies in Focal Length**

Now let us next suppose that the objective focal length as shown by the focometer were 2.05 in.; everything would be as before except only that this
lens must be calibrated against a hole of diameter 1.025 in. That could be done, but if it were adopted as a general method it would entail carrying a stock of standard holes to cover all possible manufacturing variations of focal length. We prefer to modify the procedure to enable us to calibrate all the small variations of focal length against the one mean standard hole.

The method used is exactly analogous to the wedge-shaped diaphragm in Townsley’s apparatus, although the means are different. In this example where the focal length is 2.05 in., that is 2\(\frac{1}{2}\)% large, we adjust the variable density \(D\) until its transmission is exactly 5% greater than that of the fixed density \(B\). There is a scale on the mounting of the density \(D\) to indicate the proper position. Compared with the previous example we are passing 5% more light through the standard hole. Now, therefore, to balance the transmission of the lens against that of the hole we have to adjust the iris to pass an extra 5%, and that will be the correct aperture for \(t/2\) on the 2.05 in. focal length objective; and further it is plain that the same adjustment of the \(D\) density will be required to calibrate each \(t\)-stop of this objective, using for each stop the appropriate standard hole.

I hope that although my review of this new technique has been rather brief I have succeeded in conveying the idea that we were presented with a difficult problem by the S.M.P.E. Committee report. We believe we have designed an instrument which will do the job under workshop conditions. It will take some time to prove whether it is satisfactory or not. A goodly proportion of the work it does will go to the Bell & Howell Company and it will there be scrutinised on their instrument, and they will furnish us with their results.

IV. ANTI\(C\)P\(I\)\(TA\)\(T\)ED PROBLEMS

Some of the problems which will arise out of the adoption of \(t\)-scales must now be indicated.

The advent of \(t\)-stops is going to bring a large number of problems to the lens designer. For example, users have been accustomed to the \(f/2\) lens. When we have done all we can at present with the reflection reduction coating the \(f/2\) lens will prove to be \(t/2.13\), say. It will be asked by those who like round figures, why not \(t/2\). Now \(t/2\) will be equivalent to \(f/1.88\). The fact that we issue the design at \(f/2\) can be taken to mean that in our considered opinion \(f/2\) is the maximum aperture at which the lens will operate, and that at \(f/1.9\), say, it would certainly appear over-apertured—a condition we generally strive to avoid. It would never do in a burst of enthusiasm about transmission to overlook the other fundamental properties of an objective, definition and resolution. We certainly must get as much light as possible on to the film, but it must go to the right place on the film. And if we are to give the same definition at \(t/2\) which we produced at \(f/2\), then here and there it will be necessary to introduce an additional element.

Lens Vignetting

I have said that it is, in my opinion, a point of the highest importance that the Committee decided against adopting a proposal to define transmission in terms of the flux from the whole field aperture. Such a course would, in one sense, give a true overall picture, but far preferable I believe is the alternative course adopted by the Committee which defines \(t\)-transmission as the transmission at the centre, and so segregates the losses due to vignetting in existing objectives. The increasing use of back projection is bound to throw emphasis on the vignetting losses in objectives, and if this matter is pursued to its logical conclusion, which I consider inevitable, it is going to introduce more radical innovations in lens design than any we have yet seen.
Let us consider what information we get from the corner-to-centre ratio. The total losses comprise two distinct effects: firstly there is the vignetting caused by the fact that the whole aperture of the iris diaphragm is normally not visible from a point in the image plane remote from the centre. When the aperture of the iris is reduced for the purpose of improving the vignetting, the iris aperture is reduced to a point at which the whole of the iris can be seen from nearly the whole area of the gate. After that adjustment has been made, however, there is still a residue of unevenness owing to the operation of the cosine-to-the-fourth-power law.

**Correcting Light Distribution**

The first effect, sometimes called the cat’s eye effect, can be corrected by suitably increasing the front and back diameters. Fig. 6 shows the 35 mm. Speed Panchro lens, and superimposed is a drawing of the full pencil going to the corner of the gate. It is clear that a substantial increase in the back diameter is necessary, and there would also be a corresponding increase at the front. It is not, however, merely a matter of making bigger glasses: the increased aperture will produce a number of aberrations—but let us suppose that difficulty could be overcome.

**Cos² Law**

We would then be left with the second effect, which does not originate in anything the optician does or fails to do, but it is inherent in the laws of radiation, and it must be considered irreducible except by subtractive methods. I include among subtractive methods the empirical means adopted by cameramen of interposing opaque obstructions in front of the camera lens and generally in the neighbourhood of the optical axis to reduce the exposure in the centre without interfering with that at the outer parts of the field.

Fig. 7 shows the distribution over a 35 mm. silent frame, as measured for current commercial 50 mm., 35 mm., and 25 mm. lenses. Fig. 8 shows the distribution which would be obtained if the iris aperture is reduced, so that the whole of the iris perimeter is seen from the corner of the gate. The point about this comparison is that by suitable design the second distribution could be obtained: a further point is that there is no very obvious way of improving on that distribution, and a still further point is that, however unsatisfactory it may appear, in order to achieve that distribution, really drastic alterations will be necessary.

**Modifications to Cameras**

We cannot be quite certain at this stage that all the necessary alterations can be effected in the objectives. In order to reduce the vignetting to this unavoidable minimum value the designer must increase the diameters of most of the glasses, especially the outer ones, in order to transmit to the corners
of the frame pencils of light which fill completely the iris diaphragm. This may result in an overall increase up to 50% in the outer diameter of the lens barrel.

Now, the camera designer leaves a conical shaped space converging towards the gate to accommodate the lens. It seems in fact that cameras have been built as a shrink fit to existing objectives, and very little clearance is normally available round the mount of the short focal length lenses. If reduced vignetting is demanded it looks as if unavoidably the camera designer will have to make considerable modifications to existing equipment to provide space for larger diameter lenses close to the gate.

It would be very helpful to have the opinion of cameramen on the value of development along the lines I have indicated.

Acknowledgments

I have to acknowledge with thanks permission of the S.M.P.E. to use material published in the Journals. I have quoted freely from Daily's and Townsley's papers and from the unpublished report of the Sub-Committee.

Author's Note.—Although the Sub-Committee completed its Report more than a year ago agreement has not yet been reached and the publication of a standard is delayed. However, in so far as the Committee's Report relates to 35 mm. equipment for studios, it seems probable that the Report will be adopted exactly as it stands.

March, 1949.

REFERENCES


DISCUSSION

Mr. C. W. Smith: The accuracy of calibration of a lens must be thought of in relation to the accuracy with which the cameraman can set the iris ring. If one is photographing a film for which one wants a deep-focus technique, one may want to work at f/8. Is there any possibility of modifying the uneven character of the present iris scales, to make them more accurate at f/8?

The Author: The answer is yes; there is the possibility of providing an improved approximation to a linear law for the iris scale, and we regard this as a problem which must be solved.

Mr. Percy Harris: One will be faced
with a problem in still camera work, if
the t stop method is adopted. In the Bell
& Howell Foton still camera, the lens is
going to be calibrated in the t stop method.
Whatever objection there may be to the
f system, it does at least give us a scientific
method of computing depth of field. In
different types of lenses with different
efficiencies of transmission, we can have
two lenses, both set for the same t value,
but the actual diameters of the stops will
be different, and unless the lens is also
marked with f numbers, I fail to see how
the user is in a position to calculate the
depth of field, which becomes increasingly
important in close-up work. If the lens
were marked with f numbers, we would
retain the ability to calculate depth of
field. If the efficiency factor were given
by the manufacturer, we could still cal-
culate our exposure. Depth of field is not
important for infinity work, but many
types of lenses have a relatively poor
transmission. When working at very close
distances, there may be an important
difference in depth of field between what
is obtained on a t number and on an f
number. If simultaneously lenses were
to be marked with f numbers as well, there
would be no difficulty.

The Author: In reply to Mr. Harris,
the t stop campaign started in Hollywood,
and all the most enthusiastic supporters
are 35mm. motion picture people. All the
t scale lenses first produced will be for the
Studios, the only exception being those
for the Bell & Howell Foton camera.
Possibly the factors peculiar to the still
camera lens have not yet received the
attention they deserve, and this may be
one of the reasons for the delay in the
adoption of the S.M.P.E. Committee's
report. When finally that report is adopted,
there will arise out of it a definition of the
engraving of iris scales on photographic
objectives, and this will be embodied
first as an American standard, and then as
a British standard. To some extent the
decision what to engrave is taken out of
the hands of manufacturers.

I think the errors in depth due to cal-
culations based on a t number instead of a
true f number are not likely to be very
serious. The difference in size between
the actual disc of confusion and that
expected is a constant at all distances
and in the case of a t2.0 lens whose f
number is 1.88, the increase only amounts
to about 6%. If you want both f and t
scales engraved, please do not make it
compulsory on all lenses, including the
small ones, because doubling the amount
of engraving would impair the legibility
on a small lens. On larger lenses where
there is room for twice the present amount
of engraving, the double scale could be
provided, but I can imagine most users
would regard it as redundant and un-
necessary.

Mr. L. Isaacs: From the practical
point of view, can manufacturers put a
clear mark instead of an irregularly
rounded dot opposite an irregular triangle,
coupled with very small figures engraved
with a microscope?

The Author: Yes, I agree that some-
thing of that kind should be done.

Mr. C. Vinten: Mr. Warmisham men-
tioned the possibility of increasing the
diameter of the back glasses of lenses.
Camera manufacturers view with some
alarm this question of the diameters of
lenses. On many present-day cameras
the turrets would come to pieces if they
were made to carry bigger back glasses.
On a single-lens camera, where you have a
reflex shutter, the distance between the
back glass of the lens and the reflex shutter
is sometimes very close indeed. If lenses
were appreciably larger in the back glass,
a greater back focus would be very desir-
able. The diameter of the front lens is
not very important. But I agree that if
the back glass will improve evenness of
exposure, it should help very much in
colour work.

Mr. W. M. Harcourt: While the
enormous difference is not so noticeable
in black-and-white work, in any integral
tripack system of colour the falling off is
in colour as well as in density, and it is
immediately noticeable. The negative of
an integral tripack may hardly show it,
but in projecting the print, which after all
is itself vignetted, the effect will be evident.

Mr. F. N. Bush: The emphasis of the
industry at the moment is very much on
process projection. I have no doubt that
big developments are overdue in this
direction. When the vignetting of the
photograph on the background projection
plate is added to those of rear projection
and re-photography, the total vignetting
creates an increasingly important problem.
If there is no satisfactory method of
improving the optical system of the camera,
other than the subtractive manner you
mentioned earlier, to give an even field,
then I think some rearrangement of the
front of the camera may be necessary, and
would be worth while. I agree with those
people in Hollywood who decided to set
up a system of standardisation by using
transmission values.
STUDIO AND O.B. TELEVISION PRACTICE IN GREAT BRITAIN

T. H. Bridgewater, A.M.I.E.E.*


TELEVISION technique is built fundamentally on the basis of the performance of the pick-up tube. In the studio, the standard "Emitron" tube has held its own since 1936. In 1937 the introduction of the "Super-Emitron" (the parallel American development of which is known as the "Image-Iconoscope") greatly enhanced the technique of outside reporting, and made possible the pick-up of indoor events, such as theatres, boxing, etc., though not without some increase in their normal lighting.

In 1947 the "C.P.S. Emitron" tube was introduced, which combined the advantages of absence of "shading" with increased sensitivity. It was employed extensively for the televising of the Olympic Games.

Studio Cameras

Apart from minor alterations, the present studio cameras are those installed at the commencement of the service in 1936. Despite their early vintage they have, on the whole, proved most satisfactory. The viewfinder is of the optical (parallel lens) type and the image appearing on the ground glass screen is inverted. There are no lens turrets, but this is not a major drawback, since a variety of lenses is not technically feasible with the tube in its present form (6 in. f/3 and 12 in. f/4.5 only); the size of shot can be more elegantly varied by tracking the camera. In general, it seems probable that no radical alteration of existing operational facilities will be required so much as the perfecting of the mechanics of important details such as smoothness of panning and tilting, lens movement, etc.

*Engineer-in-Charge, Outside Broadcasts, B.B.C. Television.

Fig. 1. The new "C.P.S." Cameras in action at the Olympic Games (Swimming Events). The camera on the left is fitted with short focal-length lenses while that on the right has telephoto lenses for close-up views. Note the focusing control near the rear of the camera.
Fig. 2. Three types of camera mountings in use in the Studio. Left to Right: Simple 'Dolly,' Crane (with crew of three) and movable stand.

O.B. Cameras

The introduction of the "Super-Emitron" tube, which has a photocathode of only 30 mm. diagonal, makes possible a wider range of focal lengths and smaller lens angles, although view-finding is more difficult owing to the reduced size of image.

The variety of possible lens angles has led to the introduction of quick-change facilities, and turrets mounting three or four lenses are now appearing in service on all outside cameras. The use of turrets adds to the problem of viewfinding, and the old style of optical finder ceases to be practical. The solution now adopted is a 3 in. diameter cathode-ray tube built in to the camera, showing the image from the camera screen.

The control of lens aperture is receiving special attention. Nearly all types of pick-up tube operate best at a given value of light, and when the local light level alters it is almost essential to compensate by appropriate adjustment of the lens iris. This is at present controlled from the back of the camera, but it may be more convenient to transfer the control to the vision control engineer's position.

Lighting

For subjects of moderate tones, an average illumination to suit the Emitron camera would be 200 foot-candles incident, giving a typical reflected brightness at the camera of some 50 foot-lamberts from medium tones. This can be achieved with a power consumption averaging 170 watts per sq. ft. of illuminated area for tungsten gas-filled lamps.

Experiments with discharge lamps are taking place with a view to improving efficiency and reducing the heat.

In outside broadcasts it is usually necessary to supplement the existing illumination at indoor events, and with the pick-up tubes used in the past an illumination intensity of 100 foot-candles was required. The more sensitive tubes now coming into use will permit the televising of many indoor scenes
under normal lighting conditions. A typical play at a London theatre gives a brightness measured in the Dress Circle of 15 foot-lamberts, highlights, and 0.25 foot-lamberts in the shadows. These values are within the capabilities of the new "C.P.S. Emitron" tube.

At the Empire Pool, Wembley, where the Olympic Games swimming events were held, the brightness measured at the camera was:

- Highlights 16 ft.-lamberts
- Medium tones 6 ft.-lamberts
- Darkest parts 0.4 ft.-lamberts

and the C.P.S. cameras picking up these scenes gave excellent results at an aperture of f/3.

**Studios**

The present B.B.C. studios measure 70 ft. by 30 ft. by 24 ft. high, and are becoming inadequate for programme requirements.

![Fig. 3. Layout of equipment inside the new mobile control room. Note the small waveform oscillograph to the right of each picture screen.](Courtesy of the B.B.C.)

The design of new studios is now receiving attention, but it is unlikely that they will ever grow into the mammoth buildings of the film industry. Future expansion will probably be on the lines of a group of medium-sized studios, each designed for and allocated to a particular type of programme. This need arises from the unique "continuity" requirement of television, each component of the day's programme requiring a self-contained studio insulated from the others, to allow rehearsals and programmes to proceed simultaneously without mutual interference. There is also a need for several sets pertaining to any one production to be grouped closely within the studio to enable quick movement from one to the other by the artists.

Apart from the design of individual studios, the project of a multi-studio television centre is also being considered, possibly with a fan-shaped grouping of studios. The fulfilment of such a project is, however, still somewhat distant on account of post-war difficulties.

**Film Transmitters**

In addition to showing films and newsreels, the film transmitter is valuable for "effects" in studio productions and for supplementing studio scenes.
To fulfill the two functions it is convenient to have a scanner which will operate at any speed from a stationary frame to 25 frames per second, and the Mechat type of projector has proved very successful in conjunction with the Emitron cameras.

A modern version of the “flying-spot” scanner is shortly being adopted, in which the film is scanned by a cathode-ray tube, the image being projected direct on to a photo-cell.

Production Facilities

The general facilities necessary for operational control of the cameras within each studio and the co-ordination of the output from each studio and other programme sources can be summarised as follows:

(a) A production position associated with each studio for overlooking the scene and selecting the cameras by cutting, fading, or mixing. The producer views the outputs from all the cameras in use.

(b) A comprehensive signalling and communication system which includes “talk-back” from producer and engineer to cameraman, and the use of small monitoring screens disposed as necessary in the studio.

(c) A film transmitter associated with each studio as well as a second type acting as a programme source.

(d) A caption transmitter associated with each studio.

(e) A small announcing studio to enable announcements to be made without disturbing the settings in the main studio.

(f) A continuity room in which all programme sources are received before transmission. In this room the incoming programmes are pre-viewed and proper co-ordination is achieved with the aid of adequate two-way communication.

Acknowledgments

Acknowledgment is due to the B.B.C. for permission to give this paper, and to the author’s colleagues for information on various points.

DISCUSSION

Mr. Phillips: Why is not the cathode ray tube finder suitable?

The Author: It is ideal in some respects but the resolution of such tubes is unlikely to be as good as the system as a whole is transmitting. If you slightly reduce the definition on a view finder you effectively increase the depth of focus to the cameraman. The scene outside the area being transmitted is not shown to him; with an optical view finder he can see a wider field than the camera is taking.

Other objections to the cathode ray tube are its complexity and the fact that it is a device on which the cameraman is very dependent, and extra complexities may impair the reliability.

Mr. A. Englander: Why is it that the normal incandescent lighting is inefficient?

The Author: The heat on the artist has to be sustained throughout the television programme and it would be too great for him to bear. With increased lighting the resultant infra-red can deteriorate the picture due to its not being focused to the same position as visible light. Our tubes do respond to infra-red.

Mr. H. Bastie: At the International Conference did you formulate any views on comparative British and American progress in the television field?

The Author: I listened to a paper by Dr. Zworykin and I did not gather that there were any fundamental differences in progress. They have different types of pick-up tubes, standards, number of lines and repetition speeds and appeared to have got further ahead of us in quantity. They have more stations and more relays to other towns but do not seem to be doing anything as useful as we are over here.

Their Zurich delegate insisted upon extremely bright receiving tubes, aluminium backed. Their television picture is now so bright that you can look at it without drawing any of the curtains in your room at home, and so with great advantage, because television could not be regarded as an intruder.
CARBON BRUSHES FOR ELECTRICAL MACHINERY

W. D. Harrison*

Summary of a Paper read to the B.K.S. Newcastle-on-Tyne Section on September 7, 1948.

The properties of carbon which make it particularly suitable to withstand the combination of rubbing and current collection in electrical machinery are:

1. Its electrical and thermal conductivity;
2. Its low friction;
3. Its inability to weld to metals;
4. Its inability to withstand high temperatures;
5. Its abrasion resistance.

The range of materials available for carbon brushes may be divided into four main classes:

1. Graphite has good natural lubricating qualities and this, combined with its high thermal and electrical conductivity, makes it particularly suitable for high rubbing speeds.
2. Hard carbon is more robust than graphite, but permissible loads and speeds are lower; it is widely used on industrial motors.
3. Electrographitic carbon, converted into graphite at very high temperature in an electric furnace, is tougher and more refractory, and able to withstand severe mechanical conditions and electrical overloads.
4. Copper-graphite, incorporating metal to increase conductivity, is suitable for high current densities.

Brush Holders

Both brush holders and brush arms should be of rigid construction. The brush holders should be securely clamped to the brush arms or spindles and set so that they are exactly in line across the commutator. The spacing of the brushes round the commutator should be uniform. Where practicable, by reason of adjustment provided, the distance from the bottom of the holder

*Morgan Crucible Co., Ltd.
to the commutator should not exceed 3/32 in.; care should be taken not to disturb the angle of the brush to the commutator when making this adjustment.

If the brush rocks in the box then the contact surface cannot be maintaining a complete arc of contact with the commutator. The importance of the face of the box, against which the brush is supported, being perfectly flat cannot be too strongly emphasised. Fig. 2 illustrates in exaggerated form the effects resulting from the use of boxes whose supporting faces are not flat. Note the small moment \( ab \) of the friction force when the box is flat as in (4).

**Brush Angle**

There appears to be no angle universally best for brush setting—the diversity of practice bears this out, but small departures from the radial are unsatisfactory. The brush should either be truly radial, trailing 5 to 10 degrees, or at a reaction angle of 30 to 35 degrees. If the machine is reversible the brushes must be set at a true radial angle.

The correct bedding of brushes is of importance; imperfectly bedded brushes cannot be expected immediately to operate satisfactorily under full load conditions. The usual method of bedding is by means of abrasive cloth, this being placed between the brush and the collector and drawn backwards and forwards. At the end of the preliminary bedding fine glass paper should be substituted for the abrasive cloth; this should be drawn through only in the direction of rotation of the machine. The use of suitable brush bedding stones is increasing in favour and superseding the above method, but is not effective on slip-rings.

**Troubles, Causes and Cures**

Commutation and collection troubles are invariably cumulative and more often than not originate in some quite trivial cause. The commonest trouble is sparking at the brushes; this may be due to a large number of causes, the following being those most frequently met with, grouped under: Commutating Conditions, Mechanical Faults, Brush Holders, and Extraneous.

(a) **Incorrect brush position.** The running position is generally indicated by the machine maker, but this may have been rendered inaccurate by a
major repair. On machines fitted with interpole, the running position will be at or very near the neutral position, sometimes a shade in front if the machine is a motor, and sometimes a shade behind if a generator, to give a slight compounding effect. With non-interpole machines the adjustment will be in the opposite direction.

(b) Commutating poles: Reversed or of incorrect strength. This can be checked by the use of a low reading voltmeter, one terminal of which should make connection with the brush flexible while the other is in turn made to bear on three or more equispaced points on the commutator under the brush. It is customary to use an insulated, chisel-pointed pencil of carbon for the moving contact, thus preventing damage to the commutator surface. Fig. 3 shows brush potential curves corresponding to straight line, under and over compensation; the upper curves show the current changes as one coil passes under the brush.

(c) Brush pressure should be set uniformly, preferably by spring balance on each individual brush. Normal pressures are 2 to 2½ lbs. per square inch of brush section in the case of commutators; highest pressures are desirable for the small brushes of F.H.P. motors. In the case of slip-ring brushes, pressures should be 2 to 3 lbs. per square inch.

(d) Spacing. Some machines are very sensitive to small irregularities in the spacing of the brushes and this should be adjusted to say within 0.05 in. Check by wrapping a strip of stout paper around the commutator, marking the leaving edges of the brushes at each spindle and then measuring to see that the spaces are equal.

(e) Alignment. Brushes which are nominally in line should be accurately so, otherwise, if two or three are out of line too much work may be thrown on these, giving rise to sparking.

(f) Imperfect bedding. A new set of brushes may run less satisfactorily than the worn-out set, as they are longer and therefore less stable, making it doubly important that when fitting replacement brushes these be carefully bedded.

(g) Overload. Commutating conditions under overload are less satisfactory; magnetic saturation of the interpole and increased armature reaction may result in a deterioration in commutation; in addition, the rate of brush and collector wear is increased.

(h) Unsuitable grade of brush. The brush grade selected by the machine designer should not be changed without consultation with the machine or brush manufacturers.

(i) Unequal air-gaps are generally due to wear in the bearings, and will give rise to circulating currents in the armature as a result of variations in field strength and will cause overloading of the brushes; in addition, vibration is sometimes set up by circulating currents in the armature.

Mechanical Faults

(j) Projecting mica is a common cause of sparking as it prevents good contact between the brush and commutator; where possible the mica should be undercut. A square-bottomed, full width groove should be provided, the segment edges being bevelled.

(k) Out of balance. Vibration of the armature as a result of mechanical out-of-balance will reduce the efficiency of contact between brush and commutator.

(l) Eccentricity or flatted commutator. Due to its inertia, the brush cannot maintain equal contact around a collector that is either eccentric or flatted. Unsatisfactory contact will occur where the surface of the commutator is low, so that a flat or low point always tends to worsen.

(m) Bad joints. Flats on the commutator are often due to bad joints
between the winding and the commutator; therefore, if a flat appears, the soldering between winding and commutator should be carefully inspected.

**Brush Holders**

(n) *Sticking brushes* are fatal to satisfactory operation. These can be prevented by regular cleaning.

(o) *Brush clearance.* If the design of the holder is such that the brush is held definitely against one face of the box from top to bottom, there is no objection to a relatively large clearance. Should the brush not be definitely located a fine clearance becomes important.

(p) *Position of Holders.* The holders may be too far from the commutator, or the brushes of excessive length, leading to brush chatter. Holders should be set at approximately 3/32 in. from the collector.

**Extraneous Faults**

(q) *Dust or grit* in the atmosphere is liable to impair contact between brush and collector, and may cause collector scoring in addition to sparking.

(r) *Loose contacts* in brushgear or field system will induce sparking at the brushes.

(s) *Bad joint in belt or excessive vibration on machine.* Either of these faults may so disturb the brushes as to result in sparking; a temporary measure of correction is to increase the brush pressure.

(t) *Corrosive fumes.* Both commutators and slip-rings are susceptible to attack by chemical fumes. Where a machine has been standing in a corrosive atmosphere for any length of time, the collector surface will be chemically attacked except at those points immediately under and protected by the brushes and, if not cleaned with fine abrasive before being put into service, the collector is liable to develop flats at those points which had been covered by the brushes.

**Brush Chatter**

As mentioned previously, this may be due to excessive box clearances. Other common causes are incorrect adjustment of brush holders, collector out-of-truth or having developed high bars or flats, vibration, or prolonged periods of no-load, or light load running.

Brush chatter can often be cured by altering the angle of brush to collector, making it either 5 to 10 degrees trailing, or 30 to 35 degrees reaction. In cases where the brushes are not definitely located in their boxes a suitable top bevel is often helpful, this tending to hold the brushes steady against one face of the box.

**Causes of Wear**

Wear of brushes and collector is due both to mechanical abrasion and to the removal of material by burning due to the high surface temperatures resulting from the passage of current.

The amount of wear due to mechanical abrasion is usually very small and it is rarely that excessive wear occurs from this cause. Electrical wear is, of course, most pronounced when sparking occurs, but it also takes place when there is no visible sparking. A very common cause of excessive wear is imperfect contact between brush and commutator; this may be the result of proud mica or of insufficient brush pressure.

Many difficulties in the operation of electrical machines arise from relatively simple causes and are almost always of a cumulative nature. Careful attention to collector, brushes and brushgear amply repays the engineers responsible for their maintenance.
TECHNICAL ABSTRACTS

Most of the periodicals here abstracted may be seen in the Society's Library

ELECTRICAL ENGINEERING PROBLEMS IN THE TROPICS.
A valuable survey of the problems of tropicalisation, which are considered under the following headings: unskilled labour, high temperature and strong sunlight, high relative humidity, salt-laden atmosphere, dust, and rodents and insects. Due primarily to the heat and humidity, many normally satisfactory insulating materials—including even porcelain if unglazed—become conductors. Provision must be made in equipment and wiring installations to guard against condensation.

R. H. C.

PROJECTION EQUIPMENT FOR SCREENING ROOMS.
The quality of projection in a preview theatre must be related to that in a regular theatre. The projectors must be capable of handling green prints with many splices. Screen brightness must fall within the accepted intensities; light from an H.I. arc may be reduced either by the use of a three-bladed shutter, or by fitting a shield over the arc mirror.

R. H. C.

THE NEW "SPECTRA" MEASURES COLOUR TEMPERATURE.
The "Spectra" colour temperature meter, a photo-cell is covered by a red filter, and the reading of a meter is set to a reference mark; movement of a trigger then replaces the red filter by a blue filter, when the colour temperature reading in degrees Kelvin is indicated on the meter.

R. H. C.

TRANSITION LENS FOR TELEVISION CAMERAS.
The "Dualmar" lens is designed to permit of an instantaneous change from long-shot to close-up. The present model provides focal lengths of 8 ins. and 16 ins., with an aperture of f/2. Provision is made for varying the centring of the two images.

R. H. C.

ZOOMAR LENS FOR 35 MM. FILM.
A Zoomar lens for 35 mm. cameras has a focal range of from 3½ ins. to 13 ins., and maintains an aperture of f/4.5 at all focal lengths. Its weight is 11 lbs.

R. H. C.

THE USE OF COMPACT SOURCE DISCHARGE LAMPS IN MOTION PICTURE STUDIOS.
The article briefly describes the illumination requirements on sets in film studios and to what extent they can be met by the high-pressure colour-corrected mercury-cadmium vapour discharge lamp. The construction and properties of these lamps and their associated circuits for steady running and high tension starting are described in detail and a comparison between their performance and that of tungsten and high-intensity carbon arcs is made.

There follows a full account of a floodlamp and spotlamp using a 2½ Kw. mercury lamp, now in current use, and finally some details are given of an experimental spotlamp.

F. S. H.

THE GAUMONT-KALEE MODEL 21 PROJECTOR.
A comprehensive description of the engineering aspects of the G.K.21 projector is followed by some instructive comments by an American technician.

R. H. C.

THE RACKING SYSTEM OF A PROJECTOR.
A survey of various methods of racking covers a number of systems employed in the past. The principle almost exclusively used today consists in rotating the oilbath around the camshaft centre, necessitating adjustment of shutter phasing. AUTHOR'S ABSTRACT.

CAUSES AND PREVENTION OF DAMAGE TO 35 MM. RELEASE PRINTS.
Inter. Prof., Oct., 1948, p. 5.
A comprehensive survey by the Eastman Kodak Company of the causes of damage to prints. Recommendations are made under the headings of laboratory procedure, the exchange process, and the projection process.

R. H. C.
THE NEW SLIDE-BACK CHAIR.

The paper deals with a retractable type of chair for facilitating travel between rows of occupied seats without reducing seating capacity; details of research, requirements of design and considered advantages are given.

H. L.

OPTICAL PROBLEMS IN LARGE SCREEN TELEVISION.

DEVELOPMENTS IN LARGE SCREEN TELEVISION.
R. V. Little, Jr., Ibid, p. 37.

DISCUSSION ON LARGE SCREEN TELEVISION.
Ibid, p. 47.

The first of these papers relates to the optical problems and the processing of the 42 in. Schmidt system, made by RCA. The second describes the two RCA projectors, one giving a picture 6 ft. × 8 ft., while the larger model gives a picture 16 ft. × 24 ft. and uses a 42 in. mirror and 36 in. correcting lens, and a 15 in. diameter cathode-ray tube. The high voltage rectifiers necessary for working these high intensity projection tubes are described. It is predicted that with this equipment a screen brightness of 8 ft.-lamberts will be obtained.

A discussion and demonstration followed the paper.

T. M. C. L.

PLASTIC LENSES IN TELEVISION PROJECTION
D. Starkie, Jnl. Television Soc., Vol. 5, No. 3.

For plastic optical systems for television projection two plastic materials are available: Transpex 1 and Transpex 2. A description of their physical and optical properties is given. The low surface scratch resistance of plastic optical materials in comparison with glass is regarded as over-emphasized; microphotographs show that the scratch on glass has broken edges, extending well beyond its boundaries and providing a large light-scattering area.

Points of practical interest in connection with the use of Schmidt systems for television projection include the precision required for the curved face of the cathode ray tube, the accuracy of positioning the correcting plate in relation to the concave mirror, and the maximum sizes of deflecting and focus coils which can be used so as not to obscure too high a percentage of light. A short note is included on directional viewing screens.

T. M. C. L.

HISTORICAL SKETCH OF TELEVISION'S PROGRESS.

The object of this paper is to convey a general understanding of how the numerous contributions have been pieced together in the general development of television. A large number of the important inventions are given in chronological order in a completely unbiased manner.

The proposal of Alexander Bain in 1842 to send pictures over electric circuits is given as the first recognition of the fundamentals of picture transmission. The parts played by Sir William Crookes, J. J. Thomson, Nipkow, Sutton, Campbell Swinton, Zworykin, J. L. Baird, C. F. Jenkins, Farnsworth and Goldmark are brought together in their true relationship.

T. M. C. L.

COLOR-TELEVISION FILM SCANNER.

The optical system and scanning arrangements used by Columbia Broadcasting System in their color-television film scanner serve to analyse the image into the three primary colours, which follow each other sufficiently rapidly to be integrated by the observer's eyes, and also to make allowance for the difference between the film travelling at 24 frames per second and a mains frequency of 60 frames per second. Since a continuously moving film projector is employed, compensation has to be made for film shrinkage.

On the electrical side an image dissector is used to scan the pictures. A quick change-over can be made in a matter of minutes from colour to the American standard black-and-white transmission.

T. M. C. L.
BOOK REVIEWS

AMATEUR MOVIES & HOW TO MAKE THEM, by Alex Strasser, The Studio. Price 15s. net.

The book is divided into two main sections, the first devoted to the technicalities of handling the camera and making exposures, the second to picture making technique.

To attempt to deal with the technicalities of filming within 15 pages of typescript is unduly ambitious, and has resulted in many cases in over-simplification that at times develops into actual error, giving the impression that the author's knowledge of this part of his subject is very limited. For example, the illustration of a "typical" camera shows the film winding on the spools in a manner entirely contrary to accepted custom; while we are told that a lens with twice the focal length covers half the area. Workers are advised to use 16 mm. film if they intend to have their films blown up to 35 mm. for sale to commercial film distributors, in spite of the fact that this technique has rarely proved successful. Altogether I regard this portion of the volume as of doubtful value to the amateur.

The other 25 pages of type, and the associated illustrations, are devoted to the taking of the picture and the build-up of the various scenes to make a simple film. Here the author is much more convincing. He suggests a number of subjects and the manner in which they might be brought to the screen. Film animation is briefly touched upon and the amateur film play is dealt with at somewhat greater length. Some methods of adding sound to films are indicated. Colour films are discussed and there are some remarks on editing and titling.

The book will perform a useful function in indicating to the tyro the many possibilities of his new hobby. Its value would be enhanced if it included a bibliography which would enable the reader to study in greater detail the many things which have been left unsaid. GEORGE H. SEWELL.

SCIENCE IN FILMS. Edited by Blodwen Lloyd. 198 Pages and 40 Plates. (London: Sampson Low, Marston & Co., Ltd., 1948.) Price 15s. net.

This book, with chapters by a number of well-known authors and under the able Editorship of Dr. Blodwen Lloyd, is a veritable mine of information concerning science films and everything connected therewith.

It deals with scientific films for instruction, research, record and information, while endeavouring to exclude films of the documentary class.

The principal divisions of the book are under the following headings: The Scientific Film To-day, Scientific Film and the Peoples, Visual Physiology and the Cine-Film, Film and Medicine, Film and Scientific Symbols, Films and Mathematics, Cinéradigraphy, Technique and Equipment, and Script and Science. Many chapters conclude with copious references which, in themselves, should be of very great value.

The remaining half of the book is the Reference Section and this contains more information on scientific films, their producers, distributors and similar data than it would have been thought possible for an Editor to assemble in one volume and present in useful form. Apart from international organisations, the national headings range from Afghanistan to Yugoslavia and include no less than 96 countries. This portion of the book alone is a reference library of the greatest possible value to anyone interested or connected, no matter how remotely, with the scientific film.

The book is excellently produced, well illustrated and appears to be singularly free from errors. Certain words and phrases, however, strike one as unusual and some of them are inconsistent, and on page 3, one finds the following: "cine-film," "ciné-projection," "ciné-photography," "ciné: projection," but "cinematography" without either accent or hyphen. Page 4 contains the word "ciné-photogenic," which would seem to mark the very nadir of hyphenated word making.

These minor defects cannot mar the usefulness and excellence of the book which will probably remain the standard reference book and source book in this field for many years to come. R. McVITIE WESTON.

CINE-FILM PROJECTION, by Cecil A. Hill. The Fountain Press. Cloth Bound, 10s. 6d.; Paper Bound, 8s. 6d.

Mr. Hill has endeavoured to fulfil a long felt need, but his book is likely to be acceptable only by the amateur or beginner. He has been somewhat facetious both in the illustrations and the text! Nevertheless, a number of sound tips have been given and it is pleasing to see that the reflective characteristics of beaded, silver and matt screens are explained clearly and correctly.

There are a number of points with which the expert will disagree, and the designer will not like the profile of a "new sprocket"
shown under an example of "sprocket wear." Renters will most probably object to the statement that if Parts 1–4 measure 1,200 ft. then, *ipso facto*, Parts 1–4 constitute three reels.

Descriptions of projectors have been obtained from the manufacturers and largely repeat their own claims, but may interest some readers.

The section entitled "Fault Finding" is very short, fortunately so, if we are to believe the author's experience when it took him ten minutes, with the aid of a voltmeter, pliers and screwdriver, to find out why the lamp was alight without any picture on the screen. He tells us he found the dowser accidentally, but he did not say to what use he was putting his voltmeter—or was it a hammer?

H. S. Hind.

THE COUNCIL

Meeting of March 2nd, 1949.

Present: Messrs. A. W. Watkins (Vice-President), L. Knopp (Deputy Vice-President), E. Oram (Hon. Secretary), I. D. Wratten (Past President), B. Honri, R. B. Hartley, R. E. Pulman, H. S. Hind, G. Burgess, R. H. Cricks (Technical Consultant), and W. L. Bevir (Secretary).

Divisional Committees.—The following Officers of Divisional Committees were appointed:


Sub-Standard Film Division: Chairman—Mr. H. S. Hind. Committee—Messrs. M. V. Hoare, G. H. Sewell.

Film Production Division: Chairman—Mr. B. Honri. Committee—Messrs. F. G. Gunn, H. Harris, T. Howard.

Donations.—The Secretary reported that £100 had been received from Messrs. Kodak, Ltd., as Patron Members, and a similar sum from Messrs. Associated British Picture Corp., Ltd., new Patron Members. Messrs. Oram, Wratten and Hartley were thanked for their efforts on behalf of the Society.

Nominations.—As despatch of the nomination papers had been delayed it was agreed that the Annual General Meeting be postponed until May 25th, at 6.15 p.m. It was reported that neither the President nor Hon. Treasurer sought re-election, but that those members due to retire from Council were eligible for re-election.

Sub-Standard Film Division.—Mr. Hind reported the success and full attendance at the last Division meeting and announced that the 1949-1950 Lecture Programme had been drawn up.

Film Production Division.—It was agreed that a circular on the low standard of screen illumination be drafted for circulation to C.E.A. members.

Newman Memorial Plaque.—Mr. Wratten reported that he and Captain A. G. D. West were recommending that Mr. Stuart Williamson be awarded the Newman Memorial Plaque.

B.S.I.—It was agreed that Dr. O. K. Kolb and Mr. B. C. Sewell should alternate as the Society representatives on the Acoustic Industry Committee.

EXECUTIVE COMMITTEE

Meeting of March 2nd, 1949.

Present: Messrs. A. W. Watkins (Vice-President), L. Knopp (Deputy Vice-President), I. D. Wratten (Past President), E. Oram (Hon. Secretary), W. L. Bevir (Secretary) and Miss S. M. Barlow (Asst. Secretary).

Lantern.—The purchase of a lantern for use at Society meetings was approved.

Elections.—The following were elected:

William John Edward Ede (Member), G. B. Kalee, Ltd.
Benjamin L. Leather (Student), Pinewood Studios.
Dennis Charles Walls (Member), President, C.E.A.
John Grafton Temple-Smith (Member), Brunner Lloyd & Co., Ltd.
John Stuart Dooley (Member), Ealing Studios, Ltd.
Ernest Taylor (Member), Ealing Studios, Ltd.
Robert Cyril Penn (Associate), Ealing Studios, Ltd.
Frank Buckingham (Member), A.B.P.C., Ltd.
Vivian Jones (Associate), Denham Laboratories, Ltd.
Donald E. Hyndman (Member), Eastman Kodak Co.
Francis David Watkins (Student), British Railways (S.R.), Film Unit.
LIBRARY COMMITTEE

Meeting of March 7th, 1949

Six new accessions were noted with thanks and it was agreed that any spare copies of periodicals should be sent to the Newcastle Section. It was suggested that Members be asked, through the Journal, to co-operate in obtaining required books and supplying back numbers of periodicals needed to complete volumes for binding.

PAPERS COMMITTEE

Meeting of March 16th, 1949

It was recommended that during the 1949/1950 session each of the Divisions should have the honour of arranging a paper for presentation at a Society meeting, in addition to the joint meetings with other societies. It was proposed that there be joint meetings with the Royal Photographic Society, the Television Society and the British Sound Recording Association.

The Committee of each Division of the Society was requested to prepare its proposals for next year's papers.

JOURNAL COMMITTEE

Meeting of March 28th, 1949

Attention was drawn to the fact that if the size of the Journal were to be maintained as at present advertising had to be increased.

The printing of the title and date on each page of the Journal was approved, commencing with Volume 16 in 1950.

It was recommended that the Council consider a fusion of the functions of the Journal and Papers Committees.

THEATRE DIVISION COMMITTEE

Meeting of March 31st, 1949

The showing of "Films not generally seen" at the March meeting had been a success and was well attended.

Two Members and one Associate were enrolled in the Division.

THE FELLOWSHIP

The Council announces that nomination forms for the Fellowship of the Society are now available. Nominations are required to be submitted not later than July 1st next.

Attention is drawn to the requirement that a nomination shall be supported by five Members, and to the fact that not more than five Fellows may be elected in any one year.

R.P.S. ANNUAL EXHIBITION

Preparations are already in hand for the 94th annual exhibition of photography organised by the Royal Photographic Society, which will take place at their premises at 16 Prince's Gate, London, S.W.7, next September. As usual, it will be separated into a pictorial and colour section, and a scientific and commercial group. The last day for receiving entries is July 23rd and entry forms may be obtained from the Secretary at the above address.

BRITISH KINEMATOGRAPH SOCIETY

ENTRANCE FEES AND SUBSCRIPTIONS

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The Subscription of persons joining after June 30th of any year is halved for that year.

Members, Associates and Students are entitled to attend meetings. Only Members are entitled to hold office or to vote.

The journal of the Society, British Kinematography, is supplied free of charge to Members and Associates; subscription to Students 16s. per annum (otherwise 37s. 6d. per annum).

Proposal form on application from the Secretary
PERSONAL NEWS of MEMBERS

Members are urged to keep their fellow members conversant with their activities through the medium of British Kinematography.

LESLIE MURRAY, on the incorporation of Universal News in the Rank Organisation, has gone over to Gaumont British News.

HAROLD L. SMITH, of Corsham, a founder-member of the 16 mm. Film Exhibitors' Guild, is putting his Wiltshire circuit up for sale owing to ill health.

IAN DENNIS WRATTEN, Past-President of the Society, has been re-elected a Vice-President of the R.P.S.

ALEXANDER RUSSELL BORLAND, M.A., M.B.K.S.
Died March 22nd, 1949.

The sudden death of A. Russell Borland at the early age of 40, has halted one of the most colourful careers in the field of visual education. His unfailing belief in the value of visual aids for education led him to give up the teaching profession in 1938 to join, as Director, the Scottish Film Council and Scottish Central Film Library. Under his direction considerable and practical progress was made for the inclusion of educational films in the school curriculum.

At various times his duties included the organisation and management of the Kinema Theatre at the Glasgow Empire Exhibition in 1938; the Scottish Evacuation Film Scheme in 1939, when film shows were given to 150,000 evacuee children; and later the organisation on behalf of the British Film Institute of the Amateur Film Festival.

After serving for three years as Educational Officer in the Royal Air Force, he organised in 1946 the Scottish Celebration to mark the 50th Anniversary of the first public showing of films in Britain. In the same year he joined British Instructional Films, Ltd., as Controller.

Many will remember his unassuming personality and unwavering belief in the development of the balanced use of visual aids of all types as a normal feature of modern education. Under his guidance a valuable contribution was made in the production of educational films, film strips and other visual aids. It is not too much to say that the present firmly established position of visual aids in education owes much to the untiring efforts of Russell Borland.

G. F. G.

PERSONAL ANNOUNCEMENT

VINTEN KI LOCATION CAMERA.—Unused; three lenses on turret. £85.—YATES, 56, HALLAM STREET, W.1.

Small announcements will be accepted from Members and Associates. Rate, 4d. per word, plus 2s. for Box No. 4 required (except for Situations Wanted). Trade advertisements, other than Situations Vacant, not accepted.
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LECTURE PROGRAMME
May, 1949

May 7 Visit to A.B.P.C. Studios, Elstree (by ticket only)
May 25 ANNUAL GENERAL MEETING, 6.15 p.m., at the G.B. Theatre, Film House, Wardour Street, W.1; followed at 7.15 p.m. by a Joint Meeting with the A.C.T. "Thirty Years of British Film Production," by Sir MICHAEL BALCON, M.B.K.S.

MANCHESTER SECTION
Meeting to be held at the Lecture Theatre of the Manchester Geographical Society, 14 St. Mary's Gate, Parsonage, Manchester, commencing at 10.30 a.m.
May 4 Discussion Meeting.

NEWCASTLE-ON-TYNE SECTION
Meeting to be held at the Lecture Theatre, Newe House, Pilgrim Street, Newcastle-on-Tyne, 1, commencing at 10.30 a.m.

LEEDS SECTION
Meeting to be held at the Y.W.C.A., Cookridge Street, Leeds 1, commencing at 10.30 a.m.
May 7 "Bloomed Lenses," by D. F. BURNETT, M.A., A.Inst.P.

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STEREOSCOPIC MOTION PICTURE SYSTEMS

Edwin H. Wright, M.B.K.S., F.Tel.S., F.R.S.A.

An abridged, non-technical account of research and development jointly by Three Dimensional Films Ltd., and Stereoscopic Motion Pictures Ltd.

THERE seems to be no diversity of opinion in that practically all motion picture films and film strip subjects will gain immensely in educational efficiency, speed, accuracy, and entertainment value, if they can be presented both in natural colours and in three dimensions instead of two. This achievement has been sought by physicists, optical technicians, and kinematograph engineers since the possibilities of the motion picture became first realised.

Most of the known methods of stereoscopy can be made to function quite well in the laboratory or workshop; some of them without the aid of spectacles or analysers. The latter systems are generally known as "grid-systems," or parallax stereograms.

Parallax Stereograms

In these, the necessary condition of presenting each eye with an isolated view of its correct perspective (which incidentally is fundamental to any stereoscopic system) is accomplished by dissecting the picture into adjacent or interlacing vertical strips, each strip carrying alternately its quota of right- or left-eye perspective information. Then, by utilising one of the many optical or prismatic methods of directing the strips of information to the correct eye only, the object of stereoscopic vision is achieved. The "screen-strips" may be of reflecting wires, plastic or glass; or may consist of mathematically calculated prismatic arrays or combinations.

Such systems must rely for their functioning upon accurate angles-of-view-point, concomitant with distance from the screen; and to avoid blind spots or parallaxial double-images, special theatre seating arrangements are needed, which result in severe loss of seating capacity. Still worse is the disadvantage that the viewer must keep the head quite still in order to avoid "scintillation" or intermittent loss of accurate viewing-position, this effect varying critically with distance from the screen; whilst front-seat viewers experience loss of definition, due to obtrusiveness of the strip-division lines, and the greater perception of unavoidable image "break-up." Further, in most of the parallax stereogram methods the requisite extreme accuracy of registration between projector and screen is impractical under theatre conditions without recourse to some such system as, for example, electronic position-control for each strip; which would add tremendous expense without restoring lost seating capacity.
The Russian system, so much in the news recently, falls into this category, with its early tonnage of interlacing viewing-wires, and later, its multiplicity of reflectors forming the screen.

To be successful, any system for mass viewing must require neither adjustment nor strain on the part of the viewer, who must be free, also, to move; and it must be simple and foolproof or it will fail. For these reasons, serious work turned towards the system known as the anaglyph.

Two-colour Anaglyphs
The most commonly known form of anaglyph consists of the superimposed presentation of differently coloured binocular views correctly selected by each eye through appropriately coloured filters. For example, a red image on a white screen is invisible to the eye, if the eye be covered by a red filter, but if we view the red image through a blue filter we see a "black" image.

Conversely, a blue image on a white screen would be invisible through a blue filter, but would be visible through a red.

Disadvantages were found, however, in the two-colour anaglyph which far outweighed its advantages. The lights and shades of normal photographic images are composed of minute silver particles which, in effect, vary the opacity of the film. Thus on projection, even through colour filters, such images are built up of much light, less light or no light; and since this will be equivalent to blacks and greys against a coloured screen, the blacks are visible through both filters, irrespective of their colours, and as a result, each eye perceives both its correct and incorrect perspective, resulting in parallaxial double-images. Thus it is essential that the film itself should carry dye images of the appropriate colours. Further, since the stereoscopic functioning of the system depends on projection of two colours only, obviously it can never cope with natural colour films.

A further serious drawback prohibiting the use of the two-coloured anaglyph is the danger of eye-strain, due to the difference in wave-length of the red and blue light rays, which focus, through the normal chromatic aberration of each eye-lens, at different focal planes.

Polarised Anaglyphs
The two-colour anaglyph was, therefore, ruled out; and the possibilities
of polarised light were examined. This working upon a "light or no light" principle throughout the visible spectrum, promised to take care of either normal opaque images, or the translucent images used in colour systems.

The polarised light system which was chosen for development falls into the anaglyph class; but utilises plastic sheet polarising material (the latest types being practically water-clear) instead of coloured filters, for viewing. Polarised light projection is employed, thrown upon a "silver" or metallic-sprayed screen to avoid depolarisation.

**Alternate Frame Camera**

The first step was to design a motion picture camera to provide left and right eye views upon normal film stock. The "alternate full frame" system was initially adopted, in order to retain full image space for each picture and to preserve the aspect ratio, thus avoiding the loss in photographic area which must accompany any attempt to place the binocular images side by side upon a single frame without unacceptable prismatic modifications to the projector. As will be seen, this advantage was to prove of less importance than a number of disadvantages which it introduced. The first experimental camera was constructed as shown in Figs. 1 and 2.

It will be seen that with the spinning mirror A in the position shown, the left eye image (looking from the camera) will pass without interruption into the lens L, and will be recorded upon a single film frame.

---

**Fig. 2. Alternate-frame Camera—plan.**
The film now moves forward one frame, during which movement the spinning mirror $A$ rotates into position in front of the lens, at an angle of 45 deg. thereto, parallel with the stationary mirror $B$, as shown in plan Fig. 2.

The right eye image seen by mirror $B$ is now reflected into the spinning mirror $A$, and from thence into the lens $L$, being recorded on the film frame succeeding that which was previously exposed.

In order to adjust parallax or image displacement at any selected plane of the view photographed, the static mirror $B$ may be swung upon its axis in either direction out of parallel relationship with $A$, by means of control knob 43—thus moving one image only, of the binocular pair, to left or right; whilst the binocular separation, or distance between the "eyes" of the camera may be reduced or exaggerated with respect to the normal 65mm. by adjustment of control knob 51, which moves the static mirror $B$ nearer to, or further from the spinning mirror $A$.

Thus we obtained a film with alternate binocular viewpoints as shown in Fig. 3.

Alternate Frame Projector

A standard projector was then modified by polarising its light beam and arranging to alternate the plane of polarisation intermittently in synchronism with the picture-shift mechanism, so that upon the screen simultaneous changes of viewpoint and polarisation plane occurred 24 times per second. The set-up, as in Fig. 4, functioned as follows:

The light-beam passed through the polariser, 3, which consisted of a plurality of juxtaposed Nicol prisms. After passing through a single image-space of film 5 (Fig. 4) together with an "optically active" half-wave plate comprising a single "frame" space of the endless band 7, the polarised beam carrying its picture was projected on the screen 9. The intermittent motion then operated, and the film 5 shifted down, together with the half-wave plate in the endless band. The succeeding viewpoint was now presented through the succeeding half-wave plate in the band; but since this plate was in optical orientation 45 deg. from its predecessor, the polarisation plane of the light was turned by 90 deg. to and fro.
The unit 11, in Fig. 4, was an auxiliary half-wave plate mounted on the lens, for immediately reversing both polarisation planes into register with viewers' spectacles in the event of mis-threading of projector, or wrongly-made film-joint; since by flicking 11 round 45 deg. one way or the other, the planes of polarisation were instantly turned 90 deg.

Owing to the non-permanent nature of the endless band 7 in Fig. 4, the system was modified to that shown in Fig. 5; wherein the polariser is indicated for simplicity as 12a. Here, a half-wave plate was mounted in a geared holder 13 which was driven by flexible cable and pinion 14 and 16 of correct gear ratio from the intermittent sprocket shaft 15.

Other Experimental Systems

Other systems were attempted as shown in Figs. 6, 7, 8 and 9. Fig. 6 represents a continuously rotating shutter, fitted with a plurality of half-wave plates, progressively oriented relative to each other on the one half; whilst the other half is left open. Polarised light from the projector lens passed in its own plane, straight through the open half; but whilst the "activated" half passed in front of the lens, the plane of the light was turned 90 deg.; and these changes took place during each picture shift. For 100% plane-rotation efficiency an infinite number of progressively oriented plates in the active half was found to be necessary; and for that reason it was discarded in favour of a single-plated drum, rotating at right angles to the plane in which the flat shutter was spun. This is sketched in Fig. 7, and was very much better, since the mechanical movement of the half-wave plate remained constant in direction through the beam.

Another "intermittent" system as in Fig. 9, was tested, in which the half-wave plates, 28 and 28a, revolved around a stationary polariser 29, thus turning the polarisation plane in synchronism with picture-shift. A still further "front of lens" test was made by means of Fig. 8, which was an electromagnetically oscillating carrier, alternately interposing differently oriented half-wave plates into the beam.

On thoroughly testing, it was confirmed that the normal film speed of 24 frames per second, giving only the continuity of light for each eye equivalent to 12 pictures per second, was insufficient to take full advantage of the essential effect of persistence of vision, and introduced intolerable flicker. This was because each eye became "blacked-out" during the period of
exposure to the other eye. Increase of film speed practically cured the defect, but could not be specified, as it threw the sound-track speed outside normal practice, resulting in sound-distortion; thus destroying any possibility of making the machine universal in operation. In addition, the extra film cost of double-speed running was found sufficient to condemn the practice; whilst the alternating black-out of each eye reduced the apparent total of illumination to 50% of that transmitted by the polariser.

**Light Efficiency**

A 50% loss of light was already occurring in the polariser itself; every type obtainable being tested. This particular loss was fundamental to all types known at the time. Only the "extraordinary" rays were transmitted, comprising 50% of the light, the other 50% comprising the "ordinary" rays being lost by absorption, refraction and deflection from the polariser.

![Fig. 6. Continuous Motion Shutter.](image)

![Fig. 8. Electro-magnetic System.](image)

Trouble was also experienced due to destruction of the polarisers from the heat of the arc light; and this applied to every type tested until the well-known "glass plate pile" was resorted to. This was constructed of Chance Bros.’ high silica heat resisting glass, and gave no trouble.

It may be questioned here why plastic sheet polarising material was not used, being placed in front of the film or projection-lens where it would receive less heat. The reply is twofold. Firstly, it was noticed the intense actinic rays of the arc appeared to cause deterioration—probably due to bleaching out of the iodine constituent; secondly, this could not have contributed toward recovery of the 50% light-loss already explained. It was realised this problem would have to be attacked; and that it would be better to attack it in the unobstructed portion of the beam.

Of passing interest, another defect was discovered, though of such minor importance in presentation of entertainment films, that in demonstration it actually passed unnoticed. Since each image of the stereoscopic pair was photographed alternately along the film, each one of the pair was a fraction of a second out of phase, in time of recording, with its neighbour. Thus, only the motionless parts of the picture were accurately matched as binocular pairs; any objects in motion being slightly mismatched.
Fundamental Requirements

Some useful conclusions were now drawn. Firstly, flicker in any increase above normal could not be tolerated; therefore, alternate black-out of each eye must be avoided entirely, together with its resulting light-loss. Secondly, the polariser must be not only fire-proof, but of light weight, diminutive size, and capable of transmitting both ordinary and extraordinary rays. Lastly, there must be no mis-matching in terms of motion between consecutive binocular image-pairs.

Since it was obvious that any alternating frame exposure system fundamentally introduced flicker and mis-matching, it became apparent that both left and right viewpoints must be photographed, as well as projected, simultaneously. This involved major modifications and disappointing sacrifice of much previous labour.

Double-frame Projector

Taking the projector first, and referring to Fig. 10, the first stages were accomplished by lengthening the film gate aperture 14 to accommodate a pair of frames together, one above the other; and the polariser 12 was doubled in height to cover both images. A half-wave stationary plate 15 which turned the polarisation plane 90 deg. was inserted in front of the area of polariser covering only one of the frames; thus attaining the oppositely polarised pair of projections. Condenser, objective, etc., were suitably modified.

The manually-operated half-wave plate 16 was still retained for instant correction of mis-registered film-joins, etc.; and the two simultaneously projected images indicated by the straight-through parallel lines were projected in juxtaposition on to the mirror 20. From here, one picture was reflected to mirror 21 and thence to centre of screen 19; and the other to mirror 22, which by hinge 24 was adjustable to throw its image into register with that of mirror 21.

Unfortunately, a further problem was introduced: in order to keep the left and right eye images always polarised in their identical planes, double the length of picture-shift seemed an absolute necessity, resulting in serious alterations to the standard projector mechanism, and doubling the amount of film to be used. Such modifications were out of the question; yet a method of avoiding them had to be found. Essentially, it was now required to exchange the polarity of both frames simultaneously and at a speed of 24 exchanges per second; but in synchronism with standard single picture-shift.

Fig. 10. Principle of Double-frame Projector.
Rotating Half-wave Plate

Ultimately it was found possible to achieve this, at the same time abolishing the auxiliary Maltese cross motion, and gaining greater simplicity. A spinning optical unit was conceived which not only functioned as would a stationary half-wave plate, but actually left the altered light-planes stationary whilst itself spinning in the beam.

Two half-wave mica plates in the form of discs were taken; and their optically active axes with reference to plane-polarised light were oriented against each other until they were 90 deg. in opposition. These plates were then sealed together, face to face, and functioned as follows:

The first plate turned the plane of polarisation progressively during its spinning motion, by 90 deg., this being quite normal. The second plate, being optically reversed, cancelled the mechanical effect of the motion, and with it, the progressive nature of the optical change; so that whilst the double unit transmitted the beam, the polarisation plane was turned, and remained set at 90 deg. different angle from that obtaining in its absence. Thus, by dividing the composite disc into two semi-discs and discarding one of them, it was only necessary to spin continuously the remaining semi-disc alternately with normal single picture-shift, into and out of the double-beam carrying the two images. This unit (18, Fig. 10) exchanged the two planes of polarisation simultaneously, and abolished the need for any auxiliary intermittent motion; or devices such as Figs. 4, 6, 7, 8 and 9, which it quite superseded. Modification to the standard picture-shift system was thus avoided, and instantaneous plane-changing accomplished.

Improving the Polariser

Progress had now eliminated flicker, presented both viewpoints simultaneously, eliminated intermittent motion of either polariser or half-wave plates, and avoided double-frame picture-shift; but the system still suffered from 50% light loss in the polariser, plus its far too bulky pile of plates; which in order to accommodate the full diameter of the light-beam from the condenser measured (when sloped at the polarising angle) approximately 12in. × 8in. × 1in. thick.

In attempts to reduce the size of the polariser, units constructed with specially made thin films of glass were tested; but the object was defeated by the naturally tight adherence together of the films driving out the
intermediate air layers; thereby preventing the successive changes in refractive index essential throughout the pile for its function as a polariser. Attempts to find equivalent fire-proof materials sufficiently different in refractive index for replacing the air layers, completely failed.

Extremely thin mica plates, other materials and "coatings" were tested without complete success; but partial success was obtained with thin mica plates, and as these were virtually fire-proof, this material was persevered with.

**Polarisation by Mica Laminae**

Eventually it was found, that by careful thermal processes, a lamina-separatad pile from the solidly-bound strata of raw mica material could be fabricated. Correct processing resulted in microscopical detachment of the plates, reticulation of surfaces maintaining the air-spaces; thus permitting the required interleaving changes in refractive index. Good polarisers of thickness as low as .0005 in. have been obtained by this method.

A fire-proof polariser of ideal thickness had now been obtained; but due to the polarising angle at which it had to be used with reference to the light beam, it was still a little too great in length. This was reduced to reasonable proportions by sandwiching the laminations between heat-resisting glass prisms as indicated by Figs. 11 and 12; from which it will be seen that due to the refraction of the incident and transmitted beams I and T, by the prisms ABC and DEF (Fig. 11) it was possible to reduce the acuteness of the angle of the polariser proper in relation to the film-gate. The splitting of the incident ray I into the transmitted ray T and reflected ray R at the point S (Fig. 11) is shown by the magnified section S in Fig. 12.

The complete instrument now slipped comfortably into the gate-aperture of a standard projector; but the 50% loss of light fundamental to any known type of polariser had still to be contended with; since only the transmitted rays (in this case vibrating in the plane of the diagram) are normally available for use. The reflected rays (approximately 50%) oppositely polarised, were, of course, still beyond reach.

Attempts to recover and use these lost rays were next initiated, and numerous "freak" polarisers were designed. Ultimately success was achieved; and the new polariser became "frozen" as in Fig. 13.

Here, the shape and size of prism DEF in Fig. 11 is modified to the construction L, M, N, O, P, Q, of Fig. 13; and the previously lost rays R now impinge on the mirror-face P, Q, of the modified prism. From here, they are reflected as shown to the exit face N O; so that both the 50% transmitted rays and the 50% reflected rays are available for service; both being polarised oppositely, and both in juxtaposition; the polariser being fire-proof, of ideal dimensions, and impervious to actinic rays.

**Double-beam Polariser in the Projector**

Having fulfilled so many of the conditions considered essential, fresh projection equipment was ventured upon, the schematic diagram of which
is illustrated in Fig. 14; the normal picture-shift shutter being omitted for the sake of clarity.

The double-beam polariser 12a, as explained, illuminates both left and right frames (A and B) simultaneously, but each oppositely polarised. The picture shift remains single, standard; but when the left-eye image is pulled down before the "right-eye polariser," the semi-disc half-wave plate 26 (18 in Fig. 10) has now spun into the double beam. This instantly rotates the right-eye polarised light into the left eye plane, holding it set, while spinning, and thus corrects the single picture-shift error. Since the semi-disc is covering the beam from the "left-eye polariser" as well, it simultaneously changes the left-eye polarised light to its correct orientation for the right eye frame which is now in position. Upon a further single picture-shift occurring, the semi-disc 26 has spun entirely out of the beam so that both planes exchange places and return to their original orientations. The sequence repeats itself throughout the film.

It will be noticed the half-wave "Corrector-plate" 16 is still retained; whilst an additional optically active plate (quarter-wave) was introduced at 25 to change the vertical and horizontal plane-polarised beams into clockwise and anti-clockwise circularly-polarised beams respectively. This provided the advantage of avoiding loss of stereoscopic effect if the viewer leaned over sideways to anything approaching 45 deg.; but was, by general consent, dropped as an unnecessary refinement, since film-audiences do not generally move their heads in such directions sufficiently to notice any change. The bi-prism 29 in Fig. 14 displaced the mirror-system for screen image registration.

Practical Objections

Whilst admitting the results now obtained were extremely good, creating extremely favourable impressions upon demonstration, dissatisfaction was still felt. Unfavourable reaction was "sensed" among some representatives of the film industry, to the extra mechanism introduced by the semi-disc half-wave plate, in spite of its smooth spinning. Frowns, too, were conferred upon the lengthened film-gate, on the grounds of non-standardisation. Further, the mis-matching of the alternately photographed frames, though still unnoticed by visitors, had not been dealt with.

Eventually it was found the only practical way to return to standard gate size, without duplicating both film and projector, would be to sacrifice the previous advantages of full frame images; and to place smaller binocular images side by side upon single frames. This was no longer considered a retrograde step, since so many achievements had been made to compensate.
Re-design was therefore undertaken; the camera was entirely re-cast, and built upon the basis of the rough sketch, Fig. 15.

Quarter-frame Camera

It will be seen the binocular images are recorded side by side upon each single frame or image space, by means of the optical binocular unit, and gate mask. These images retain the normal picture aspect ratio, and therefore each comprises approximately 25% of full-frame surface area. Parallaxial lens adjustment is provided at P. This moves the lenses nearer to, or away from each other in guides mounted on the prism-faces; and enables the photographer to determine in advance how far behind, or in front of the screen, any given plane of the view shall appear on projection. The layout produces a film as also shown on the diagram.

The unexposed portions of the frame above and below the pictures are transparent in the negative; therefore black in the positive print, and form their own masking borders on projection. Everything behind the camera-gate remains normal; and the binocular unit may be taken out of the lens-mount to exchange for others of different ocular separation or focal length. Tests have indicated that the use of fine-grain film satisfactorily counterbalances the effect of the extra magnification required in projection; which is accomplished by change of focal length (reduction) of the projector objective. When desired, the stereo unit may be replaced by a normal single lens, and the frame-dividing mask removed; so that the camera reverts to normal operation.

Quarter-frame Projector

A reasonably efficient design of projector now became possible, since there was no longer need for any additional moving parts. The system became entirely static, involving the mere addition to the normal projector of simple and stationary optical units. Fig. 16 shows the present projection scheme in diagrammatic form. Its results are described by disinterested viewers as splendid; but further improvement is anticipated.

The whole of the light source is condensed to the area of the incident aperture of the polariser at P, this aperture being approximately 25% of full-frame area; and in transmission through the polariser it is split to cover both similar-area frames of the film.

Using a normal projection lens, as for flat projection conditions, it is found that two images are projected on the screen, side by side; each image covering approximately 25% of the normal screen area, and be it noted, approximately 100% higher-than-normal in light intensity; due to the full illumination available from the arc being concentrated upon a polariser.
aperture one-quarter of normal "spot-size." After superimposing the two images by the prismatic unit $Aa$ and $Bb$, it will be found, considering the intensity of the light varying inversely with area, the projection objective may be changed to fix the picture area at 70% of the previous "flat" normal without decreasing the light intensity. Or if a decrease in light intensity can be tolerated, the picture may be enlarged to previous "normal" size. To change over to "flat" film projection, the operator has only to swing the polariser and prismatic unit out of the beam, exchange the lens, and re-centre the light by adjusting the arc.

Conclusion

The system is respectfully submitted to the Industry as the most simple, least expensive, and most efficient solution to the stereoscopic motion picture problem yet conceived. It is 100% more efficient in light than any competitive system known; and is commended to the Film Industry in the belief it is a thoroughly practical and easily operated additional attraction to the public. It should yield results for many years to come, beyond all comparison with the relatively low cost of modifying existing equipment.

NOTE.—The foregoing work is the subject of 65 patent applications, patents pending, and patents granted in Great Britain and abroad.

BOOK REVIEW

THE BRITISH JOURNAL PHOTOGRAPHIC ALMANAC, 1949. 592 pages plus photogravure supplement. Henry Greenwood & Co., Ltd. 5s. and 7s. 6d. (cloth bound).

With its annual increase in size the B.J. Almanac has increased its range. The uses and merits of the new facilities and apparatus are described, and reviews and illustrations of these new goods occupy a third more pages than in any previous post-war Almanac.

The change in attitude towards 16mm. and smaller work is reflected in the new title of "Narrow Gauge Cinematography" for the useful section formerly referred to as "Sub-Standard." The increasing importance of colour photography is indicated in editorial and advertisements of many firms offering colour facilities for the first time.

Instead of looking into the practice and future of some aspect of photography, the editors give us a comprehensive historical survey in "The Story of the Latent Image." Versatile knowledge is illustrated in articles by Richard Willcock and T. F. Langlands, both contributors to the 1945 and 1947 issues. Others cater equally for the amateur and professional, and the invaluable tables and miscellaneous information complete this indispensable handbook.

A. W.
MODERN KINEMA EQUIPMENT

I. THE G.K. 20 and 21 PROJECTOR OUTFITS

At the meeting of the B.K.S. Theatre Division, held on November 21, 1948, there was presented the first of a series of papers and demonstrations on projection and sound equipment.

I. PROJECTOR DESIGN

N. J. Addison, M.B.K.S.*

When the design and manufacture of these equipments was first proposed, it was decided that each outfit was to be a complete unit, and yet every item—lamp, projector, etc.—was to be perfectly adaptable to other manufacturers' equipment.

Consideration was given to the projectionist’s convenience and to avoiding the necessity of operating switches being distributed around the walls of the projection room. Provision is made at the front of each stand for cable entry, and all the internal wiring is run in the factory and terminates at a block situated near the cable entry point. Installation can thus be easily and neatly carried out.

The projector is built upon a rigid cast frame, maintaining gear alignment, and also acting as the oil sump. The mechanism operates under a constant stream of oil circulated from a pump situated in the base; the oil is filtered whilst the projector is being filled and is also constantly re-filtered whilst in circulation. All spindles receive an adequate supply of oil and are carefully finished and grooved.

* A. Kershaw & Sons.
Change-over System

A "built-in" change-over device has been incorporated, making use of the safety shutter which is mounted in the gate and immediately behind the film path. The safety shutter is jointly operated from a governor mounted on the shutter shaft and a robust short stroke magnet housed in the shutter case. This magnet when energised pulls down an armature connected to the actuating lever of the shutter, which, with the centrifugal force from the governor, lifts the safety shutter. Both these forces must be exerted in order to lift the shutter, and if either the magnet or governor cease to exert its pull, the shutter must fall; thus the function as a safety shutter is not interfered with. With the switch circuit employed the magnet can be operated from either machine, and if necessary, a main selector switch can be provided and the change-over operated from any pair of a three-machine installation.

![Fig. 2. Mechanism of G.K.21 Projector.](image)

Another feature when considering the completeness of the equipment is the provision of a "built-in" fire extinguisher. This comprises a sealed cylinder of carbon dioxide gas, with a spring loaded piercer mechanism held in check by a celluloid loop. Any fire is quickly transmitted by a cotton fuse to this loop, which when broken, allows the gas cylinder to be pierced; the gas is transmitted through pipelines to several points along the film path, immediately extinguishing the fire and at the same time knocking off switches connecting the power supply for both driving motor and arc lamp, so shutting down the complete equipment.

Arc Lamp

The light output enables the screen illumination requirements in the
largest theatres to be easily met. The 16in. diameter mirror in the "Light-master" lamp provides the largest possible collection angle, and yet the larger mirror-to-crater distance, nominally 6in., results in substantial freedom from pitting and considerably reduces the risk of mirror breakage. Indeed, it has been found quite safe to operate this lamp at projection rakes of as much as 30 deg.

Another not always so obvious advantage, is that the larger mirror is less critical for arc focus than the more usual smaller diameter. The formation of a satisfactory crater is assured by the energised magnet mounted behind the mirror.

A mirror of this specification immediately calls for the use of a lens of wide optical aperture. The lens is of the standard 2.781 in. diameter, and the projector is so designed as to leave this diameter clear to within 1\(\frac{3}{4}\) in. from the film path, thus allowing lenses of short back focus to be used. In addition, the mounting provides for the use of large stepped lenses which maintain constant aperture at all focal lengths. The lens holder itself is rigidly mounted, but fitted with a sensitive focusing attachment, and is optically set in alignment with the mask plate aperture before leaving the factory.

**Shutter Efficiency**

In the design of the shutter, the only variable is the "twilight" period during which the blade is cutting the beam of light. Thus to increase shutter efficiency, this twilight period must be reduced. There are two obvious methods of doing this: the first is to have twin shutter blades rotating in opposite directions running at normal speeds and cutting the beam from both sides; this in theory is quite sound, but in practice it has been found very difficult to mount twin shutters in such a way that they are both reliable and quiet in operation.

The second method, which is the one incorporated on the G.K. 21 projector, is to mount a single-bladed shutter running at twice the normal speed. The nominal 90 deg. cut-off blade must, of course, now subtend an angle of 180 deg., and in view of the high running speed necessitates careful balancing and rigid mounting.

The G.K. 20 mechanism uses a conventional two-bladed shutter.

**Picture Steadiness**

There appears to be no recognised standard of picture steadiness; the only available figure is one, believed to be of Dutch or German origin, which stipulates less than .3% of the picture width for weave and less than .3% of the picture height for jump. After much investigation and experiment, this figure has been reduced to .10% in each case, and every projector is tested and released at that figure. It has proved in practice a perfectly satisfactory standard.

To attain this figure, however, production limits of 0.1 to 0.2 mils have been imposed in the intermittent unit. The intermittent sprocket itself is of the highest standard for tooth spacing, profile and finish, with, of course, a truly concentric mounting on the spindle.

The positioning of the guide rollers and pressure skates has been carefully determined. The correct spring tension of these skates has also been carefully determined and they are set as a complete assembly and yet in correct balance with each other.

The racking system incorporates automatic shutter phasing; "picture creep" is impossible, due to the two-way clutch in the masking knob and the mounting of the masking gear on an eccentric spindle, assuring elimination of all backlash.

Film damage has been avoided by the high finish of all parts which contact
the film. All sprockets are hardened and ground, with the corners of each tooth chamfered to avoid sharp corners cutting the film. All rollers are undercut and run on recessed spindles, thereby reducing bearing friction to the minimum, and ensuring their rotation when contacted by the film.

2. SOUND EQUIPMENT

A. S. Pratt, M.B.K.S.*

The Gaumont-Kalee post war sound equipments are entirely new, the main design objectives being reliability, simplicity, accessibility and first class performance.

In the interest of reliability all components are rated for continuous tropical use and all valves are run well within their makers' ratings for continuous operation.

G.K. 21 Amplifiers

The No. 21 amplifier equipment is normally available in three forms:

1. Single channel 30-watt.
2. Dual channel 30-watt.
3. 60-watt.

Each uses the same basic units which consist of steel panels on which the components are mounted. A feature of the design is the fact that all the wiring is kept in one plane; this gives the maximum accessibility to all connections and components.

The layout of each panel has been carefully studied so that the wiring is almost a circuit diagram, thus making servicing a simple matter.

30-watt Single Channel

In the simplest, the 30-watt single channel equipment, one voltage amplifier is used, normally mounted on the front wall of the projection room between the two projectors. This unit consists of a three-stage voltage amplifier panel and a volume control panel. The photo-cells of the sound-heads are connected by low capacity concentric cables to the voltage amplifier unit, change-over being effected by switching from one cell connection to the other. A remote control unit to operate change-over and volume control is provided so that complete control is available at both operating stations.

The remainder of the amplifier system, consisting of a power amplifier panel, power supply panel, meter panel, dividing network, and exciter lamp supply panels, is mounted on the main amplifier rack. The power amplifier, which is rated for 30 watts undistorted output, employs four 6L6G or equivalent tubes in the power stage. The power supply panel which provides H.T. and L.T. for the whole system uses two U52 or equivalent tubes. A separate exciter lamp rectifier panel is used to supply each sound-head. Selenium rectifiers are employed, followed by two-stage choke input filters to give adequate smoothing.

In the mains transformers, untapped primaries are used, wound for 230 volt supply, because it has been found that greater reliability can be achieved with untapped windings. In order to cope with the variety of supply voltages that exists, the amplifier system is fed through a switch fuse distribution unit, which houses an auto-transformer to step the incoming voltage up or down to 230 to suit the amplifiers. The standard supply panels are suitable for 50 and 60 c/s mains; alternative units designed for operation on 25 c/s upwards are available.

The dividing network is of the constant impedance type and the cross-over frequency is 500 c/s. Should the treble units fail, the treble portion of the

*Chief Designer, British Acoustic Films, Ltd.
dividing network output may be switched to the low-frequency horns, enabling the programme to be carried on with the maximum intelligibility.

30-watt Dual Channel

The dual channel 30-watt system consists, in the main, of the same units as the single channel system just outlined, most of them duplicated. A separate voltage amplifier unit is used for each machine, and two complete power amplifiers and supply units are provided. An emergency switch is arranged so that if a voltage amplifier fails, the cell lead connected to it can be switched across to the other amplifier.

Two amplifier racks are provided, each housing a complete set of power amplifier panels, which are standard and interchangeable with those used on single channel equipment. One rack also contains a control panel that enables either amplifier to be used as desired.

60-watt Channel

The 60-watt equipment is almost identical with the dual channel 30-watt equipment. The control panel provides facilities for either amplifier to be used separately, or for both amplifiers to be connected in parallel; in the latter condition a specially designed transformer is automatically switched in circuit between the power amplifiers and the loudspeakers to maintain correct matching.

A power level meter is provided, together with two gain controls, one in the input circuit of each power amplifier, so that the sensitivities of the two channels can be precisely matched. A monitor amplifier panel is also available and is normally used on dual channel and 60-watt equipments.

Frequency Response

The overall frequency response of the amplifier systems is flat in the useful range, that is, from 50 to 8000 c/s. The desired overall frequency characteristic is obtained by using a relatively large slit width in the sound-head, thus attenuating the higher frequencies.

Our experience indicates that the reproducer frequency characteristic recommended by the Academy of Motion Picture Arts and Sciences gives the optimum results under most conditions, and a slit width is therefore chosen that gives this curve. This method of obtaining the desired overall frequency characteristic has the advantages of simplicity and greater light flux on the photo-cell, hence better signal-to-noise ratio; it requires no electrical filter components and it gives the desired results with a flat amplifier characteristic. This latter point means that the frequency characteristics of other inputs, as, for example, the non-sync., can be adjusted to give the optimum results, and do not have to be handicapped by an electrical characteristic better suited to some other input.

G.K. 20 Amplifiers

The No. 20 amplifier equipment consists of a voltage amplifier unit, which is normally mounted on the front wall between the machines, and a power amplifier unit.

The voltage amplifier unit uses two double-triode valves, giving in effect four amplifier stages, the first three of which are used in a more or less normal manner, whilst the second part of the second valve is used as a cathode follower in order to provide a low output impedance.

The volume control is a grid circuit potentiometer immediately preceding the cathode follower, and provision is made for remote control of the volume control by means of Bowden cables. The amplifier chassis is mounted in its case in such a way that it can be hinged forward for servicing purposes without disturbing any connections—if necessary, whilst in use.
H.T. and L.T. power supplies are derived from the power amplifier. In the power amplifier cabinet there are two chassis, the larger being the power amplifier unit and the smaller the exciter rectifier unit; the former contains both the power amplifier itself and mains transformer and smoothing components. The power stage consists of two 6L6G or equivalent tubes connected in push-pull, together with a single-ended stage using a similar valve to feed the monitor. The amplifier is rated at 20 watts output, the actual power available from the main output being 18 watts and the power available from the monitor stage being 2½ watts.

Two double-triode valves are used in the early stages of the power amplifier, the two halves of the first one as normal amplifiers and the second one with its two halves strapped together as a phase-splitter to feed the push-pull output stage. It will be seen that apart from the rectifier valve, only two types are used in this equipment, thus keeping to a minimum the number of spares that have to be carried.

Exciter Supply

The exciter rectifier chassis uses a selenium metal rectifier and a two-stage choke input filter, and provides enough output to feed one exciter lamp only. On this equipment, in the interests of economy, change-over is effected by switching the exciter lamps, the unused exciter lamp being kept warm by a pre-heating current derived from a winding on the mains transformer. Provision is made in the amplifier to short-circuit a resistor normally in series with the pre-heating supply, so that in the unlikely event of the exciter lamp rectifier system failing, the show can be kept going by running on the pre-heat supply.

Dual Channel

The No. 20 amplifier equipment is available in dual form, in which case all components are duplicated. Two voltage amplifier chassis are used, each fed from, and connected to, its own power amplifier unit. A switch enables either voltage amplifier to be connected to the soundheads, as desired, and a control unit associated with the power amplifiers enables either to be selected.
A somewhat more complicated control unit is available which converts this equipment into a 40-watt version, the switching enabling either power amplifier to be used separately or both of them together. As in the 60-watt equipment, proper provision is made for maintaining output impedance matching when changing from 20-watt to 40-watt operating conditions.

**GK 21 Soundhead**

The type 83 soundhead, which is used in the Gaumont-Kalee 21 equipment is, like the amplifier system, of entirely new design. It has been designed to fit into a unified projector assembly, but at the same time the layout has been so arranged that the soundhead can be used on other types of projector stand having the conventional neck.

Simplicity of design has been one of the major considerations and the liberal use of stainless steel and light alloy die castings, and the provision of very large bearing surfaces, will ensure long trouble free life.

Constancy of speed at the scanning point is ensured by a mechanical filter consisting of the compliance of a free loop of film and the inertia of a fluid flywheel. The viscous damping which the fluid provides ensures that the filter system is adequately damped.

The driving motor is mounted immediately in front of the soundhead and the drive is taken through a pair of endless canvas and rubber "V" belts to the main drive pulley. Two identical sprocket shaft assemblies are used differing only in respect of the sprockets fitted to one end and the gears fitted to the other. The top or sound sprocket also carries a large non-metallic gear which meshes with the main drive pinion below and the projector drive pinion above; it will be seen that this arrangement transfers the main mechanical load of the projector very simply and directly from the input shaft of the soundhead to the input shaft of the projector itself.

An 8mm. roller chain, driven by a sprocket fixed to the main drive gear, is used to drive the take-up.

The complete scanning unit, consisting of exciter lamp, optical system, photo-cell, sound drum shaft and flywheel, is resiliently mounted in the main soundhead casting in order to minimise the effect of mechanical vibration. The optical system is of the enlarged image or back scanning type, wherein a magnified image of the sound track is projected on to a large slit. The optical magnification is six, thus the scanned area on the sound track, which is 84 mils wide, is projected on to a slit approximately 3/16 in. long, and it is comparatively easy with this large image to check that the track is correctly focused and positioned.

Special attention was paid in the design of this optical system to obtaining even illumination along the length of the slit. The surfaces of the lenses are coated for maximum light transmission. The flanged guide roller, which is mounted just above the scanning point, is adjustable for position, and an engraved scale is provided on the adjusting knob so that if the guide roller is displaced to accommodate misplaced sound tracks, it can be readily reset to the correct position.

**GK 20 Soundhead**

In the Gaumont-Kalee No. 20 sound equipment, which was introduced a little later than the No. 21 just described, some economies have been introduced in the design in order to reduce the cost.

The soundhead, which is known as type 378, differs from the type 83, in the use of a single sprocket, and a simpler optical system. All the main mechanical components are interchangeable with their counterparts on the 83 soundhead. In place of the bottom sprocket shaft assembly, a spring loaded jockey roller is used to isolate jerks arising from bent spools
and other irregularities in the take-up, and this saves two gears and one complete sprocket shaft assembly with its bearings, pad rollers, etc., which, of course, reduces the cost of manufacture without appreciably worsening the performance.

The optical system on the type 378 soundhead is of the front scanning or projected slit type, wherein an image of an illuminated slit is projected on to the soundtrack. The whole optical system is attached to the scanning unit by three screws and positively located by dowel pins so that removal and inspection can be carried out if necessary without disturbing the focus. The whole scanning unit is, of course, resiliently mounted.

**Loud-speaker Systems**

In the Duosonic two-way speaker system, the multi-cellular treble horn uses one or two treble units according to circumstances. The L.F. horns are of a new type, having direct flares and closed backs. The back radiation from these speakers is lower than that on previous types, whilst the forward response is appreciably improved.

![Type 378 Soundhead](image)

Several loudspeaker combinations are available to suit auditoria of different sizes. The low-frequency cone units are permanent magnet types, and a new permanent magnet treble unit is now coming into production to replace the energised treble units previously used.

Normally, the loudspeakers used with the G.K. 20 outfit are exactly the same as those used with the larger equipments, although a small version known as the No. "0" Duosonic speaker assembly is available, which is specially suitable for use in small theatres having less than about 1,000 seats.

**NEWMAN MEMORIAL AWARD**

The first Newman Memorial Award has been presented jointly by the B.K.S. and R.P.S. to Mr. Stuart Williamson in recognition of his contributions to the design and production of photographic apparatus, including the "Cinegun" camera and other cameras for air photography.
THE PURPOSE OF THE EDUCATIONAL FILM

Read to the B.K.S. Sub-Standard Film Division on December 8, 1948.

Frank Wells*

The making of educational films is a highly skilled task. The technicians required for this type of film have to be expert in a large number of specialised fields, and we are fortunate in this country to have the technicians able to produce animated diagram, for example, of such high quality. Photomicrography, high-speed photography, stop-motion work, X-ray kinematography, and so on, are all available to the producer and the teacher. Each technique can play its part in giving the learner exciting and interesting material that could not otherwise be made available.

Nevertheless, to the teacher the use of film in the classroom is an inconvenience. Black-out has to be carried out, the projector and screen fitted up, and the film threaded (preferably the right way round), and so on. It is a sad but inescapable fact that many of the comparatively few projectors already in schools are hardly used at all. Too many of them lie, or just lie, in the great hall and never get into classrooms.

The Class-room Projector

The educational film needs projection equipment that is really portable and easy to use, and schoolrooms in which it can be used. We cannot do anything about the latter, but we can do something about the former. Too many sound projectors now made are magnificent machines, able to project a picture on a full-sized kinema screen before an audience of twelve hundred. The equipment consists of several heavy pieces and rolls of cable.

We need machines on prams, that will pass easily through doors, that are completely self-contained, and that need have no capabilities beyond the scope of the classroom. If we do that then we can quite confidently expect the schools to deal with the far simpler problems of black-out and ventilation. We should be able to eliminate these and provide daylight projection.

Standard of Films

To the class the film may be a welcome relaxation or a bore. The best type of educational film is neither; it requires from the class a very high degree of concentration. A great deal of learning material is compressed into 10 or 20 minutes—and the class is unable to take notes.

It is clear, therefore, that we must provide something that the teacher cannot better provide by other methods, or cannot provide at all, and we must make our statement to the class with absolute clarity and in a manner which cannot easily be forgotten.

Thus it is necessary to provide films of such a quality that both class and teacher will willingly suffer any inconveniences. Every bad educational film will harm the whole idea of using educational film—and in that term "bad" we must include, possibly as the most dangerous type, the ill-chosen subjects. For as soon as teacher or class sees a film and then thinks afterwards "I would rather have taught or learned that in some other way," then the destruction of the film idea has begun.

Experience of Teachers

Earlier this year there was published in the United States a very detailed "Report to Educators on Teaching Films Survey," made by a committee of seven publishers of school books and visual material. To many of its readers the most remarkable of the conclusions in the Report are these:

*G.-B. Instructional, Ltd.
(1) Longer and wider experience in the use of motion pictures tends to produce less and less interest on the part of the teachers.
(2) The teachers who have the most desire to use motion pictures tend to be the ones who have had the least opportunity to use motion pictures. The teachers who have the least interest tend to be those who have made the most use of the films that are now available.

This is, of course, a very damning criticism of the educational films available to those teachers. Only the best will arouse and hold the interest of the teachers; second-rate films will do immeasurable harm to the whole idea of using films in education.

Background Films

Demonstration films within the limited scope of a particular subject have their uses. They are, in the words of an official report, "Motion pictures that get down to brass tacks about specific topics and really teach the subject matter of the curriculum." But there are other important functions for the film to perform, for example: to supplement the curriculum and help the pupil to understand the background of the subject, to co-relate it with other subjects, to provide understanding of the human picture as a whole.

The learner must be made to want to learn, and must be told why learning is worth while. The pupil should be excited about a subject and must realise the adventure of learning, and have an emotional feeling aroused in that exploration. The film is probably one of the best media for doing that, although very little has yet been done consciously in that field.

In another way the film has a very important part to play. Students are inclined now to the belief, as they pass from one classroom and teacher specialist to another, that history and geography are two separate watertight subjects, and that biology and chemistry and physics are all separate things. The film can provide demonstration of such fallacies and show how completely interdependent 'subjects' are.

Broadening Horizons

Specialisation is one of the necessary drawbacks of this modern technical world. It is now an economic necessity in many countries to complete the general education of children at about 15 or 16 years of age, and very largely to decide on the specialised education that they are to receive at a much earlier age. The opportunity of giving them the broad outlook necessary for a world citizen and to combat the limited outlook of the specialist, or the sectarian, is scarcely possible in the time available, when this can only be done by talking and reading. To a student in a present-day school, without film, able only to look and listen with his own eyes and ears, the horizon is extremely narrow.

The film has no horizon. It has speed of expression as fast as the working of the human mind. It is capable of precise statement. The film can blow the walls of the schoolroom wide open and it can give to its audience, if nothing more, at least an idea that this is a wide, wide world that has been drawn so close together that no man can harm another, however remote, without harming himself.

I do not think that many teachers have as yet grasped the important part that films can play in this broadening and correlating that is so necessary in education. They are more concerned with how much the pupil knows in certain subjects. Trevelyan's criticism of national education, as turning out people who 'are able to read but unable to distinguish what is worth reading,' is still largely true.

The immediate effect of this is to frighten commercial producers, and to make them confine their attentions to curriculum films. We know that no
educational film is likely to earn a quick profit; it will take years to earn a profit at all. This makes it necessary to think in terms of educational progress, and to try and anticipate what teachers will require from films, when they have had time to get trained and experienced in their use.

Co-operation between Producers and Teachers

The film, as a medium of education, is in its pewling infancy. It can open up and broaden education in a way at present dreamed of only by a few. Curriculum teaching, although manifestly essential, is nevertheless too narrow, and production should not be confined to curriculum films.

If it is, then teachers will have no way of finding out the full potency of the film as an educational medium. They are, as we are, in the experimental stage in the use of films, and their method and outlook is largely confined within the limits of the tools made available to them.

Producers and teachers, working together, must have this well in mind. They must be able to differentiate between teaching and broad education. They must know where they are going. They must be prepared to change their beliefs as logically as the future comes. And it comes very quickly.

We need, therefore, to work with teachers, not just to find out what they now want. Having had limited or no experience of using films, what teachers want now is something that will fit neatly into their existing teaching method. We need to work with teachers to discover how films should be used. If the film is really as valuable a teaching tool as we believe it is, then it can quite noticeably alter teaching method.

The Teacher's Faith in the Film

During the last generation there has been an immense change in outlook, in living and in knowledge; a scientific approach to the realities is more and more rapidly overwhelming the fixed beliefs and traditionalism of the past. We must see that through the film, as through other media, we not only provide a fair and accurate account of the world, but we also instil a desire to know what is fair and accurate.

The most important requirement of the educational film today, then, is a very large body of teachers with the widest possible experience in using the tool, and the imagination to see its possibilities. The makers of educational film are primarily the people who can create that body and fulfil that requirement.

The faith of the teacher must be built up by careful and laborious work. Films must captivate him as they must captivate their audience. They must sell the truth as something exciting, and the desire for knowledge as a great adventure; they must relate each part of knowledge in its proper place with others and help the child to know that he is a part of the world and not just an individual in a tangled mystery.

I will conclude by quoting the final paragraph in a book called "Some thoughts on Education" written by John Locke and published in 1728:

"I have published these my occasional thoughts with this hope, that though this be far from being a complete treatise on the Subject, yet it may give some small light to those, whose concern for their dear little ones, makes them so irregularly bold, that they dare venture to consult their own Reason in the Education of their Children, rather than wholly to rely on old Custom."

DISCUSSION

Dr. Dennis Ward: What is the ideal length of classroom films?

The Author: That can only be estimated by the time it takes to put over the topic.

Mr. A. C. Snowden: The B.K.S. might consider it worth while forming a new Division or Section to look after the interests of educationalists and film people jointly engaged in making educational films. This would give teachers a better idea of the
difficulties we have to contend with as technicians, while we would have better opportunities of understanding the difficulties of the teacher.

Mr. S. W. Bowler: To what extent does the maker of educational films receive assistance from any survey of audience reaction by the people to whom their shows are directed?

The Author: It has been done in America, but so far the survey work has been on the teacher and not on the pupil. We need a survey of the unfortunate children who have to see the films.

Mr. Raymond: Could not it be arranged that mobile units go round to the schools with their own technicians and apparatus?

The Author: It would be a mistake to do anything to divorce a teacher from the showing of the film. A travelling unit causes too much disturbance to the class.

Mr. Mercer: Are the teachers approached as a body with regard to the type of film which is made?

The Author: Bodies exist, but we get very little real help from them as to what they want. They each have different notions and have not used film enough to appreciate what they really do want.

Mr. H. S. Hind: The primary consideration is to teach the child how to use his brain and secondly to teach facts. Is anything being done in the making of films to teach the child to do this?

The Author: The best way to teach children is to show them how to find out facts and where to get information. Such a film can bring material for the child to watch and learn which would otherwise be very difficult to bring into the classroom.

TECHNICAL ABSTRACTS

Most of the periodicals here abstracted may be seen in the Society's Library.

FLICKER IN MOTION PICTURES: FURTHER STUDIES.

The tendency towards increased brightness of the projected picture calls for increasing attention to be paid to the avoidance of flicker. Flicker in projectors is caused by shutter rate, non-uniform shutter velocity, arc-supply ripple, and arc-burning characteristics. Sources of flicker in film production include illumination, camera, film stock, processing, and printing. Much experimental work is described.

R. H. C.

REPORT OF THE STUDIO LIGHTING COMMITTEE.

New lighting equipment described includes a remotely controlled shutter of the Venetian blind type, a 40-amp. arc lamp, and the so-called "Brute" (all by Mole-Richardson), a new midget filament lamp, an aircraft landing lamp suitable for use in motor-car headlamps, and a 500-watt photoflood. Tests are reported on the effect of arc lamp supplies and of arc lamp maintenance, upon colour rendering of Kodachrome.

R. H. C.

QUALITY FACTORS IN FILM RECORDING.

The nature, measurement, and methods of dealing with the major sources of distortion in film recording are clearly set out, and, without dwelling on the historical background, the paper provides a lucid and concise survey of the present state of the art.

N. L.

MICROPHONE CALIBRATOR.

Frequency response curves of microphones are automatically drawn to a dB scale by means of a chart recording apparatus. A standard crystal microphone forms the basis of comparison, and reflection effects are avoided by a pulse technique. Above 1 kc an ordinary room may be used, while below this frequency the microphones and sound source are mounted in a damped pipe of moderate size.

N. L.

MAGNETIC RECORDING FOR THE TECHNICIAN.

Part I of this article deals generally with the theory of magnetic recording. Longitudinal, perpendicular and transverse types of recording are referred to, and it is stated that it is more common to use longitudinal recording. Transfer and recording characteristics are described and reference is made to the frequency response with and without equalisation. Part II gives experimental data regarding bias input versus output, audio input versus output, distortion and frequency response.

O. K. K.
35MM. MAGNETIC RECORDING SYSTEM.


The article describes the conversion kit for the RCA PR-23 recorder and the necessary alterations to the camera and amplifier, including the addition of a recording and a reproducing head to the former, in order that magnetic recording can be carried out.

**OPTIMUM HIGH-FREQUENCY BIAS IN MAGNETIC RECORDING.**


The article deals with investigations on the optimum level of the high-frequency bias in magnetic recording, and examines the influence of its variations on frequency response and non-linear distortion. The results show some characteristic differences for the different types of tape.

**SYSTEMS OF RELIEF KINEMATOGRAPHY BY MEANS OF A MOVING GRID.**


A fundamental objection to proposed systems of stereoscopy employing a stationary grid before the screen is that, while only a single stereoscopic pair is projected, viewing is possible only along a line parallel with the screen. The Cyclostéroscope employs two grids, in the form of a truncated cone, rotated around the screen.

**THE COUNCIL**

Meeting of April 6, 1949

Present: Messrs. W. M. Harcourt (President), A. W. Watkins (Vice-President), L. Knopp (Deputy Vice-President), E. Oram (Hon. Secretary), P. H. Bastie (Hon. Treasurer), R. B. Hartley, B. Honri, F. G. Gunn, H. S. Hind, A. G. D. West, R. H. Cricks (Technical Consultant), and W. L. Bevir (Secretary).

Accounts.—Accounts presented by the Hon. Secretary were examined and discussed; it was decided to appeal against any income tax assessment for the year which might be made.

Nominations.—The names of Members nominated for Council and the three Divisions were reviewed. Messrs. Bland and Alston were nominated as scrutineers for the Council elections.

Journal Committee.—A fusion of the functions of the Journal and Papers Committee was not approved, as there were already three Members who served on both committees.

Papers Committee.—It was decided to withdraw charges for refreshments at meetings. Plans were approved for each Division to supply one of the Society’s papers during the next season’s lectures.

Library Committee.—An increase in the insurance of the Library was approved.

B.S.I.—Messrs. Brian Sewell and L. H. Bacon were nominated to represent the Society on the British Standards Committee on Electro-Acoustic Transducers.

**EXECUTIVE COMMITTEE**

Meeting of April 6, 1949

Present: Messrs. W. M. Harcourt (President), A. W. Watkins (Vice-President), E. Oram (Hon. Secretary), P. H. Bastie (Hon. Treasurer), W. L. Bevir (Secretary), and Miss S. M. Barlow (Assistant Secretary).

Elections.—The following were elected:

- Claude Appleyard (Associate), Regent Cinema, Leeds.
- Terence Sydney Johnson (Student), Films and Equipments, Ltd.
- Walter William Ross (Associate), Cnetechnic, Limited.
- Raymond Hart O’Brien (Member), C. W. S. Film Unit.
- Stanley Greenall (Associate), C. H. Champion & Co., Ltd.
- Harry Benson (Member), Associated British Picture Corp., Welwyn Studios
- Peter John Oram (Member), P. J. Equipments.
- Richard Raper Brumwell (Associate), Palace Theatre, Gateshead-on-Tyne.
- Harry William Armstrong (Associate), Geo. Humphries & Co., Ltd.
- Howard Maxwell Blaber (Member), De Haviland Propeller Co.
- Donald Sankey (Associate), Signal Films, Ltd.
- Michael Bennoson (Associate), RCA Photophone, Ltd.
Dudley Harold May (Member), Associated British Picture Corpn., Ltd., Elstree.
David Willingham Rawnsley (Member), Television Film Production, Ltd.
Sir Michael Balcon (Member), Ealing Studios, Ltd.
Transfer.—From Associate to Corporate Member—James Masterton.
Reinstatement.—Approval was given for the reinstatement of Lionel Keith Anthony Tregellas.
Resignations.—The resignations of three Members and four Associates were accepted with regret.
Expulsions.—Owing to non-payment of subscriptions after repeated reminders, four Members of the Society were expelled.

THEATRE DIVISION
COMMITTEE
Meeting of April 28, 1949
The dates of four divisional papers in the 1949-1950 Lecture Programme were agreed upon and the proposed papers discussed.
Two Members and five Associates were enrolled in the Division and one transfer from Associate to Member agreed.

SUB-STANDARD
FILM DIVISION COMMITTEE
Meeting of April 27, 1949
Mr. J. Masterton was welcomed as a member of the Committee.
Mr. W. Buckstone was thanked for the work he had put in to the organisation of the display of new apparatus.
Suggestions for papers for the 1949-1950 Lecture Programme were discussed.

JOURNAL COMMITTEE
Meeting of April 25, 1949
Journal accounts for 1948 and the first quarter of 1949 were presented.
It was agreed that a type-set title should replace the present front cover of the Journal next year.
The issues in which editorial matter was to be placed were agreed, including a statement on the new standard of Screen Brightness, prepared by Mr. Cricks for the C.E.A.
An approximate rate for the acceptance of coloured insets was considered.

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EXHIBITION NUMBER

The June issue of BRITISH KINEMATOGRAPHY will contain a full report of the exhibition of new studio equipment held at A.B.P.C. Studios, Boreham Wood, on May 7. Those who will require extra copies of this issue should inform the Society immediately to ensure that they may be made available.

PERSONAL NEWS of MEMBERS

Members are urged to keep their fellow members conversant with their activities through the medium of BRITISH KINEMATOGRAPHY.

J. P. J. CHAPMAN, of Bournemouth, is representative for Messrs. Ganz & Co., of Zurich, one of the most important Swiss optical and kinematograph firms.

J. L. CLEINGE, Hon. Member as a U.N.E.S.C.O. scholarship holder, has returned to Belgium, where he hopes to direct films. He thanks many B.K.S. members for their co-operation during his visit.

W. E. KELLY, a former Student of the Kinematography Course at the Regent Street Polytechnic, who has returned to Australia, is Technical Kinematography Officer with the Long Range Weapons Establishment at Brisbane.

W. S. KENNEDY, from New Zealand, is in this country studying and making contacts with those in the film industry.

P. G. VOIGT, a Fellow of the Society, is indisposed with a spinal complaint.

A. A. WATERS has left United Motion Pictures, Ltd., and joined Brent Laboratories, Ltd., as recording engineer.

K. WILES has just returned from Jamaica, where he has been recording for a feature documentary.

PROVINCIAL LECTURE PROGRAMME

June, 1949

LEEDS SECTION

Meeting to be held at the Y.W.C.A., Cookridge Street, Leeds 1, commencing at 10.30 a.m.

June 4 Brains Trust. A panel of experts will answer questions.

NEWCASTLE-ON-TYNE SECTION

Meeting to be held at the Lecture Theatre, Newe House, Pilgrim Street, Newcastle-on-Tyne, 1, commencing at 10.30 a.m.

June 7 Discussion Meeting.

Small announcements will be accepted from Members and Associates. Rate, 4d. per word, plus 2s. for Box No. if required (except for Situations Wanted). Trade advertisements, other than Situations Vacant, not accepted.
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PLEASE MENTION B.K.S. JOURNAL WHEN MAKING ENQUIRIES
After studying electrical engineering at London University, Mr. Watkins joined the outside broadcasting staff of the British Broadcasting Corporation. In 1928 he entered the film industry, and was engaged in pioneer research work when sound was first introduced. In 1929 he became Superintendent of Recording in this country for the Western Electric Company and installed the first Western Electric sound recording equipment at the British & Dominion Studios, Elstree. He later joined London Film Productions as Recording Director and was responsible for the sound and acoustical installations at Denham Studios. In 1945 he became Recording Director of the Metro-Goldwyn-Mayer British Studios, Elstree.

Mr. Watkins was made a Fellow of the Royal Photographic Society in 1943, became Chairman of the Kinematograph Section, and was elected to Council. In 1944 he became a Fellow of the Royal Society of Arts.

He was elected a Member of the B.K.S. Executive in 1941, and on the formation of the Film Production Division in 1944, became its first Chairman. He was Vice-president of the B.K.S. in 1948. He is an Associate Member of the Institute of Electrical Engineers, and a member of the Society of Motion Picture Engineers and of their European Advisory Committee.
EDWIN ORAM (Fellow)
Hon. Secretary
P. H. BASTIE (Hon. Fellow)
Hon. Treasurer

ORDINARY MEMBERS OF COUNCIL
(left to right)
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REX B. HARTLEY, A.R.P.S., F.R.S.A. (Fellow)
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REPRESENTATIVES OF DIVISIONS
Sub-standard Film Division:

Film Production Division:
T. W. HOWARD (Fellow)
VISIT TO A.B.P.C. STUDIOS

On Saturday, May 7, a party of 200 Members, Associates and Students of the Society made a tour of the newly re-opened studios of the Associated British Picture Corporation, at Boreham Wood. An exhibition of studio equipment, estimated in value at £300,000, was held in the afternoon on stage 4.

ASSAMBLING in the studio restaurant, the visitors were first conducted in parties of forty to Stage 1. Here was erected a set for the production "Landfall": an attractive ball-room scene, the ceiling of which was constructed as a hanging miniature. Producer of the film is Victor Skutezky, director Ken Annakin, and cameraman Wilkie Cooper.

A new block in front of the stages houses, on the ground floor, the wardrobe department, on the first and second floors the stars' and crowd dressing-rooms, and on the third floor the enormous plenum plant which supplies conditioned air to all stages and departments.

On Stage 2 was a number of smaller sets—one using a large painted backcloth. Of technical interest here was the control console, designed by Charles Evemy, chief engineer, which prior to the commencement of a shot locks the studio doors, switches on warning lights, switches off fans, and gives a signal to the camera operator, recordist and director. Adjoining this stage is the garage which houses the RCA sound recording truck.

From here the parties were conducted to the power house, with its two double-ended motor-generators, converting the incoming A.C. to 115-volts D.C. supply; the output is 2,500 kW.

Next came the many ancillary departments which contribute to set construction and furnishing: the stores for incoming goods; the engineers' workshop, where a number of spot-rails and camera tracks were under construction from Hiduminium; the electricians' shop, with its stores of lamps and cables; and the paint shop, where a demonstration of the silk-screen process was in hand, together with examples of the striking results secured.

The carpenters' shop was, at the time, devoted chiefly to the building of ship models, to be filmed in the studio tank. In the property department, the visitors found an amazing assortment of "props," from classified sets of bottle-caps to an over-size telephone which had been used for a trick sequence. In an adjoining shop, furniture was being upholstered.

On stage 3 the visitors saw a realistic outdoor set; a feature of the cut-outs and painted backing was that they were all mounted on trolley-frames, for ease of assembly and dismantling. At the rear of the set was a Mitchell process projector, which was set up to produce moving backgrounds to sections of a bus and an underground train.

In the new block behind the stages are housed the scoring, re-recording and preview theatres. In the first provision is made for the recording on
windows through which can be seen the conductor, who can listen in at any of the microphones and can interchange cues with the recordist. Adjustable louvres on the side walls permit the sound quality to be varied. The recordist is housed in a glass-fronted room overlooking the stage, and hears the sound through an actual cinema speaker assembly.

The re-recording theatre operates in conjunction with a projection room equipped with "Ross Stereolite" double-film projectors and RCA sound heads, fitted for push-pull or normal reproduction, also six play-off heads.

In the sound department, in the charge of Harold King, equipment is under construction which will eventually permit every sound circuit to be checked from the central control room. Two chambers of irregular form have been designed for echo effects; the degree of echo will be variable by means of a sliding door between them.

In the art department, Art Director Terence Verity demonstrated a model of a set recently built on a turn-table; provision was made for different backgrounds, the result being that during the ten weeks for which the set was in use, all equipment was kept in place while shots of different aspects of the set were taken. Drawings for "Landfall" and for the forthcoming production, "Stage Fright," were displayed.

The still department, under Frank Buckingham, is provided with a well equipped little studio, and dark-rooms for developing and printing. The department also handles photo-printing.

Finally the visitors toured the cutting rooms, all equipped with "Acmiola" editing machines and winders. After lunch, an exhibition of equipment was held on Stage 4.

Thanks were expressed by Messrs. A. W. Watkins, Chairman of the Film Production Division, and Baynham Honri, to Mr. Vaughan N. Dean, General Manager, for the efficient organisation of the visit; to Mr. Evemy for the arrangement of the exhibition; and to Executives, Heads of Departments and members of the studio staff, who had devoted their time to making the visit such an overwhelming success.

The same evening a cablegram was sent to Mr. Robert Clark, care of Warner Bros. Studios, Burbank, expressing the appreciation of all members of the Society for the visit so well organised that day for their benefit.

Photographs by John Bennett

EXHIBITION OF STUDIO EQUIPMENT

In conjunction with the visit of the British Kinematograph Society to the Studios of the Associated British Picture Corporation, Ltd., Boreham Wood, an exhibition of Studio Equipment was, by courtesy of Mr. Vaughan N. Dean, arranged by Mr. Charles Evemy.

I. CAMERAS.

"Caméflex" 35mm. Model B. Portable Reflex Camera*

The outstanding feature of the Eclair "Caméflex" camera is its adaptability to all classes of work and due to its construction it is the solution of the many problems which are met with in taking shots at complicated angles or in difficult positions.

The automatic magazine, loaded in the darkroom, or changing bag, is instantaneously attached to or removed from the camera; two sizes are available, 100ft. or 400ft. Fixing the magazine to the camera automatically opens the light traps and adjusts the pressure pads; the internal film loops are automatically made from outside the magazine.

The divergent turret will accommodate three lenses of any focal length, enabling short-focus lenses to be used in conjunction with lenses of the longest foci without any danger of cut-off—for example, 24mm. to 500mm. and over, lenses can be mounted simultaneously. The standard equipment is normally 25mm., 50mm. and 100mm. lenses; all are mounted in quickly detachable bayonet fittings.

The view-finder can be set in 3 positions for convenience of viewing; it employs the reflex principle, the optical system providing a highly magnified image through the actual taking lens. The shutter opening is adjustable from 40° to 200°.

Three types of drive may be employed. For the hand drive, a silent gear-box is incorporated, giving 1, 8 or 16 frames per turn of handle. A spring drive transports approximately 30ft. of film per wind; a governor allows for speeds of 8 to 26 frames per second. A 6/8-volt D.C. electric motor is so designed as to form a convenient handle while filming; current is supplied by four 2-volt non-spillable accumulators, carried in pouches attached to a leather waist belt; when fully charged the battery will run approximately 3,000ft. of film. The speed of the camera is indicated by an electro-magnetic tachometer.

 Provision is made for mounting glass filters inside the lens hoods and gelatine filters, masks, vignettes and mattes next the film.

The weight of the camera with electric motor and 100ft. magazine, is 10 lbs., or with 400ft. magazine 13 lbs. Batteries weigh 8 lbs., and the tripod 14½ lbs. The tripod head is instantly removable with the camera in position and with its universal movement and screw attachments.

*W. F. Dormer, Ltd.
can be fixed to any other suitable support so enabling it to cope with practically every possible camera position required.

**Newall Camera***

The Newall camera is built in two parts of which the lens unit is stationary, and the camera body slides across from "taking" to "focusing" position, so that for focusing the telescope is brought into line with the taking lens, which is thus not disturbed except to change lenses. The movement of the camera body for focusing is by a single handle, in the centre of which a release button controls the locking pin and gives positive, accurate registration in either position of the handle.

The integral focusing telescope provides image-magnifications of 5X or 10X, with immediate change to either. The base carries the four-way mattes, filter discs, turret plate and turret, rising and falling front, sun-shade, and upright viewfinder. The film-movement and driving mechanism are housed in the camera body, which is dovetailed into the base.

A locking pin motion is employed with overlapping action of the claws and register pins. The lower part of the gate, which is curved to suit the claw-path, is plated with wear-resisting chromium. The back-plate, secured by two locks, is easily removable for cleaning. The movement operates equally well in forward or reverse direction. In case of film buckling or take-up failure, the camera is stopped automatically by the "buckle-trip."

The turret, which revolves independently of the rising and falling front, accommodates four lenses, in optically centred mounts. The rising and falling front gives an adjustment equal to a 15° tilt of the tripod, without angle-distortion.

With a maximum opening of 175°, the shutter is arranged for hand-operated dissolves or fades.

A miniature shutter showing the position of the main shutter, Veeder footage counter, thousand-foot film meter and spirit level are built into the rear of the camera body.

Two motors are normally supplied with the camera: one 220 volt 3-phase, 50-cycle synchronous motor; and one variable speed motor, 12 volts D.C., for location work. Other types of motors can be supplied to special order.

Velvet lined 1,000 foot magazines with frictionless light traps are supplied as standard equipment, and six Taylor-Hobson Speed-Panchro lenses from 1in. to 100ins. focal length.

"**Everest** " Studio Camera, Types I and II†

The reflex system introduced in the "**Everest** " Type I camera† and used also in the Type II, employs a reflecting shutter giving a direct view through the taking lens; the shutter is made from a solid piece of stainless steel, with optically worked surfaces, and being of the double-sector type ensures perfect balance. The view seen by the operator consists thus of 24 images per second, interlaced with those recorded on the negative. The image is reflected to the rear of the camera, where it is thrown upon a matt screen; since the screen is looked at with both eyes, eye-strain is eliminated.

Internally the Type II is similar to the Type I, but it has the additional facility of a coupled rangefinder. The optical system for the rangefinder

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*GB-Kalee, Ltd.

†W. Vinten, Ltd.
is arranged in a vertical plane, one lens above and one below the taking objective; the eyepiece for the rangefinder is situated above the focusing dial. The focus operator can therefore use either the coupled rangefinder or the scale markings and cue-marks at will, without changing his position.

The efficient sun-hood affords protection to the rangefinder optics as well as to the taking lens.

As in the Type I, the focus and iris controls are brought out to the side of the camera, and form a large diameter scale with a comfortable hand grip. The lenses supplied range from 28mm. to 100mm. focal length. The camera is completely silent in operation.

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2. CAMERA ACCESSORIES

The "Avo" Exposure Meter*

The "Avo" Exposure Meter Model I is the first meter to be scaled in the new B.S. exposure index numbers and to conform to the B.S. specification for Photo-electric Exposure Meters in terms of accuracy and performance.

The outstanding feature of the new meter is an automatic mechanism which gives a combination of high sensitivity with very wide range. As the illumination is increased, so that the needle approaches the end of the scale, final rotation of the calculator disc brings an automatic mechanism into action—a mask falls in front of the photo-electric cell, the needle swings back towards the other end of the scale, and the meter is now ready to deal with a wide range of high light-intensities.

*Distributed by Kodak, Ltd.
Exposure times marked in the calculator range from 1/2000th second to 60 seconds and a red dot indicates the normal motion picture speed of 16 frames per second.

S.E.I. Exposure Meter*

The S.E.I. Exposure Photometer was exhibited, and its methods of use demonstrated. The brightness of a comparison spot in the centre of the viewfinder is matched with the selected part of the subject by turning a knurled ring which carries the f number and film speed number scales.

Studio Camera Head†

A new rotary and tilting head designed to carry all types of studio cameras. Running entirely upon heavy-duty ball-races, it gives exceptionally smooth pan and tilting movements. It is quite silent in operation.

The two movements are controlled by multi-plate, grease-packed friction pads, both of which are adjustable to a fine degree to suit the particular camera or operator. Tension springs are provided to counterbalance the weight of the camera when it is off the horizontal position; the springs are housed in quick release containers that can be instantly removed, when the head moves freely. One pair of springs only may be used, or alternative sets of springs slipped into the containers and replaced; the tension can therefore be quickly varied between wide limits. The range of tilt is 35° either side of the horizontal. Positive action locks are fitted to both tilt and pan, giving absolute rigidity with a minimum of effort. The pan-bar may be used at either side of the platform.

Three camera-screws, two adjustable, are provided, ensuring secure fixing for any type of camera or mounting plate.

3. LIGHTING EQUIPMENT

G.E.C. Compact Source Illuminators‡

130/140 amp. (10kW.) experimental Compact Source Spotlight.—This unit comprises a 150-amp. H.I. Arc Lamp body, but the internal mechanism is specially designed to accommodate the 10kW. Compact Source Lamp. The

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*Ilford, Ltd.  †W. Vinten, Ltd.  ‡General Electric Co., Ltd.
10kW. lamp is mounted vertically with a 20in. diameter Fresnel lens in front and a spherical backing mirror behind the lamp. "Simmering" mechanism is provided. Full electrical and mechanical interlocks are provided to ensure safety to the lamp and to the operator. The ballast resistance with this unit is separate from the spotlight, but the starting mechanism is an integral part of the lamp house.

Two types of starting mechanism were shown, one of the type where the lamp must be allowed to cool down before it can be re-started, the other, of the hot re-start type, where the lamp can be re-started immediately.

35 amp. (2½kW.) "Compact" Studio Spotlight.—This spotlight is a completely self-contained unit in that the ballast and control mechanism forms an integral part of the lamp house, and a twin core cable fitted with a spider plug comes from the control panel. The 2½kW. lamp is mounted vertically with a 10in. diameter Fresnel lens in front of the lamp and a spherical backing mirror behind it. Full simmering is provided. Here again, full electrical and mechanical interlocks are provided to ensure safety.

35 amp. (2½kW.) "Compact" Studio Floods, remote control type.—These units use the same lamp as the 35 amp. (2½kW.) Compact Studio Spotlight. Optically they are in every way similar to the manually operated types. With the remote control up to six units can be interconnected from one hand controller, and lamp striking and shutter operation, i.e., simmering and full light output, are controlled from the one controller. The number which can be remotely controlled is not limited to 6; as many as are required for a particular "set" can be connected in banks of 6 and remotely controlled.

Compact Source Hand Torch.—For burglary scenes and the like, demonstrated by kind permission of the M.G.M. Studios. The torch is of approximately the same size as an ordinary torch, but accommodates a 125-watt Osram Compact Source Lamp. Its control mechanism provides for automatic simmering when the torch is placed on the rest.

A small display box showed the similarity between two lengths of colour film processed by Messrs. Technicolor, Ltd., one a piece of film taken under normal arc light, and the other taken entirely with Compact Source lighting.

Samples of the 10kW., 2½kW. and 125-watt Osram Compact Source Lamps and a control tray from a 35 amp. (2½kW.) Remote Controlled Compact Studio Flood, were also exhibited.
MR 1450 Arc ("The Brute") *

The American Mole-Richardson lamp, nicknamed "The Brute," was distinguished by an exceedingly high efficiency; as compared with the Type 170 lamp, an increase of 50% in current—from 150 to 225 amps.—increases the light output three or four times.

A feature of the British model is that access to the mechanism is secured not through doors in the lamp-house, but by pivoting the whole of the mechanism towards the rear. An indication is provided showing when the positive carbon is nearing the end of its run, by the flashing of a pilot lamp, which serves also as a polarity indicator. The lamp is fitted with a 24 in. Fresnel lens.

Maintenance is facilitated by the easy removal of the mechanism from the lamp-house. The burning hours of a lamp are indicated on a counter.

Remote Control System for Studio Lighting *

A system for dimming a number of lights simultaneously by remote control consists of shutters of the Venetian-blind type, mounted on each lamp, provided with a motor drive. The system of operation resembles the Selsyn system, but operates on the D.C. of the arc supply.

The control unit consists of a tapped resistor; tappings are connected to appropriate poles in the six-pole stator of a small motor, within which a two-pole armature rotates, its movement exactly following the movement of the control contacts.

A single hand control will operate six shutters, which may of course, be on lamps of different types, or for example with differently coloured filters; further, a reversing switch on each shutter motor enables it to be either opened or closed on the movement of the controller, so that a gradual change of colour may be effected.

By means of a motor-driven controller, up to 200 lamps can be controlled in gangs of 50. Furthermore, the shutters can be made to close instantaneously, and may be operated by a practical switch on the set.

The system was demonstrated by the following exhibits: A spot rail fitted with five studio lamps, comprising two Type MR 170 arcs operating in series and fitted with automatic striking, one Du Arc, and two Type MR 414 incandescent spotlights. All were controlled by means of contactors operated from a console on the floor, providing remotely operated switching, dimming and colour-changing.

An entirely new range of compact source lamps was exhibited 

The spotlight, designed to take a 10 or 5 kW. lamp, is completely remote controlled, and gives more light than the MR 170 at 10 kW. The lamp may be struck, dimmed, focused and simmered from a small controller. Run-up time is only 3 to 4 minutes, and a restriking circuit enables the arc to be re-ignited if it has been switched off. A built-in motor controls focus and another a dimming shutter.

A remote controlled floodlight is designed for 5 or 2.5 kW. lamps, and at the former rating produces twice as much light as a Du Arc.

*Mole-Richardson (England), Ltd.
Multiple HD Lighting Equipment*

1 kW. *Compact Source Lamp, in all-weather housing.*—The lamp in this particular illustration is designed for maximum flood. Between the outside of the reflector and the outer casing, a continuous air circulation is maintained, thus achieving great efficiency in cooling. It is operated by one switch (patents pending) which automatically allows a time lag from the initial striking to the full capacity of the lamps, which varies from one to 2½ minutes.

This unit is also made using a 2½ kW. bulb and is adaptable either as a Sky-Pan or in standard 2 kW. spot housings.

10 kW. Lamp—Similar in design and construction to the 5 and 7½ kW. models, these units have three switches at the rear, the simmering, striking, and main. The initial run-up period is approximately 15 minutes. The oven or pre-heating arrangement is automatically operated in each case from the main switch. With the exception of the ballast resistance, which is housed in a separate unit, either on the stand or in any convenient position on the floor or gantry, the whole of the electrical and mechanical equipment is housed in the rear of the lamp, a patented feature of all lamps manufactured by this company.

200w. *Streamline Projector Housing on light collapsible telescopic stand.*—The optical system is a 3in. Chance Fresnel lens in conjunction with a spherical mirror. The whole is extremely light, the total weight, including stand and 25ft. cable being only 10 lbs. The stand enables the lamp to be adjusted to a height of 10ft. with perfect safety.

A 100w. model is also manufactured of similar design and construction, but having a 2in. plano-convex lens.

Mobile Generator†

The diesel-electric power plant at Ealing Studios was more than adequate for black-and-white production, but insufficient for Technicolor. Various schemes for obtaining the additional power were considered by Baynham Homri, Technical Supervisor, and it was ultimately decided to provide a large mobile 260 kW. single unit diesel-electric generator rather than instal static plant.

*Multiple H. D. Industries, Ltd.  †Ealing Studios Ltd.
This huge mobile power plant is believed to be the largest single unit mobile generator in the world—at any rate, in the film world. It is now in regular use for large night locations and for supplementary Technicolor lighting at other studios when not used at Ealing.

The equipment comprises one Siemens 230 volt D.C. dynamo with rotary balancers on a 3-wire supply, giving an output of 2,300 amps. at 115 volts, with a 200 amp. out-of-balance load. This is coupled direct through a flexible coupling to a Davey Paxman 12-cylinder 400 h.p. 1,000 r.p.m. diesel engine with electrical starting equipment and charging generator. The whole, including switchboard and all accessories, is mounted on an Atkinson 8-wheeled diesel lorry, enclosed and efficiently sound-proofed to enable the equipment to be operated within a reasonable distance of the shooting site.

The equipment assembly was designed by Jack Ford, Chief Electrician at Ealing Studios.

4. FLOOR EQUIPMENT

The "Spelleroller"

A lifting jack specially designed for moving heavy pieces of scenery, flats, etc., about the studio floor. Its use in production enables floating pieces of sets to be moved readily and speedily with the minimum of labour, thus speeding up the handling of floor shooting and reducing the length of time a studio stage is occupied for building purposes.

Portable Microphone Boom†

Mounted on a collapsible stand, this boom can be elevated horizontally from 5ft. to 9ft. 6in.; it is capable of extension from 6ft. to 11ft. 6in. The favouring device is worked by telescopic tube carrying noiseless bevel and pinion. By withdrawing one screw from the elevating or depressing handle and lifting the boom out of the stand, the whole equipment is easily transportable. It is capable of being used with an 8½ lb. microphone.

*Designed by George Speller and exhibited by Ealing Studios, Ltd.
†Multiple HD Industries, Ltd.
5. SOUND RECORDING

"Ferrosonic" Synchronous Recording and Reproducing Equipment*

This equipment can be used not only for magnetic recording of sound, but also for reproducing the recorded sound synchronously with the pictures at normal speed. The recording medium is "Ferrosonic" film, a 35mm. perforated film coated with a magnetic layer 5.

The recording head and the playback head are both mounted so that they ride on the flywheel drum, an arrangement which ensures a constant and highly uniform film speed—the flutter content is of the order of 0.1%. The signal-to-noise ratio (weighted according to ear response curve CCIF 1934) measures 60 db. The overall frequency response of the equipment is 50/0000 c/s.

The head for wiping or erasing the recorded sound makes it possible to re-use previously recorded film. The wiping head is so mounted on the recorder that wiping takes place before the film passes the recording head; this arrangement ensures that no accidental erasing of the sound signals being recorded can take place.

The amplifier and ancillary units are mounted in an interconnected stack so that the complete equipment stands in a compact and readily accessible form. Check metering of all circuits is provided.

The recording amplifier is a 3-stage amplifier, push-pull throughout and using negative feed-back in the output stage. Facilities for automatic volume-range-compression can be made available if required, but this is not generally necessary due to the wide volume range of magnetic recording.

The equaliser unit is provided with low and high pass filters and a voice equaliser (a slight "boost" at 3,400 c/s. for dialogue-recording), together with jacks and switches for checking and circuit testing.

The playback amplifier incorporates an equalising circuit, and feeds the monitor amplifier, which is a 3-stage power amplifier, with push-pull output, giving high quality signal for monitoring purposes, and with self-contained power unit.

A special generator which supplies the wiping current at a frequency of 100 kc/s. is either supplied as a separate unit or is incorporated in the power pack.

The equipment operates to the best advantage when two or more machines are employed, as with one single apparatus it is not possible to make a copy of the original sound record for editing and cutting purposes. Existing editing machines can easily be adapted for use with the magnetic sound tracks.

Visatone Portable Recording Channels.†

A feature of the new model of the Visatone portable channel, is its easy convertibility from 35mm. to 16mm. The twin magazine has been replaced by single magazines, so that a smaller weight of empty magazines is carried.

The equipment as previously demonstrated to the Society 6 comprised three units only: the power pack, the control panel, and the recorder. It operates either from a 12-volt battery or from 3-phase mains.

*GB-Kalene, Ltd.  † Films & Equipments, Ltd.
M.S.S. Disc Recording Equipment*

Studio Equipment, Type CB/E.—A heavily built recorder for fixed installation. The massive turntable is driven at 77.92 r.p.m. by a 230/250 V. 50 c/s synchronous motor. A friction drive enables adjustment of the number of grooves per inch; adjustment to cut from outside to inside or vice versa is also easily made. The electromagnetic cutterhead is equalised to give a flat characteristic ±2 db. from 50 to 10,000 c/s, and a recording range of 60 db. is obtainable. The electronic equipment, recording and reproducing characteristic controls, etc., are mounted on a rack 6ft. 6in. high.

Portable Studio Equipment, Type SP/1/2.—Separately controlled inputs for two microphones, two reproducing heads, telephone line and high impedance source are provided. The 30-watt amplifier feeds either or both cutterheads, a loudspeaker system or a telephone line. Loudspeaker or headphone monitoring is provided and the equipment gives powerful public address facilities. The standard equipment comprises two 12in. turntable machines with reproducing heads, one amplifier unit, and a monitor loudspeaker unit.

Portable Equipment, Type PR4/C.—A recorder ideally suited for location work when compactness and portability are essential. It is housed, complete with microphone, loudspeaker and all connecting leads, in two light aluminium cases. Normally operated from the 230/250 volt A.C. mains, it can also be operated from a motor generator and car batteries.

Prototype Studio Recording and Reproducing Trolley.—This equipment can be easily moved from stage to stage, and gives facilities for immediate playback for sound track, and for the introduction of sound effect, etc. Two direct-coupled synchronously driven 12in. turntables can be used for recording and reproduction. Recording is at 77.92 r.p.m. and "radius correction" units are fitted. A microscope enables the groove to be examined during recording. The reproducing heads are mounted on micrometer groove locators so that reproduction can be commenced from a particular point on a disc. "Instantaneous Start" mechanism is fitted.

6. RE-RECORDING EQUIPMENT†

A complete re-recording unit made by British Acoustic Films comprises:

Tandem Drive Projector
This projector consists essentially of a Gaumont-Kalee 21 Mechanism, together with the special sound-head type 381, stand-mounted and provided with driving motors as follows:

(a) Synchronous motor, 1/2 H.P. operating from A.C. mains 3-phase 50 c/s., at 1,500 r.p.m. and driving the projector through worm gearing; and
(b) Interlock motor, operating at 1,440 r.p.m., and driving the projector through spur gearing.

In association with the projector, up to two pedestal-mounted reproducers may be used, each consisting of the type 381 sound-head, a dummy mute-head, upper and lower spool-boxes, and the necessary switching.

*M.S.S. Recording Co., Ltd. (distributed by GB-Kalee, Ltd.) †GB-Kalee, Ltd
With each sound-head in this system, photo-electric cell amplifier type 138 is used. This is a 3-stage resistance-coupled amplifier, stabilised, with negative feed-back to eliminate distortion, and powered by supply unit type 139.

Outputs from such amplifiers are fed through changeover panels, type 332, to the Theatre Reproducer Main Amplifier (Gaumont-Kalee type 51), or to the inputs of the mixer console, as required.

**Gaumont-Kalee/B.T.H. Interlock System**

The system operates on the "AC interlock" principle, and considerable attention has been given to obtaining a high standard of performance, particularly as regards freedom from instability, smoothness of start-up and slow-down characteristics, minimum angular displacement between machines, and ease of control.

Its "distributor" comprises a synchronous motor coupled through gearing to a "transmitter." The latter is generally similar in construction to a "follower" motor, in that it has a wound stator wound rotor with three-phase star connected windings. The "transmitter" and all the "follower" motors are connected in parallel.

The operation may readily be visualised as follows: The "follower" motors and also the transmitter machine are in effect three-phase transformers with rotatable secondary circuits. When power is supplied to the primary circuit the voltages across each of the secondary windings may or may not be in phase, depending upon the rotational alignment of the machines. When misaligned, circulating currents will flow between the various machines in the secondary circuit, and these currents will tend to pull all the rotors in phase so that the circulating currents become a minimum. In this condition, the machines will all be in interlock, and turning any one of the spindles will result in the other spindles turning in a similar manner as regards the direction and angular displacement. The synchronous motor on the distributor provides the mechanical torque for turning over the whole assembly of machines at the correct speed when interlock has been achieved.

The control cabinet contains contactors, relays, time control circuits, etc., which govern the performance of the machines and also enable them to be started and stopped remotely by push-button controls. A standard push-button station has four buttons labelled: Interlock, Start, Stop, Shut Down.

A patch bay enables any required optional set-up to be achieved by means of double-ended jumper connections.

**Six-Channel Re-recording Console**

The Console body is of polished Sapeli and is made in three sections, the centre section forming the desk top. It is fitted internally with mounting-frames which accommodate all items of electronic apparatus, which may thus be inserted or removed as required.

The console embraces the following items of equipment:—

**Mixer Unit Type 302.**—The top panel bears six attenuator keys, and the lower one, when removed, gives access to the contacts of the seven edgewise type faders. These faders each give a maximum finite attenuation of 60 dB; one is a master and is placed at the output of the unit; the remainder are channel faders and are mixed in pairs by 2-way mixer transformers (hybrid coil type). The three groups of two are then mixed in a 4-way mixer transformer, the fourth way providing a spare input into which a supplementary 2-way mixer (an optional accessory) may be fed. The attenuator keys are placed before the channel faders and have three positions: on, off, and 20 dB attenuation. The line impedance throughout the mixer unit is 500 ohms.
Equaliser Networks.—The resistive network is used in conjunction with equaliser reactive networks type 309, 310, and 311, which are located in the left-hand side cabinet. The switches have eleven positions, the centres give zero equalizations, anti-clockwise rotation gives five degrees of cut, and clockwise rotation five degrees of lift. The frequency at which the maximum lift or cut occurs is determined by the type of reactive network which is plugged into circuit. Type 309 gives a resonant "lift," which is maximum at 90 c/s and a continuously drooping "cut" characteristic of 6 dB per octave at low frequencies. With types 310, both "lift" and "cut" are resonant and have maximum effect at 3,400 c/s. Type 311 gives a characteristic similar to the 309, but with maximum lift at 7,000 c/s and a high frequency cut.

Rear Patching Panel, 490,000.—This is located at the back of the desk and enables equalizers, gain units, and auxiliary apparatus, to be patched into the mixing circuit.

Gain Unit Type 306.—If used the unit is intended to make good the loss introduced by equalizer networks and may be operated at either 10 of 20 dB gain. It will therefore, compensate for a maximum of two equalizers. It has input and output impedance of 500 ohms.

The following units are not supplied with a standard console:

Overload Distortion Simulator and Indicator Unit.—This unit is inserted in the monitor line and gives audible and visual indication of overload, the former by introducing distortion into the monitor signal, and the latter by flashing a Neon tube which is located in front of the operator at the top of the desk.

Limiter/compressor Unit.—This is on a meter located at the top of the desk and indication is given of when the compression or limiting action is working.

Automatic Background Control Unit.—This unit enables the levels on one or more channels to be controlled by the signal on another; for example, it will reduce the level of background music in the presence of speech commentary.

Microphone Input Amplifiers Type 307.—These enable any standard microphone to be used with the console.

Fixed Frequency Oscillator Unit Type 333.—This provides 1,000 c/s tone at 1 volt on 500 ohms.

The console includes also patch panels and H.T. and L.T. supplies.

7. SOUND RECORDING INSTRUMENTS
Avo Electrical Testing Instruments*

The following instruments were exhibited:

Electronic Testmeter.—A 49-range measuring instrument, consisting of a D.C. valve millivoltmeter with subsidiary circuit switching to provide wide ranges of readings in volts, current, A.C. watts, decibels, capacitance, resistance and insulation.

Valve Characteristic Meter.—Will test any standard receiving or small

*Automatic Coil Winder and Electrical Equipment Co., Ltd.
dower transmitting valve on any of its normal characteristics. A patented method enables A.C. voltages of suitable magnitude to be used. Heater volts up to 120-volts are available.

*Universal Meters.*—Model 7 Universal Avometer covers 50 ranges and the Model 40 covers 40, all without the aid of external shunts, transformers or multipliers.

**Avo Minor.**—The Universal Model has 22 ranges and the D.C. Model has 10, selected by plugging leads into appropriate sockets.

*Wide Range Signal Generator.*—This instrument gives laboratory performance at low cost. It covers a frequency band of 50 Mc/s—80 Mc/s, is directly calibrated, accurate to within 1%, highly stable, output has harmonic content of less than 1% it has excellent attenuator performance, minimum signal approximately 1 μV, high level signal output is substantially constant through frequency range.

**Flutter Meter***

The Gaumont-Kalee Flutter Meter, Type 495, is an instrument designed to measure small frequency variations of the recording and/or reproducing machine. The instrument operates at a nominal carrier frequency of 3,000 c/s, but will tolerate up to 5% variation in mean carrier frequency.

An amplitude limiter, to eliminate effects due to signal level variations, is followed by a power amplifier which drives a discriminator operating at a mean frequency of 3 Kc/s. The discriminator may be tuned from 2850 c/s. to 3150 c/s., to accommodate variations in mean carrier frequency.

The rectified output from the detector which follows the discriminator is directly coupled to a meter amplifier, and from this, again directly coupled to a push-pull amplifier, so that, when desired, a standard cathode-ray oscilloscope can be connected. As both the meter and the oscilloscope are directly coupled, they will respond down to zero frequency and will therefore indicate accurately the lowest wow components present. The calibration is such that the meter, up to about 3 c/s, and the cathode-ray oscilloscope for the full band-width of the instrument, indicate peak frequency deviation.

A pair of meters is also incorporated in the instrument to indicate R.M.S. wow and flutter components, wow being defined as speed variation below 20 c/s., and flutter as speed variation above 20 c/s.

### 8. EDITING EQUIPMENT

"**Acmiola**" Editing Machines†

The "**Acmiola**" editing machine is available in various forms, with projected picture or viewing lens, and with or without take-offs and take-ups.

Three models were exhibited. The Model 16B makes use of the standard 16mm. picture head, giving a projected picture measuring 2½in. × 1¾in., with a 16mm. sound-head; the optics of the latter are of such design as to ensure highest reproduction quality from 16mm. tracks. The Model B is substantially similar, but with a 35mm. sound-head. The Model C is for 35mm. picture and sound, giving a projected picture 9½in. × 6in.

All machines are mounted upon trolleys, and have provision for varying the running speed, and for reverse running.

"**Acmade**" Synchroniser and Joining Press†

A 4-way synchroniser permits of synchronisation of both 16mm. and 35mm. films. The joining press has since its inception been modified to cope with many types of film joins: unperforated film, 16mm., 17.5 mm., 35mm. diagonal sound joins, etc. The provision of retractable registering pins makes for ease of adaptation.

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*GB-Kalee, Ltd.*

†Acmade, Ltd.
"Dell Syncrola" *

This machine was designed to simplify and speed up the preparation of dialogue cues, and to assure quicker and more precise cutting of final sound tracks, when operating the De Lane Lea process for post sync or foreign language dubbing, for sub-title spotting, for cueing commentaries in film and television, for making pre-animation charts for cartoon and puppet films very rapidly. 10

Looking at the machine from the front, the first handle on the left is for de-synchronising picture from sound. The second is the forward/reverse switch and brake. The third provides alternative speeds of 90 or 60ft. a minute. The fourth is the Frame by Frame control.

Above the first handle is the framing lever, which functions by changing the relative position of the scanning beam to the picture sprocket. At positions of rest the picture is lit.

In the De Lane Lea process for post-synchronising an envelope wave-form is recorded by the Dell Oscillector on a slow moving film which enables the phonetic features of the sound to be studied for synchronising, dubbing, preparing foreign versions, etc.

The table on which the Syncrola is fitted carries the three-way variable ratio detector mechanism, which feeds the detector tape—paper or film—over an illuminated ground-glass screen. The variable ratio of detector to picture speed is simply changed by sliding the detector sprocket shaft through a keyed way. The variation is used when preparing work for cartoon-pre-animation charts, or for television cueing. The Dell Oscillector, when in use, fits on to the front edge of the table.

Track Reader†

A device for reproducing sound tracks, adjustable to accommodate either 35mm. or 16mm. gauge by means of a simple control knob. The track is looped round the sound drum and flanged rollers and drawn through at the desired speed by a conventional rewinder. The outside rollers may be quickly adjusted to suit either vertical or horizontal rewinders. Although a power driven rewinder may be used, the hand operated type gives a more sensitive control and hence more efficient results in practice. A reference mark on the rotating sound drum enables any particular sound to be located on the track with precision. The film may be wound back and any selected portion replayed as slowly and as often as is necessary.

The sound drum and rollers are on self-oiling bearings. The amplifier is

*De Lane Lea Processes, Ltd. †Leevers, Rich & Co., Ltd.
contained in the cast metal case and may be swung open for access by releasing one screw.

16mm. Animated Viewer*

A well built machine made up in cast aluminium with a number of features to satisfy the professional user.

It projects a picture 3½in. × 2½in. on to a ground glass screen and gives a brilliant illumination, using a 12 v. 24 watt standard car lamp in conjunction with a built-in transformer working from 250 v. A.C. mains.

A nicking punch is fitted for cutting frames and a skate is provided to prevent film slipping on sprocket.

A pair of non-geared winder heads are included. Pleasing finish in bronze crackle enamel. Weight 10 lbs.

Bell & Howell-Gaumont Automatic Film Splicers†

These splicing machines are available in eleven different models for 35mm., 16mm. and 8mm. film. The Combination model, combining all three sizes, is worked by means of interchangeable register pins.

The basic machine incorporates the standard features which include foot-pedal operation and identical methods of scraping and cutting. A heater element is embodied to ensure complete welding of the splice. Certain models also make provision for scraping the film on the celluloid side in order to provide a maximum thickness at the splice of .008in.

9. LABORATORY EQUIPMENT

Bell & Howell-Gaumont Printer Models D and J†

Model “D” is the standard printer for 35mm. film, and Model “J” for 16mm. film. The two models embody exactly the same essential principles. The only difference is in the dimensions of the sprockets, rollers, flange, hubs, masks, etc.

The light control of the machine is semi-automatic, i.e., while the actual range of light volume at the film contact-point is controlled electro-mechanically, the changes are pre-set by the operator, one step ahead of the printer operation, hence the term “semi-automatic.”

A 22-position shutter encloses the lamp side of the printing sprocket. The exposure variation between steps is approximately 10%, and the range of exposure covers all normal negatives. The shutter is pre-set by a control lever working through a roller and switch operated by normal 35mm. film notches. This switch also operates the timing card indicator control.

*E. D. Runkel & Son, †GB-Kalee, Ltd.
The printing lamp is a new 300-watt projection type lamp, equipped with pre-alignment gauge, which ensures correct position of lamp filaments, irrespective of physical variation in lamps.

Voltage control is provided by a variable resistor, which enables the lamp to be set at an operating voltage suited to any printing requirement.

Five methods of printing are provided by the five-way printing drum on the Model "D" (35mm.) Printer. They are:

(a) Silent full aperture pictures or composite picture and sound;
(b) Picture area when negative film is led to the aperture "head-first";
(c) Sound track led to the aperture "head-first";
(d) Picture area when negative is led to the printing aperture "tail-first";
(e) Sound track led to the aperture "tail-first".

The above arrangement of aperture openings permits running the negative many times in succession without rewinding, if desired. On Model "J" three aperture positions for printing are provided, as in a, b and c above. Silent 16mm. film negatives do not require to be rewound for repetition printing. Because 16mm. sound films have only one row of perforations, rewinding is necessary.

The Model "D" printer is recommended for use at a speed of 60 ft. of film per minute, but arrangements are provided, by means of stepped belt pulleys and change of motor pulley, for speeds of 40 and 100 ft. per minute. The motor speed does not change. Model "J" operates at 60 ft. per minute.

Bell & Howell-Gaumont Model E Printer*

The Model E Printer prints both sound and picture in one operation. It is entirely automatic in its functioning. It operates equally well in either direction so avoiding re-threading of the negative.

Light control is effected by a matte on positive film which travels at a quarter the speed of the negative. By means of the matte, 30 geometric steps in light control are available, each giving 10% more light than the preceding step. From matte negatives prints are made which are cut to suit light control requirements for picture and sound negatives.

Both sound and picture heads use 100 volt 500 watt lamps, which are operated at about 85 volts for economy, and to obtain extreme constancy of illumination. Densitometric control of printed light values is so exact that the same negative and matte can be used in any of a number of printers.

Air pressure on both top and bottom of films insures perfect contact at the printing apertures. Combination compressed air and vacuum cleaning

*GB-Kalee, Ltd.
devices insure perfect cleaning of negatives, mattes, and positive. The air for these purposes is filtered and its pressure is equalised.

Controls are completely interlocked, insuring fool-proof operation. One handle starts the machine forward or backward, controlling motor, brake, air, vacuum, water, lights, tension, weights, and trip locks on all gates. It is impossible to start the machine if any gate is open, or if any lamp is burnt out.

One set-up operator can handle five to ten printers. An operator, who can attend a number of the printers, need only thread in additional positive film when it is needed, and engage the single starting lever.

"Eel" Universal Densitometer*

This instrument consists of an optical system which focuses the light from a 36-watt lamp on an aperture in the white table top of the instrument. A heat-absorbing filter is provided in the system to prevent damage to the sample. An "EEL" photo-cell carried at the end of a movable, friction loaded arm, can be lowered over the sample in line with the aperture. The output from the cell is measured on an accurate, hand calibrated 4-in. microammeter from which the decimal values of density are read.

Three ranges are provided, covering densities 0-1, 1-2, and 2-3.

Density differences as low as 0.02 may be read with certainty and reproducibility at even the higher densities. The ultimate limit of the instrument is actually density 4, but densities between 3 and 4, whilst somewhat crowded at the extremity of the meter scale on range 2-3, are yet capable of being read to approximately 0.1.

An accessory provides a reflection densitometer invaluable for surface comparison and the examination of photographic prints, reproductions and originals. The instrument has two ranges of reflection density, 0-1 and 1-2. A colour filter wheel enables accurate measurements to be made of three-colour reproductions.

10. PROJECTION EQUIPMENT

"Streemlite" Equipment with RCA Soundhead†

The Ross projector embodies the G.C. mechanism with the modern pedestal stand and a Streemlite arc lamp. The last is of sturdy construction; the 13in. mirror is designed to give a large angle of illumination, providing a greater aperture than many larger mirrors.

The mechanism is fitted with a special gate; the runners provided for studio use are designed to eliminate the possibility of pick-up when using new film, and the gate and roller assembly accommodates two thicknesses of film. Special detachable gate masks to suit picture projection or sound track projection can be provided and changed instantly.

The double-film model, as supplied for studio use, provides in the lower magazine an additional take-off and take-up to accommodate separate picture and sound films.

*Evans Electro-selenium, Ltd.
†Barnet Ensign Ross, Ltd.
This equipment is provided with an RCA LG 230P sound-head, which is a special version of the LMU 9031P Rotary Stabiliser head. Special features include close tolerance ball bearings, Vulcaprene multisection pressure roller, .00075in. scanning beam developed by a special optical unit with a curved slit designed for constant longitudinal illumination, and with facilities for precision azimuth adjustment. The head also embodies RCA 290 push-pull photo-cell and a beam splitter for standard or push-pull reproduction.

**"EEL" Screen Brightness Meter**

This instrument, provides an integrated reading of reflected light, as specified in the relevant standard of screen brightness. To use, the unit is held level with the face, and the illuminated kinema screen is viewed through a view-finder. The user walks backwards or forwards until the screen appears to fall between the frame marked on the view-finder. The switch is then pressed on, and a direct reading in foot-lamberts appears, representing the light reflected by the total area of the screen.

The unit consists of a bank of "EEL" self-generating photo-cells yielding a current proportional to the illumination to which they are exposed; a light grid to limit the acceptance-angle; a sensitive microammeter to measure the current generated by the photo-cells; and a view-finder to ensure that the exposure of the photo-cells is limited to the screen area.

The 4in. scale can be read easily in reduced light, and is calibrated 0-24 foot-lamberts.

**REFERENCES**

5. See "Developments in Magnetic Sound-on-Film" to be printed shortly in this journal.

**LIST OF EXHIBITORS**

ACMADE, LTD., 101, Wardour Street, W.1.

AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO., LTD., Winder House, Douglas Street, S.W.1.

BARNET ENSIGN ROSS, LTD., 26, Conduit Street, W.1.

DE LANE LEA PROCESSES LTD., 40, Frith Street, W.1.

W. F. DORMER, LTD., 14, Edgeworth Avenue, N.W.4.

EALING STUDIOS, LTD., Ealing Green, W.5.

*EVANS ELECTROSELENIUM*, LTD., Harlow, Essex.


GENERAL ELECTRIC CO., LTD., Magnet House, Kingsway, W.C.2.

ILFORD, LTD., National House, 60-66, Wardour Street, W.1.

LEEVERS, RICH & CO., LTD., 80-82, Wardour Street, W.1.

MOLE-RICHARDSON (ENGLAND), LTD., H.I. Arc Works, Bashley Road, N.W.10.

MULTIPLE HD INDUSTRIES, LTD., 11, Thames Street, Sunbury-on-Thames.

E. D. RUNKEL & SON, 121 & 123, New Cavendish Street, W.1.

W. VINTEN, LTD., North Circular Road, N.W.2.
THE MAINTENANCE OF STANDARD SCREEN BRIGHTNESS

Memorandum prepared by the British Kinematograph Society and circulated to members of the Cinematograph Exhibitors' Association.

FROM the beginnings of the film industry the exhibitor has complained of print density, maintaining that he is not able to project a satisfactory picture with prints of the density favoured by the laboratory; while the laboratory technician has retorted, with perfect accuracy, that he cannot do justice to the photographic quality of the original negative unless the print is made to a minimum mean density.

The Film Production Division of the British Kinematograph Society, whose members are profoundly concerned in the manner of the ultimate presentation of their films to the public, wishes to draw the attention of exhibitors, projectionists and projection engineers to the recent standardisation of screen brightness, which in its turn will lead to a standardisation of print density at an appropriate level.

Investigations made in 1938 showed that the range of screen brightnesses in London kinemas was greater than 10 to 1. Although the worst examples in this range may by now have been improved, it is obviously impossible for the same print to be shown with equal satisfaction under conditions so widely differing. Even if specially light prints were to be made to suit low brightness levels in projection, such prints would show a lack of discrimination in the highlights, and thus an inferior photographic quality.

In British Standard Specification No. 1404: 1947* the brightness of the kinema screen is fixed between 8 and 16 foot-lamberts. Screen brightness is to be measured in the centre of the screen with the shutter running, but no film in the gate. In any kinema achieving a lower standard of picture illumination the satisfactory presentation of prints of average density is impossible.

In order that the meaning of this specification may be completely clear, attention is drawn to the distinction between the measurement of light reaching the screen from the projector (the appropriate unit for which is the foot-candle) and the measurement of light reflected from the screen and reaching the eyes of the audience, for which the foot-lambert is used. The latter measurement takes account of the reflective properties of the screen.

Methods of measurement of screen brightness are at the present moment the subject of investigation by the responsible committee of the B.S.I. It may however be stated that a level of 8 foot-lamberts would require a minimum illumination in the projector beam of 11 foot-candles, or, according to the condition of the screen, even over 16 foot-candles.

While instruments for the measurement of reflected brightness are available, the measurement of the brightness of the beam is more usual, and, pending the formal approval of reflected-light instruments, may be preferred. In this case it is strongly recommended that a minimum intensity of 16 foot-candles in the centre of the screen be maintained in order to allow for aging of the screen, and for losses through dust and dirt in the atmosphere which may not be present during tests.

While every projectionist is aware that picture quality will suffer from too low a level of screen illumination, the degradation of picture quality resulting from too bright a picture is perhaps not so well realised. There is a very small number of theatres where screen intensities in excess of the above B.S.I. recommendations are to be found. In order that the upper limit of

*Obtainable from the British Standards Institution, 28, Victoria Street, London, S.W.1, price 2s., post free.
16 foot-lamberts reflected brightness should at no time be exceeded, it is recommended that the brightness of the beam should not exceed 20 foot-candles.

The last paragraph applies especially to the projection of colour films. Lengthy investigations by the B.S.I. committee have demonstrated that, provided the recommended minimum brightness is attained, a colour film needs no greater illumination than a black-and-white picture. But on the other hand, it is more easily marred by excessive brightness.

An important factor which is now the subject of research by the B.S.I. committee is the centre-to-edge distribution of light. While no recommendations have yet been made on this subject, the desirability of maintaining a reasonably high centre-to-edge ratio (that is, of maintaining well-lit sides and corners) will be appreciated.

Yet another factor awaiting detailed consideration is the effect of auditorium lighting upon picture quality.

It is not the purpose of this memorandum to indicate to the exhibitor or engineer the method to be adopted for attaining these requisite figures of screen brightness. It may however be pointed out that it is rarely efficient merely to supply a higher current to the arc lamps; if full advantage is to be taken of a higher current, the use of larger carbons and re-adjustment of the optical system of the projector are generally necessary. It may be further mentioned that in many cases, the installation of new equipment will enable the desired standard of screen brightness to be attained with no increase of electrical consumption.

BOOK REVIEWS

Books reviewed may be seen in the Society’s Library

KINEMATOGRAPH YEAR BOOK, 1949. Odhams Press, Ltd. 21s.

Continuamur more solito.

LESLIE KNOPP.

BRITISH STANDARDS INSTITUTION YEARBOOK, 1949. British Standards Institution. 5s.

The 1949 edition of the B.S.I. Yearbook shows a considerable increase in the number of published standards on cinematography and allied subjects. The list of work in hand by the cinematograph committees shows no fewer than 26 projects, in addition to three photographic projects.

The bulk of the book is occupied by abstracts of published specifications, which indicate the very wide field covered by the B.S.I. Sectional lists of specifications are now available, and the cinematograph section is inserted with this issue of British Cinematography. Actually, however, the film industry covers such a diversity of interests that many specifications not shown in this list are nevertheless included in the B.K.S. Library, as being of interest to members.

Complete sets of standards are maintained in 36 provincial libraries and in many overseas centres; enquiries as to the libraries housing these standards will be gladly answered by the B.K.S.

R. H. CRICKS.

ART AND DESIGN IN THE BRITISH FILM, by Edward Carrich, Dennis Dobson (London), Ltd. 18s.

Roger Manvell, in his usual erudite manner, states in the introduction that "the film is at war with itself." In the section devoted to him, Michael Relph maintains there must be "some revolutionary new use of the film as an art."

It seems that this attractively presented volume is also at war with itself, for, although it contains many pleasant illustrations of the work of British art directors, it does not tell us very much about that work. In fact, it is more like an illustrated "Who’s Who" of art directors, than a profound analysis of the subject.

However, it is a useful volume as it contains much detailed information relating to individual art directors, and examples of their work.

J. H. CROYDON.

THE NEGRO IN FILMS, by Peter Noble, Skelton Robinson. Price 15s. net.

Here is a very carefully prepared mass of evidence in defence of the Negro race, particularly as portrayed by Hollywood. Mr. Noble points the unjust treatment of the Negro in films ranging from Griffiths’ "Birth of a Nation" to "Gone with the Wind," and, incidentally, proves once again, the magnitude of the indirect propaganda force of the cinema.

G. E. BURGESS.
TECHNICAL ABSTRACTS

Most of the periodicals here abstracted may be seen in the Society’s Library.

COLOUR KINEMATOGRAPHY TODAY.
A valuable survey of the principles of and problems confronting Technicolor, Technichrome, Ginecolor, Magnacolor, Trucolor, Agfacolor, and Ansco Color. R. H. C.

THE ANSCO COLOR PROCESS.
The modification of laboratory equipment for the processing of integral tripack material includes an increase in processing capacity, provision for the introduction of balancing filters in printing, and the testing of each batch of stock for colour balance. R. H. C.

MAKING FILMS SPEAK ANOTHER LANGUAGE.
The Lingua-Synchrone dubbing system employs an envelope oscillogram of the sound wave to facilitate the preparation of the translated dialogue; in recording, the new dialogue is projected below the picture, in order to assist synchronisation. Oscillograms of the various tracks are also used in re-recording to facilitate mixing.

VARIABLE AREA RECORDING WITH THE LIGHT VALVE.
Variable area soundtracks may be recorded using a light valve mounted with ribbons at right angles to the normal position. Two and three ribbon types of valve may be arranged to record various forms of single and multi-track, including push-pull, and the performance of these tracks as regards azimuth error is calculated and compared. N. L.

VARIABLE AREA LIGHT VALVE MODULATOR.
The modulating unit comprises recording optical system, visual monitor, photo-cell monitor, and interchangeable light valves for dulateral or push-pull tracks. Illustrated descriptions are given together with major characteristics, and cross modulation curves. N. L.

PROPOSED STANDARDS FOR THE MEASUREMENT OF DISTORTION IN SOUND RECORDING.
The proposals fall conveniently under four main headings corresponding to major types of distortion, and comprise definitions, conditions of test, and notes on current practice in each case. Differing views on the measurement of flutter and the use of pre-emphasis are discussed in an appendix. N. L.

MAGNETIC SOUND RECORDING.
Dr. B. Vinzelberg, Funk und Ton, Dec., 1948, p. 663.
Experience has shown that magnetic sound recordings on tape occasionally produce a magnetic “printing effect” or “transfer” to adjacent layers of a reel, thus adding an undesired signal to the existing recording. Investigations carried out to overcome this effect show that the printing effect depends upon time and frequency, and can be influenced by temperature. Printed levels of 45 phons below recorded signal were found in the adjacent layer, and even in the fifth layer the effect was noticeable.

No satisfactory explanation of the effects is given in the paper, and it certainly does not depend on the general properties of the tapes, such as sensitivity, recording level, etc. Further investigations are recommended. O. K. K.

FRENCH TELEVISION AND ITS RELATION WITH THE KINEMA.
Roger Colas, Le FilmFrancais, Vol. 5, No. 200, p. 27.
A review of the present position of television in France. Succeeding articles deal with television in Great Britain and the United States. R. H. C.
ORDINARY MEETING

The third Ordinary Meeting of the British Kinematograph Society was held on May 25, 1949, at Film House, Wardour Street, W.1. The retiring President, Mr. W. M. Harcourt, was in the chair.

Minutes

The minutes of the Ordinary Meeting of April 28, 1948, were read by the Hon. Secretary, Mr. E. Oram, and on the President's proposal were agreed.

Hon. Secretary's Report

The Hon. Secretary submitted his report as follows:

It has repeatedly been stated that the kinematograph industry is passing through a critical period, but as we do not hear so much about this now it is hoped that the storm is being weathered. Undoubtedly, many industries are experiencing difficulties and I wonder if ours is in any worse plight than most others which have experienced similar rising costs and difficult export markets. Whatever the answer, I am glad to report that the progress of the Society has been continued.

Membership.—Although the intake rate of new members appears to have passed the maximum there has been a healthy increase, taking into consideration the difficulties of the period. The figures of membership are as follows:—

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These figures show a net increase of 62.

General Activities.—In addition to the general meetings and lectures, your Committees and Sections have had a very full programme, having held in the order of 100 meetings covering all aspects of the industry, including film production, theatre and sub-standard interests. The most important features of discussion are reported in British Kinematography, and I think it will be agreed that the lecture programme has been maintained at a high level.

Once again I emphasise that the Council welcome suggestions from Members for material for papers to be considered by the Papers Committee, who have the task of endeavouring to cover all interests. In this connection I would like to record the assistance afforded by the co-operation of other Societies with whom we have had joint meetings, i.e., the Television Society; the British Sound Recording Association; the Association of Cine-Technicians; and the Royal Photographic Society.

Education.—Although all our activities are of an educational character, I now refer particularly to direct educational courses. As you know, the Society, for many years, sponsored courses in kinematography and allied subjects at the Regent Street Polytechnic. Unfortunately, the Polytechnic found it necessary to discontinue these. The Education Committee is now exploring various schemes, as the value of such education properly organised within the industry is fully realised.

Standardisation.—The Society has contributed very considerably in representation to the many committees which are now active in the British Standards Institution. A number of standards have been passed for circulation and many more are in preparation, covering such subjects as Projection Room Equipment, Lens Measurements, Electrical and Mechanical Equipment for both Studio and Projection Theatre use.

Library.—This is one of the activities which could be described as "back-room work." Only those who avail themselves of its facilities can appreciate the work that has been done and is being done by the Library Committee.

Mr. Rex Hartley is relinquishing his office as Chairman, which he has held since its inception in September, 1946. It is a tribute to his enthusiasm to record that the Library now contains nearly 500 volumes pertaining to the film industry, and is of considerable value, especially as some volumes are unobtainable today.

As a first effort, a duplicated catalogue was produced; this was followed by a printed catalogue which has been sent to every member of the Society. Lantern slides followed by two sound films were produced in this period for publicising the Library, and I am sure
Mr. Hartley will wish me to emphasise that he is still hoping for further contributions in the form of volumes or suitable technical data.

*Journal.*—Since July, 1947, the Journal has been published monthly under the title of *British Kinematography.* The Journal Committee, under the chairmanship of Mr. Geoffrey Parr, and its Editor, Mr. Cricks, have maintained a consistently high standard which will be appreciated by all members, particularly those who are unfortunately unable to attend our lectures and meetings. This monthly publication is a considerable expense to the Society, but your Council feel that it is justified and has your support in this method of disseminating knowledge.

**Patron Membership.**—I am pleased to express our thanks to our Patron Members, who have so generously supported our work through the difficult financial period through which the industry generally is passing. Without these Patrons we could not achieve more than a small portion of our aims and objects—particularly the unremunerative educational aspects. Not only have we had the continued support of former Patron Members, but we have enrolled several new ones, as will be seen by reference to the lists published in the Journal.

**Staff.**—I would like to express on behalf of the Council, and I am sure on behalf of the Members, our appreciation of the untiring efforts of all our staff. It is, as you know, the first year that Mr. Bevir has carried the work of Secretary, supported by Miss Barlow, and those officers and members of Committees who see behind the scenes will readily realise how much we appreciate their loyal support.

**Finance.**—Like other businesses and societies, we are finding it difficult to expand activities to the level of demand and to keep expenditure within income. A major portion of the work of committees and general running of a Society, such as this, falls on voluntary workers who give much of their time so freely, but it must be remembered that this has to be supported by office routine and organisation incurring expenditure. I shall leave our Hon. Treasurer to submit our Balance Sheet for approval and feel that you will agree that the firm hand of our President, Mr. Harcourt, has been justified.

You will, I am sure, wish me to make reference to our retiring President’s help and guidance which has made exceptional demands on his time. I can assure you that although retired, he is not lying down, and his enthusiasm for the Society will ensure his support for our new President.

**Hon. Treasurer’s Report**

The Hon. Treasurer, Mr. P. H. Bastie, in submitting the accounts for the year ended December 31, 1948, expressed the opinion that the financial position of the Society was, in the present difficult circumstances, satisfactory. He nevertheless drew attention to the rising costs; although subscriptions had increased, it had been difficult to keep the balance on the right side.

On the proposal of Mr. J. A. Walters, seconded by Mr. T. S. Lyndon-Haynes, the adoption of the reports and accounts was agreed unanimously.

**Election of Officers**

The President reported that the following Officers had been elected unopposed:

- President ... ... ... ... Mr. A. W. Watkins
- Vice-President ... ... ... ... Mr. L. Knopp
- Hon. Secretary ... ... ... ... Mr. E. Oram

The President stated that Mr. P. H. Bastie had wished to retire from the office of Hon. Treasurer; unfortunately, neither of the Members nominated for the office was willing to serve. Mr. Oram proposed the following motion:

That in view of the fact that neither of the two Members nominated for the Hon. Treasurership was willing to stand for this office, Mr. P. H. Bastie be co-opted as Hon. Treasurer for a term of one year.

Mr. Bastie stated that he was willing to accept co-option. The motion was seconded by Mr. I. D. Wratten, and carried unanimously.

**Election of Ordinary Members of Council**

The President stated that Messrs. P. W. Alston and W. S. Bland had been appointed by the Council to act as scrutineers. Mr. R. H. Cricks stated that Mr. Bland had been absent from the scrutiny and he (Mr. Cricks) had accordingly acted as scrutineer; in the absence from the present meeting of Mr. Alston, he read the report of the scrutiny, which showed that the following had been elected:

Messrs. I. D. Watten, Baynham Honri and R. R. E. Pulman.
The President declared the afore-men ioned duly elected, and on his motion a vote of thanks was carried to the scrutineers.

Divisional Representatives

The President reported that Mr. T. W. Howard had been elected Council Representative of the Film Production Division, and Mr. H. S. Hind of the Sub-Standard Film Division. Mr. Pulman had been elected by the Theatre Division, but in view of his election as an Ordinary Member of Council, the Theatre Division would be entitled to appoint another representative.

Appointment of Auditor

The Hon. Secretary reported that Mr. J. Foster was unable to act as auditor. On the proposal of Mr. Wratten, seconded by Mr. G. E. Burgess, Mr. H. B. Johnson, Chartered Accountant, was appointed auditor.

Address by Retiring President

Mr. Harcourt in relinquishing office quoted the phrase, *Le roi est mort—vive le roi*, and expressed confidence that Mr. Watkins would prove an energetic President. The Society had shown good sense in electing Mr. L. Knopp as Vice-President; he had rendered enormous assistance to the Society. The untiring efforts of Mr. Oram had marked every year since the inception of the Society, while he was delighted that Mr. Bastie had agreed to serve for a further year.

He wished to add his personal thanks for the excellent work done by Mr. Cricks. Mr. Bevir had justified himself as an able secretary during his first year of office.

The serious situation in the Industry was, continued Mr. Harcourt, reflected in the finances of the Society. Fortunately, the big companies of the Industry were appreciating the services it was rendering to the Industry. It was the duty of every Member to endeavour to get new members, particularly in the film production side; many of the men in the studios were beginning to feel that it was part of their function to become members of the B.K.S.

Mr. Harcourt concluded by expressing his appreciation of the assistance given him by the Officers and Council during his year of office.

Votes of Thanks

On the proposal of Mr. Oram, seconded by Mr. Bastie, a vote of thanks was carried to the G.-B. Picture Corporation for the use of the theatres, and to Mr. J. S. Abbott and his staff for their constant services. Mr. Watkins proposed a vote of thanks to the Cinematograph Exhibitors’ Association and to Mr. Knopp for the use of the council room and for their general support; the motion was seconded by Mr. Wratten and carried unanimously.

On the proposal of Mr. Wratten, seconded by Mr. Honri, thanks were conveyed to the Patron Members; to the advertisers in *British Kinematography*; to the trade press for their reports of meetings; and to all Members who served on committees.

Dr. F. S. Hawkins proposed a vote of thanks to the Officers and Council, stressing the extraordinary amount of work they did for the Society. The proposal was seconded by Mr. B. C. Sewell and carried with acclamation.

*Reports of Divisional annual meetings have been unavoidably held over.*

**BULGARIA NEEDS KINEMATOGRAPH EQUIPMENT**

The B.K.S. Library is receiving a monthly bulletin issued by Bulgarian Kinematography, the State organisation which controls all branches of the film industry in that country.

The Commercial Section of this organisation has, it is stated, sole rights for import and sale of equipment and accessories for photography and cinematography; it is desired to enter into relations with foreign suppliers.

Communications should be addressed to the Commercial Section, Bulgarian Kinematography, Rue Rakovsky 96, Sofia.

**CANADIAN STANDARDS**

The Committee on Motion Picture Photography of the Canadian Standards Association has adopted an American specification for projection rooms and lenses, Z.7.1, and is considering a number of reports on 16mm. equipment.
THE COUNCIL

Meeting of May 4, 1949

Present: Messrs. W. M. Harcourt (President), A. W. Watkins (Vice-President), L. Knopp (Deputy Vice-President), P. H. Bastie (Hon. Treasurer), R. B. Hartley, A. G. D. West, F. G. Gunn, B. Honri, H. S. Hind, R. E. Pulman, G. F. Burgess, R. H. Cricks (Technical Consultant), and W. L. Bevir (Secretary).

Accounts.—When a cash statement was presented Mr. Hind pointed out that no budget had been prepared for the current year, and it was agreed that a meeting of the Finance Committee should be called.

Sub-Standard Film Division.—Mr. Hind reported that the anticipated co-operation at meetings of the R.P.S. (Kine Section) and the S.F.A. had not materialised, and the Committee felt that no useful purpose would be served in continuing with them. Subjects for next season’s papers had been discussed.

Theatre Division.—Mr. Pulman requested that space be allocated in the Journal for the publication of papers not necessarily read to the Society. This was agreed subject to their being of the necessary high standard, and to space being available in the Journal, a factor which was dependent upon the volume of advertising.

Film Production Division.—Mr. Watkins reported that Mr. Leewers had asked that Divisional Annual General Meetings should be followed by a paper. The suggestion of a monthly programme card going out with the Journal should be referred to the Papers Committee for estimation of cost. The printing of the posters on tinted papers was also suggested for consideration.

B.F.A. Co-operation.—Mr. Cricks said he had discussed with Dr. Roger Manvell, methods of co-operation between the B.F.A. and B.K.S., and the institution of Fellowships.

Annual General Meetings.—Council was asked by Mr. Knopp to consider holding the A.G.M. of each Division on the same day and at the same place, to be followed by the Society A.G.M. and the Presidential Address.

EXECUTIVE COMMITTEE

Meeting of May 4, 1949

Present: Messrs. W. M. Harcourt (President), A. W. Watkins (Vice-President), L. Knopp (Deputy Vice-President), I. D. Wratten (Past President), P. H. Bastie (Hon. Treasurer), W. L. Bevir (Secretary), and Miss S. M. Barlow (Assistant Secretary).

Elections.—The following were elected:—

JOHN HEYER (Member), Shell Film Unit.
GORDON PERCIVAL DINES (Member), Ealing Studios, Ltd.

Resignation.—The resignation of JOHN FREDERICK BARTON (Associate) was accepted with regret.

DIVISIONAL COMMITTEES

The composition of the Divisional Committees for the current year, as completed by the recent elections, is:—

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JOURNAL COMMITTEE  
Meeting of May 16, 1949

Miss Barlow reported that the prospect of obtaining adequate revenue from advertisements was disturbing.

A more comprehensive index to the present volume of the Journal was approved, incorporating a title page and cross-references.

Dr. Bohn drew attention to the condition in which the Journal was delivered by post and it was agreed to a certain if other Members were dissatisfied with its handling by the postal authorities.

FINANCE COMMITTEE  
Meeting of May 18, 1949

The audited accounts for 1948 were considered and the Newcastle Section requested to reduce their expenses.

The President revised the estimate for the current year on the basis that there would be an increase in expenditure and a fall in income owing to present conditions in the industry.

THEATRE DIVISION COMMITTEE  
Meeting of May 26, 1949

On his election as Deputy Chairman of the Division, Mr. S. A. Stevens automatically became Chairman of the Papers Sub-Committee and the Divisional representative.

Mr. R. E. Pulman was appointed to the Branches Committee and Mr. S. B. Swingler to the Membership Committee.

Arrangements for papers during the next lecture season were approved.

The Secretary was asked to ascertain how many of recent resignations and expulsions referred to Members of the Theatre Division.

SUB-STANDARD FILM DIVISION COMMITTEE  
Meeting of May 30, 1949

Arrangements for next season’s lecture programme were discussed and it was agreed to hold a joint meeting with the Institute of Engineering Inspection.

Mr. Norman Leever was appointed Deputy Chairman of the Division and its representative on the Membership and Journal Committees; Mr. D. Cantlay, Hon. Sec.; Messrs. W. Buckstone and D. Ward representatives on the Papers and Branches Committees respectively; and the Chairman, Mr. H. S. Hind, Divisional representative on the B.S.I. Committees.

Six members, four Associates and three Students were enrolled in the Division.

BRITISH STANDARDS INSTITUTION

Draft standards are at present being prepared by committees of the B.S.I. on the following kinematograph subjects: film rewinders; film storage cabinets; carbon-electrodes and holders for projectors; and fire-shutters for projection rooms. Publication of the draft standards will be announced in the B.S.I. Monthly Information Sheets, which are available for reference in the B.K.S. Library.

Mr. R. F. H. Banister, who since 1945 has been the technical officer on kinematograph work at the B.S.I., has transferred to the transport section. He is succeeded by Mr. M. J. Parker who recently joined the Institution. The kinematograph section remains under the general control of Mr. J. S. Stanley, Assistant Technical Director.

PERSONAL NEWS of MEMBERS

Members are urged to keep their fellow members conversant with their activities through the medium of British Kinematography.

J. H. Jacobs has left for Canada and the U.S.A. and will notify friends in the industry of his new address in due course.

F. T. Jones has left the G.E.C. and is now with the 16mm. Film User.

H. K. Paul has taken up a position as Sales Manager with Dawe’s Instruments, Ltd.

W. R. Stevens was recently elected a vice-president of the Illuminating Engineering Society and Hon. Editor of transactions.

James Willoughby, formerly a Wing Commander with the R.A.F. Film Production Unit, and a technician of 20 years’ experience, is in charge of Thomas Cook’s new Film Location Facilities Dept.

Small announcements will be accepted from Members and Associates. Rate, 4d. per word, plus 2s. for Box No. if required (except for Situations Wanted). Trade advertisements, other than Situations Vacant, not accepted.
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ITITTLE is known about the relationship of the kinema to the community as far as town and country planning is concerned—or, at least, little has been published. That one should add “so far as we know” to this statement shows the need for the dissemination and integration of knowledge in this field.

I. PURPOSES OF INVESTIGATION

There are two aspects of this matter. First, there is the social influence of the kinema; and, second, the physical position of the kinema in the community. In facing the immediate task of practical town and country planning, the positions are reversed and it is the physical locations of kinemas that are of prime concern. There is another reason for studying this important recreational function. All industries and services are developing and the planner should try to keep abreast of these changes and, if possible, to anticipate the form which some of them may take. This is all the more true regarding the ubiquitous activity of kinema entertainment.

A most important example of this immediately arises when one contemplates the future of television. When this is properly developed, will it sound the death-knell of the kinema, because people will prefer to see films in the comfort of their homes? Obviously, the maximum foresight is essential here, in view of the profound effect which any developments would have on the provision of various facilities in town and country planning schemes.

Put simply, the main aim of town and country planning is to achieve the best use of land. This is easier said than done; and we cannot now consider who is to decide and how one decides the most appropriate use of land, when the natures and needs of all the possible competing interests have to be taken into account. Nevertheless, achieving the most suitable use of land has a two-fold aspect. There is, first, the actual location of kinemas themselves and, second, their influence, by this very location, on so many other land uses—housing, shops, other recreations, garages and transport.

How does the kinema perform its function and relate itself to the people and, therefore, to town and country planning? This, again, can be looked at or measured in two ways. First, how are kinemas provided for the public, i.e., what is their distribution? Second, how do the public use what is provided? In practice, it is more convenient to consider these two questions in the reverse order.

*Director of Research, West Midlands and North Staffordshire Plan.
II. WAR-TIME SURVEY

One aspect of the problem has been tackled in "The Cinema Audience," an inquiry made by the War-time Social Survey for the Ministry of Information, by Louis Moss and Kathleen Box.

There are some outstanding general findings which will begin to focus attention on the problem faced by town and country planners as a whole. Although most of them are obvious conclusions, they are based on actual investigations and it is valuable to have confirmation of what many of us would surmise if we thought about the problem for a little while. They are:—

70% of adult civilians sometimes go to the cinema, and 32% go once a week or more often (June-July, 1943). Younger adults go much more than older people, and children go rather more than do adults, but not as much as young wage-earners.

The lower economic groups, and those with elementary education, go more than the higher economic groups and those with higher education.

Factory workers, clerical and distributive workers go rather more than other occupation groups. Managerial and professional workers, housewives and the retired and unoccupied go rather less.

Town dwellers go more often than people living in the country, and women go rather more than men.

The kinema is able to reach large sections of the population which are less accessible by other publicity media.

In general, the larger groups of the population are relatively better represented in the cinema audience than they are in the public reached by other visual publicity media such as newspapers and books.

It will be seen that all paragraphs, except the penultimate one, have some bearing on town and country planning.

It is important to remind ourselves that "The kinema is thus an important form of recreation for one-third of the adult civilian population, who go once a week or more often."

Utilising Facts

The physical planner may decide to take account of the slight tendency of women to go to the kinema more than men. The figures do not show differences of great significance; but the matter should obviously be investigated further, either so that it can all be discounted and ignored, or so that, if there is anything in it, this may be taken into account as one of the 'pulls' affecting the location of kinemas of certain kinds. Similar remarks flow from the finding that 43% of children between the ages of 14 and 17 go twice a week or more to the kinema. Should this be a factor in locating certain types of kinemas nearer to children's homes? I do not know; but certainly if town and country planning is going to try to follow any scientific investigation, and not to proceed arbitrarily, this is obviously a matter for further research.

The sharp differences in kinema-going habits exhibited by education groups may seem at first sight to be remote from town and country planning; but here is brought up the problem of the kinema in relation to schools, universities and so on. Of more direct importance is the analysis by size of town. Here, obviously, is the germ of an excellent idea which could be developed much further and might yield most valuable guidance for the physical planner. Finally, there is the recognition of regional deviations which clearly should not be overlooked.

III. RESEARCH FOR THE PLAN

What follows is an extract from one of the chapters in the Survey undertaken for Sir Patrick Abercrombie and Mr. Herbert Jackson, in support of their Regional Outline Plan on the West Midlands for the Minister of Town and Country Planning, as published in an Interim or Advance Edition on
November 3, 1948. Although I am responsible for all that it contains and any defects should be ascribed to me, any credit for its virtues should go to Mr. Aylwyn M. Lewis, since it consists entirely of his ideas and work. He would be the first to point out, however, and I wish to echo, the serious limitations attaching to what is now offered. This is largely due to the hopeless inadequacies of the raw material available, i.e., information about kinemas and the areas which they serve.

Social Development

In the course of the last thirty years the kinema has become a ubiquitous form of urban entertainment. The very smallest towns can usually boast some kind of kinema and virtually the whole population is to be numbered amongst its patrons. This ubiquity has created a measure of uniformity in the quality and quantity of kinema accommodation, and that very size and constancy of the demand has led to its own complete satisfaction. The trade itself believes that there is sufficient kinema accommodation in the country as a whole; but recognises that there are many local deficiencies and defects. It is these local variations that are of interest to the planner.

The kinema industry has grown up on a purely commercial basis. It has not been governed in choice of sites or in the type of accommodation provided by any considerations of tradition or public service. It must, therefore, be taken to reflect popular demand with a fair degree of accuracy. Variations in quality and quantity of accommodation will relate roughly to real differences in wealth or in social habit. Furthermore, the era of free and unregulated development is past, and the planner needs to know the nature of the demand if the kinema is to take its proper place in future development.

The very ubiquity of the kinema leads to another and more important consideration. It is now so universal and essential a need, that a reasonable standard of kinema accommodation is as important as the social services are to the contentment and well-being of town and country. A place where the kinemas are deficient or inferior may well lose some of its attraction as a residential district.

There are, then, three reasons why a study of kinema facilities is of interest in a social survey: the reflection of social conditions which kinemas provide; the need to understand the demand if it is to be allowed for in town and country planning schemes; and the fact that the kinema is now so popular an entertainment that adequate provision is essential to social life.

Sources of Statistics

The lists of kinemas and their seating capacities were obtained from two sources. The most important of these was the trade itself which furnished, partly through the Kinematograph Year Book, and partly in personal contacts, lists of all kinemas in the region and their seating capacities. These were supplemented and checked by information from various Local Authorities. Comparative figures for the United Kingdom were obtained from the trade, and for other regions, from the Local Authorities concerned, through the Regional Offices of the Ministry of Town and Country Planning.

Quantity and Quality

The mere quantity of kinema accommodation available is easily measured by relating the total number of seats in any place to the total population. The population taken is that of the administrative area in which the kinema is situated. This is not wholly satisfactory, since the kinemas in any town are not used exclusively by people who happen to reside within the political boundary, and the extent to which a town serves surrounding rural areas or attracts people from another town must be borne in mind.
In Rural Districts this difficulty becomes much more acute. It is, indeed, clearly absurd to relate the seating capacity of tiny kinemas in small market towns to the total population of the Rural District in which they are placed. In such cases, the numbers not using the kinemas are likely to vary in relation to total populations even more than in urban areas. For this reason, no statistical attempt to compare kinemas in Rural Districts has been made. The relation between seats and population has been expressed in terms of persons per seat, obtained by dividing seating capacity into population.

The quality of the kinema accommodation provided is much more difficult to assess, indeed it is only possible to arrive indirectly at very tentative conclusions. It is necessary to begin by defining the standards of quality to be applied. This is a matter in which there is a temptation to import personal values; the only effective way to avoid this fault and to find a standard generally acceptable is to accept the standards of the industry itself; that is—the luxury and size of the kinema and the speed with which it is able to exhibit the newest films. A thorough-going investigation of these qualities would require either individual visits to every kinema or access to information which is possessed only by the kinema exhibitors themselves. The information required would be such data as the incidence of barring clauses, the “run”—first, second and third—of each kinema, and the ownership of the kinema. None of these lines of investigation could be pursued with the staff and time available.

Analysis of Size

As a poor substitute, an analysis of the size of kinemas was undertaken. Five size ranges were used: 500 and less; 501-700; 701-1,000; 1,001-1,500 and greater than 1,500. These ranges were determined because for them comparable figures for the United Kingdom were available. It was unfortunate that the figures of the United Kingdom related to the percentage of kinemas within each range and not to the percentage of seats, which would have enabled a more refined comparison to have been made.

The theoretical justification for this analysis of size is that the larger the kinema, the more likely is it to be possessed of the desirable qualities outlined above. There must be many exceptions to this assumption. It is easy to multiply examples of kinemas in the 1,001-1,500 group, which show ancient films in an uncomfortable auditorium. A kinema which holds 1,001-1,500 people is not certain to be of good quality! It is, however, less easy to recollect a kinema in the 501-700 group, which shows modern films in a luxury interior. No doubt such examples exist, but it would seem to be true that very small kinemas are generally of poor quality and conversely that very large kinemas are of good quality. The intermediate groups, 701-1,000 and 1,001-1,500 are of less value, as indicators, for the size of kinemas is to some extent governed by the size of the town they serve and, since most towns of moderate size have at least one “good” kinema, these “good” kinemas will vary in size. Despite the caveats, this analysis of size has been used as a rough guide to the quality of accommodation.

British Facilities

The only direct comparison between the United Kingdom and the West Midlands which it is possible to make is in a comparison of the percentage of the total number of kinemas in the various size groups. This is shown in Table I and it reveals the West Midlands to be slightly superior to the country as a whole. There are less kinemas in the lower size groups and conspicuously more kinemas which hold over a thousand people. It will be seen, however, that the percentage of the total in the group 1,501 and over is very much the same for the Region as for the country as a whole.
TABLE I.
Kinemas in West Midlands and United Kingdom, 1946.
Comparison in Terms of Numbers of Kinemas.

<table>
<thead>
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<th>Place</th>
<th>Percentage of Total Kinemas whose Seating Capacity is:</th>
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<tr>
<td></td>
<td>500 and less</td>
</tr>
<tr>
<td>(i) United Kingdom</td>
<td>...</td>
</tr>
<tr>
<td>(ii)</td>
<td>20.9</td>
</tr>
<tr>
<td>(iii) Staffordshire (exc. North Staffs)</td>
<td>...</td>
</tr>
<tr>
<td>(iv)</td>
<td>14.9</td>
</tr>
<tr>
<td>(v) West Midlands</td>
<td>...</td>
</tr>
<tr>
<td>(vi) Warwickshire</td>
<td>...</td>
</tr>
<tr>
<td>(vii) Worcestershire</td>
<td>...</td>
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</table>

It has been impossible to obtain the national average of persons per kinema seat, but the trade believe the figure of 12.0 to be very close to the truth. An average for the West Midlands as a whole is 11.2 persons per seat; so that by this measure also, the West Midlands appear to be rather better off than the country as a whole. This slight superiority is reflected in the number of kinema attendances per week, which is slightly above the average for the United Kingdom. More detailed internal analysis must be related to this background of a slight, but definite, superiority.

West Midlands Groups

The Conurbation is a continuously built up area of two or more urban districts with no significant stretches of open space between them. The difference between all the urban and all the rural areas is enormous, but hardly surprising. In the Rural Districts there is, in fact, only one kinema in each of the size groups 1,001-1,500 and 701-1,000. There is very little accommodation available in the rural districts and the great majority of what does exist is in tiny and, therefore, usually poor quality kinemas. When the Conurbation as a whole is set against the Rural Lowlands, i.e., all Urban Areas and Rural Districts outside the Conurbation, the same distinction appears though on a smaller scale. The Rural Lowlands have 13.4 persons per seat to 10.5 in the Conurbation; and the percentage of large kinemas is higher, and that of small kinemas lower in the Conurbation than in the Rural Lowlands. The urban areas outside the Conurbation have to serve the population of country districts to a much greater extent than do the towns of the Conurbation.

The dual function tends to create a greater demand for kinema accommodation, and one finds that the urban areas outside the Conurbation are better served than the towns in the Conurbation. The Conurbation has a figure of 10.5 persons per seat, slightly above the West Midlands urban average, whereas the urban areas outside the Conurbation have 9.8 persons per seat.

If Birmingham is excluded, the disadvantage of the Conurbation in persons per seat is intensified: the figure rises from 10.5 to 11.6, which is even above the average for the West Midlands as a whole. The proportion of total seats in very large kinemas falls sharply and is now 20.5% compared with 25.9% in the urban areas outside the Conurbation. The proportion of total seats in kinemas of over 1,000 seating capacity remains much higher.
Table II provides figures of persons per seat and a size analysis for every place in the Conurbation ranked according to the size of its population. These detailed figures again require circumspect use for it would be all too easy to lay too much emphasis upon the differences in quantity and quality they reveal.

**TABLE II.**

**KINEMAS IN THE CONURBATION, 1946.**

**PERSONS PER SEAT AND SIZE ANALYSIS (IN TERMS OF SEATING CAPACITY).**

<table>
<thead>
<tr>
<th>Administrative Area</th>
<th>Population Reg. Gen's. 1946 Civilian Estimate</th>
<th>Persons per Kinema Seat</th>
<th>Percentage of Total Number of Seats in Kinemas whose Capacity is</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 and less</td>
</tr>
<tr>
<td>(i)</td>
<td></td>
<td>(ii)</td>
<td>(iii)</td>
</tr>
<tr>
<td>Birmingham ...</td>
<td>1,044,600</td>
<td>10.7</td>
<td>4</td>
</tr>
<tr>
<td>Wolverhampton ...</td>
<td>152,160</td>
<td>10.1</td>
<td>5</td>
</tr>
<tr>
<td>Walsall ...</td>
<td>107,270</td>
<td>9.9</td>
<td>14</td>
</tr>
<tr>
<td>West Bromwich ...</td>
<td>82,670</td>
<td>8.9</td>
<td>12.0</td>
</tr>
<tr>
<td>Smethwick ...</td>
<td>74,430</td>
<td>8.9</td>
<td>12.0</td>
</tr>
<tr>
<td>Solihull ...</td>
<td>61,720</td>
<td>8.9</td>
<td>12.0</td>
</tr>
<tr>
<td>Dudley ...</td>
<td>61,480</td>
<td>8.0</td>
<td>7</td>
</tr>
<tr>
<td>Oldbury ...</td>
<td>51,890</td>
<td>12.3</td>
<td>23</td>
</tr>
<tr>
<td>Rowley Regis ...</td>
<td>46,930</td>
<td>13.2</td>
<td>23</td>
</tr>
<tr>
<td>Brierley Hill ...</td>
<td>46,190</td>
<td>8.0</td>
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<td>Sutton Coldfield ...</td>
<td>44,460</td>
<td>12.1</td>
<td>23</td>
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<tr>
<td>Halesowen ...</td>
<td>39,240</td>
<td>11.1</td>
<td>23</td>
</tr>
<tr>
<td>Tipton ...</td>
<td>37,390</td>
<td>11.5</td>
<td>23</td>
</tr>
<tr>
<td>Stourbridge ...</td>
<td>35,260</td>
<td>11.5</td>
<td>23</td>
</tr>
<tr>
<td>Wednesbury ...</td>
<td>33,140</td>
<td>8.2</td>
<td>7</td>
</tr>
<tr>
<td>Coseley ...</td>
<td>31,420</td>
<td>12.8</td>
<td>27</td>
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<tr>
<td>Bilston ...</td>
<td>31,220</td>
<td>12.8</td>
<td>27</td>
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<tr>
<td>Willenhall ...</td>
<td>29,300</td>
<td>12.5</td>
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<tr>
<td>Aldridge ...</td>
<td>26,830</td>
<td>12.3</td>
<td>27</td>
</tr>
<tr>
<td>Sedgley ...</td>
<td>21,500</td>
<td>11.3</td>
<td>27</td>
</tr>
<tr>
<td>Darlaston ...</td>
<td>20,710</td>
<td>11.3</td>
<td>27</td>
</tr>
<tr>
<td>Wednesfield ...</td>
<td>16,040</td>
<td>11.6</td>
<td>27</td>
</tr>
<tr>
<td>Tettenhall ...</td>
<td>7,020</td>
<td>11.6</td>
<td>27</td>
</tr>
<tr>
<td>Amblecote ...</td>
<td>2,912</td>
<td>11.6</td>
<td>27</td>
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<tr>
<td><strong>Conurbation Total</strong></td>
<td><strong>2,104,784</strong></td>
<td>10.5</td>
<td>2</td>
</tr>
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</table>

**Birmingham and Other Cities**

The position of Birmingham as the main centre of the West Midlands and as a would-be regional capital, makes it necessary to discuss it in relation to similar large towns throughout the country rather than in relation to other towns of the Conurbation. The number of persons per seat for various comparable towns is:

- Manchester C.B. ... ... ... 6.5
- Leeds C.B. ... ... ... 8.5
- Hull C.B. ... ... ... 9.0
- Sheffield C.B. ... ... ... 10.6
- Bradford C.B. ... ... ... 7.3
- Liverpool C.B. ... ... ... 8.9
- **Birmingham C.B.** ... ... ... **9.7**

The population figures upon which this Table is based are not strictly comparable with the population figures used to determine the persons per seat of the West Midlands including Birmingham. It was, unfortunately, impossible to obtain Registrar-General's estimates on exactly the same basis for the areas outside the Region.
None of the towns shown is as large as Birmingham, but certainly Manchester, Liverpool and Leeds are comparable both as regards function and size. This Table shows Birmingham's position to be far from advantageous. It is, in fact, the worst served place in the list with the exception of Sheffield. Manchester, which provides perhaps the fairest comparison with Birmingham, is significantly the best. The difference in the total number of persons per seat may reflect the accommodation in the suburbs of Manchester and Birmingham rather than the luxury accommodation available in the centre. A further comparison is, therefore, provided between the kinemas in the central wards only of Birmingham, Manchester and Liverpool. The seating capacity of these central kinemas is related to the total populations of the three cities.

Liverpool C.B. ... 42.8  Birmingham C.B. ... 47.4  Manchester C.B. ... 56.7

This shows Birmingham to be considerably better off than Manchester, though not so well off as Liverpool. But this comparison is of doubtful value, for the definition of 'central wards' employed is that made by the three Local Authorities concerned, and it is only too likely that the definitions they employ are not strictly comparable.

The Rural Lowlands

The general superiority of the kinemas in the towns of the urban areas outside the Conurbation has been ascribed to the dual function of serving both their own population and at least some part of the population in the surrounding country districts. Coventry, after Birmingham, the largest town in the area, is so large that its figure of 10.9 persons per seat is close to the regional average. It undoubtedly has a much greater attraction for population outside its own boundaries than have any of the County Boroughs in the Conurbation with the exception, of course, of Birmingham; but at present its percentage of seats in kinemas of over a thousand capacity is rather lower than that of Wolverhampton or Walsall. This is probably due to the after-effects of the blitz which destroyed many of the principal kinemas; and it is indeed surprising that Coventry is still so well served. The dependence of Bedworth upon Coventry is well shown by the very high figure of 26.5 persons per seat, and the fact that even this small amount of accommodation is in kinemas of less than 700 capacity.

Most of the other towns of more than 30,000 inhabitants in the Lowlands have a large industrial element and it is interesting to note the difference between them. Worcester is clearly badly off for kinemas. Its figure of persons per seat is 12.2, which is much above the average of 9.8 for all towns over 30,000 outside the Conurbation.

Burton-on-Trent, Rugby and Kidderminster, however, are all well served; but Kidderminster, though it has the lowest figure of 7.5 persons per seat, does not appear to have many large kinemas. Cannock and Brownhills present a surprising contrast, Cannock having a large quantity of kinema accommodation, though little of it would seem to be of good quality, whereas Brownhills has only one small kinema and has the figure of 30.0 persons per seat, highest of any urban district in the region. The kinema provision of the Cannock Coalfield cannot, however, be adequately measured since there are three or four small kinemas in Lichfield Rural District.

Stafford, although a County Town and a natural centre for a large rural area, is not, surprisingly enough, as well served as might be expected, for its figure of 10.0 persons per seat is not significantly above the average for the Region as a whole. A good part of the accommodation available in Stafford appears to be in relatively small kinemas. Redditch and Bromsgrove appear to be not markedly dissimilar, both having an adequate amount of kinema accommodation, but a tendency to the lower size groups.
Significant Towns

The remainder of the urban areas in the Rural Lowlands may be considered in two groups which have been used elsewhere in this Report. First, there are the towns of more than local significance—Kenilworth, Leamington, Malvern, Warwick, Droitwich and Stratford; and, secondly, the County Towns. The first group is by no means as well served as might be expected. Leamington is perhaps the best with a figure of 9.1 persons per seat, but it is by no means outstanding. Malvern has the high figure of 13.5 persons per seat and both its kinemas are small. Warwick and Stratford are much smaller towns and so one would not expect to find any large kinemas there.

"Country Towns" is an expression used here in a special sense for the purposes of the West Midlands Town and Country Planning Survey. The idea behind this classification is part of a conception too lengthy to be reproduced in this article. Here, it must suffice to say, that not every country town in the ordinary sense is included, but that reference is being made to "small places whose functions are mainly related to their surrounding area."

The advantageous figure of persons per seat which most of these small towns exhibit is not, perhaps, a very significant indication of their dual function of serving their own population and that of the surrounding districts, for even a small kinema in these places would create a very low figure of persons per seat.

If social facilities are to be the concern of the town and country planner, some thought must be given to the facilities for entertainment, and in this field, kinemas are today most important. The commercial value of an area may not always be the best guide to the facilities which are desirable there. This may be particularly true in rural areas where the country-dweller is now in a position to demand social facilities equivalent to those which he might obtain in towns. In industrial areas, too, it would be desirable to improve the standards of kinema provision which at present exist. Increased prosperity in both countryside and industrial towns may tend to bring this about in any case, but it may be necessary for the town and country planner to consider the possibility of accelerating or guiding the process.

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BOOK REVIEW

*FILM USER YEAR BOOK, 1949. Compiled by John Montgomery. Current Affairs, Ltd. 10s. 6d.*

When a publisher sets out to produce a Year Book which is not only the first of its kind, but also aims to cover such a rapidly growing subject as 16 mm. films and Filmstrips, he might be excused if the problem is approached with caution and the subject matter limited to the bare essentials. With this extremely comprehensive book of reference no excuses seem to be necessary, and the publishers can justifiably feel proud of their achievements.

The book is divided into two main parts: the Review and Technical Section and the Directory Section.

The Review quite rightly limits itself to a survey of 1948 and does not attempt to deal with anything before that year. A very good all-round picture of the progress and events during 1948 has been given and a good balance has been obtained on subjects which will be of interest to the majority of readers.

The Directory Section is, in itself, sufficient to justify the publication; it includes practically everything of interest or use to those whose activities bring them in touch with 16 mm. film or filmstrip, whether it be education, industry or entertainment.

H. S. HIND.
MAKE-UP AND THE MOTION PICTURE

Papers read by Neville Smallwood to the B.K.S. Film Production Division on December 22, 1948.

I. MAKE-UP IN RELATION TO THE PHOTOGRAPHIC EMULSION

Ernest Taylor M.B.K.S.*

MAKE-UP is essential to photography in motion pictures, because it corrects the irregularities in pigment and texture that discolour the face and prevent it recording faithfully. In still portraiture retouching can remedy faults, but this procedure is not possible with motion film.

The face is made up of a network of tiny blood vessels and pigments which give colouring to the skin. These natural pigments and blood channels are unevenly arrayed all over the face, causing a change of colour and skin texture around the eyes, nose, cheeks and chin.

Photographed without make-up, the face records mottled on the emulsion. A balanced, and graded monotone of colours is produced with the use of make-up which cures over-absorption of light; and allows the emulsion to reproduce the subject accurately. Its subtle use can also give character to the face.

Lighting and Emulsion Characteristics

The camera, lighting and emulsions are far more involved in use than is make-up. For the best photographic results between all factors, the lighting key should be studied carefully. Strong and hard light tends to burn the make-up off the skin, causing it to record chalkily, while subdued low key lighting tends to cause the make-up to record much darker in tone than would be expected.

First-class straight make-up photographs perfectly. With character and corrective make-up patience, practice, and experience are required, both on the part of the make-up artist and the photographer. To master the technique a creative imagination, thorough understanding of light and shade and facial contours, all in relationship to photographic reproduction, is necessary.

In this way, make-up artists, in co-operation with the lighting men of the film industry, have learned to create beauty and character with almost any subject. Foundation creams, false eyelashes, rouges, eyeshading, lip colours and liners, combine to permit the stars to be photographed at their impeccable best.

After experiments with leading technicians on lighting and emulsions, Max Factor evolved panchromatic make-up for use with panchromatic emulsions. It must be applied with painstaking care, and thick, obviously crude lines have to be avoided in use with the soft high-lights and low-lights.

The make-up is of a thin creamy texture which allows a filmy and smooth application. There are approximately thirty shades in the panchromatic range of colours, ranging in carefully graded tones, from pale pink to warm brown tan. A half tonal range of "N" series, slightly softer in colour and texture, is now widely used.

Appropriate lip and rouge shadings are all brownish in tone.

Straight Make-up

Apart from providing the necessary protective coloration suitable for the various emulsions, make-up is used to give character to the face. Corrections can be made in the shape of the face and various features by careful shading and correctly placed lighting. Results have to be of a flattering

*Ealing Studios, Ltd.
nature and any subject that photographs well normally can photograph beautifully with make-up.

Straight make-up for a well-formed face consists of a foundation and enhancement of eyes, lips and general facial structure without resorting to corrective shading. Thinly applied foundation, correctly balanced eye-shading, artificial eyelashes if necessary, cheek rouging, lip shaping, and powder of the correct photographic shade have to be considered. All this, and balanced application, should result in a completely natural effect.

This lifelike and natural transparency is further achieved by washing the whole of the make-up with a damp wad to eliminate a matt finish that would photograph flat. A dry wad to wipe away perspiration caused through long periods under the intense lighting is also necessary.

Characterisation

The mere addition of beauty aids does not ensure glamour. Artificial eyelashes, for instance, unless tailored for the individual eye, seldom record naturally. They should be shorter in width at the outer corners of the eyes otherwise they are likely to throw a harsh shadow from the cheek, immediately below the eye, at its outer edge, towards the ear. This shadow unbalances the face. Brown eyelashes are preferable to black, which may appear theatrically beaded.

In handling highlights and shadows, both for make-up and lighting, the intricacies of illusory relief have to be understood. The best results can only be achieved by co-operation between lighting man and make-up artist.

To create character studies, the foundation will have to be dispensed especially to suit the normal skin texture after lighting tests have been made, as character lines record harshly unless accompanied by correct lighting.

Colour Photography

All the spectrum colours cannot be faithfully reproduced on colour film, which is either under- or over-sensitive to certain colours. The human complexion has a greater proportion of red than any other pigment tints, and not only has make-up to be considered, but the surrounding colour scheme, as blues and reds are particularly absorbed and reflected. Colour make-up is at present very much a matter of blending shades to compensate for the peculiarities of the natural skin pigmentation.

Nearly neutral complexion colours are in use today, resembling street or day make-up, but denser to cover the skin transparencies. The aim is naturalness plus the texture to resist fading under the intense arc lighting. The colour foundations are of pale olive tone, becoming greyer or greener until the warmer shades of tan are reached. Lip and cheek rouges are orange-red with no blue or purple in their composition.

Make-up varies with the several colour processes which have different sensitivities to certain colours, and co-operation between lighting and make-up departments is again essential. Generally, foundations have to be of an extremely fine texture and applied very thinly. Since coloured powders darken in tone soon after application, due to the oily base of the foundation, neutral shades should be used. It is an art still a matter of trial and error.

II. PROSTHETICS AND MAKE-UP

Neville Smallwood*

It has long been my contention that when attempting a heavy character make-up more use should be made of the materials which have been developed in the last few years—materials which are suitable for the manu-

*M-G-M. British Studios, Ltd.
facture of false foreheads, cheeks, noses, chins and so on. Until recently, there were no make-up laboratories in this country, but, owing chiefly to the foresight and planning of W. G. Pearce, now retired, and the understanding and generosity of Metro-Goldwyn-Mayer, a very well stocked and equally well equipped laboratory was built in their Boreham Wood Studio.

In order to show the value of this type of work, take, for example, the case of a comparatively young woman, who, as a story unfolds, has to appear as a very much older woman. Suppose we contrive to make this woman look old with the use of make-up only.

First of all the make-up artist should know the direction of the main source of light to be directed on the artiste, otherwise he cannot know whether his highlights should be above or below his shadows. This is a point all too often overlooked, and I would here stress the importance of co-operation between make-up artist and cameraman, sometimes sadly lacking.

Assume, then, a normal shot with main light coming from above the artiste. The make-up artist does his job accordingly and everything looks fine, the lights helping to give the required effect.

Then the Director suddenly decides the next shot—to be done immediately—shall be in a dark room in front of a fire. Into the fireplace goes an enormous lamp shining up into the face of our poor artiste—lighting up the carefully placed shadows, and leaving the highlights invisible. The result is that our comparatively young woman looks as she did before she was made-up! (I am ignoring here the effect of white hair, clothes, acting ability and so on.) The stand-by make-up man is probably not in a position to argue with the powers on the floor.

Unaltered Profile

Another snag is the “profile problem,” which is very difficult to overcome. Our artiste looks at herself in the mirror when she is made-up and sees herself as a much older woman, with a satisfied make-up man peering happily over her shoulder. But what has happened to her profile? Nothing! The heavily ridged forehead is not really ridged—the bags under the eyes are not bags, the double-chin is not double; and unless an artiste is given absolute preference and every consideration before the camera, sooner or later a fairly close shot of her profile will creep into the picture, and the result will be unsatisfactory, even if only to the make-up artist.

The author with and without character make-up, which includes false pieces of plastic, rubber, cotton-wool, and collodion, false hair, moustache, teeth and eyebrows.
There are many more disadvantages:

1. Blood, tears, or perspiration will not run naturally in furrows and ridges which are in fact only highlights and shadows.
2. Retouching by the stand-by make-up man is a very difficult and delicate procedure.
3. It is much easier to maintain continuity when applying identical pieces day after day. Slight variations in make-up can all too easily be noticed when an artiste is not far from the camera.

I am not suggesting that all and every character make-up should be a seething mass of false features, forced on to the poor artiste's face; rather am I trying to put forward good and sound reasons why every studio should be equipped with a make-up laboratory, and have capable technicians who are alive to the possibilities and advantages of prosthetics when applying a character make-up, which is required to show a definite and unmistakable change in a person's face, whether for historical accuracy, or for ageing, or for any other reason.

The Development of Materials

Various types of putty, wax cotton, wool pads, collodion and so on, have been used for years, with varying degrees of success, latex or plastic preparations have been painted on to a face to cause wrinkles through shrinkage when drying. But to my mind, none of these things comes up to the standard required at the present time.

It was found that any non-porous material was useless. Take, for example, a false nose; nothing will stop a hot nose in the heat of intense lighting from perspiring. And no matter what is used as an adhesive, the perspiration will find its way between the skin and the nose, and either form a bubble or blister, or give the artiste the appearance of having a permanently running nose, which is not really desirable. The stand-by man in this case has to wipe the artiste's nose before each shot and probably has to stick it back on his face, which also damages the fine edges where it blends into the face.

Then it was found that the adhesive to be used must not form a skin or barrier between the face and the false piece, as this rendered useless the porous properties of the material to be used.

The material had to be made with a skin of its own, also porous, which could be varied to suit the texture of skin to which it had to be applied, and it had to be of very light weight, able to give and stretch with the movement of the face, and recover its normal shape rapidly.

The next problem was to find a material with all these properties which would "take make-up" in the same way as the human skin, without showing differences of tone and colour where skin and false pieces met. In addition, the material had to be such, that it could be made in shapes having really extraordinarily fine thin edges tapering away practically to nothing.

A specially prepared porous sponge rubber has been used with success, though this needs a special grease paint, as normal make-up changes colour when applied to rubber. More useful and having similar properties, is a porous sponge plastic, which has advantages over rubber, in that it is not affected by any grease-paint, and does not perish or deteriorate.

The only advantage the rubber has at present, is that it cures at a lower temperature than the plastic—and, consequently, a mould will last longer when used for rubber than it will when used for plastic—a point worth bearing in mind when contemplating a long picture where an artiste may have to be made up many times, as all these things can be used only once each for screen work, although for the stage they may be used many times.

The search for a really good material from which a mould can be made easily and quickly, and which will stand repeated and prolonged periods at high temperatures and pressures, continues, and is one of our main problems.
MODERN KINEMA EQUIPMENT
II. B.T.H. SUPA EQUIPMENT*

The second of a series of papers and demonstrations on projection and sound equipment, presented to the B.K.S. Theatre Division on January 16, 1949.

I. INTRODUCTION

E. S. Hall, M.I.E.E., M.B.K.S.

The equipment described in this paper has been designed to provide a 35 mm. sound film projector of improved performance, attractive in appearance and easy to operate. Accessibility for servicing has been given very careful consideration.

As will be seen, the projector design has been treated as a composite whole, rather than an assembly of sound system with a lantern and projector, and full advantage has been taken of this in the construction. There may be some sceptics who wonder how good appearance can contribute to improved operation, but the authors' views are that a neat and tidy operating box does much to ensure efficient projection and to encourage the projectionists to take a pride in their work.

Unit Construction

A complete equipment consists only of the two projection units and the speaker system; the amplifiers, monitor speaker, change-over, arc contactors and all operating controls are contained in the base of the main projection units. The amplifier can, if desired, be used with a separate turntable for gramophone reproduction or with a microphone for public

Fig. 1. General view of Supa outfit.

* British Thomson-Houston Co., Ltd.

Fig. 2. Supa gate and fire prevention devices.
address work. Space is also available in the bases for stand-by amplifiers.

Two main ratings of equipment are available, one suitable for smaller kinemas up to 1,500/2,000 seats, and the other, with greater amplifier output and more light, which is suitable for larger kinemas. It is, of course, possible to have the higher rating amplifier with the lower rating lantern, or vice versa should there be peculiar circumstances demanding such an equipment.

Another of the main features of the equipment is that it is almost entirely automatic in operation; all the projectionist has to do is to lace the film, carbon the arc, press the right push-button at the correct time, and the equipment will do the rest.

2. PROJECTION EQUIPMENT
   A. Bowen

The first problem in the design of the framework of the SUPA projector was to make provision for adaptation to all the different angles of rake and port-hole heights found in kinemas. A survey of 200 kinemas in England (Fig. 3) showed an average angle of projection of $71^\circ$ and an average porthole height of 3ft. 10in. The machine was, therefore, designed having the optical centre line at this angle and to suit this height. A body construction was designed having a range of $\pm 71^\circ$. This, with three sizes of plinth, covers the area enclosed on the diagram, and others outside this range may be taken care of by the use of a special plinth.

The jacking system to cover this range consists of a pivot which may be at either the front or the back, and a rake adjusting screw placed at the opposite end to the pivot. Three jacking screws serve to level the equipment as well as adjust height.

Film Path

The main purpose of the machine is to run film, and particular attention has been paid to the film path. The fact that the normal lateral curve across the film flattens out when the film is curved longitudinally is an effect that has been used in the sound gate for years, but in the Supa the effect has been used in both the sound and picture gates.

The application to the picture gate is explained in Fig. 4. On the left is a film, straight from top to bottom, but curved across its width by an amount which varies with conditions of storage and the heat to which it has been subjected. A lens is also shown and lines to indicate the spherical curvature...
of the focal plane of that lens. It is apparent that the film and the focal plane do not coincide, particularly in the horizontal plane where the two curves are in opposition. On the right-hand side, the film is purposely curved in the vertical plane to an amount to agree with a curve given by the lens designers. In the horizontal plane the film is held flat. This gives an improved condition which is constant in spite of varying storage and heat conditions. The actual arrangement is shown in Fig. 2.

The aperture plate can be easily changed to correct keystone effects or give special outlines to the picture. Cleaning of the gate and threading are also simplified.

Safety Devices

A most important feature of a picture gate, is that it shall keep cool in spite of the high arc currents now used. At 75 amps. the aperture plate of this gate has a temperature rise of not more than 20°C. This is due to a system of heat shields immediately behind the aperture, which reflect 80% of the heat back towards the lantern; the remainder is dissipated by convection currents in the air surrounding the shields. This arrangement is patented.

In Fig. 2 can also be seen some of the fireproof devices that are incorporated which are well known. One great advantage of this method is that the machine cannot be restarted until the device is reset, and the fuse is only another small bit of film which is always at hand.

Projector Drive

The mechanism except the sound drum is driven by an induction motor running at 1,440 r.p.m. and having the motor pinion in direct engagement with the gear on the geneva camshaft. All the high speed wheels are mounted together in a single sub-assembly. The widely spaced slow speed drives are driven by 8 mm. roller chain, having a breaking stress of 1,500 lbs. The intermittent mechanism is self-contained and oil tight, and fitted with a breather to prevent loss of oil.

Framing is done by rotating the intermittent mechanism complete with sprocket, and the shutter is compensated by a link from the intermittent casing to the phasing differential. This arrangement keeps a constant loop at the top of the gate, while the feed sprockets to the sound drum are not affected.

Change-over and Fire Shutters

The change-over shutter, fire shutter and flicker shutter are grouped together just behind the gate. The change-over shutter is operated by an electro-magnet through an armature and spring. The object of the spring is to allow the armature to store energy before moving the shutter vane, so that sticking of the vane is readily overcome, and the energy from the coils efficiently transferred to the vanes. The vanes themselves are heat reflecting and capable of standing up to the heat of a 75 amp. lantern.

The fire shutter is supported on the flicker shutter spindle by a ball bearing and may swing between two stops from the closed to the open position. A magnet on the shutter vane, embracing an aluminium ring on the flicker shutter, causes the fire shutter to open when the machine is running. The shutter is closed by gravity. As the magnet torque varies as the square of the speed and the torque due to gravity is constant, the shutter operates quickly at the change-over point, which is approximately at half normal speed of the machine.

Flicker Shutter

The shutter is made of aluminium and polished to reflect the heat of the lantern. The thermal conductivity is sufficient to spread, and the surface
area sufficient to dissipate, the small percentage of heat absorbed. Tests show that this shutter is safe if a 75 amp. lantern is left shining on it indefinitely.

The flicker shutter consists of a dish-shaped blade driven by a bevel from the gear assembly, as opposed to a flat blade or a drum. The beam is cut by one side of the dish only, and that in the narrow part of the beam. The B.T.-H. K.B. type mechanism needed 52° shutter movement to cut off the beam; a plain dish 7 in. dia. cutting the narrow portion of the beam can operate in 19°.

In the Supa mechanism there is also introduced a vane located at the leading and trailing edges and rotating with the shutter (Fig. 5). This has the effect of reducing the beam cutting time still further, to 14°, and this, of course, occurs four times per frame. The action of the vane is to enter the beam so as to cast the minimum shadow; before it leaves the beam it has rotated on the axis of the shutter shaft and also moved in the beam to cause a considerable shadow.

Sound Head

The sound gate consists of a standard cylindrical drum, 1½ in. diameter, round which the film is fed by a guide roller, which also provides slight back tension to the film. It passes away from the drum over a frictionally driven roller so that tension is maintained in the film, tending to hold it to the drum while in motion. The guide roller gives a ready lateral adjustment of the sound track while the machine is running, and is self-locking. A cork pressure roller is provided to cope with extreme variations of voltage and frequency of the mains supply.

The sound drum driving unit is located in the main casting by a spigot mounting. It consists of a small drum for the film, a heavy flywheel and an eddy current disc mounted on a single shaft on ball bearings. The shaft is driven by three sets of split-phase driving coils which are plugged directly into the mains supply. This arrangement is also supplied with a control potentiometer so that a convenient torque control is available.

This drive is nearly a constant torque device, and is free from ripple due to pole pieces. The speed of the drum is controlled by the film to take care of shrinkage, and alters the speed by the difference in pressure between the top and bottom loops. Irregularities in the running of the film due to sprocket ripple and other causes are eliminated by the mass of the flywheel and the elasticity of the film loops acting as a resonator. The natural vibrations of this resonator are damped by the eddy disc in the driving magnet.
Optical System

The optical system designed by Messrs. Taylor, Taylor & Hobson, apart from the exciter lamp and photo-cell consists of two units each readily removable from the optical casting.

The condenser unit is an aspheric system projecting a patch of light on to the film. The pick-up unit accepts the light from the film, magnifies it and forms an image of the film on a mechanical slit. The light then passes through a lens to form a roughly circular patch on the photo-electric cell. All the glasses are surface coated to prevent internal reflections, and the hardness of the coating allows the glasses to be cleaned in the usual way.

The projected slit image is tested optically to a width of .00045 in. to .00055 in. and is parallel to $\frac{1}{3}$ of one ten-thousandth of an inch. On test, the beam is eclipsed in the film plane, and it is a requirement that no distortion of the image takes place or redistribution of the light patch during eclipse. This is required as the sensitivity of the photo-cell is not uniform over its surface, and a change in light distribution will give rise to undesirable harmonics.

Another source of harmonic distortion is in the image of the coils of the filament passing through the system. The lenses are arranged to prevent the filament image falling on the mechanical slit.

Mechanical Construction

The whole of this equipment is built up on the basis of a rigid framework having the working units mounted on ball bearings and spigoted into it. This means that they are easily dismantled and replaceable on site with the minimum of disturbance to the complete equipment. The sprocket units, the sound drum, the intermittent mechanism, and the geared driving unit are each sub-assemblies and available as spares. The driving motor similarly is available and spigots into position. In fact a replacement intermittent unit and gear drive assembly is almost equivalent to a new mechanism.

3. ARC LAMP

F. A. Tuck, M.B.K.S.

Our standard design of arc lamp, some fourteen years ago, comprised a 75 amp. mirror arc, with an ellipsoidal mirror having a collection angle of 126°, and an aperture value of f/2.5. In 1936, an increase in collection angle to 153° was made, and it was found that using the lenses then available, the light output at 50 amps. was equivalent to that previously obtained at 75 amps. When the time came to develop the Supa lantern, new projection lenses of the bloomed type and having an f value of 1.9, constant for all focal lengths, were being developed by Messrs. Taylor, Taylor & Hobson Ltd. and new carbons were being developed by the Morgan Crucible Co. The mirror system was, therefore, redesigned to have a slightly better f value than the new bloomed lenses, and the collection angle was still further increased.

It is my personal opinion that the limit of collection angle has now been reached with this system. It is known that whereas the centre of the mirror reflects a picture of the crater in the form of a circle at the gate, the extreme edges of the mirror “see” an ellipse, and as the edge of the mirror is further from the crater, the magnification is less than that given by the mirror centre, so that the mirror edge reproduces a series of small ellipses at the centre of the gate. It will be obvious that the centre brightness in the gate aperture (and on the screen) with relation to the edges increases with the collection angle, and we have now reached the generally accepted minimum ratio of edge to centre brightness of 62%.
Carbon Combinations

The 50 amp. rating is based on a 7 mm. positive carbon, and the 75 amp. rating on a 10 mm. positive. Although the 75 amp. mirror has a slightly different contour the initial result of the larger positive would be to give too large a gate circle. In the case of the 50 amp. lantern, a plain glass is inserted in the lantern nose to meet local bye-laws, but in the case of the 75 amp. lantern, this is replaced by a lens of low power, which reduces the image of the 75 amp. positive to the correct gate size. This corrected image, in conjunction with the special gate cooling described in the previous paper, results in an extremely cool gate, despite the 75 amp. arc current.

The carbons recommended for the two standard current ratings, and whose characteristics form part of the optical system as developed, are the copper plated high intensity types made by the Morgan Crucible Company.

<table>
<thead>
<tr>
<th>Amp. Rating</th>
<th>Arc Volts</th>
<th>Size and description</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>38/40 7 mm.</td>
<td>HMS positive</td>
</tr>
<tr>
<td></td>
<td>39/41 6 mm.</td>
<td>HIN negative</td>
</tr>
<tr>
<td>75</td>
<td>48/50 10 mm.</td>
<td>HRS positive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7 mm. HIN negative</td>
</tr>
</tbody>
</table>

Control Magnet

Whilst on the subject of carbon trims, a few words on the arc control magnet may be appropriate. In selecting a suitable design, the possible use of a permanent magnet was ruled out without hesitation, as such magnets are unreliable owing to ageing, and the field strength cannot be made to follow any variations in arc current.

An electro-magnet was the obvious choice, and the design adopted consists of a soft iron strip placed over the positive guide (which is of non-magnetic material) in such a position that the carbon itself gives the required ampère-turns, and the magnet poles are immediately under the arc.

Positive Feed System

The most important function of the mechanical design is the maintenance of the crater in its correct position. Tests have shown that variations of $\pm \frac{1}{4}$ mm. in the crater position, with the optical systems of the size used, do not visibly affect the light on the screen. An automatic control device was therefore produced to maintain the crater position well within these limits.

This device consists of an optical system giving a greatly magnified image of the crater, and any movement of the crater is naturally magnified at the
same time. This image is projected on to a relay using bi-metallic strips* and the general arrangement is shown in Fig. 6. It will be seen that a lens is mounted a few inches away from the crater, and that for convenience, the optical system includes a periscope mirror, diverting the crater image to the relay mounted near the front of the lantern. Movement of the crater in the forward direction causes the relay contacts to close; conversely, a backward movement of the crater causes the contacts to open.

The contacts of this relay are connected to a solenoid on the gear box to enable the positive feed rate to be varied, so that should the crater feed forward the relay contacts close, and the feed speed reduces to 75% of the burning rate, which causes the crater to fall back slightly. A few seconds of the slow feed rate are sufficient to cause the relay contacts to open and to put the feed rate up again.

Fig. 7 illustrates how this 2-speed system operates. The circuit from the thermal relay contacts energises a solenoid fitted to the gear box; the right-hand picture shows the solenoid closed with the ratchet feed device being limited to one tooth for each stroke of the driving pawl. When the relay contacts open, the solenoid is de-energised, and the pawl is allowed to operate three ratchet teeth per stroke. By thus making the carbon feed forward at high and low speeds, monitoring of the crater position within narrow limits is possible.

During these variations of the positive feed rate, the negative carbon continues to feed at its correct rate, as pre-set by the motor rheostat.

Angle of Negative

The next point in the arc lantern design became the placing of the negative and positive carbons, in other words, whether to adopt a straight or angular arc. Full consideration led to the retention of an angular arc, with the negative carbon tilted at 13°. This decision was based on three points:

1. In the angular arc the negative tip is low in relation to the crater, and there must be less obscuration of the crater in regard to light collection by the mirror.
2. The arc voltage is slightly higher with an angular arc, so that the arc watts are greater than with a horizontal arc, again with a probable increase in light.
3. The angular arc is inherently more stable than the straight arc.

* C. G. Heys-Hallett, Brit. Kincl., 11. No. 6, Dec., 1947, p. 188
Striking Mechanism

A further automatic feature has been introduced in connection with the arc striking.

A push-button on the stand connects the arc supply to a striking solenoid in the lantern. In certain cases where potential is not available from the rectifier until the arc has been struck, an auxiliary rectifier is brought into service for the same purpose. By operating the "start" push button, the solenoid is energised, and through the mechanical system shown in Fig. 8, the carbons are brought together. The mechanical arrangement utilises the stroke of the solenoid clapper which is connected by links to a lever on a wayshaft, at the end of which is a sector with two rollers.

Rotation of the shaft presses the front roller into engagement with the continuous chain drive of the negative carriage. As the chain is held at one point by the gear box driving sprocket, this pressure on the forward portion of the chain causes the carriage to move forward so that the carbons touch. The main arc current now flows and also passes through a small relay; this relay opens the striking circuit and de-energises the solenoid, and a spring return gives reverse rotation to the wayshaft so that the sector is made to operate on the lower portion of the chain, retracting the negative carriage and drawing out the arc.

In the striking actions just described, a delay mechanism is used in order to slow down the speed of striking so that the carbons cannot be damaged, and to also ensure that on the opening stroke the arc is allowed to form gradually without danger of being extinguished. Operation of the relay also switches on the motor feed, thereby ensuring that the 50-volt motor cannot inadvertently be connected to full line volts when first switching on.

Before leaving the subject of arc striking, it may be of interest to point out that with the usual arc supply employing a ballast resistor, the striking step is calculated to give 60\% of the normal operating current, which limits the short circuit current when the carbons touch, to a safe figure. With this arrangement, pressing of the "Start" button initiates arc striking at the reduced current quoted, and operation of the "Run" button brings in a second contactor giving full operating current.

Where "constant current" supply is available, arc striking is carried out on full load, as the short-circuit surge is then negligible.

Details of Mechanism

The generally accepted arrangement of coupling the lantern front shutter and the mirror shield has been adopted, but the shield itself is rather novel in that it retracts into the centre hole in the mirror. It is made from Inconel.

The negative chain drive has already been mentioned and a continuous chain drive is also used for the positive carriage, avoiding possible troubles resulting from the use of lead screws. The design of the lantern has permitted extremely long strokes of both the negative and positive carbons, equivalent to almost one hour of continuous running without resetting. An indicator is provided to show the amount of positive travel still available.

Provision has been made for the device which is known as a carbon saver; these additional fittings enable positive and negative carbons to be burnt down to very short stubs.

Controls and Ventilation

The optical system has already been described in a general way, and the mirror used is of the heat resisting silvered glass type, this being mounted in an adjustable frame, pivoted about its optical centre. The control knobs are brought out to the operating side of the lantern and are engraved to show the direction of rotation required with reference to the screen.
Cooling and ventilation have also received their share of attention in design, and the judicious use of plated reflecting screens and ventilating apertures results in a cool lamp house without arc flicker due to draughts.

Attention to detail is also seen in the provision of suppressor devices to the contacts of the various relays described, in order that there should be no risk of interference with the sound system.

The arc chassis can also be assembled in the form of a complete arc lantern for separate sale in both current ratings.

**Arc Performance**

Fig. 9 shows the improvements obtained in screen illumination by the new Supa equipment. It should be stressed that these figures are not merely laboratory readings, but are averages of actual installations with the port hole glass in position and usual atmospheric losses existing in the cinema. The screen lumens per arc watt are 2.7 for 75 amps. and 3.2 for 50 amps. (shutter running). The difference between these figures is substantially due to a small difference in mirror collection angles. The total light flux is 6,000 lumens at 50 amps. and 10,000 at 75 amps.

**4. ELECTRO-ACOUSTIC SECTION**

J. Moir, M.I.E.E.

In order to make the best use of the short time available for the talk on the electro-acoustic section, it is proposed to deal only with those items that differ appreciably from our prior practice, commencing at the photo cell and ending with the loudspeakers.

**Photo-cell Coupling**

The war-time development of polythene as a low loss dielectric with relatively low permittivity, has enabled coaxial cables to be produced with a capacitance as low as 7 \( \mu \)f per foot. This has permitted the use of a fairly high value of photo-cell load resistance, directly coupled by a short length of polythene insulated coaxial cable, to the first valve in the amplifier. The signal voltage developed at the first grid is some 20 dB higher than in earlier equipments, easing the problem of obtaining hum- and noise-free operation.

Volume control is obtained by the use of a valve of the AC/SP1 type, in which the anode circuit mutual conductance is a function of the D.C. bias applied to the third grid. This has several advantages over the more usual type of gain control placed directly in the signal circuit; the gain control
may be placed at any point in or remote from the amplifier with complete freedom as to how and where the leads are run, hum or noise due to pickup on the volume control leads is non-existent, and the lead capacitance has no effect upon the frequency characteristic of the amplifier. Noise, inevitably produced by the first valve, is attenuated with the signal so that the signal/noise ratio is always the maximum possible. This remote control feature has been found invaluable in major theatres, where it becomes feasible to monitor any special show from the hall without the use of motor driven controls. The theory is simple, the current leaving the cathode at any particular value of bias on GI is fixed by the voltage on the second grid, but the division of current between screen and anode circuits is controlled by the negative bias applied to the third grid, high values of negative bias (10v.) giving zero anode current (and consequently zero gain,) zero third grid voltage giving maximum anode current and maximum gain. One valve is associated with each machine.

**Sound Change-over**

Machine to machine sound change-over is made by a miniature P.O. type relay in circuit after the first valve, where a signal of several volts exists. Trouble due to high contact resistance, dirt and contact potential "clicks," etc., are avoided by this high signal voltage, and the use of an hermetically sealed type of relay.

The operating circuit for the relay is extremely simple. It is required that on pushing the change-over button on any machine, the relay associated with that machine should "close" and that the relays associated with the other machines should "open" if they are not already open. The conventional method of achieving this would be to add three other sets of contacts to each relay, these contacts and the inter-connecting wiring being required for the operating coil circuits alone. The desired end has been achieved in this equipment without any extra contacts or inter-connection leads.

Each relay coil has in series with it a small metrosil resistor, all units being supplied in parallel by a substantially constant total current through a series resistor from a conventional rectifier. Metrosil is a silicon carbide base material in which the resistance is a function of the applied voltage instead of being constant as for normal metallic resistors. Halving the voltage across a resistor of this type increases the resistance by approximately 8 times.

The change-over push-button associated with each machine short-circuits the metrosil resistor in series with that machine's relay. On pressing a sound change-over push-button, the current in the associated relay rises from about 7 m.a. to approximately 25 m.a. and the relay closes. Short circuiting the metrosil with the push-button reduces the voltage across the relays by a factor of about three times. This reduction in voltage, combined with the large increase in resistance of the metrosil resistors in series with the other relays, reduces the current on all the other relays to about .25 m.a. and those relays "open." It is worth noting that further push-buttons can be added in parallel at any desired position in the theatre, only two small wires being required. This feature is used to permit change-over from "Film" to "Public Address," etc., and from a control point in the auditorium.

The middle section of the amplifier circuit is straightforward and requires no particular explanation except for the tone control circuits. It is a matter of common experience that some local adjustment of frequency characteristic is required to obtain optimum results in each theatre. This requirement is covered by providing three "bass" levels and three "top" levels available by soldering two short jumper wires across appropriate tags. The optimum characteristic is selected by the installation engineer after hearing a few
programme items, but personal likes and dislikes are minimised by requiring that the overall frequency characteristics should be measured and recorded with a copy for the Design Engineers Dept. This is also invaluable in dealing with later queries on sound quality.

The final stages of the amplifier consist of two or four 11E1 tetrodes in a push-pull circuit, heavy negative feedback being applied between the 500 ohm stage line and an early stage of the power amplifier.

Tetrodes as output stages have certain advantages, but a somewhat inaccurate picture of the position is obtained by a simple perusal of the valve manufacturers' data sheets, where the output power and distortion are quoted for a resistance load only, and for the condition where HT and screen supply voltages are held constant against load current changes.

A practical speaker load consisting of separate HF and LF units with a change-over network presents a load which has large reactive components at the low frequency end, due to the loudspeakers, around the cross-over frequency due to the change-over network, and at high frequency due to the speakers and various reactances in the filter unit. Typical results of this at the LF end show that the distortion increases by approximately twelve times due to the low frequency reactance of the loudspeaker assembly. These points have been taken care of in co-ordinating amplifier and loudspeakers, with the result that the working distortion is held at low level over the whole of the frequency range, rather than being low at some mid-point in the frequency range and high everywhere else.

Stabilised Supply

Where an output power of more than, roughly, 20 watts is required it is necessary to use valves with anode voltages of about 400 and screen voltages of 200 to 300, and there is a somewhat troublesome problem of deriving the lower screen voltage from the anode voltage. In equipment of low power and performance it can easily be achieved by a resistance potentiometer across the HT supply, but at our power level, adequate performance can only be secured by resistance potentiometers dissipating some tens of watts. Fig. 10 shows the effect of screen circuit resistance for valves of the 6L6 class and it will be seen that screen circuit resistance increases the distortion within the power range, and restricts the maximum power obtainable.

To remove this source of distortion, the Supa rectifier unit is fitted with a simple form of voltage stabiliser designed to provide a 250-volt line which is not affected by main voltage or load current changes.

This stabilised voltage can be used with great advantage for other purposes. The photo-cell operating voltage (90v), is derived from the 250-volt supply through a potentiometer consisting of precision resistors, and it is therefore free from the effects of mains voltage change. Multi-stage audio amplifiers are prone to "motor boating," a type of low frequency oscillation mainly due to impedance in the HT supply. This trouble is commonly limited by the use of multi-section R.C. filters in the anode circuits of the early amplifier stages, but as the stabilised 250-volt supply presents an exceptionally low output impedance (less than 1 ohm) it is used to provide HT for all early stages, thus eliminating about 90% of the normal complement of anode decoupling condensers. Similarly the stabiliser acts as a most efficient smoothing filter, serving to remove the last traces of mains frequency ripple in the HT supply to the early stages.

Loudspeakers

The loudspeakers specified vary in detail with the size and shape of the hall, but in general are a large low frequency horn driven by two 18-in.
low frequency speakers and a short multi-section 2 unit HF horn. In a typical 90 watt unit the energy radiated from the rear of the LF cones is reversed in phase and radiated by a port on the front of the horn. This minimises trouble due to “backstage hang-over” in addition to increasing the efficiency over the lower end of the frequency range. The HF power is handled by two metal diaphragm units in parallel and as an additional safeguard, a change-over switch can deflect the whole power on to the low frequency horn, which has sufficiently good characteristics to carry the show. Change-over frequency is 500 c/s, a frequency selected in 1936 and one to which all the other equipment manufacturers have slowly gravitated.

General Arrangement

The complete assembly of amplifier trays and the associated rectifiers are mounted in an angle-iron cubicle which is carried on bonded rubber vibration absorbers in the bottom half of the B amplifier cubicle. The individual circuits are assembled on trays which slide on guides into the cubicle, the electrical connections being made by multi-contact plugs. The trays can be withdrawn and operated in an inverted position, so that the whole of the wiring is exposed for service, while a faulty tray can be withdrawn and replaced in twenty or thirty seconds. When desired the whole of the amplifier is duplicated, the spare being put into circuit by operating a single switch. The non-operating controls, fuses, etc., are relegated to a second panel at the rear of the equipment, provided with a socket for soldering iron or inspection light, while the controls required by the operator in putting the show over are conveniently grouped on an illuminated panel.

DISCUSSION

Mr. Ross: What provision has been made in the Supa for use in studios, with a push-pull track, possibly 200 mils?

Mr. Moir: If any special optical system is wanted, it can be provided. In the same way, where stand-by amplifiers are wanted there is ample space. We can even deal with four-track films for stereophony.

Mr. Fitzgerald: Regarding the automatic arc striking feature, it is noted that the operation commences with the carbons apart. Have you considered the alternative commencing with the carbons touching?

Mr. Tuck: Arc striking with the carbons touching necessitates operation by current, and entails full-load striking. The present scheme utilised the line volts with only a small current drain.

Mr. Willis: Is the feed system intermittent or continuous?

Mr. Tuck: Strictly speaking, it is intermittent. However, the speed of operation is so high as to result in a feed which is continuous by practical standards.

Mr. Clark: It was mentioned that the lantern had been designed around a certain proprietary make of carbon. Does this mean I will not work with other makes?

Mr. Tuck: The reference to a proprietary make of carbon and projector lens was included in the script as an acknowledgment of team work in the development of the complete equipment. The lantern will, of course, work satisfactorily with their suitable carbons.
TECHNICAL ABSTRACTS

Most of the periodicals here abstracted may be seen in the Society’s Library.

HOLLYWOOD REPLACES f BY t NUMBERS.

The transmission system of lens calibration is briefly described, also an alternative suggestion by M. F. Cooper, based on the specifying of unit aperture as that at which the foot-candles falling upon the film are equal to the foot-lamberts reflected from the subject.

MOBILE CAMERA LAB.

A laboratory, with accommodation for processing of motion picture and still negatives, and for the transport of cameras and accessories, is constructed in a field trailer.

IMPROVED OPTICAL REDUCTION SOUND PRINTER.

The RCA Type PB-177 35 mm. to 16 mm. sound reduction printer operates at a speed of 180 or 150 ft. per minute of 25 mm. negative. A flutter content not exceeding 0.1% is claimed.

DUPLEX OF CONCERTS.

Successful experiments are reported in the reproduction of concerts in a second hall. Stereophonic reproduction was provided, the equipment comprising two treble channels and a single bass channel, each of 60 watts; the frequency range covered extended to 8,000 c/s. The quality of reproduction was held to be equal or even superior to that of the original.

THE MEN WHO MADE “SCOTT.”

Much of the filming of “Scott of the Antarctic” was achieved actually in the Antarctic, in Switzerland and Norway. Problems encountered were the delay in receiving processed Mencpack negative, and in the studio, in the perfecting of artificial snow, and the effect of the material used (foamed urea formaldehyde) upon personnel and equipment.

TELEVISION IN THE STUDIO.

An account of the experimental use of a television monitoring channel in the Nettlefold Studios.

THE GAS ARC—A NEW LIGHT SOURCE.

While at low current densities a discharge through any of the inert gases produces light having a discontinuous spectrum, as the current density is increased, so the continuum predominates. The “gas arc” consists of a discharge through xenon, producing light of sunlight quality. Experimental lamps have been demonstrated having a linear light source (both water- and air-cooled) or a compact source suitable for projection.

PRESIDENTIAL ADDRESS.

A valuable survey of the development of electronics, from the Maxwell theory to radar and television.

THE COUNCIL

Meeting of June 1, 1949

Present: Messrs. A. W. Watkins (President), L. Knopp (Vice-President), W. M. Harcourt (Past President), I. D. Wratten, F. G. Gunn, R. B. Hartley, R. E. Pulman, H. S. Hind, T. Howard, R. H. Cricks (Technical Consultant) and W. L. Bevir (Secretary).

Deputy Vice-President.—The President suggested, and it was agreed, that the appointment should be deferred until the next meeting.

Committee.—Business Committees were re-appointed (see inside back cover).

Standing Orders.—The Standing Orders for 1948-49 were examined and adopted for 1950, with the omission of the clause on the organisation of the Library.

Finances.—Mr. Harcourt reported that the Finance Committee had prepared a budget for the current year, allowing for a deficit, calculated on an increase in expenditure and fall in income.
EXECUTIVE COMMITTEE

Meeting of June 1, 1949

Present: Messrs. A. W. Watkins (President), L. Knopp (Vice-President), I. D. Wratten, W. L. Bevir (Secretary), and Miss S. M. Barlow (Assistant Secretary).

Elections.—The following were elected:
GERARDUS RAUCAMP (Member), Royal Dutch Airlines Film Unit.
JACK BARRACLOUGH (Member), I.C.I., Ltd.
GEORGE JOHN MATHYS (Member), Andrew Hyslop & Co., Ltd.
HENRY ROBERT ALEXANDER DE JONGE (Member), GB-Kalee, Ltd.
ALEXANDER GEORGE THOMSON (Associate), J. Arthur Rank Productions, Ltd.
FRANCES MARJORIE STEWART (Member), Cinematograph Export, Ltd.
WILLIAM BRAMWELL HAKES (Associate), W. Vinten, Ltd.
DAVIS CLAUDE BOULTON (Member), M.G.M. British Studios.
JOHN SOUTHAM ABBOTT, Jnr. (Member), Big Six Film Unit.
WILLIAM ALFRED VICTOR WILSON (Member), Itala Acoustica, Rome.
JOHN HOPKINS (Member), Mullard Electronic Products, Ltd.
WILLIAM CLARENCE GREEN (Member), British Lion Studio Co., Ltd.

Transfers.—From Associates to Corporate Members:
HUBERT WILLIAM PRESTON LESLIE HORACE EDWIN DUNK.
From Student to Associate.—GEORGE JOSEPH LEVY.

Resignations.—The resignations of PERCIVAL WALTER ALSTON and ERIC THOMAS MERRY were accepted with regret.

Polytechnic.—It was decided that a balance of £58 remaining from a grant made by the Society to the Regent St. Polytechnic for scholarships be returned to the Society, for other educational schemes under consideration.

FILM PRODUCTION DIVISION COMMITTEE

Meeting of June 22, 1949

Thirty nine Members were enrolled in the Division and the following Committee Members appointed: Deputy Chairman—F. G. Gunn, Hon. Secretary—Rex B. Hartley; Representatives—Papers Committee—T. W. Howard, Branches and Membership Committees—Rex B. Hartley.

Continued on page 28
Architect for castles—and cottages . . .

- FROM blueprint to model, from model to full-size structure—so grew this “dream castle”—product of the set designer’s skill.

As architect for filmdom’s castles and cottages, he heightens dramatic effect by his creative work with materials and textures. His sets help to establish and maintain story mood . . . give camera and actors the freedom needed to do full justice to the scene.

For this he must be more than master architect: he must have real understanding of the photographic element in which his sets will “live”.

And from his close association with the camera art, he knows how much creative latitude depends on the proper films. Films with the versatility for which the ‘Kodak’ motion picture family has long been famous.
HEWITTIC Cinema Rectifiers efficiently meet every requirement for the operation of projector arcs in cinemas, large or small; bearing a name with a world-wide reputation amongst cinema technicians—modern as the minute, exceptionally simple to install and operate, amazingly economical, compact in design, styled to match the modern projection room. Backed by well over 40 years' experience in rectifier manufacture.

Illustrated:
UNITARC Major (up to 75 amps D.C.) with projection room remote control unit.
UNITARC (25 to 65 amps D.C.)
UNITARC Minor (up to 45 amps D.C.) for smaller halls.
Econotrol DUPLEX: Operates two projector arcs from a single bulb.

HACKBRIDGE and HEWITTIC ELECTRIC CO. LTD.
WALTON-ON-THAMES, SURREY

Continued from page 26
To meet A.C.T.—Messrs. B. Honri, B. C. Sewell, I. D. Wratten, and F. G. Gunn as alternate.
Suggestions for the 1949-50 Lecture Programme were agreed.
Representatives for the Society were appointed in each British Film Studio, and in those abroad where there were B.K.S. Members; and in each British processing laboratory.
Mr. Baynham Honri, the Chairman, and Mr. Hartley were authorised to appoint representatives in any other firms.

LIBRARY COMMITTEE
Meeting of June 13, 1949
Mr. M. F. Cooper was congratulated on his appointment as Chairman of the Committee.
Eight books were accepted for the Library.
A rota was prepared, indicating which member of the Committee should be on duty in the Library on Monday evening, until 8 p.m.
It was decided to ask Council to request committees not to meet on Monday evenings so that the Library might be open to borrowers and readers.

FELLOWSHIP COMMITTEE
Meeting of June 24, 1949
Proposed alterations to Fellowship regulations were considered, a decision being deferred until a subsequent meeting.

PERSONAL NEWS of MEMBERS
Members are urged to keep their fellow members conversant with their activities through the medium of British Kinematography.
Y. A. FAZALBOY, our Indian representative, has been in this country purchasing equipment.
GEORGE LEVY has just completed photographing "Idlers that Wait," directed by Lindsay Anderson, advertising Richard Sutcliffe's Conveyor Belts.
PARVIS P. SHAYAN has returned to Iran to resume work with a kinema circuit, and will be glad to hear from all friends at P.O. Box 86, Abadan, Iran.
CHARLES VINTEN, accompanied by W. H. NORRIS, is piloting a private plane on a sales mission to France, Spain and Portugal.
A. W. WATKINS has been elected a Director of Arkley Golf Club.
HARRY WAXMAN has been on location in Germany, as lighting cameraman with the crew of "They Were Not Divided."
ERIC ("BUNGAY") WILLIAMS, General Manager of Ealing Pagewood Studios, Sydney, N.S.W., is at present visiting this country.
When you're in need of our co-operation and advice—remember our new address. At 104 High Holborn (lift to sixth floor), you will find the Ilford Cine Sales Department as ready to help you as ever, and very conveniently situated above the Ilford Gallery for those whose interests include general photography. This move is the first step in a programme of reorganisation aimed at giving even greater service to Ilford customers.
16mm Sound-film Projector

(Type 301)

- **Easiest Threading**—only one sprocket. Wide-opening gate.
- **Films Last Longer**—independently-sprung, lightly-loaded gate skids prevent damage to film.
- **Minimum Maintenance**—grease-packed ball-bearings throughout. Intermittent mechanism requires only occasional lubrication. “Unit” construction enables any part to be easily removed for routine cleaning.
- **Unequalled Light**—from standard 750 watt lamp, in conjunction with wide-angle duplex condenser system. Surface-treated lenses by Taylor, Taylor & Hobson, Ltd.
- **Steady Picture**—ensured for life by the unique design of the spring-loaded claw and cam follower.
- **Vivid Sound**—sound-frequency range 50-7,000 cycles from 0.0005” scanning slit. Viscous drive to sound drum gives smooth, ripple-free scanning.

ENTIRELY BRITISH IN DESIGN AND MANUFACTURE

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METAL RECTIFIERS
for
CINEMA ARCS

Rectifier style H.I. 60
supplying power for
the arc lamp at
Salters Cinema
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DEVELOPMENTS IN MAGNETIC SOUND-ON-FILM RECORDING

Symposium delivered to a joint meeting of the British Kinematograph Society and the British Sound Recording Association on April 6, 1949.

I. MAGNETIC SOUND AND THE FILM

Dr. O. K. Kolb, M.B.K.S.*

The impression is widespread that magnetic sound—whether the magnetic wire recorder or the Magnetophon, which uses a tape coated with a magnetic material—is a comparatively recent development. Whilst it is true that great steps forward were made in Germany and in the U.S.A. during the war, which now allow magnetic recording to take its place for quality alongside the other recording systems, such as the gramophone and the photographic sound film, the original invention of recording sound magnetically dates back to 1898, in which year the Danish physicist Valdemar Poulsen produced and patented what he called his "Telegrafone." He gave practical demonstrations with his apparatus in which he used a steel wire, similar to piano wire, upon which the sound signals were recorded, and from which they could be reproduced, by running it past a magnetic head.

Thus, magnetic sound appeared round about the same time as the earliest photographic sound, but, of course, both systems suffered from many drawbacks at that time. There were no good microphones, no thermionic valves and amplifiers, and no loudspeakers capable of handling enough volume to fill an auditorium.

The art therefore stood still until the advent of the necessary electrical and electronic auxiliary means opened the gates to wider fields. It is an interesting fact that whilst stylus recording on gramophone discs and photographic sound went ahead very rapidly as soon as the thermionic valve appeared, very little was done in the magnetic sound field to reach perfection.

Practical Applications

In the late '20's and early '30's, Stille and Blattner developed what can be considered as improved versions of Poulsen's original Telegrafone, and the British Broadcasting Corporation, together with the Marconi Company, produced a magnetic sound equipment which used a steel tape.

Before the war, news came of a German development which used magnetic

*British Acoustic Films, Ltd.
powders on a tape, but this was not, at that time, viewed as a fundamentally superior process of sound recording, and was only considered to be a better version of a dictating machine.

However, further developments during the war, mostly in Germany by Dr. von Braunmühl and the late Dr. Weber, by introducing the H.F. bias method on the oxide tape, and also the work in the U.S.A. by Marvin Camras of the Armour Research Foundation and S. J. Begun of the Brush Development Co., raised the standard and quality of this new recording means to a very high level, so that it can now enter the field as one of our best methods of sound recording and reproduction. It has already resulted in equipment which, because of its versatility, is finding its way into broadcasting studios all over the world.

The film industry, which always has two main principles in view—the perfect picture and perfect sound accompaniment—watched these new developments with great interest, and it soon became apparent that consideration would have to be given to the use in the industry of the new improved magnetic sound method, side by side with the existing photographic sound methods.

Requirements of the Film Industry

Before magnetic sound can be introduced into the film industry, however, it has to fulfil several requirements.

Essentially, of course, perfect synchronisation must be kept between the magnetic sound record and the complementary photographic picture record. The simple application and use of the existing Magnetophon tape recorders and of the wire recorders is impracticable, because these two recording media do not present any method of achieving perfect synchronism, and normally run at a much higher speed than that of sound film. The only way, therefore, to achieve this desired result is to do the same to the magnetic sound track as had been done with the photographic track, namely, place it on a perforated carrier so that it can be run synchronously with the picture record.

Another requirement is that the magnetic sound must be at least of the same high standard in every respect as the existing photographic sound. That is to say, it must be possible to record on, and reproduce from, the magnetic carrier at least the same frequency and volume range, with the same speed constancy and maximum permissible distortion as the existing photographic sound film records.

Many preparations and alterations to the film and equipment are therefore necessary before the magnetic sound-on-film can be put into practical commercial use.
Magnetic Sound Materials

First a suitable base material has to be chosen; the most obvious is either standard celluloid or acetate film base. The latter type of base appears more suitable, as not only does it lessen the risk of fire very considerably, but there is also the tendency to have all photographic release prints made on this type of base in future; in addition to which, the magnetic coating can be keyed on to the acetate base very firmly. This base has to be perforated in the usual way, and it also has to be coated with an emulsion containing the magnetic particles. The thickness of this coating, for all practical purposes, has been found to be about the same as the photographic emulsion, namely, of the order of half to three-quarters of a mil (15 to 18 microns).

Coating with the magnetic emulsion is of two different kinds: one where the magnetic coating is put on a plain carrier for a sound record only, and the other where it is put on a photographic film which already, or ultimately, carries a picture record as well.

Fig. 1 shows a magnetic carrier of the first kind, in which the coating covers the whole width of the 35mm. film. Stock of this kind can be manufactured by coating large sheets of base material over their entire area and then slitting and perforating them.

![Fig. 3. 35mm. Magnetic Film, Type C.](image1)

![Fig. 4. 35mm. Magnetic Sound-with-Picture Film.](image2)

However, the ferric-oxide with which the base material is coated constitutes a very good abrasive and will, in some cases, very quickly blunt the perforating punches. Manufacturers may therefore prefer to coat the base stock in the manner shown in Fig. 2, in which the film is perforated before it is coated and the coating is applied to the space between the two rows of perforation holes only. The advantage of this type of film is that it can be run through the machine without the abrasive coating coming into contact with any of the rollers, sprockets, etc., and that it allows edge numbers to be printed clearly visible.

Fig. 3 shows a modified type of magnetic film in which the magnetic coating occupies approximately half of the width of the base material, the other half being given a white coating on which cue signs, markings and notes may be made.

Fig. 4 illustrates a magnetically coated film of the second kind in which the film is already coated with a photographic emulsion and has a picture on it. The space normally occupied by the photographic sound track is coated with the magnetic emulsion for the reception of a magnetic sound track; this track has a width of approximately 0.1in.

However, if this coating is made alone, and 1,000 or 2,000 feet of film are reeled upon a spool, difficulties are experienced in reeling due to the greater
thickness at one side than the other. Proposals have therefore been made to have a dummy coating on the opposite edge of the film to equalise the sound track coating. The additional coating is also illustrated in Fig. 4.

**Application to Sub-standard Films**

Fig. 5 shows a 16mm. film, similar to the 35mm. film exhibited in Fig. 4. In this the sound track coating occupies the same space as that normally occupied by the photographic track, and it is again of about 0.1in. in width. The second row of perforations is as in the photographic film omitted in order to accommodate the magnetic track. The above remarks also apply with regard to the provision of an additional dummy coating to facilitate reeling—a point of particular importance now that the use of large reels of 16mm. film, up to 1,600 feet in length, is so frequent.

We now have to welcome a new arrival in our midst, namely, the 8mm. sound-on-film. The technically minded will, generally, have mixed feelings about this new arrival because the results we can expect must inevitably be very limited. Up to now it has been impossible to make an 8mm. film with photographic sound, due to the limitations of the latter, but the arrival of modern magnetic sound, and particularly the different materials with which the film can be coated, make it feasible to apply a magnetic sound track to 8mm. film as well.¹

![Fig. 5. 16mm. Magnetic Sound-with-Picture Film.](image)

![Fig. 6. 8mm. Magnetic Sound-with-Picture Film.](image)

The coating for the sound track on 8mm. (Fig. 6) can, perhaps, be placed on the sprocket hole side (8mm. film has only one row of perforations) or on the opposite edge. Either position can be arranged to allow a maximum width of only about 30 mils (0.030in.) and the necessity of a "dummy" coating also holds good if the use of large reels is contemplated.

Naturally, the proximity of the sprocket holes may influence the recording and reproduction of sound. On the other hand, if the sound track coating is placed on the opposite side of the film, this will necessitate slight consumption of the picture area, and I propose to leave it to the experts in the industry to thrash out this reduction in picture size between them.

**Requirements of Apparatus**

Having coated the film and having made the required stock available, the question arises of the different functions which we require the apparatus to fulfil.

In many respects the equipment has to be different from photographic equipment. Complicated optics and optical adjustments disappear. The sound signals are impressed upon and picked up from the magnetic track
by means of coils having annular cores of soft magnetic material with a well defined gap in them. The recording head for use with the oxide coated film is always fed, in addition to the sound signals, with a supersonic bias of the order of 50—100 kc/s. and this, although not shown specifically, is employed in the arrangement now to be explained.

**Recording Channel**

Fig. 7 illustrates the general layout of a magnetic sound-on-film system. The sound is picked up by a microphone, passes on to a voltage amplifier having a straight-line response, and then on to a special amplifier having a pre-emphasising characteristic which compensates for losses (particularly of the higher frequencies) incurred in the transfer of the signals from the magnetic recording head to the sound record carrier. The curve shown above the amplifier illustrates how the higher frequencies are pre-emphasised before being impressed on the sound record carrier. The magnetic field impressing the signals will therefore have a similar characteristic to that of the pre-emphasising amplifier, with the result that the signals recorded on the carrier will have a substantially straight-line characteristic.

The sound record carrier, now with the magnetised layer on it, passes round a drum to a second magnetic head which can be used either for reproducing, re-recording or for monitoring whilst recording is taking place.

The frequency characteristic of the picked-up signals is not a straight line, but is approximately as shown on the graph. This response curve is equalised by the inverted characteristic of a special reproducing voltage amplifier, the output of which is applied to a power amplifier feeding the reproducing loudspeaker.
In order to adjust the equipment, and also for comparison purposes during recording, a change-over switch is incorporated in the apparatus by means of which the signals from the microphone amplifier may be fed either directly to the power amplifier and thence to the loudspeaker, or else via the recording head, record carrier and reproducing head. If the apparatus is functioning properly, there will be no difference in the sound from the loudspeaker between the directly reproduced sound and that played back via the recorder and reproducer when the switch is moved from one position to the other.

**Frequency Characterisitcs**

Fig. 8 illustrates the characteristic curves through the whole process:

1. The pre-emphasis characteristic of the main recording amplifier which remains flat until about 5,000 c/s, and then rises approximately 10db to 9,000 c/s. (there are, of course, slight variations in the higher frequencies due to different coatings and materials).

2. The straight-line characteristic of the recorded signals on the sound film.

3. On the reproducing side the induced voltage in the playback head has a characteristic which begins at approximately 50 c/s, rises 6db per octave up to a maximum response at about 3,000 c/s, and then drops slightly. This response is compensated in the reproducing voltage amplifier which has an equalising network giving a response—

4. which is an inversion of that of the induced voltage in the playback head.

Fig. 9 shows the approximate overall response obtained with 35mm., 16mm. and 8mm. magnetic sound-on-film.

With 35mm. film the frequency response can be kept straight from approximately 50 c/s. to about 10,000 c/s. In 16mm. film, our requirements must be limited to a more modest response, owing to the reduced film speed, but it is possible to obtain a response which is approximately flat from about 100 c/s. to something like 5,000 c/s.; this still gives very tolerable quality which is at least equal to present 16mm. photographic sound-on-film.
Even on 8mm. film it is possible at the speed of 24 pictures per second, to obtain a reasonably straight response from about 150 to 3,000 c/s. which is comparable with the best quality of a good telephone.

If frequency responses like those shown are obtained, the quality of the magnetic sound will be of the same standard as present photographic sound, provided that flutter is kept to the same low figure as with the latter, namely, of the order of one-tenth of 1% for 35mm. The total distortion can also be kept down to the same low level as with sound film.

Background Noise

In photographic sound films there are other important features which must be considered. It has long been standard practice to record sound photographically by so-called noiseless methods, which reduce or eliminate background noise during quiet passages of sound or periods of silence by keeping the light transmission of the positive track as low as possible during such passages. In addition, use is often made of compression and limiter circuits which prevent the sound wave traces from over-shooting the width of the track allotted to them.

In this respect, magnetic sound-on-film has certain advantages. Abrasions, scratches, finger-prints and other similar markings do not affect reproduction, and the amount of background noise does not increase with worn films, as it does with photographic ones. As a matter of fact, the only cause of increased background noise is dust which has magnetic properties, but as this is very rare in the usual projection room, it is not a serious matter.

It may be useful, at this point, to mention the signal-to-noise ratio which can be obtained. With photographic sound recorded by one of the noiseless methods, there is a volume range of up to perhaps 50 db, whilst when recording on magnetic sound film at least 10 db better can be obtained.

We do, however, meet a new kind of noise with magnetic sound, which is known as modulation noise, as it comes and goes with the signal. It is primarily due to bad emulsions or coatings or uneven distribution of the magnetic particles in the coating, or to rough surfaces on it.\footnote{3}
An idea of this modulation noise can be obtained by taking a virgin or recently wiped film, pre-magnetising it with D.C. or with a permanent magnet, and listening to the record when played back. If the magnetic particles are unevenly distributed in the coating a hiss will be heard, which will vary according to the degree of unevenness. If the rollers of the coating machine have pressed on the emulsion with varying pressure this influences the distribution as well, and the periodicity of the variations will also be heard.

However, careful coating of films overcomes these difficulties and the background modulation noise can be kept so low as to be of no consequence when sound signals are recorded and reproduced. With magnetic sound film no ground noise reduction unit is necessary, nor are compressor or limiter circuits essential.

**Synchronisation for Editing**

Although it is possible to dispense with some items, it is advisable to add some other equipment to the magnetic sound film gear. This arises from the fact that the magnetic sound record is invisible. It is not possible to tell, merely by looking at it, whether or not sound has been recorded on magnetic sound film; the editor or cutter will not know where to put his scissors when cutting the magnetic sound track to synchronise it with a complementary picture film.

Possibly the simplest way to obtain an approximate idea where to cut the film is to rely upon an audible signal. This can be done very easily on existing editing machines, the optical system for the sound reproduction and the exciter lamp being removed and replaced by a magnetic pick-up head. If the audible signal thus obtained is not sufficient, the addition of an oscilloscope in parallel with the loudspeaker will enable a transitory visible indication of the sound to be obtained as well. In this way, it will be possible to adjust the synchronism and cut and edit the magnetic sound track where necessary.

**Envelope Recording**

For very accurate synchronism between picture and sound as, for example, for close-ups, it is advisable, however, to provide equipment which will make the magnetic sound track permanently visible to the editor.

One type of marking which would be very useful to the editor would be a visible recording of the actual sound signals made simultaneously with the magnetic recording, or even afterwards; this visible recording could be of the actual signals or only a registration of their envelope or an indication derived from them. Fig. 10 shows registrations of the envelope of the sound. This registration can be effected in different ways: (a) by an inking method, in which a small nib fed with indelible ink traces the envelope of the sound waves; (b) a dry chemical process in which a stylus, somewhat similar to a gramophone stylus, traces the visible indication on the white coating; (c) a similar process requiring chemical intensification.

The white coating is made of zinc oxide and the recording stylus is made of bronze or brass or an alloy of these materials, the reaction between the coating and the stylus forming the marking. This particular process has the advantage that it is entirely dry and perfectly clean—a point of quite considerable importance, as with other methods, such as a pen recorder or modified undulator of

![Fig. 11. Photomicrograph of "Developed" Magnetic Recording.](image-url)
the kind used for recording high speed morse signals, the splashing ink—particularly when starting—has been found to present some difficulties.

Making the Record visible

And now I have to make a certain revision about the statement that merely by looking at the magnetic sound track one cannot say whether or not a signal has been recorded. Actually, the signal on the magnetic layer can be made visible, and one can tell whether or not a recording head which has been in contact with the magnetic layer has been energised.

Fig. 11 is a photomicrograph of a piece of magnetic sound film on which the recorded signals have been made visible by means of a kind of "magnetic developer," consisting of a solution containing very small magnetic particles in suspension as well as a few other chemicals; when the recorded film was dipped in this solution, the magnetic particles were attracted to the energised portions of the oxide layer, but left the unenergised portions entirely blank. The whole process only takes a few seconds. The photomicrograph shows a 3,000 c/s. signal, and it is interesting to note that it has an appearance somewhat like a variable density photographic sound record.

A test of this nature will be of a very practical use to a recorder operator, actually using magnetic recording equipment, as it will enable him to check that the magnetic recording head is properly aligned and making even contact. The sections of film measured under a microscope provide excellent means by which the azimuth of the magnetic gap to the direction of travel of the film can be checked and adjusted.

Recording Equipment

Figs. 12 and 13 illustrate the general assembly of equipment which can be used, not only for magnetic recording of sound, but also for reproducing the recorded sound synchronously with pictures at normal film speed. It consists of a combined recording and reproducing machine and a stack of amplifiers and ancillary units. The equipment can be used with any microphone input and mixer table, which are not shown. The amplifier and ancillary units are mounted in an interconnected stack so that the complete equipment stands in a compact and readily accessible form. The apparatus
is also equipped with a special head for wiping or erasing the recorded sound, thus making it possible to re-use previously recorded film.

From Fig. 13 it will be seen that the recording head and the playback head are both mounted so that they ride on the flywheel drum round which the film passes; the drum is connected to a shaft carrying a flywheel, which is consequently driven by the film itself—an arrangement which long experience has shown ensures a constant and highly uniform film speed. The cover of the recording head has been removed to illustrate the magnet, which is normally enclosed in a screening can. The film passes the reproducing head only a fraction of a second after it has passed the recording head, and the former can be used for playback, re-recording or monitoring purposes.

Fig. 14 illustrates details of the recording and reproducing heads and of the bridge on which they are mounted. The cover has been removed from the recording head and the position of the bridge reversed to that shown in Fig. 13 in order to illustrate the means by which the heads can be aligned in proper position.

Comparison with Photographic Recording

It is now time to make a brief comparison between photographic sound film and magnetic sound film, and I will therefore enumerate some of the many advantages and one of the few disadvantages of the latter.

1. Magnetic sound film requires no developing and printing before it can be played back, which can be done immediately, for example through the monitor amplifier, thus giving the assurance that what is heard from the monitor amplifier is on the film. As a consequence of the elimination of film processing, photographic types of distortion are absent. Moreover, since the magnetic sound film stock can be handled in daylight no dark rooms are required for it.

2. The magnetic sound records can be erased and the magnetic film stock used over again.

3. It is possible to erase a part only of the magnetic sound track and to dub in new sound in its place.

On the other hand, there is a certain wear and tear of the heads, which have a normal life of about 300 hours, after which time they need replacement.

Summing up, therefore, there is a number of reasons why magnetic sound film could be introduced with advantage into the film studios:

1. The frequency response can be made at least equal to that of the present photographic film.

2. The signal-to-noise ratio is very appreciably better.

3. The magnetic coating can be introduced on the same carrier as the photographic coating, having approximately the same physical dimensions.

4. The present speed of 35mm. film of 18in. per second and the same film driving mechanism can be used.

5. Photographic types of distortion are absent.

6. The cost of developing and printing can be avoided until the final release negative is made.

7. The small size of the magnetic recording and reproducing heads does not necessitate bulky equipment, and in many cases existing equipment can be easily adapted to accommodate them.

One can therefore assume that there should not be too many difficulties in the way of introducing magnetic sound into the film studios, as it is so easy to handle and can be so readily adapted to the whole of the existing technique of mixing, dubbing and cutting, etc., to produce a final composite master sound record.

Magnetic Sound only in the Studio

All these advantages can be used to the best purpose in the studios, but
the final magnetic sound track will then need to be transferred to a negative photographic sound track, from which the theatre release prints will be made. The use of magnetic sound up to that stage will have the great advantage, that the distortion and errors inevitably incurred in the previous developing and printing of numerous photographic tracks will be eliminated.

It is difficult, however, to visualise that the thousands of kinemas will be willing to go over to magnetic sound film reproduction, owing to the change necessary, and it is equally difficult to contemplate the film renters being willing to issue two different sets of film copies, one with magnetic sound and one with photographic sound. The question whether magnetic sound will ever ultimately come into the public kinemas is therefore quite a speculation because of the commercial difficulties mentioned above, as well as the technical difficulties it presents.

On the technical side, the added magnetic coating, although only very thin in itself, will also occupy quite a considerable space on a 2,000 feet reel of film, so that either less film would have to be put on each reel, leading to an increased number of change-overs, or the spool boxes on all the thousands of existing projectors would have to be increased in size.

A further technical difficulty for public kinema use would be the necessary reconstruction of the projector film gates to allow the highly abrasive magnetic coating to pass through smoothly. Even so, frequent renewal of the pressure pads would probably be necessary.

In conclusion therefore, and so far as the future is concerned, I see a combination of both magnetic sound film and photographic sound film, both used to their best advantage—the magnetic sound film in the studios, because of the greater facilities it provides, and the photographic sound film in the kinemas because of the technical and commercial difficulties of replacing it there. Both systems will combine very happily in the future.

I would like to end by expressing my thanks for the assistance and cooperation I have had from Dr. von Braunmühl and from Col. Elliott, for preparing the slides for this lecture, and I am indebted to Mr. E. Penkala for the use of his micro-photographic equipment and for preparing the photomicrographs.

II. MAGNETIC RECORDING IN FILM PRODUCTION

Norman Leewers, B.Sc., A.C.G.I., F.B.K.S.*

It is the purpose of this symposium to discuss the magnetic system of sound recording in relation to the known conditions of film production, and to deduce, where possible, what modifications are necessary to the new system on the one hand and to present recording practice on the other to achieve fullest efficiency. Our starting point is therefore the way in which a sound department usually operates at present.

Modern film production calls for sound recording units of various types, which may be classified according to their functions, as follows:—

1. Fixed installations for final mixing.
2. Studio equipment for original recording.
3. Accessories for recording wild tracks, guide tracks, or playback.

The relationship between the various units which comprise a complete sound department is indicated in the diagram, and we note the important position occupied by the cutting room by virtue of which it is entitled to special consideration in any discussion on new methods of recording.

Existing Technique

Most sound departments will have as a nucleus a more or less elaborate

*Leewers, Rich & Co., Ltd.
fixed installation comprising a number of synchronised film reproducers, loop machines, and disc reproducers, all controlled by mixers and equalisers, and feeding a machine which records track of standard release dimensions. Live microphones may also be included as the sound sources, but they do not form an essential part of such an installation except on special work such as news reels, where a preliminary recording may be dispensed with for speed or other reasons. In other words, this installation only handles primary recordings.

The primary recordings, assembled by the cutting room and re-recorded on the main installation, will originate in equipments of the remaining types. In particular, the greater part of film production recordings are made on high quality studio recording channels, which may be mounted in trucks to enable location sequences to be undertaken.

Great care is taken to ensure that these primary recordings—the master tracks—are of the highest possible sound quality and have a very low noise level. Since they are not intended for cutting into a final release negative, but are reproduced on the special re-recording heads, they do not necessarily conform to release track specifications; for example, any of the various push-pull tracks may be used, including double-width push-pull.

The recordings must be easy to handle in the cutting room, however, and disc recordings, for example, would not be suitable.

News reel recording units perform the same broad function in feeding the main installation with primary recordings, but here the stress is on portability, simplicity and reliability, rather than on highest sound quality.

Accessory recorders for special purposes include the following:

(a) Ultra-portable "wild" track recorders used mainly for sound effects. Since there is no need for synchronising, it is often convenient to use disc or magnetic tape or wire recorders.

(b) Guide track recorders in which synchronising is essential but only "intelligible" speech quality is required. Single film cameras or camera attachments are useful here.
(c) Playback recorders in which synchronising is also essential, combined with ease of locating any section of a recording and repeating it ad lib. over a reproducer. Disc recording is supreme for this purpose, and is likely to remain so.

Sound Quality

Future improvements in sound recording technique will take place in two main directions: improved quality, and simpler operation.

With modern high quality equipment, skilled operation and adequate maintenance, the best recordings more than satisfy present requirements in kinemas. Let there be no mistake about that. Indeed, the full volume range and frequency range of primary film recordings is rarely reproduced. In primary recording, however, the mixer may be glad of any added volume or frequency range which may be possible, and, in particular, welcomes any development tending to simplify operation or maintenance. It should also be remembered that in each stage of re-recording, the resultant signal-to-noise ratio is reduced whether or not compression be used.

Magnetic recording promises a noticeable improvement in sound quality; also, and this is perhaps even more valuable, it permits immediate playback from the master track itself even while recording, and without risk of deterioration—a notable step forward in reducing the risks and costs of film production.

Adoption of Magnetic Recording

Magnetic tape is already in use for wild track recording, and as perforated magnetic film and the machines to use it become available, we may expect the system to be adopted in one of two ways:

Firstly (though possibly only as an interim measure), we may make our primary recordings on magnetic film, later re-recording the chosen takes on to photographic film, before editing and mixing by the usual methods on standard equipment. This would exploit the ease in handling of magnetic equipment and would reduce stock and processing charges.

Secondly, if the difficulties of handling the film in the cutting room are satisfactorily overcome, we may cut and edit the original magnetic tracks, use multiple magnetic play-off heads in the mixing stage, and record direct on to our final release negative. In short, all primary recorders and cutting room equipment would handle magnetic track and the central mixing installation would be the only channel requiring a photographic recorder. It is not contemplated at present that release prints should carry a magnetic track.

The complete change-over of equipment involved may take some considerable time, and transition may be assisted by fitting magnetic modulators to existing film recorders. In some machines this can be done without impairing the performance on either photographic or magnetic track.

Standards

Before the new system can come into wide commercial use, it is desirable that certain specifications relating to materials and track position be standardised. Great Britain is certainly not behind in this important aspect, and last year the British Standards Institution set up a group of technical sub-committees covering all aspects of the subject.

Both the B.K.S. and the B.S.R.A. are well represented on these, indeed, Dr. Kolb is Chairman of the Film Committee. The work of the committee is well advanced, and those working on magnetic systems are advised to get in touch with the B.S.I. in order to keep up to date with recommended practice and proposed standards.
III. PERFORMANCE DATA OF MAGNETIC COATINGS

A. Tutchings*

The object of this part of the discussion is to clarify ideas on choice of magnetic characteristics for tape or film coating and on head design—the film speed being fixed for us at 18 in. per second for 35 mm. film and 7.2 in. per second for 16 mm. film.

Fig. 16 shows a typical B-H loop for the material used to coat magnetic recording film or tape. \( H \) is the applied magnetising force in Oersteds, and is proportional to the ampere-turns and signal current in the recording head. \( B \) is the magnetic induction in Gauss remaining in the medium when the magnetising force is removed.

If we start with a magnetically neutral sample and slowly increase the magnetising force \( H \), it will be seen that there is little or no change of \( B \) until \( H \) is taken above a certain critical value. This opposition to change of magnetisation which we might call "magnetic stiffness," is known as coercivity, and is the main factor affecting distortion in magnetic recording. Beyond this point a change of \( H \) produces a more or less linear change of \( B \) until saturation is reached. The value of \( B \) remaining as permanent magnetisation for any applied \( H \) is a function of the remanence or "permanent magnet goodness" of the material. Remanence, therefore, mainly affects the playback voltage in the reproducing head.

Need for Biasing

The non-linear amplitude response, which is due to the coercivity of the magnetic medium, may be corrected in two ways, known respectively as D.C. and H.F. biasing. In D.C. biasing, the tape is first saturated by passing it over a head carrying a strong D.C.; this erases or wipes off any previous recording. The recording head has a smaller amount of D.C. superimposed on the signal, which produces a field of opposite polarity to the erasing or saturating field. This D.C. bias brings the working point down on to the straight part of the B-H loop, so that, in the absence of any signal, the tape leaves the head in a nearly neutral magnetic state. It will be seen that this D.C. bias is very critical, and, in fact, due to minute variations in coating characteristics along the length of a tape, a small fluctuating D.C. magnetisation is left on the tape. This noise is predominantly low-pitched in character, and is quite objectionable at high tape speeds.

H.F. biasing has many advantages. In this method the magnetic medium is erased or prepared for recording by passing it over a head carrying a strong A.C. signal. The frequency is so high (35—80 kc/s.) that several complete reversals of field take place while any particle of the tape passes over the gap. The strength of the field is arranged to fall off quite gradually on either side of the gap so that the tape leaves this head in a perfectly neutral magnetic state. A small amount of supersonic bias is mixed with the signal to be recorded, in the recording head. The H.F. bias level is not as critical as in the D.C. method; it must be high enough to overcome the "coercive crust" of the medium, but not high enough to start erasing on its own account. Due to the balanced "push-pull" action of the combined bias and signal on the initial magnetising curve of the material, second harmonic distortion is markedly reduced, and about 30% more level may be recorded for a given amount of harmonic distortion or intermodulation.

De-magnetisation

In magnetic recording it is necessary to pack the minute magnets re-
presenting the signal waveforms very closely together, and this crowding or packing increases at high frequencies and at low tape speeds.

Short magnets are inefficient and a certain amount of mutual de-magnetisation takes place at medium and high frequencies. If a range of frequencies is recorded, with appropriate biasing to cancel coercivity distortion, and with constant current in the recording head, the tape will be nearly equally magnetised at all frequencies.

Fig. 17, curve (1), shows the playback response of this constant current recording. At low frequencies the voltage output rises 6db per octave due to the fact that voltage is proportional to rate of change of flux, so that doubling the frequency (one octave) doubles the rate of change of flux, and so increases the output by two to one (6db). At medium frequencies the demagnetisation effect, mentioned earlier, levels off the response.

For any given tape speed and gap width this turnover point is controlled by the ratio of remanence to coercivity of the recording medium. For optimum results the remanence should be not more than three times the coercivity. The extreme high frequencies are mainly affected by the gap width of the recording-reproducing head.

It is standard practice to pre-emphasise the high frequencies in recording to cancel losses due to gap width and demagnetisation (curve 2). It is not usually advisable to equalise beyond about 15db, so that the 15db point on the constant current curve gives the cut-off of the system. The fall in low note response cannot be corrected in recording as the lower frequencies carry much of the energy in speech or music, and overload might easily occur. For this reason, the low note loss is made good in the playback amplifier circuit (curve 3).

**Types of Magnetic Coating**

The magnetic characteristics of film and tape coatings can be divided broadly into three groups. The red coloured gamma ferric oxides, Fe$_3$O$_4$, of which the German C type tape is a good example, are magnetically fairly "soft," with a coercivity in the range 150 to 200 Oersteds and a remanence of 200 to 300 Gauss.
The black magnetite coatings can be made to have high remanence, 700-800 Gauss, and high coercivity, 300-400 Oersteds. The increased remanence gives about 10db higher output from a given head and tape speed, and the high coercivity maintains the top response to a higher frequency.

The third class of coating, also usually black in colour, uses a mixture of permanent magnet alloy, finely divided, and mixed with a binder for application to the surface of the film or tape. This material has a high coercivity, 350-550 Oersteds, which maintains a good high note response, with a remanence of 200-250 Gauss, giving a playback level comparable to the "soft" oxide materials.

Magnet Head and Response

Fig. 18 shows the construction of one of the ring type heads used for tape recording. It consists of two semi-circular stacks of high permeability laminations 4 mils in thickness, each-stack carrying a coil of 250 turns. The bottom gap is 12 mils and the top gap normally 1.5 mils; the coil has an impedance of 600 ohms at 1 kc/s. This type of head was originally used in a German "Magnetophon" with a "soft" oxide tape running at 77 cms. or 2.5 ft. per second.

The constant current response using the same head for playback is shown in the top curve of Fig. 19. The output level of 2mv at 1 kc/s was obtained from a signal recorded at 8db below overload, where overload is defined as the point where the input output curve departs from linearity by 1db.

Curve (2) shows the response at 18 in. per second with the gap reduced to 0.5 mil. Note the reduced output due to the lower tape speed. Curve (3) shows the constant current response at 7.2 in. per second.

Curve (4) shows the effect of changing to higher remanance and higher coercivity coating at 7.2 inches per second, and with the 0.5 mil gap. The high output of this coating eases the problem of maintaining adequate signal-to-noise ratio with the relatively narrow 2mm. track space available on 16mm. film. By taking the gap down to the physical limit of around 0.25 mil, a good high note response can be obtained at tape speeds as low as 5 in.

With H.F. erasing and biasing the tape noise should be 45 to 50 db below mean programme level. It is very difficult indeed to get system noise down to anywhere near this level, particularly when it is realised that up to 30 db of bias lift, relative to the 1 kc/s level, must be provided in the reproducing amplifier. Particular attention must be paid to the hum and thermal noise level at the grid of the first amplifier stage, and the playback head must be well screened from stray motor and transformer fields.

D.C. Bias

For guide track, made on ultra-portable recorders, D.C. biasing and erasing
may be reconsidered. With the best available coatings, and using low tape or film speed, D.C. noise may be reduced to 30db below mean programme level. This is comparable to the best 16mm. film recording, and is more than adequate for many purposes.

So we come round, full circle, to a system not very different in principle to that devised by Poulsen in 1898. With better magnetic materials, and the advantages of valve amplification, we find ourselves with a tool which may alter radically the whole complex business of sound film production.

REFERENCES
5. Draft B.S. CK(ACM)3152.

DISCUSSION
Mr. W. S. Bland: The added 60 db. dynamic range is not going to be of much use, because owing to audience noise level you cannot make use of what volume range is available on film.

Are you not risking trouble by putting an abrasive coating on the side of the film, which is taking all the wear?

Dr. Kolb: The coating can be placed on acetate or plastic base, but it is difficult on to the gelatine of the emulsion. The abrasive effect can be overcome by suitable construction of machines.

Mr. Tutchings: On the point of preemphasis of bass, the Americans have standardised on 5 db. bass lift when using speech and music as broadcast material. On film, we could probably go to 15 db. lift at 50 c/s. That would help in the noise problem in the play-back amplifier.

Mr. N. Leevers: On the question of volume range, one of the chief worries of the mixer is to get the recorded sound into the volume range at his disposal. Surely an extra 10 db. is of importance.

A Visitor: In the use of the thin tape, sometimes it was found that there was a transfer of the magnetic signals to the next layer, which caused an echo.

Dr. Kolb: Acetate base is about three times as thick as the tape, and we have no trouble whatever with transfer. 4

Mr. R. H. Cricks: What is the effect upon sound of wear of the magnet head?

Dr. Kolb: Wear may widen the gap, and the frequency range will be altered.

Mr. L. H. Bacon: What is the permanency of magnetic recording?

Mr. Tutchings: I have had no first-hand experience over about a year. But in the States they have had an endless loop running for several hundred thousand times, and the play-back did not reduce the output more than about 1 db. in several thousand playings.

Dr. L. E. C. Hughes: I made tests years ago, and we got 14,000 reproductions before the response fell 3 or 4 db.

Mr. B. Honri: With photographic recording in the studio, you have the sound negative, which is a sacred thing, carefully preserved until the picture is cut; here you have this record on magnetic material, with no method of transferring the negative key numbers.

Dr. Kolb: You can take a re-recording which can be handled, or you could put two magnetic recorders in parallel and preserve one track. As regards edge numbers, a new technique will have to be evolved to print numbers on the film.

Mr. A. W. Watkins: Did Dr. Kolb mention the width of the sound track?

Dr. Kolb: Our proposals to the B.S.I. for standardisation are to use on the negative for studio use a play-back head of 187 mils, a recording head of 200 mils, and a wiping head of 220 mils. If magnetic sound ever comes in the cinema, we shall try to use about 100 mils.

A Visitor: Are any facilities available for blooping a join?

Dr. Kolb: If the film is carefully joined a little magnetic paint makes it almost inaudible.

Mr. Leevers: The main difficulty with sync appears to be that a single machine can record and re-play its material to a surprising accuracy, but when two or more machines are to be matched up, the individual driving capstans have to be carefully adjusted. Using a single machine, I have found that we can run 800ft. of 16mm.—equivalent to 2,000ft. of 35mm.—on a complete take, and the music and effects band has been within half a second.
DEMONSTRATION OF SUB-STANDARD KINEMATOGRAPH EQUIPMENT

At a joint meeting of the B.K.S. Sub-standard Film Division with the R.P.S. Kinematograph Section and the Scientific Film Society, held on April 13, 1949, sub-standard kinematograph equipment was demonstrated.

DANSON PROJECTOR D23

W. Lacey*

The projector is built into two light alloy cases, one containing speaker and lengths of cable, and the other the projector mechanism and amplifier.

The mechanism is driven by a series-wound motor through the medium of a belt drive; the speed is kept constant by an electro-mechanical speed governor which can be varied from sound to silent. The projector operates on A.C. mains only and on voltages from 110-240 40/60 cycles.

The film is fed on a single sprocket (also used for sound scanning) then looped through the adjustable straight pressure gate, moved by a single cam-operated claw, and is then returned to lower side of single sprocket over sound and reader lens, out to receive spool. Framing is controlled by a small friction cam fitted at the rear of the claw fulcrum.

The sprocket is driven through the medium of a pair of helical gears, its motion smoothed by a spring loaded flywheel. The sprocket is also used as a scanning drum and has the P.E.C. fitted in the centre, with a sound reader and exciter lamp beneath it.

The projection lamp used is a 300 watt prefocus type, supplied from an internal transformer, or alternatively up to 750 watts with the aid of an outside transformer.

The amplifier employs a feed-back circuit, with an output of 9/10 watts, and has adjustable polarising control for the photo-cell. There are two tone controls, for bass and treble.

A central oil container for lubrication is situated in the top of the cabinet. The spool arms are suitable to carry spools holding 400 to 1,600ft.

Mr. W. Buckstone: Will the machine operate at silent speed?

The Author: Yes, a stroboscope indicates whether it is running at sound or silent speed.

Mr. W. S. Bland: What is the weight of the outfit?

The Author: The projector weighs 29 lbs., and the speaker 15 lbs.

*Danson Development Co.
DEBRIE DI6 PROJECTOR WITH ARC LAMP

T. A. Bartlett, M.B.K.S.*

The new British built "D.16" Arc Projector is built to suit conditions of projection by arc lamp. It is dismantled without tools within seconds for transportation, into three units. Unit construction is used throughout the machine, ensuring trouble-free servicing.

Incorporating all the well-known Debrrie features, including automatic oiling, it has in addition synchronous motor drive with heavy-duty gears, independent motor-driven forced draught cooling on gate and mechanism. The cooling unit and main drive are electrically interlocked; the gate cannot be illuminated unless blower and film drive are in motion.

Over one hour's operation of the Strong H.I. professional arc lantern is achieved without retrimming the carbons, which are electromagnetically stabilised, and automatically motor fed. The lamp has a 300mm. dia. frame-corrected mirror, and is supplied for A.C. or D.C. operation. The total consumption is 1,800 watts, and the light output is 1,300 lumens on A.C., and 2,600 lumens on D.C.

Excitation for the sound-head is obtained from a standard 75-w. exciter lamp. The negative feed-back amplifier delivers 26 watts into a twin channel loud-speaker, having crossover network and H.F. cellular horn. The equipment has adjustable stand and optical framing for picture centring.

Mr. Johnson: Are you running at 25 frames per second?

Mr. W. S. Bland: Have you a heat filter?

The Author: We were running at 25 frames per second with a synchronous motor.

The Author: No, there is a separate blower on the gate.

LONG-RUNNING PROJECTOR WITH MERCURY LAMP

P. J. Oram, M.B.K.S.†

A N Ampro "Premier 20" projector was demonstrated, having the following improvements making it particularly suitable for professional use:—

Compact-source Illuminant.—A 250-watt compact source lamp is capable of a light output in excess of that of a 1,000-watt filament lamp. Its rated life is 500 hours, effecting considerable economy in lamp replacement. In the adaptation of the lamp to the projector, the blower output is deflected to cooling simply the mechanism and not the lamp. A control box provides for different mains voltages, from 200/250 A.C., a voltmeter indicating the correct tapping. Provision is also made for adjusting the speed of the projector to 25 frames per second, to eliminate beat-frequency flicker.

The P.J. "Gramstand."—Designed to provide a solution to the problem of housing a gramophone in a convenient position for operating with a

*Cinétechnic Ltd. P.J. Equipments, Ltd.
projector. The unit is fitted with a 12in. turntable and magnetic pick-up. The desk withdraws from the case automatically when the front is opened. The concealed pilot light provides illumination to operate in the dark. Supply sockets are situated on the rear end of the unit, providing current distribution for other equipment. The exterior is acoustically lined to prevent drumming.

The P.J. "Nonstop."—This unit may be used separately or combined with the "Gramstand" to provide uninterrupted projection of up to two-and-a-quarter-hours on any type projector of the 16mm. gauge. The feed spool is supported on its own arm, attached to the stand. A slight impedance applied to the reel spindle prevents overrunning. The reels, of special construction, have a large centre diameter and overall diameter of 23in. The take-up arm attaches to the underside of the special stand and embodies a 110v. A.C. motor which is completely silent in operation. The drive to the spool is taken via a large diameter felt-lined clutch mounted on ball races and adjustable for tension. In the event of the clutch being overtightened to produce excessive tension on the film, the motor will fail to produce its full power so that it is impossible to damage film perforations in this way. 5,000ft. of film may be rewound in approximately ten minutes.

Mr. R. H. Cricks: Is the lamp mercury or mercury-cadmium?
The Author: Mercury.
Mr. W. Humberstone: What about the colour of the light?

M.R. TYPE 356 CINE-FLASH
H. K. Bourne, M.Sc., M.B.K.S., F.R.P.S.*

HIGH-SPEED kinephotography with speeds of 1,500 to 3,000 pictures per second demands an extremely high intensity of illumination. For example, using Kodak Super XX film at 1,500 pictures per second with an aperture of f/2.8, a light intensity of some 10,000 f.c. will be required on a normal subject, while with Kodachrome film ten times this intensity is necessary.

"Cine-Flash" equipment makes use of a mercury vapour lamp which

*Mole-Richardson (England) Ltd.
can be overloaded to give a considerable quantity of light. The light source consists of a specially designed Mazda mercury-cadmium compact source lamp with a continuous rating of 1 kW., special electrodes enabling it to be flashed at very high power for short periods. The light source is mounted along the axis of a 13 in. diameter metal parabolic mirror.

Two types of control gear are available; one is for operating a single lamp and the other for two lamps in series from a 200 to 250 v. D.C. supply. The control unit contains the following equipment.

(1) High voltage impulse striking circuit for igniting the arc. This will strike the lamp even when it is quite warm, so that re-striking delays are minimised.

(2) Automatic timing of the flash.

(3) Selection of a flash power of 3, 5 or 10 kW. for 3, 2, or 1 seconds respectively.

(4) Switch for operation of the flash and a socket for remote operation—e.g., from a switch built in a camera.

(5) Paralleling socket to enable several units to be connected for simultaneous operation.

In order to avoid stroboscopic effects, the lamp must be operated from D.C. For cases where no D.C. is available, a separate 3-phase rectifier has been designed to operate the unit from an A.C. supply.

Dr. D. Ward: What is the effective colour temperature of the light?

The Author: An exact value of colour temperature cannot be given as the lamp produces a discontinuous spectrum, but practical tests show that the lamp gives good results with Kodachrome Daylight film.

Mr. R. H. Cricks: It would of course be impracticable to use condensers to reduce the load on the mains?

The Author: The condenser required to produce a long flash similar to that given by this equipment would be impractically large.

Mr. J. Dynes: What is the life of the lamp?

The Author: The life under normal continuous operating conditions is 500 hours. It should produce many thousands of flashes.

“Brook” Continuous Projector

H. S. Hind, A.M.I.E.E., M.B.K.S.*

The “Brook” Projector comprises a cabinet approximately 7 ft. high × 3 ft. × 3 ft. incorporating a 16mm. sound projector with a continuous loop attachment and arranged to project a picture measuring 24in. × 18in. With this size picture and employing rear projection, the quality and definition is very good even in daylight.

The unit is started by means of a press button and can be arranged to stop automatically when the film has been shown once, or, alternatively, can operate continuously until stopped by means of a press button.

The essential equipment in the model demonstrated includes a modified Victor projector and a continuous loop attachment capable of handling up to 1,600ft. of 16mm. film. This attachment is driven, thus relieving the film of strain, and it is quite common to project copies of films 500 or 600 times before they are considered unsatisfactory for further use. Arrangements are made for the

*Sound Services, Ltd.
unit to stop automatically in the event of a film break and the standard Victor trips have also been retained. Special arrangements to obtain adequate cooling have been made and the air temperature in the cabinet rises only 7° F. after the unit has been running continuously for four hours.

This projector has been designed to show films in places where space is limited, darkening impractical and where continuous projection is desirable. Such examples as exhibitions, stores and showrooms and places where people wait are some of the obvious applications.

A 16mm. model of the Levers-Rich track reader and the Runkel 16mm animated viewer were also demonstrated (see June issue of this Journal, pp 191, 192."

**BOOK REVIEWS**


This manual is based on a translation of *Le Cinéma d'Amateur*, but has been revised and partly re-written by Arthur Pereira. As the manual which it claims to be, it has no counterpart at the present time and is by far the most comprehensive book of its kind yet published.

The subject matter ranges from the artistic aspects of film making to the technicalities of polarised light. The script, the camera, lighting, editing and the projector all have their place. Each subject is dealt with in a clear and straightforward manner with a wealth of technical information. Nothing seems to have been omitted; colour, sound and cartoons are all there and wherever an illustration is needed, it has been provided.

Although this book has been produced primarily for the amateur, it can well find a place on the bookshelf of the professional and most certainly should be owned by every student and learner in the industry.

**H. S. HIND.**

**HOW TO FILM**, by G. Wain. *Focal Press. 6s. net.*

This book reminds me of those conducted charabanc tours through the countryside. As we dash onwards the conductor throws out interesting comments upon whatever happens to come into view (within less than a dozen pages we glance rapidly at Shot Timing, Shot Transitions, Composition, Building Interior Sets, Lighting with Photoflood, Colour Schemes for filming in Colour, back to Artificial Lighting and then a few words on Make-up).

Sometimes the conductor's remarks are a little incomprehensible to anybody who has not been that way before (e.g., we are told that camera claws have a *sideway* motion); sometimes parts of his remarks are blown away by the wind (all reference to variable sector shutters is missing from the section on fading techniques); now and then he trots out traditional phrases rather than useful information (we are given the stock remarks about correction and contrast filters, but no description as to how they differ in principle); occasionally the man with the megaphone gets mixed up ("you can use positive film and develop it at home by the reversal method to a negative"); and now and then he even strays a little from the truth.

But on the whole, we are given a rousing trip through the country of amateur cinematography and, provided he is prepared to buy a few local guide books later on, the traveller will not find that his journey has been wasted.

**GEORGE H. SEWELL.**

**HOW TO SCRIPT AMATEUR FILMS**, by Oswell Blakeston, *Focal Press. 6s. net.*

This is the second in the new Focal Press Cinebook series. Because the author is dealing with a single subject, he has not attempted to cram too much into 145 pages, but has been able to deal with the subject in an ordered and reasoned manner.

We are first told "Why a Script" and something of the screen's basic material. Then shots are considered, first as single entities, later as parts of sequences. The balance of the whole film is discussed: the different types of shot and angle: scenes are built into sequences and sequences into films. The writer discourses upon captions, music, sound, commentary and dialogue.

This volume should be of considerable benefit to the amateur who takes his hobby seriously.

**GEORGE H. SEWELL.**


An instructive booklet for the tyro in film-strip projection, relating chiefly to its use in churches, youth clubs, etc.
TECHNICAL ABSTRACTS

Most of the periodicals here abstracted may be seen in the Society's Library.

FILM COLLECTION PROGRAMME.
Positive paper rolls of motion pictures, submitted for copyright registration between 1897 and 1917, have been successfully copied on to celluloid, by means of optical printing.
R. H. C.

CORROSION EFFECT ON STAINLESS STEELS OF RAPID FIXING BATHS.
The use in rapid fixing baths of ammonium chloride causes stainless steel equipment to be attacked. As a result of tests, it is recommended that ammonium sulphate be substituted. The use of molybdenum-containing stainless steel is advisable.
R. H. C.

MOTION PICTURE PHOTOGRAPHY AT TEN MILLION FRAMES PER SECOND.
An optical system is described by which a rectangular image can be dissected into a very narrow strip across the width of the film. A 24in. length of 16mm. film, carried within a drum, is driven at a rate of 400ft. per second, producing exposures of a brevity limited only by the resolving power of the film, but estimated at one-ten-millionth of a second. By means of a similar optical system, the image can afterwards be reconstituted upon normal 16mm. film with, however, very poor definition. Reference is made to a similar system patented by Scophony, Ltd.
R. H. C.

TREND CONTROL IN VARIABLE AREA PROCESSING.
Cross-modulation testing using a single sideband oscillator and a phase meter is described. The method indicates from a single print density whether the print is optimum, too light, or too dark.
N. L.

VOLUME COMPRESSORS FOR SOUND RECORDING.
Establishing first a theoretical basis for the use of volume compression, the paper surveys the theory and practice of known methods in the widest sense, and without allowing detailed consideration of any particular circuit to obscure the careful reasoning.
N. L.

WIDE TRACK OPTICS FOR VARIABLE-AREA RECORDERS.
The optical system designed to adapt certain RCA recorders to double width push-pull track consists of a barrel containing the physical slit and final optics, of which some details are given.
N. L.

SOUND FILM RECORDING TUBES.
In the NGD recording tube, the discharge is in a nitrogen-helium mixture; the tube operates at a voltage of 220 and a current of 10 ma. It has a very wide working range, permitting the use of noise reduction.
R. H. C.

SOME DISTINCTIVE PROPERTIES OF MAGNETIC-RECORDING MEDIA.
Different magnetic tapes require a different bias for optimum results; excessive bias tends to attenuate the high frequencies. Measurements are given concerning the influence of poor contact of the playback head on the tape, showing that the high frequency response is greatly reduced even for distances as low as 0.5 mil. D.C. noise is found to be a measure of uniformity of the magnetic layer, and of "modulation noise," which occurs with the H.F. bias method only when a signal is present.
O. K. K.

EFFECT OF TELEVISION ON MOTION PICTURE ATTENDANCE.
A questionnaire addressed to 550 owners of television sets showed a marked reduction in cinema going as a result of television.
R. H. C.
THE COUNCIL

Meeting of July 6, 1949

Present: Messrs. L. Knopp (Vice-President), P. H. Bastie (Hon. Treasurer), E. Oram (Hon. Secretary), F. G. Gunn, R. B. Hartley, B. Honri, T. Howard, R. E. Pulman, I. D. Wratten, R. H. Cricks (Technical Consultant), and W. L. Bevir (Secretary).
Deputy Vice-President.—An appointment to this office was deferred until the September meeting.

Published Papers.—Authority was given to the Journal Committee to approve arrangements for the publication in textbook form of papers which had appeared in the Society's Journal.

B.S.I.—Mr. W. M. Harcourt was appointed the Society's representative on the B.S.I. Film Processing Committee.

Accounts.—A cash statement for the first half of 1949 was approved.

Library Committee.—It was agreed that all expenditure be referred to Council for approval.

Provincial Lectures.—It was determined that five papers be delivered before the Newcastle and Leeds Sections during the next lecture session. In addition, Newcastle could organise visits provided no expenses to the Society were involved.

Film Production Committee.—Mr. Honri reported that Mr. W. S. Bland had been co-opted to the Committee. Next season's lecture programme would consist of four joint papers with the A.C.T., one with the B.F.A., and one Society paper.

Society Papers.—Details of the forthcoming Society papers, reported by Mr. Knopp, were approved.

Annual General Meetings.—Messrs. Watkins, Knopp, West, Oram and Wratten were appointed to consider a proposal to hold the annual general meetings of the Divisions and of the Society on the same day, followed by the Presidential address.

Discussions.—The Papers Committee were asked to consider Mr. Gunn's proposal, that discussions after lectures be opened by a person well acquainted with the subject matter, who had had a preview of the paper.

Award of Medals.—Mr. Wratten reported that an anonymous member of Council had once again offered a medal to be presented to the author of the best paper delivered during the past President's term of office.

EXECUTIVE COMMITTEE

Meeting of July 6, 1949

Present: Messrs. L. Knopp (Vice-President), P. H. Bastie (Hon. Treasurer), E. Oram (Hon. Secretary), I. D. Wratten, W. L. Bevir (Secretary), and Miss S. M. Barlow (Assistant Secretary).

Elections.—The following were elected:
Hugh John Brough (Associate), Long Range Weapons Estb., Adelaide.
Godfrey Dennis Wairen (Associate), M.O.W., Film Unit, Wellington.
Norman Frank William Rumball (Associate), Ilford, Ltd.
Frank Henry James Knight (Member), C.O.I.
A. C. Eales-White (Student), R.A.F. Cinema Corporation.
George Blackwell (Member), A.B.P.C., Ltd.
Stanley Horace Wray (Associate), Ministry of Supply.

Transfers.—From Studentship to Associateship:
Roy Alan Fletcher,芭芭拉·利莲·克洛西,
Reginald Hassard Mason, Esat Ozgul.

From Hon. Membership as a U.N.E.S.C.O. Scholarship holder, to Corporate Membership:
E. van Moerkerken.

Resignation.—The resignation of Derrick Edmund Timmins was accepted with regret.

THEATRE DIVISION

The Annual General Meeting of the Theatre Division was held on April 24, 1949. The Chairman, Mr. S. B. Swingler, presided, and submitted the following report.

Chairman's Report

Membership.—The total of 439 Members of the Division represents an increase of 52 over last year. It is made up:—275 Members, 152 Associates and 12 Students. This figure can still be extended very considerably and I ask all Members of the Theatre Division
to do their utmost to introduce at least one Member during the coming year, and to promote in every possible way the interests of our Division.

Activities.—Members of the Theatre Division have been very active on the Committees of the British Standards Institution and have put forward the views of this Society on matters vitally affecting projectionists and theatre engineers, such as screen brightness, release prints, transit cases, auditorium safety lighting, spools, screens, slides, lenses and sprockets.

Your Committee feels that it has been fully justified in the policy adopted, through the Papers Sub-Committee, in regard to the lecture programme. This is evidenced by attendance at the demonstrations of modern equipment held during the past session. This policy will be continued during the next session, and subjects of immediate interest, such as large screen television, will be brought to your notice.

Representation.—Although the Theatre Division is no longer responsible for the running of the Provincial Sections, it has representation on the main Branches and Papers Committees, and members of the Sections, whose interests are concerned with the Theatre Division, have been amply catered for by the Papers Programmes recently completed.

Our Members are fully aware of the advantages offered by the B.K.S. Library and they have not only used its facilities, but have contributed generously to the substantial mass of technical books and periodicals now available. It is hoped that Divisional support to this educational effort will grow and that our Members will use the facilities in ever increasing measure.

Votes of Thanks.—May I take this opportunity of thanking all Members of the Theatre Division Committee and Sub-Committees for their continued zeal and their valuable work during the past year.

Your Committee has always welcomed suggestions from the Membership on any matters of interest to them and I personally hope that you will all exercise your right to put forward suggestions for the good of the Division.

Film Mutilation

Mr. A. E. Ellis enquired as to the position of the proposed Film Mutilation Brochures. Mr. Leslie Knopp reported that the B.K.S. had suggested that, rather than publish these brochures, it might be preferable to issue a booklet dealing with Safety Film.

A vote of thanks to the Chairman and Committee, proposed by Mr. J. Gregory, was carried by acclamation. Mr. Knopp conveyed the appreciation of the Council to the Officers and Committee.

SUB-STANDARD FILM DIVISION

Mr. H. S. Hind, presiding at the annual general meeting of the Sub-standard Film Division on April 13, 1949, submitted the following report:

It is gratifying, in looking back over the session which is now ending, to be able to report definite progress of no mean order. The membership of the Division has increased by 55 to a total of 239, but what is far more important, the attendance at meetings has about doubled. This is a most healthy sign and we look forward to still better attendances at our meetings next year.

Meetings.—One reason for this improvement is probably the change in venue of our meetings, but I believe that the hard work put in by your Committee in arranging the papers has been the major factor. It has been, and will continue to be, our aim to arrange papers which are of the widest interest to members of the Division, but we ask for and will welcome any suggestions which may be put forward for consideration.

Standards.—A new British Standard entitled "16 mm. Cinematograph Sound-on-Film Release Prints," shortly being issued, was originally drafted by a Sub-Committee of this Division and was accepted by the British Standards Institute with only minor changes. There are now in existence a number of B.S.I. Committees considering various matters of interest to 16 mm. users, from 16 mm. spools and cans, on the one hand, to performance requirements of projectors on the other. The Society is fully represented on all these Committees.

Finally, I wish to express my personal thanks to all Members of the Sub-standard Film Division Committee for their efforts and support during the past year.

Election of Officers

The Chairman announced the election and appointment of officers and committee (see p. 202 of the June issue of this Journal).
Mr. R. Pulman proposed a vote of thanks to the Chairman and members of Committee, which was carried by acclamation. The thanks of the Division were expressed by Mr. W. Buckstone to the G.B. Picture Corporation, for the use of the theatre, and to Mr. J. S. Abbott and his staff.

**FILM PRODUCTION DIVISION**

The Annual General Meeting of the Film Production Division was held on April 27, 1949. The Chairman, Mr. A. W. Watkins presided.

**Chairman's Report**

The Council has appointed Mr. Baynham Honri as Chairman of the Division for the ensuing year.

*Membership.*—An increase of 93 in the Division during the year has brought total membership to 470. There are 53 new Members, 26 new Associates and 14 new Students.

*Activities.*—The Division has had a very successful year. In addition to four Divisional meetings and the visit to the A.B.P.C. Studios, five joint meetings have been held with the A.C.T. and one with the Television Society. Proposals for papers would be welcomed from Members.

In conclusion, may I express my appreciation to the members of the Committee for their services.

**Discussion**

Mr. Norman Leivers objected to the fact that no paper was to follow the meeting, thus resulting in a small attendance.

Mr. F. Bush requested that better means be taken to draw the attention of Members to fixtures and Mr. T. W. Howard suggested that the British Society of Cinematographers be approached for a paper on camera work.

**Vote of Thanks**

Mr. Norman Leivers proposed a vote of thanks to the Chairman and Committee, which was carried by acclamation.

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INTERNATIONAL SCIENTIFIC FILM ASSOCIATION

The Third International Scientific Film Congress will be held in Brussels from 30 September to 5 October, 1949. A scientific film festival will include four public sessions with films dealing with research, education, scientific documentary, and general scientific films. In addition, there will be four sessions intended for specialists.

The Scientific Film Association of Great Britain would appreciate information regarding privately produced films which would be suitable for inclusion.

POLYTECHNIC STUDENTS

We are advised that several former students in the Polytechnic two-year course in kinematography, having served their term of military service, are seeking employment. Members able to offer suitable employment are invited to communicate with the Editor, who will be pleased to supply names and addresses of the students concerned.

PERSONAL NEWS of MEMBERS

Members are urged to keep their fellow members conversant with their activities through the medium of British Kinematography.

R. M. CRAIGEN, formerly of Realist Film Unit, has been appointed chief cameraman and technician to the newly formed British Transport Film Unit.

ANTHONY HINDS is probably the first student of the two-year Polytechnic cinematography course (now discontinued), to become a producer: he is producing for Exclusive Films.

WILLIAM T. MOYLAND, F.R.S.A., F.R.G.S., has been appointed exclusive representative for DeLane Lea Processes, Ltd., in India, Pakistan, Ceylon, Burma, and the Far East.

H. K. PAUL is in charge of “Electronics Centre,” 83, Piccadilly, W.I, a showroom opened jointly by Cinema-Television, Ltd., and Dawes Instruments, Ltd.


Killed August 22, 1949

With much regret we have to record the death of Captain West, for eight years President of the Society, who was killed in a mountaineering accident near the Matterhorn.

An obituary notice will appear in the September issue of this journal.

ARThur Pereira FRPS, MBKS

is the Editor of the most comprehensive book available in the English language on the subject of Sub-Standard Cinematography. Never before has the technique of the 8 mm., 9.5 mm. and 16 mm. cine camera been so fully explained. Never before has the amateur — or professional — been presented with so clear and detailed an exposition of the principles underlying the art of sub-standard cinematography.

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ALBERT GILBERT DIXON WEST

Killed August 22nd, 1949

Members will have heard with deep regret of the death of Captain A. G. D. West, as a result of a climbing accident in Switzerland. It is not my purpose here to record his considerable achievements in the fields of science and technology, but to draw attention briefly to the work which he has done for our Society. My excuse for doing so is that we were closely associated in the operation of the B.K.S. for a number of years.

Captain West was the second President of our Society. It is true to say that he was personally responsible for much of its progress. He had very clear ideas as to the work the Society should do, and he worked with energy and enthusiasm to put these ideas into effect. The Constitution of the Society embodies most of his plans. No one can read this Constitution without thinking of West, who gave so freely of his time and abilities to ensure the success of the B.K.S.

By his death the Society has suffered a great loss. I believe, however, that we can all to some extent repay the debt we owe to the memory of Captain West by keeping active and alive the Society which he loved so well.

Members will wish me to extend to Mrs. West, his daughter and his sons, our heartfelt sympathy in their sad loss.

I. D. WRATTEN.

A. G. D. West was educated at King's School, Canterbury. After taking his M.A. at Cambridge, with distinction in mathematical tripos, he gained a B.Sc. in London University, and then returned to Cambridge as a research student in the Cavendish Laboratory—birthplace of atomic fission.

During the 1914/18 war he was wireless experimental officer in the Forces, and afterwards joined the newly formed B.B.C., where from 1923 to 1929 he was head of research. His assistant during this period was Mr. Baynham Honri (now of Ealing Studios) and he was responsible for much original research in radio transmission and acoustic measurements. Capt. West left the B.B.C. to take a similar position with the Gramophone Company, and in 1932 entered the film industry as chief recording engineer of A.T.P. Studios, Ealing.

The following year he was appointed technical director of Baird Television, Ltd., where he was responsible for some of the first demonstrations of high-definition television. He retained this position when, under the title of Cinema-Television, Ltd., the company became associated with the Gaumont-British organisation.

He was among the group of technicians who, in 1931, formed the British Kinematograph Society, and became a member of the Executive Committee, which position he held until, in 1938, he became second President of the Society. For his invaluable guidance during the war years the Society owes him a great debt.

Capt. West was keenly interested in the educational work of the Society; he was chairman of the Education Committee, and had employed a number of former students.
The Royal Photographic Society in 1939 conferred its Fellowship upon him. In 1946 he was elected one of the first fifteen Fellows of the B.K.S., and in the following year the Honorary Fellowship was conferred upon him.

In 1947 he was elected Chairman of the Electronics Group of the Scientific Instrument Manufacturers' Association, and in 1949 became Vice-president of the International Television Committee.

At the early age of 52, Capt. West was killed while mountaineering in the Alps, accompanied by his elder son. At the funeral service held at Shortlands, Kent (where he and Mrs. West were married) the Society was represented by Messrs. A. W. Watkins, P. H. Bastie, B. Honri, R. B. Hartley, P. G. A. H. Voigt, R. H. Cricks, and W. L. Bevir.

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COUNCIL APPOINTMENTS

At the meeting of the Council held on September 7, 1949, the following appointments were made:

Mr. EDWIN ORAM to be Deputy Vice-president.
Mr. REX B. HARTLEY to be Hon. Secretary in place of Mr. Oram.
Mr. MARCUS F. COOPER co-opted Member of Council in place of Capt. A. G. D. West.

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LECTURE PROGRAMME—AUTUMN, 1949

Meetings (except that of Dec. 1) to be held at the Gaumont-British Theatre, Film House, Wardour Street, London, W.1, commencing at 7.15 p.m., Sundays, 11 a.m. Meetings of the Substandard Film Division in the G.B. Small Theatre.

SOCIETY MEETINGS

Oct. 5 “A SMALL CONTINUOUS PROCESSING MACHINE FOR EXPERIMENTAL WORK,” by G. I. P. LEVENSON, Ph.D., B.Sc., M.B.K.S.

Nov. 2 “THE HEATING OF FILM AND SLIDES IN PROJECTORS,” by HUGH McG. ROSS, M.A.

Dec. 1 “VISUAL AND OTHER AIDS TO INSTRUCTION,” by H. E. DANCE, A.M.I.C.E., M.B.K.S. (Joint Meeting with the Institution of Engineering Inspection, to be held at 6 p.m. at the Royal Society of Arts, Adelphi, London, W.C.2.)


THEATRE DIVISION MEETINGS

Oct. 9 Discussion Meeting.
Dec. 11 “Modern Equipment—Part III. Premier Accessory Apparatus,” by R. ANTHONY RIGBY.

SUB-STANDARD FILM DIVISION MEETINGS

Oct. 12 “The Film in Relation to Agricultural Engineering,” by D. HARDY.

JOINT MEETINGS WITH THE A.C.T.


Programmes of Provincial Sections are not available at the time of going to press.
CLOSED SEQUENCE CONTROL SYSTEMS


(Read by Mr. Pearson to the British Kinematograph Society on March 2, 1949)

I. INTRODUCTION

"CLOSED sequence control" is a general term which is being adopted to cover the operation of the systems generally known as "servomechanisms," "remote power controls," "regulators," "automatic controllers," and "data transmission systems," to give a few names which are fairly well known. The mere existence of such a wide variety of names tends to make many people think that they must refer to as many entirely different items of equipment, each behaving in a manner peculiar to itself.

The purpose of this paper is to show that all the above-named systems must obey certain fundamental principles, which are capable of mathematical expression and analysis, whatever physical form each system may have. The adoption of a single title which will cover all control systems included in this category is therefore justified, and the first part of the paper will be devoted to an explanation of the reasons why "closed sequence control systems" has been adopted as the generic name.

II. GENERAL CONSIDERATION OF A CONTROL SYSTEM

For the purpose of this paper, a "control system" will be taken to mean an assembly of equipment needed to enable the physical behaviour of a given 'element' to be controlled in accordance with the behaviour of another 'element,' which may be remotely situated with respect to the first.

Figs. 1 and 2 have been prepared to show the operation of two types of control system which come in the category of "closed sequence systems." They exhibit certain fundamental features common to both, although their physical forms are quite different. The diagrams are purely schematic.

Fig. 1 shows the action of the centrifugal speed governor commonly used on steam turbines, designed originally by James Watt, and intended to maintain the turbine speed constant, irrespective of changes in the load.

The sequence of operations is obvious, since if the turbine speed departs from its required value then the resulting change in the radius of rotation of the fly balls causes oil pressure to be applied to the steam flow control valve, causing the turbine speed to be brought back to its desired value. The closed aspect of this sequence is brought about by the presence of the centrifugal governor, which is continually comparing the actual speed of the turbine with its desired speed and thence causing a corrective action to be initiated whenever an error in speed is present.

*Military College of Science
Essence of "Closed Sequence" Systems

This continuous comparison of input and output quantities, by means of a suitable "difference element" (in this case the governor) and then using any difference between them (which is the error in the system) to bring about a corrective action, is the essential feature common to all closed sequence systems, and for this reason they are often referred to as "error actuated" systems. A "servo-mechanism," by modern definition, must always fall in this category, although the term is sometimes applied to systems in which power amplification occurs alone, without the accompaniment of a closed sequence of operations.

Fig. 2 shows a possible way of controlling the temperature of a bath of liquid at a required value by measuring its actual temperature continually and obtaining, by means of a suitable "difference element," any error in temperature in the form of a voltage which is used to operate the motor controlling the amount of resistance in series with the immersion heater. Although this system is physically quite different from the speed control system shown in Fig. 1, nevertheless it obviously makes use of a closed sequence in order to drive the motor by means of an error signal, in such a manner as to reduce the error.

Further examples of closed sequence systems could be quoted, and two elements will always be found within them, namely, the difference element (in which the sequence is closed), and a suitable motor arranged to control the output quantity. Most systems contain, in addition, an amplifier, but it is not always essential. The physical forms of these three elements can be realised in many different ways.

Essence of "Open Sequence" Systems

It seems pertinent, at this stage, to examine the basic behaviour of a control system in which the sequence is open, which means in effect that the difference element is omitted so that the system is no longer error-actuated.

As an example, suppose that in place of the centrifugal governor the steam control valve of Fig. 1 is provided with a dial, graduated in turbine speed, say r.p.m., and a handle fixed to the valve spindle carries a pointer which moves over the dial. The dial graduations must be determined initially as a result of a calibration run made under constant conditions of load, steam pressure, etc., hence the turbine speed will be maintained at the value subsequently set on the dial only so long as the calibration conditions are maintained. Any error in speed is allowed to persist and has no power to bring about a corrective action.

It would not be correct to state, categorically, that open sequence control systems are useless at all times, but it is certainly correct to say that when precise control is needed, especially under conditions which are likely to alter, then closed sequence technique must always be resorted to.

However, at this stage a warning note must be sounded, namely, that the existence of undesirable features such as time lags in elements, friction, back-
lash in gears, etc., tends to produce errors which are sometimes very difficult to eliminate, or minimise sufficiently. In addition, the mere act of closing the sequence tends to produce a condition of self-oscillation in the whole system, which at times can be most troublesome.

III. OPERATING CHARACTERISTICS OF A CLOSED SEQUENCE SYSTEM

It would, perhaps, be most apt in this paper to choose a practical closed sequence system of particular interest to those concerned with kinematographic work, but as the authors are not in a position to make such a choice the system which will be dealt with is one which has almost universal application, and which presents some of the most difficult practical problems.

The system which will be considered is the "position control system" which can be described briefly as the control of the linear or rotational displacement of a mass, in such a way that its movement reproduces, as faithfully as possible, that of the so-called "input element" which is usually remotely situated with respect to the controlled mass. Moreover, the power developed in the movement of the "input element" is usually considerably less than the power needed to move the mass, which in general terms is known as the "output element." In this case a suitable power amplifier must be included in the closed sequence of operations.

Position Control System

Fig. 3 shows a position control system in which the controlled mass, or output element, is a heavy gun on a rotating mounting, and the input element is a shaft whose rotational displacement is a measure of the angular bearing which is required to be reproduced at the gun mounting. The input element is rotated by a few ounce-inches of torque, while the gun requires 3 or 4 horsepower to move it. In addition the angular error between these input and output elements must not exceed a few minutes of arc, under all circumstances.

Another example of remote position control which must have a wide
application is shown in Fig. 4, namely the Magslip data transmission system used to reproduce the movement of the pointer on the "transmitter" dial by the "receiver" dial pointer situated at a distant station. In this system the power required to move the transmitter and receiver pointers is approximately the same, hence a power amplifier is not necessary, except in cases where the distance between the two is so great that the signal reaching the receiving element is unduly attenuated as a result of losses in the connecting wires.

At first sight this type of position control does not appear to come within the category of closed sequence systems, but, in fact, an electro-magnetic torque is produced whenever the receiver pointer is not in alignment with the transmitter pointer, acting in such a way as to reduce the misalignment, hence the system is self-aligning as long as the two elements are excited by the applied A.C. voltage.

Accuracy of a Position Control System

It has already been stated that the gun shown in Fig. 3 must follow the movement of the input element shaft with an accuracy of a few minutes of arc, and this requirement leads to a consideration of the static and dynamic accuracy of a position control system.

The static accuracy attained refers to the condition when the input element moves to a new position and then stops, in which case the output element is required to follow and then stop in such a position that the static misalignment between the two elements is within specified limits.

The dynamic accuracy, on the other hand, refers to the condition in which the input element is changing its position continually (either at a steady or a variable rate), hence the output element must also move continually so as to maintain the specified limits of alignment. This state of affairs brings out a fundamental feature of all closed sequence control systems, namely, the fact that since the motor which drives the load is an error-actuated one it can only continue to drive under dynamic conditions if an error is continually present.

This defect can be eliminated, or at any rate reduced to very small proportions, by incorporating certain devices within the control system. Nevertheless, a very high accuracy is not always needed, and clearly it would be a waste of effort to make use of a highly refined and accurate system when a simple one is all that is needed. The operating characteristics of some position control systems will now be described.

Discontinuous Control Systems

Systems in this category fall into one of two classes, generally known as
"on-off" and "multi-position" controls. The "on-off" system consists essentially of an arrangement whereby the motor exerts a constant force on the load whenever there is a misalignment between the input and output elements, irrespective of the magnitude of the error, while the direction of application of the correcting force must, of course, be made to depend on whether the error is positive or negative.

Fig. 5 shows how an ideal "on-off" system would operate, while Fig. 6 refers to the behaviour of such a system in practice, since the complete elimination of the dead zone is almost impossible. Hence a finite error must exist before any corrective action is applied to the output element.

If the input to an on-off system is changing continually a condition known as "hunting" is generally set up, since the control action is not switched off until the error is nearly zero, hence the inertia of the load tends to cause the output element to overshoot its required alignment position, thereby switching on the control action again, but in the opposite sense. This state of affairs is intolerable whenever precise position control is required, but with a system in which the input element moves only intermittently, and then reasonably slowly, on-off control may well be capable of providing the required accuracy and its possible use should never be overlooked. The steering of a torpedo, for example, is done with an on-off system, and the results are perfectly satisfactory.

An obvious development of on-off control is to provide a series of steps in the control action as shown in Fig. 7 so that it increases by discrete amounts with increasing misalignment, up to the maximum amount available. This modification is often able to reduce "hunting" very considerably.

Continuous Control Systems

By replacing the discrete steps shown in Fig. 7 by an infinite number of steps we arrive at a system in which control action is proportional to misalignment (up to a certain limit, of course) and this is obviously a big step towards the realisation of more accurate position control, particularly under dynamic conditions. Fig. 8 shows the relationship between control action and error, and in the case of the position control of a mass shown in Fig. 3 it is usual to make the torque which is exerted by the motor on the load proportional to the error.

It will be seen from Fig. 8 that the slope of the graph is a measure of the amount of control action (which is the motor torque in a position control system) exerted per unit error, and this parameter is generally known as the "stiffness coefficient" of the system and will be denoted by the letter k.
Clearly, an increasing stiffness coefficient means a steeper graph, and in the limit we will get full torque exerted whenever the error is not zero, so we are back to a simple on-off system in which \( k \) must be equal to infinity. An increase in \( k \) will therefore tend to increase the tendency towards instability, or "hunting," for reasons already given.

**Stability of a Position Control System**

In Fig. 3 will be found a differential equation which expresses the behaviour of the load in response to a given input \( \theta_0 \) which in this case is the angular displacement of the shaft which constitutes the input element. This equation shows that whenever this shaft is moved to a new position then the gun mounting shaft will run into alignment (thereby making \( \theta_0 = \theta_1 \)) in one of various ways, which are illustrated graphically in Fig. 9. This shows the so-called "transient response" of a position control system to an instantaneous displacement of the input shaft through a given angle \( \theta_1 \) (which in this case is unity).

The type of damping exhibited by a particular system depends on the relationships between the quantities \( J \), \( k \), and \( f \), defined in Fig. 3, and these are shown in Fig. 9, corresponding to under-damped, critically damped, and over-damped conditions. Apart from critical damping, which is uniquely specified by the relationship \( f^2 = 4kJ \), the degree of under- or over-damping is dependent on the relative magnitudes of \( f \), \( k \), and \( J \), and it must suffice to state that in the event of a system exhibiting an oscillatory response, the oscillations will die away rapidly provided \( f/J \) is large, which is achieved by arranging to have either a large amount of viscous friction \( f \) (or its equivalent) present in the system, or a small inertia \( J \).

Fig. 9 is essentially an expression of static conditions, since \( \theta_1 \) having changed suddenly, then remains the same, while Fig. 10 is an expression of dynamic conditions, in which the input shaft starts to turn suddenly at a rate \( \lambda \), hence the displacement of this shaft after a time \( t \) has elapsed is \( \lambda t \). Since the system is error actuated a misalignment must exist even when the transient response has died away, in order to keep the motor running, and this is the "steady state" error, or "dynamic lag" shown in Fig. 10.

It can be proved analytically that the dynamic lag is equal to \( f \lambda / k \), hence in order to make it as small as possible the system should be designed to have \( f \) small or \( k \) large. If \( f \) is small, however, the system becomes lightly damped, for a given value of the inertia \( J \), hence the requirements for good damping and small dynamic lag are conflicting. It is true that in theory the dynamic lag can be reduced by increasing the stiffness coefficient \( k \),
but it is not always feasible to do this, and in any case, we have already seen that a large value of $k$ tends to cause "hunting," and it is usually necessary to arrive at a compromise.

Good stability and negligible dynamic lag can be realised by arranging for the torque exerted by the motor to be proportional to the error plus its rate of change plus its time integral. Since the differentiation and integration with respect to time can be carried out fairly easily and reasonably accurately by means of electrical circuits, we generally find that high performance position control systems are mainly if not wholly electrical. In order to achieve a system with a very small inherent time constant, the designer must try to produce a transient response to a sudden input displacement such that the output will overshoot its final steady value at least once.

IV. TYPICAL ELEMENTS USED IN POSITION CONTROL SYSTEMS

Since we have been dealing with position control systems we must look at methods which are available for obtaining the positional misalignment between

The majority of position control systems involve the angular displacements of input and output elements, and we will confine our attention to difference elements designed to measure the angular misalignment between two remotely situated shafts. In practice there are many different types, and space will permit only three to be described briefly. They are all electrical, since an electrical link offers many advantages.

Electrical Difference Elements

(i) D.C. Potentiometers.—Toroidal potentiometers should be used, to permit continuous rotation, one being rotated by the input shaft and one by the load shaft. They are connected in a bridge circuit so that when the input and output shafts are in alignment the bridge is balanced, but whenever an error occurs a D.C. voltage is developed in the circuit whose sign determines the sense of the error, and whose magnitude is proportional to the error. This voltage is then suitably amplified (if necessary) and made to control the motor which drives the load shaft. If required, such devices as "feedback stabilisation," "phase advance," etc., can be incorporated in order to obtain a high performance from the system.

The main disadvantages attached to the use of this system are the extra coulomb friction associated with the rubbing of the potentiometer brushes on their windings, eventual wear on brushes and windings, and the dis-
continuities resulting from the individual wires in the windings. However, the Germans used specially designed potentiometers in many control systems, and achieved excellent results.

(ii) Magslip 3-element chain.—This is a device for obtaining the misalignment initially as an electrical signal which is then converted into the rotational displacement of the rotor of the so-called "Magslip hunter" connected electrically to Magslip transmitters rotated by the input and output shafts. Fig. 11 shows how these three elements are used in a position control system which employs an hydraulic motor to drive the load; the rate of flow of oil to the motor being controlled by means of a lightly loaded pilot valve whose piston is connected to the rotor of the "hunter." This rotor is displaced by an amount proportional to the misalignment between the input and output shafts, for small values of the misalignment.

(iii) Magslip Coincidence Element.—When a position control system is wholly electrical, including the motor, it is usually most convenient for the misalignment to be produced as a voltage to be subsequently amplified, and the Magslip coincidence element shown in Fig. 12 is often used for this purpose. Its main advantages over the potentiometer system already described are as follows:

(a) The error signal varies continuously, since there are no windings to be wiped by the rotor.

(b) The absence of wiping contacts reduces friction and eliminates wear on windings.

The error voltage developed across the rotor of the so-called "coincidence transmitter," which is rotated by the load shaft, is A.C. Its amplitude is proportional to the sine of the angular misalignment, while its phase is changed by 180° when the misalignment changes sign. For misalignments up to say ±20° the amplitude of the error voltage is sensibly proportional to misalignment, which is what is required, and in order to obtain its sense a phase discriminating network is used. The coincidence elements now sold use 50 c/s carrier frequency, but better results are obtainable if this frequency is increased, and elements using frequencies up to 1,000 c/s are in the course of development.
If angular position control is required to an accuracy of a few minutes of arc (or less) then it is necessary to employ two separate channels, known as "coarse" and "fine" channels, the corresponding transmitting and coincidence elements of which are geared together by a ratio dependent on the final accuracy required in the control system. In normal practice this ratio is generally of the order of 18/1. A device must be incorporated in the system which will switch over automatically from "fine channel operation" to "coarse channel operation" whenever the misalignment exceeds a few degrees, otherwise there is a danger of the system becoming out of sector, as it is called, since there are multiple positions of correspondence, their number depending on the gear ratio used.

Amplifiers and Motors used in Position Control Systems

Amplifiers may be mechanical, hydraulic, pneumatic, or electronic, depending on the physical nature of a particular system. In general, however, electronic amplifiers are probably the most popular, and may be D.C. or A.C., though A.C. amplifiers tend to be used most.

The motor used to drive the load may be electric (D.C. or A.C.), hydraulic, or pneumatic. The two latter types can be rotating motors, but they are often met with in the form of rams. Pneumatic motors do not, as a rule, appear in systems required to produce much power, while hydraulic motors are especially useful when the designer is striving to obtain as high a torque/weight ratio as possible, since in this respect they are definitely superior to electric motors. Very small hydraulic motors, operating at a pressure of the order of 1,000 lb./sq. inch, are capable of delivering an astonishing amount of power.

In the case of electric motors, if the power required to drive the load is greater than about 1 horse-power, then the Ward-Leonard, Metadyne, or Amplidyne systems are eminently suitable for accepting an amplified error signal voltage produced by a Magslip coincidence element. For small power systems, on the other hand, such as those often encountered in instrument systems, computing devices, etc., there is a wide range of electric motors available on the market. One developed during the 1939-45 war at the Telecommunications Research Establishment of the Ministry of Supply is of special interest, the so-called "Velodyne System" motor; it includes a small tachometer generator on the shaft, for allowing "velocity feedback" to be used as a stabilising factor in the whole position control system.

V. MANUAL CONTROL SYSTEMS

Although we find, in many walks of life, a strong tendency to replace human operators by automatic devices, this cannot be done indiscriminately, and in fact there are many cases in which such a step would lead to disaster.

Fig. 12. Magslip Coincidence System.
The steering of a car is an example of the use of the human operator in a closed sequence control system, since he is continually comparing the actual course of the car with the course he is endeavouring to keep and if he sees an error he applies an appropriate correction via the steering wheel and the front wheels. Clearly the whole system is a closed one, and contains a difference element, an amplifier, and means for moving the front wheels.

The presence of the finite time lag, which is common to all persons, tends to cause instability in the whole system. Another undesirable feature is likely to be inconsistency of performance in response to a given error signal.

These and other factors make it desirable to use fully automatic inanimate control wherever the advantages peculiar to a human operator, such as intelligence, are not required in a system. Moreover, if it is possible to release a person for a task more suitable to human operation, it is a big advantage.

Capabilities of Human Operator

However, whenever a manual control system is being designed then it is essential (and this point cannot be emphasised too fully) for the designer to make himself familiar with those aspects of the human operator which will come into play, and be prepared, at all stages, to design the control system to suit the operator. It is not sufficient to expect an operator to produce eventually the best results with any system which is offered to him, by allowing him an initial period of training on it. The failure to realise this vital point before the 1939-45 war, and also during its early stages, led to the release to the Services of much manual control equipment which was never satisfactory, merely because the human operator's performance had not been considered during the design stages.

A vast amount of research on the human operator has been done in recent years, both in this country and abroad, and some striking results have been attained. For example, the advantages accruing to many industries, as a result of Time and Motion studies (which are a form of human operator research) are too well known to need stressing here. If any readers of this paper require expert advice on manual control the authors will always be prepared to supply them with a list of sources of information.

VI. CONCLUSIONS

Problems taken as examples for discussion in this paper, with modifications to suit particular circumstances, are present in all closed sequence control systems, and the basic operating features peculiar to closed sequence technique should be studied before consideration of specific problems. Once the basic theory has been mastered little difficulty will be found in coping with most aspects of the various forms of closed sequence system known as "process automatic controls," "regulators," and "servo mechanisms."

The first named covers devices used in industrial processes, for control of temperature, pressure, level, flow, pH, etc., while the term "regulator" is used to distinguish control systems in which the input quantity is invariant; in fact a great number of process automatic controls fall in this class. The term "servo-mechanism" on the other hand, is reserved for closed sequence systems in which the input varies continually, either in accordance with a predetermined law, or in an entirely unpredictable fashion.

DISCUSSION

Mr. J. H. Jacobs: Referring to the refinements mentioned for "pepping up" a closed sequence system, does this amount to feeding back first and higher differential terms?

The Author: The main point illustrated by the demonstration control system was the reduction (and eventual elimination) of an oscillatory response by increasing the coefficient of the first derivative term in
the second order differential equation of motion of a continuous position control system. In its simplest form, this coefficient is equal to the coefficient of viscous friction, and a system can generally be stabilised either by adding more viscous friction, which, however, causes wastage of motor power and production of what may be an intolerable amount of heat energy, or by the use of velocity feedback, in which case no appreciable power is dissipated. Another way of stabilising a system is to cause the motor torque to be proportional to the error plus a fraction of its first derivative, the so-called “phase advance” technique. However, this may be troublesome in cases where the error tends to exhibit high rates of change.

Mr. F. G. Gunn: Has the lecturer had any experience of operating these servo control mechanisms from recorded data? In film studios, for example, one might want to carry out a complicated manoeuvre with the camera. One would like to have a simple means of rehearsing that, then of recording the optimum condition and being able to reproduce it automatically, as many times as required.

The Author: You want to have a control sequence, which in fact entails having the input quantity $\theta_1$ a predeter-
dined function of time. One way of achieving this might be by means of a punched tape.

Mr. L. Knopp: It might also be necessary to alter the lens focus, hence there will be two things to control at once.

Mr. Gunn: For many years we have used Selsyn controls for focus adjustment.

The Author: Are they sufficiently accurate?

Mr. Gunn: They are as accurate as the judgment of the operator. He goes through a rehearsal and carries out a certain number of measurements, then interpolates by using judgment. Some directors carry out very complicated movements with the camera, entailing the movement of tons of equipment, and at present it needs a day or days, to rehearse the sequence. If an automatic control could be devised to overcome these difficulties, it would be a very great advantage.

The Author: That appears to be a tremendous problem, especially on account of the effects of the big inertia which is involved.

A Member: You remarked that the addition of the devices needed to improve performance adds to the expense of the system.

The Author: I was not thinking of the monetary expense of the components used in the special devices needed to improve performance, but of the expense involved in extra design time and probably in time spent in laboratory trials which are generally necessary before the best values of the various parameters in the system are determined. The extra devices such as “phase advance,” “velocity feedback,” etc., which may have to be incorporated in a high performance system, are really quite simple in themselves, particularly in an electrical system. In a mechanical control system, on the other hand, the production of error derivative, for example, would entail the addition of some relatively bulky and precisely made components.

In chemical works, pneumatic control systems are almost universally used, since they do not add to fire hazards in the way that electrical systems do. The many precise controls used in refineries, for example, are invariably pneumatic in their operation. The processes of differentiation and integration are done in a pneumatic system by means of capacities and capillary tubes connected so as to form pneumatic analogues of the electrical capacity resistance circuits which will differentiate and integrate. The latest types of precise process controls use proportional plus first derivative plus integral control in order to improve stability and also to eliminate “droop.” One of the biggest problems which face designers of control systems is the reduction of the bad effects of time lags in a system, especially finite time lags such as occur in a human operator. Chemical processes also frequently involve relatively long finite time lags which are due to the low speed of certain fluids in pipes.

Mr. Peasgood: We have a problem in developing machines where we want to control the temperature of a large volume of solution within very close limits.

The Author: Precise temperature control of large liquid volumes is a most difficult problem, mainly because of the time lags associated with the heat capacities of the various elements. A deviation in temperature from the control point, for example, is not registered immediately, while the resultant change in the heat supplied to the liquid does not produce a temperature change at once.

THE APPLICATION OF MUSIC TO FILMS

Hubert Clifford, B.Sc., D.Mus., Hon.R.A.M.*

Read to a Joint Meeting of the British Kinematograph Society and the Association of Cinematograph and Allied Technicians on January 26, 1949.

MY talk on the application of music to films must take the form of a personal testimony. The scope of this subject is enormous, so, in order to keep this session within reasonable dimensions, I shall not deal with films that deliberately set out to exploit music as their subject matter, nor shall I discuss the interesting topic of the methods of planning of music for either documentary or feature films. Microphone technique and the inexhaustible subject of dubbing will also have to be omitted.

I. AUDIENCE PSYCHOLOGY

It is first of all necessary to define the target upon which the film music has to make its mark. As we cannot yet produce films for specialised minorities, it is to the picture-going public as a whole that the film, and all its contents, must be directed. Music must, therefore, be aimed at a very broad audience and should be understood by and acceptable to that audience.

There are certain commercial incentives that have to be taken into account. A good deal of film making includes film music for non-dramatic purposes, in fact a frequent use is as a soothing syrup for bored audiences. Ronald H. Riley, the documentary film producer, once suggested to me that there were good grounds for comparing the effect of certain cheap types of film music with that of the pipe of the Indian snake charmer; so long as the notes are within a certain frequency range, the snake is satisfied. Film music, at the very lowest, does exactly the same with an audience. The anaesthetic is applied and the audience is overcome and sinks into a bemused state. The effect upon them is that they feel they have enjoyed the film very much (more than they would have done had there been no music).

Unobtrusiveness

At the other end of the scale, music can occupy quite another position. Most people are very vulnerable to the emotional appeal of music, in fact, it can be said to be the Achilles' heel of the emotions. If the film composer is prepared to make his music subservient to every dramatic need of the film, the result can be that music acts as a kind of "fifth column" of the emotions.

A "fifth column" works most effectively when it is not observed. As soon as it is noticed its utility is reduced. So it is that some of the most successful film scores pass unnoticed by the layman. A good example of this is the film "Fallen Idol." Although there was as much music in that picture as in the average film, roughly 40 minutes, a common reaction has been that the film carried very little music. The explanation is that the score was so closely integrated with the film that it did not obtrude upon the notice of the audience except where it was intended that it should.

II. DRAMATIC AND AESTHETIC FUNCTIONS

Among the possible dramatic and aesthetic functions of music in relation to films, the most obvious is that of actuality. Very often there is an opportunity of introducing music as part of the action with a view to helping the story or situation. There are two ways of doing this, either directly or by antithesis. In the first method the music corresponds with the mood of the scene, gay, sentimental or nostalgic scenes having music of a similar

*London Films Production, Ltd.
nature. By the use of antithesis, the dramatic tension of the scene can be emphasised by having music of a contrasting mood. These are both familiar techniques.

Atmosphere

The most general function of film music is that of creating atmosphere. Sometimes it may be a wallpaper, a pleasant background of sound that defines the time of day or season of the year, or perhaps the geographical location. An example of this is to be found in Constant Lambert's music for "Anna Karenina," in the scene on the station square.

A second type of general atmosphere is that of mood. There is a type of music that will strike directly into the sub-conscious emotions of the audience to reinforce such moods as gaiety, sentiment, horror, exultation, anxiety, passion and so forth.

Then there is tension. This, unlike mood which may be static, is dynamic, and music can be used for a lowering or raising of tension. In films, music can be called upon to add a further dramatic dimension to what is already in the picture in order to grip the audience more tightly. The music for the scene of Vronsky's attempted suicide in "Anna Karenina" is another example in Constant Lambert's exemplary score.

Music as Commentator

Music can act as a commentator. It can provide a definite idea: a clue to the scene which the audience would not otherwise have. It can be satiric, dramatic, or almost anything so long as there is a mutual link between action and music, a link which if severed leaves each side incomprehensible.

An example of satirical comment is found in the opening of the French film, "Les Hostages." There is a procession of municipal dignitaries, which might be serious, but which is revealed by the music of Milhaud to be completely pompous. Satiric comment is not a difficult thing to do in music, and a whole scene can be made to take on a different aspect, by using music of the right kind.

Dramatic comment is well exemplified in "The Last Days of Dolwyn," in which a mother, played by Edith Evans, is told that she must evacuate her native village. She goes to an oven and turns her back on the camera to hide her feelings. The music has to reveal those feelings, which she is attempting to hide from her sons.

The addition of a quality of eeriness and uneasiness was created by music in the "Hide and Seek" sequence in "The Fallen Idol." That is a superb piece of film making in my view, and the score by William Alwyn is really masterly. As well as providing a general atmosphere, the music comments in close detail upon the action the whole way through.

It is possible to have a very closely fitting musical commentary (commonly termed "Mickey Mousing" a scene). This method is used frequently in comedy and is at its best in some of the Disney cartoons.

Emphasis and Continuity

Music is used for the underlining of something especially significant and in this way the most ordinary phrase of dialogue can be singled out for the special attention of the audience.

Mozart was once asked: "What is the greatest single effect in the whole of music?" To which he replied, "Silence." There are always good opportunities for sudden silence in a film score. The technique of a silent fanfare was used in "The Winslow Boy" when Robert Donat made his first unexpected appearance—the music stopped abruptly as the door was opened to reveal him.
For suggesting time lapses or to create continuity between two scenes, music can be the linking medium. If the music flows straight through from one scene to the next, the audience feels that time is moving on regularly; on the other hand, a change of level, tempo, or key in the score can suggest a time lapse.

Thematic Treatment

At its worst the theme song can be an abomination, and one of the most tasteless applications was in an American "Western." There, a-theme from Tchaikovsky's Pathétique Symphony was played every time the hero and heroine were brought together. It fitted ill with the horses and the desert and the cacti.

An effective theme tune that is not already familiar to everybody before-hand must be simple and easily recognisable. If you use a theme, you must have opportunities for placing and identifying it, and later occasions to exploit and use it dramatically; otherwise, it remains a technical device of the composer's workshop, a means of attaining unity and economy. A most interesting use of a theme song was in Julien Duvivier's film "Un Carnet du Bal." A waltz to which the heroine danced many years ago linked her with a number of her former dance-partners. The waltz is played long enough in the original ball scene for the audience to recognise it. One of these men she meets later in reduced circumstances, and they go into a cheap dance hall where a poor orchestra is playing their particular tune. To create the shabby atmosphere around the second playing of this tune, the music had been re-written backwards, scored for a small orchestra. In the re-recording, the track was reversed. The result was that although the music sounded the same as before, the attack on every note was inverted—the sound became incredibly cheap and shabby.

First Aid to the Actors

When I was in Hollywood, I met Adolph Deutsch, who was responsible for the classical statement upon film music, "We composers are like embalmers. We can make the corpse look pretty, but we cannot bring it to life." That is a very concise statement of the limitations and uses of film music. Nevertheless, musicians can often render first aid to scenes which are not completely dead, but have just failed to "come off." It may be that the actors over-play or under-play. Discreetly conceived music can compensate and even bring emotional warmth to a scene which lacks it.

For the sake of completeness, the function of imitative realism should be mentioned. It is found mostly in documentaries and it is better not to use it for its own sake, but to give variety in the overall planning of the sound track. If there is an opportunity of giving a musical interpretation of various mechanical actions in industrial scenes, the sequence can take on a new interest.

Music can bind together a set of loosely related shots and give them a basic rhythm. It is almost impossible to do a montage unless the shots are bound together with music.

Musical Frames

Finally, there is one time when the musician comes into his own. That is in making musical frames—the main and end title music.

One of the most effective examples of title music is that of William Walton which he wrote for Olivier's "Henry V." It opened with a single flute trickling down to accompany a wind-swept play-bill on which the titles were presented.

Another effective prelude was that to "An Ideal Husband"—it had the
charm of a Victorian Valentine with the quasi-music-box presentation of "After the Ball is Over" and the Galop for the Hyde Park Corner sequence.

In the introduction to the documentary film, "Steel," the slashed brass chords in the music were synchronised with the movement of the steam hammer.

III. TECHNIQUES OF SYNCHRONISATION

Some of the methods and technical devices used, particularly in Hollywood, in the synchronisation of music, are well worth applying here to a greater extent than is our habit.

Music Leader

A music leader I devised myself and used at Shepperton looks rather like the Plimsoll line on a ship. An arrow moves across the screen in four seconds. The last second is the operative one from the conductor's point of view. It is graduated into fractions of a second which correspond with a particular metronome rate (beats per minute).

The secret of a good orchestral attack is for the conductor to start his preparatory warning beat so that the duration of this beat is exactly the same as that of every beat at the given tempo. The conductor can start his warning beat when the arrow reaches the metronome point he requires.

Click Track Methods

The Americans often use a click track as a guide for the tempo of their recordings. A click-track indicates a metronome rate by using a sound loop punched or marked at particular intervals. It is usual for the conductor and orchestral section leaders to have one earphone to follow this click-track, but in recording music for Walt Disney films, every member of the orchestra wears an ear-phone.

The following table gives the spacings of the clicks corresponding with some important metronome rates.

<table>
<thead>
<tr>
<th>Metronome Rate (Beats per Minute)</th>
<th>Frame Spacing (Frames—Sprockets)</th>
<th>Metronome Rate (Beats per Minute)</th>
<th>Frame Spacing (Frames—Sprockets)</th>
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<tr>
<td>192</td>
<td>7—2</td>
<td>104</td>
<td>13—3</td>
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<tr>
<td>184</td>
<td>7—3 &amp; 8</td>
<td>100</td>
<td>14—1 &amp; 14—2</td>
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<tr>
<td>176</td>
<td>8—1</td>
<td>96</td>
<td>15 Frames</td>
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<tr>
<td>168</td>
<td>8—2</td>
<td>92</td>
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<td>160</td>
<td>9 Frames</td>
<td>88</td>
<td>16—1</td>
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<td>152</td>
<td>9—2</td>
<td>84</td>
<td>17—1</td>
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<td>144</td>
<td>10 Frames</td>
<td>80</td>
<td>18 Frames</td>
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<td>138</td>
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<td>132</td>
<td>10—3</td>
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<td>126</td>
<td>11—2</td>
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<td>120</td>
<td>12 Frames</td>
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<td>116</td>
<td>12—1 &amp; 12—2</td>
<td>63</td>
<td>22—3</td>
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<td>112</td>
<td>12—3</td>
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<tr>
<td>108</td>
<td>13—1</td>
<td>58</td>
<td>24—3</td>
</tr>
</tbody>
</table>
Bar Breakdown

A musician aiming at fitting music closely must have an analysis of the scene, giving every detail of shots, incidents, camera movement and each line of dialogue in its position in seconds. American musicians work on Moviolas which have seconds meters instead of footage meters, which is a great convenience. An additional aid, sometimes used, is the bar breakdown, a conversion of time into bars and beats of music of a predetermined tempo.

To find out the number of bars required, a simple formula which can be used is:

\[ N = \frac{S}{B \times 60} \]

where \( N \) = Number of Bars, \( S \) = Number of seconds required, \( B \) = Number of beats per bar, and \( M \) = Metronome rate in \( M \) beats per minute.

"Sweetener Mixing"

In their systems of multi-track recording Americans frequently use what they call a "Sweetener." In making a musical film, the original playback to which the director shoots must not tie him down in any way. Nevertheless, he wants a definite basis. The recording is commonly made on two tracks, one featuring the singer prominently and the other the orchestra. The recordings are made to an agreed tempo (controlled by click-track) and after the scene is filmed, any instruments featured prominently are recorded on separate track, to cover the particular musical phrase or section when these instruments are prominent in the scene. The "Sweetener" sections are then laid to synchronise with the main music tracks, and in the re-recording are mixed in to give the required musical perspective.

This system was used over here some years ago for the introduction of the film "Steel." Each chord corresponding with the irregular crashes of the steam hammer was recorded separately and they were then laid as a separate track and mixed in the dubbing.

Benjamin Frankel used a similar device in "Mine Own Executioner." The theme for the schizophrenic patient had two simultaneous elements, a harmonic background texture and a jerky bass rhythm corresponding with his limp. As the limp was irregular and the walk spasmodic, it would have been difficult and expensive to post-synchronise the music by the ordinary method. The various bass notes corresponding with the footprints were recorded separately as if they were isolated effects. All of the left footprints were spaced on one track, and the right footprints on another. They were mixed together so that they died naturally and were not cut off. Finally, the main music track and the combined foot-print track were mixed together in the general dubbing.

**DISCUSSION**

**Mr. Baynham Honri:** Could we hear more about the half sprocket holes?

**The Author:** The sprocket being one quarter of the frame, you can for a fraction of any 12-frame spacing have something that is between 12 and 12. By alternating the distances between 12 frames exactly and 12 frames 1 sprocket (i.e., 12 and 12) you average out to the desired 12. If you work to the nearest sprocket over many feet your final error will be too great.

**Mr. Wolfgang Wilhelm:** When do you think the composer or musical director should join the production unit?

**The Author:** There is a great advantage in having an expert musician available in the planning stage, whether he is a composer or not. But it is very important to realise that the actual sight of the first rough cut of the film makes a very big dramatic and emotional impact on a composer, who may lose that excitement and impetus if he sees too much of the film when it is slowly growing. Perhaps on balance, it would be better if the composer were left out until the later stages.

**Mr. Walter Lassally:** Some films have music during the censor's certificate.
Would it not be better to have the introductory music start before the film?

**THE AUTHOR:** The Rank Organisation very often start the title music over the censor’s certificate. It depends on the film and the composer.

Mr. MERGER: Does the musical expert have to pay any attention to the particular overall colour on the screen?

**THE AUTHOR:** In practice, the composer and musical director have a black-and-white print to work from, therefore, the composer has very little idea of the colour other than the general knowledge that in a particular scene the costumes and sets are very gay. If a particular scene has a set designed for a very subdued mood it is the mood and situation that determines both the décor and the music.

Mr. BUSBY: The question of timing seems to be extremely strict. Is it felt as a limitation on the composer and conductor?

**THE AUTHOR:** The use of metronome guides would only crop up with fairly fast music that was closely fitted. In this country we use the click-track method only occasionally. When they are asked for music that is very closely fitted and yet needs plastic and expressive treatment, the best film composers find no difficulty.

A Visitor: Can you use a flashing light instead of a click-track?

**THE AUTHOR:** At 20th Century-Fox in Hollywood, they have methods of cueing the film with jagged scratches that correspond with certain markings on the score, so that the conductor is aware of the light even if he is not looking directly at the screen. I think this is used mostly in musicals.

Mr. RICHARD SMITH: Is it not psychologically bad for each member of the orchestra to have an earphone on?

**THE AUTHOR:** No, not if one ear is left free.

A Visitor: Do you feel that the visual would be just as easy as the click track?

**THE AUTHOR:** No, because the eyes are busy in three directions already, on the screen, the seconds counter, and the score.

Mr. RICHARD SMITH: Is it psychologically bad to record vocals in a booth sometimes, to keep the band down?

**THE AUTHOR:** That depends upon the singer. In Hollywood certain singers are quite at home in a booth.

Mr. BUSBY: Regarding microphone balance of the orchestra, an attempt has been made by using several microphones on an orchestra to give the impression that a larger orchestra was used.

**THE' AUTHOR:** It is not possible to bring up the sound from a small body of men to make it sound greater.

**“FILMS NOT GENERALLY SEEN”**

In accordance with policy decided by the Theatre Division Committee a series of films of technical interest was presented at the meeting of the Theatre Division on Sunday, March 20, 1949.

These films covered scientific and other subjects of interest to the cinema projectionist and engineer which they were unlikely to come across in the normal run of duty.

The first film presented was “They’re Called Electrons,” loaned by Messrs. Edison Swan Electric Co., Ltd. The second was “This Film Is Dangerous” and was presented through the courtesy of the Admiralty. Finally, “How Talkies Talk” was presented as a contrast between early sound recording and reproduction and current practice. The presentation closed with a short section of Agfacolor of outstanding interest.

**BRITISH STANDARDS**

The following British Standards specifications have been published:

No. 1568: 1949—Sound Recording and Reproduction (Magnetic Tape Systems for Broadcasting), 2s.

No. 1580: 1949—Unified Screw Threads. 7s. 6d.

The following draft specifications have been circulated for comment:

CK 4448—Spools for 16mm. Kinematograph Film.

CK 4700—Sound-recording and reproduction on Magnetic Tape for commercial and domestic uses.

CK 4713—Mercury Arc Rectifier Equipment.

Work has been started on the following projects: Electro-mechanical sound-recording and reproduction; Rating of rectifiers for use in cinemas; Kinematograph carbon-arc equipment; Acoustical terms and definitions (revision of BS.661); Kinematograph film processing and processing equipment.
TECHNICAL ABSTRACTS

Most of the periodicals here abstracted may be seen in the Society's Library.

SELECTIVE PHOTOMETERS FOR DETERMINATION OF EXPOSURE.
The factors which influence camera focal plane illumination are quoted. The relationship of subject brightness with focal plane illumination and with the B.S. "fractional gradient" exposure index equation is developed to produce the basic fog point equation for the "shadow level" calibration of any exposure meter. It is shown that a properly designed photometer can give adequate compensation for camera flare. Calibration equations are also suggested for the "keytone" application of incident light meters, and a satisfactory form of remote calibrating equipment is described.

SPECTRAL CHARACTERISTICS OF LIGHT SOURCES.
This paper deals briefly with the measurement of the colour of light sources, and stresses the importance of their spectral distribution, particularly when the colour rendering properties of the source are discussed. It then describes what has been done in the measurement of the spectral distribution of daylight and the light from incandescent tungsten lamps, carbon arc lamps, fluorescent lamps, high pressure mercury-cadmium lamps and concentrated zirconium arc lamps. The application of these lamps to colour photography is briefly discussed.

F. S. H.

HIGH-SPEED PHOTOGRAPHY.
A series of papers on all aspects of high-speed photography and kinematography. Lighting equipment described includes the flash discharge lamp, the stroboscopic lamp, and filament lamps specially designed for the short exposure times customary. Various types of cameras are described, and a number of applications discussed.

R. H. C.

A NEW VEST-POCKET COLOUR TEMPERATURE METER.
A colour temperature meter of the null reading type may be graduated in degrees Kelvin, in "Mireds" (micro-reciprocal degrees), or in terms of filter characteristics or filter factor.

R. H. C.

PROPORTIONS OF IMAGES OBTAINED WITH UNDERWATER CAMERAS.
When photographing objects under water, due to the interposition of a medium denser than air the optical distance is shortened and consequently correction has to be made on the focusing scale. An object under water will generally be photographed only a relatively short distance from the camera and the water will have a magnifying effect. The depth of focus remains practically unchanged.

O. K. K.

RESEARCH COUNCIL SMALL CAMERA CRANE.
A camera crane designed by the Motion Picture Research Council provides a lens height of from 2 to 10ft., 360° pan, 55° upward tilt and 45° downward, and will pass through a doorway. It is provided with a number of safety devices.

R. H. C.

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N. L.

A DEMONSTRATION STUDIO FOR SOUND RECORDING AND REPRODUCTION.
A studio constructed for listening tests has provision for effecting any combination of sound source, amplifier, speaker, and recording system. The reverberation period is substantially less than is generally recommended.

R. H. C.
BOOK REVIEWS

Books reviewed may be seen in the Society’s Library


A book on the photographic emulsion naturally excites a great deal of interest in photographic circles, since the preparation of modern emulsions is a jealously guarded trade secret. The reader will be disappointed, however, if he expects the book to lift this veil of secrecy. The book sets out to be a guide not only to "practical emulsion making" but "...a textbook for technical students, industrial chemists and photographers, who are anxious to prepare emulsion of some special type." As far as the latter groups of workers are concerned, the book is entirely successful; its title is in fact deceptively modest since the coating and testing of emulsions are also covered in detail.

Since the first edition in 1941, the book has been expanded from 263 to 341 pages, to some extent by the addition of two new chapters on Three-layer Colour Films and on Plastics in Emulsion Techniques.

There are a few mis-statements which should be weeded out in a forthcoming edition, such as "The loss of gelatin on washing should not exceed 1-11% (p. 73) contrasted by "Even with the greatest care (the loss of gelatin) may amount to 6%"; "infra-red ... extending from about 760mμ to 104mμ" a statement which is misleading since it implies that this range of wavelengths is available for photography (p. 146); "early infra-red" is a rather poorly chosen phrase; "Enocyanin" is a misprint for Xenocyanin (Fig. 39). Readability of the book suffers from occasional unnecessary repetition and the splitting up of matter that should be discussed together.

Certain omissions are almost inevitable in any book, but one does miss a discussion of items such as the change in gamma in the U.V., and of gamma-ray exposures and lead intensifying screens. The "Kodachrome" process described in the book has been out of date for almost 10 years (see Mees, *Photo. J.*, 1942).

All in all, however, the book should be useful to many workers in the photographic field.

W. F. BERG.

THE MOTION PICTURE THEATER.
Society of Motion Picture Engineers, $5.

The Society of Motion Picture Engineers has a happy knack of gathering together outstanding papers on a particular subject for publication as a complete reference. Such is *The Motion Picture Theater*. It cannot fail to be a valuable help to those engaged on the remodelling or maintenance of kinemas.

The book will be of absorbing interest to all whose work lies in the 35mm. exhibition field, and the collection of articles has been well edited.

The Drive-In Theatre will be new to some readers and perhaps they will find cause to reflect on this novel method of theatre operation.

Unfortunately this country is not included under Foreign Theatre Operation, and so to see ourselves as others see us, is denied; but we do come into our own under Theatre Television in England.

The survey of theatre screen brightness carried out by the S.M.P.E. is of very great interest, and a similar survey made in this country would be of considerable value to the industry; but confusion can be caused if the reader does not bear in mind that picture areas in this country are about 75% greater on the average.

A very acceptable volume of considerable worth to the theatre engineer.

R. PULMAN.

THE COMPLETE PROJECTIONIST,

R. Howard Cricks (whose knowledge of kinematography is accepted to be outstanding) has written a fourth edition of his text book, *The Complete Projectionist*, which book has been so extremely helpful since the original edition in 1933.

The new edition is indeed a sound investment. There is something for everyone, from the expert to the junior projectionist. Although primarily for the 35mm. user, the volume contains a chapter devoted to the work of the sub-standard projectionist, and the whole can be of value to those engaged on 16mm. exhibition.

A feature of this particular volume is the ample reference to such matters as large screen television, stereoscopy, non-interriffent systems, wide film, lenticular screens, etc., and all who have an eye on the future will find this a wealth of information.

Containing as it does an abundance of technical data, photographs and circuit diagrams, this book is surely the chepest technical book available to-day.

S. B. SWINGLER.
EXECUTIVE COMMITTEE

Meeting of August 10th, 1949

Present: Messrs. A. W. Watkins (President), E. Oram (Hon. Secretary), I. D. Wratten and Miss S. M. Barlow (Asst. Secretary).

Journal Accounts.—The President stated that a Committee had been formed to investigate the costs of publishing "British Kinematography."

B.S.I.—Mr. Oram agreed to act for the Society concerning the Anglo-American-Canadian unification of Screw Threads below ¼-in.

Polytechnic Students.—After amendments had been made to a draft prepared by Mr. Cricks, authority was given for the publication in the Journal of the paragraph which appeared on p. 64 of the August issue of "British Kinematography."

Elections.—The following were elected:

George Harold Tullett (Associate), Arthur Sanderson & Sons.
Edgar Roy Mitchell (Associate), Technicolor Ltd.
Philip Augustin Willis (Member), Philips Cine-Sonor.
Peter Thomson (Associate), Roxy Cinema, Bridlington.

Transfer.—From Associate to Corporate Member, Jack Ryder Greenwood.

Death.—The death of Terence Gilbert Parsons was noted with regret.

PAPERS COMMITTEE

Meeting of July 4th, 1949

Dr. F. S. Hawkins and Mr. S. A. Stevens were welcomed to the Committee. The Chairman (Mr. Leslie Knopp) submitted the dates for next season's papers and the proposed subjects of the Society papers, all of which were approved. The preparation of a reserve society paper was requested. Messrs. Stevens, Buckstone, and Honri indicated arrangements for papers at meetings of the Theatre Sub-Standard Film, and Film Production Divisions respectively.
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The Chairman's suggestion, that Divisional A.G.M.s and the Society's A.G.M. should be held on the same day, followed by the Presidential Address, was considered a good one, and it was felt that a special committee should be formed to arrange this. The system of charging for refreshments at meetings was considered unsatisfactory.

It was agreed that the Chairman and Mr. Cricks should re-write and reduce the information supplied to authors of papers.

LIBRARY COMMITTEE

Meeting of August 8th, 1949

A list of books on different aspects of kinematography was prepared by the Chairman (Mr. M. F. Cooper). The Committee agreed that their acquisition was desirable in order to augment certain sections of the Library and that the list should be submitted to the Council for purchase approval.

The Committee were pleased to accept fifteen presentations of books for the Library, four of which were from members.

PERSONAL NEWS of MEMBERS

Members are urged to keep their fellow members conversant with their activities through the medium of British Kinematography.

Stan Double has left Multiple HD and is now with Films and Equipments in an administrative capacity.

Malcolm V. Hoare has joined Kays Laboratory on a full time basis as Chief Laboratory Executive and will not now take the post of Director of Photography to the New Zealand Unit. Although the course on kinematography at the Regent Street Polytechnic is discontinued, he will continue evening lectures on photographic theory.

Erat Ozoul has returned to Turkey and thanks all British film makers, and especially members of the B.K.S., for their kindness to him during his stay.

A. H. Page has left Air Conditioning and Engineering (N.I.) and has re-joined Mole-Richardson.

ERRATUM

A misprint in the discussion following the symposium on the B.T.H. Supa projector (page 24 of the July issue), made it appear that the arc lamp would function satisfactorily with only one particular make of carbon. This, of course, is quite incorrect; the sentence should have read: "The lantern will, of course, work satisfactorily with other suitable carbons."
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THIRTY YEARS OF BRITISH FILM PRODUCTION

Sir Michael Balcon, M.B.K.S.*

Read to a joint meeting of the British Kinematograph Society and the Association of Cinema and Allied Technicians on May 25, 1949.

Prior to the 1914-1918 war, Britain was certainly in the race for the mastery of a new medium of entertainment; but the war retarded us enormously and, at the same time, enabled America to make great strides forward. By 1920, the industry was more or less mature and had changed from a fairground novelty into one of great potential power and rewards.

Some sort of an avant-garde movement was generally established in the world to remind us that there was more in films than the photographed stage play or the custard-pie comedy. The newsreels of the war, early travelogues and nature study films gave promise of the great effect that the realist school was later to have on the commercial feature film. But it must be said that, on the whole, those of us who, like myself, were following a new enthusiasm had little idea that thirty years from then, films would be as important internationally as they are now, or that their importance would be measured not only in terms of capital and revenue, but also from the points of view of the State, of the Church, of propaganda, of education, of national culture and so on.

The industry in 1920 was dominated, but not wholly dominated, by American films. A fair number of British films were produced and, in spite of the fact that they were turned out in the small studios which had scarcely changed since before the 1914 war, some were considered to be quite good. The immense number of films being made in America and freely dumped here resulted in a huge reservoir of unreleased films, and release dates were anything from a year to eighteen months after the London trade show; sometimes the time lag was even two years.

"Block" and "blind" booking was general, and American renting companies, such as Famous Players-Lasky (now Paramount), Vitagraph (now Warners) and Western Import, competed with one another in offering exhibitors complete batches of first features for six months or for a year. Of the many renting organisations, British firms—Walturdaw (now, in 1949, concentrating on equipment), Gaumont, Stoll’s, General Film Renting Company (no relation of the G.F.D. of 1949) and, of course, the everlasting Butchers Film Service—offered similar huge batches of pictures which also contained a proportion of British product.

Needless to say, bookings were made on a highly competitive flat figure

*Ealing Studios, Ltd.
basis, sharing terms being unknown. It will be understood from this why
the exhibitor assumed such an important status in the industry vis-à-vis
the primary producer.

British Production in the 1920's

The British feature film of 1920 averaged 5,500ft. in length, took about
four weeks to shoot, and cost less than £1 per foot. If a film was reasonably
good it might obtain 500 bookings and the renters' receipts might touch
£12,000. But the producer was generally delighted to sell his picture
outright to a renter at a flat figure if this meant he could get his money
back quickly. One of the biggest successes of that year was George Pearson's
"Nothing Else Matters," which took four weeks to shoot, cost £7,000 to
make, was distributed by Jury's Imperial Pictures, and grossed about
£30,000 in the domestic market and abroad.

Other producers were less fortunate. It was a constant source of amaze-
ment to me how the British producers of the time managed to carry on.
But they did, and out of a total of no less than 881 feature films trade shown
in 1920, 147 were made in British studios. Of the British films of that year,
mention must be made of Cecil Hepworth's " Alf's Button," George Pearson's
series of Betty Balfour pictures, Guy Newall's film versions of popular
novels, and the sporting epics of G. B. Samuelson and Walter West. Quality
was improving, but costs were beginning to rise rapidly.

The studios of 1920 were all of the pre-war "glasshouse" type, in which
the principal illumination was daylight, assisted by a few enclosed-type arc
lamps. The stages were generally on the first floor, with the workshops,
offices and laboratories underneath. Later, the glass of these studios was
blacked over and artificial light only was used. Other studios were con-
structed in converted skating rinks (London Film Company at St. Margaret's
and the B. & C. Company at Walthamstow), in a disused tram shed (Davidson's
at Leytonstone), or an old gas works (Hackney Studios). The usual post-
war building restrictions prevented the construction of new up-to-date
studios, and so further conversions were made, such as Stoll's big plant at
Cricklewood (the Nieuport Aeroplane Works) and Famous-Lasky Studios
at Islington (a Metropolitan Railway power station). The last two studios
were by far the best equipped in the country and were ready for use in 1921.

The Seed of the Rank Organisation

Such was the state of the industry in 1920, when I was with Victory
Motion Pictures, Birmingham, on the renting side. Among my co-directors
were Oscar Deutsch and Victor Saville. We acquired the local agency for
W. & F. Film Service, a renting company founded by the late C. M. Woolf.
Here was the acorn from which grew the oak—the J. Arthur Rank organisa-
tion. Through the activities of the Ostrer Brothers, W. & F. eventually
amalgamated with Gaumont, Ideal and certain theatre interests. Deutsch
left and started Odeon.

Victor Saville and I started producing advertising films under contract
and arranging exhibition for them. One day, a new acquaintance, Jack
Graham Cutts, advised us to abandon advertising shorts and to make a
feature film. We talked the finance over with the late C. M. Woolf who,
with other friends, Oscar Deutsch among them, raised the necessary amount—
somewhere between £30,000 and £40,000. With Saville and another partner,
John Freedman, we made our first film "Woman to Woman," Jack Cutts
directing. This film, by the greatest luck, was an enormous success in its
day, and the success persuaded us to emulate the Gadarene swine and plunge
headlong into disaster. The title of the disaster—my second film—was
"The White Shadow." It was my first flop.
But once film production is in the blood, nothing stops the perpetuation of such follies. I decided to go on making pictures, and with Jack Cutts as co-director, I formed a £100 company called Gainsborough Pictures. I am very proud of my early connection with a company which was to achieve such a fine record of films over a quarter of a century.

Film Production at Islington

It was my present partner in films, Reginald Baker, who conducted the negotiations with Paramount when we decided to make a bid to acquire Islington Studios, which had been converted from a power house by Famous Players in order to make some of their films in Britain. Some of the films produced by Famous Players are of interest: "The Great Day," and "The Call of Youth," directed by Hugh Ford; "Princess of New York," "Appearances" and "Bonnie Briar Bush," Donald Crisp; "Spanish Jade," John S. Robertson; "Three Live Ghosts" and "Man from Home," George Fitzmaurice. Prior to the formation of Gainsborough and subsequent thereto, many other important British films were made at Islington, including great contributions by Herbert Wilcox, who was then, as he is today, the outstanding showman and producer of big box-office attractions. His films with Graham Cutts included "Flames of Passion," "Paddy," and, under his own direction, Dorothy Gish in "Nell Gwynn." Islington was also the early home of my friends Thomas Welsh and George Pearson, whose series of films with Betty Balfour, brought great credit and profit to the British industry—"Love, Life and Laughter," "Squibs' Honeymoon," "Squibs M.P." "Reveille."

At the Islington Studio plant, I made a number of pictures, some successes and some failures, under the new name of "Gainsborough Pictures." Our plant at Islington continued to be probably the most up to date in the country, for I was always of the opinion that good equipment was a sound investment.

The list of early films made at the Islington Studios is nostalgic: the early Ivor Novello's—"The Lodger," "Downhill," "Easy Virtue," "The Vortex," "The Constant Nymph" and, of course, "The Rat" series—"The Rat," "The Triumph of the Rat" and "The Return of the Rat." In connection with these it ought to be mentioned, that even in those days the film as an export commodity began to loom importantly. M.G.M. made an offer to us to distribute the Novello series.

It was at Islington I found Alfred Hitchcock working as a junior technician. The studio was indeed the alma mater of many of the key men in the industry today: Robert Stevenson, Fred Gunn, Baynham Honri, Victor Saville, Harold Boxall, Ian Dalrymple, Angus MacPhail, Ivor Montagu, Slim Hand, George Gunn, Herbert Mason, Charles Bell, Roy Kellino, are only a few.

Coincidental with this was the Anglo-German phase. Erich Pommer was the head of the German film industry. We made arrangements to make films there—"The Blackguard" and "Mountain Eagle," were the first of many—working with UFA and Emelka, and when talkies came, we made bi-lingual versions.

Quota and its Effects

Meanwhile, the number of British pictures was decreasing. In 1923, 675 pictures from all sources were trade shown, of which 64 were British. In 1925, 34 British pictures were made, and 23 in 1926. A joint trade committee was set up to seek methods of abolishing the practice of blind and block booking as a first step which would enable a British film scheme to be introduced, and it was not long before the draft of the first British Film Quota Bill began to be formulated.

The Quota Bill became an Act in 1927, and British films enjoyed a financia
The End of the Silent Film

In 1929, we were unknowingly approaching the end of the silent cinema. Generous finance was available for British production and large new studios were being built by B.I.P. and by Whitehall at Elstree, by British Instructional at Welwyn, together with big extensions to the Gaumont Studio in Lime Grove. Cricklewood Studios had the largest stage space, and four or five production companies were there, including British Instructional and Herbert Wilcox's British and Dominions Company, who later moved to their own studios at Elstree, adjoining B.I.P.

Encouraged by the new Quota Act, there was a spate of production, including a large number of expensive ventures. The British production industry had reached adolescence. Writing in The Bioscope special British film number of March, 1929, I said:

"The art of telling a story in moving pictures is a highly specialised business, calling for keen concentration and attention to detail. The fact that it is a business is very often lost sight of in the glamour which surrounds it, and many people light-heartedly enter the field of production with only the very vaguest ideas of the intricacies involved. Until it is fully realised in England that perfect and almost mechanical organisation is the first essential to success, as in fact is the case with any business, progress will be slow and painful."

The Sound-film Arrives

The talking film arrived in America, and in a few short months most of the newly purchased cameras and lighting equipment at British studios became obsolescent. "The Jazz Singer" and "The Singing Fool," caught the public's fancy—soon there was a flow of American sound films and reproducing equipment.

Vitaphone synchronised discs were the first successful method, but were quickly followed by the sound-on-film systems of RCA, Western Electric, de Forest and British Acoustic.

At Gainsborough, we experimented with the original British Acoustic system, which then used an entirely separate film for sound, running 50% faster than the picture. Meanwhile, hundreds of British theatres were being wired by Western Electric with machines capable of playing off either synchronised disc or sound-on-film, W.E. type. I was advised that the RCA system could be played off on the Western Electric reproducers, and that it could be accommodated in the limited space available at Islington Studios. And so, Islington Studios were soundproofed and fitted with RCA recording equipment at the same time as B.I.P. and Twickenham, though B.I.P. received their channel first.

"The Wrecker," "The Crooked Billet," "The Return of the Rat," "The City of Play" and "Taxi for Two," were silent pictures, which had to be held up for sound. It was a case either of complete loss, or of mitigating the loss by making these films wholly or partially into talkies. So we turned them into partial talkies. Some of them, such as "The Wrecker," had music and effects synchronised in New York. Others were recorded in

boom in the City. Most of the money was raised for distributing and exhibiting companies, who never failed to quote on their prospectuses the British films they had distributed or exhibited. These were their films, as ever—their achievement, perpetuating the domination of the primary producer by other trade interests. From this position the unfortunate producer has never escaped. Bricks and mortar and the middle-men were regarded as the tangible assets of the film industry, and were allowed to be the major influence on the first Quota Act which, as is well known, served only to increase the unhappy plight of British film production.
England on the new recording equipment. They were half-mute, with the last reel or two suddenly becoming voluble. Peculiar hybrids they were, but they were saved from the scrapheap and did not fare badly with audiences.

The Birth of Gaumont-British

I will not dwell upon the next phase. We had a fire at Islington and were out of action for a few months. "Balaclava" was completed on one of the stages at B.I.P.

Not long after the plant was rehabilitated at Islington, I extended my activities to Shepherd’s Bush, and found myself in charge of a large number of productions. Gainsborough, Gaumont Film Hire Service, Ideal and a large number of theatres had been amalgamated under the banner of the Gaumont-British Picture Corporation. The days of vertically integrated combines were arriving.

The Ostrer brothers had acquired Gainsborough and I was to be in charge of production, both at my old studios and the new Gaumont-British studios at Lime Grove, Shepherd’s Bush. Some years of really feverish activities followed. It is perhaps forgotten now, or not realised, how widespread our activities were. The Islington and Shepherd’s Bush studios were working at high pressure, but even so, we had to rent space in other studios. And we were adventuring overseas: "Rhodes of Africa" was made partly in Africa, "The Great Barrier," exteriors in Canada, "Barod" (with Rex Ingram) in the South of France, "Journey's End" in—of all places to go to make a film—Hollywood! There were the films at the Emelka Studios in Munich and at the UFA studios in Berlin, "The Constant Nymph" in Austria, "Wings over Everest"—even in these days of a contracted world, the list is impressive.

A short list of some of the films made during this hectic Gainsborough-Gaumont-British period reminds one of the formative effect of those years on our native kinema: Hulbert and Courtneidge in "The Ghost Train" and Hulbert again, with Renate Muller, in "Sunshine Susie," "Jack's
The Boy" and "Soldier of the King" on the one hand—Flaherty's "Man of Aran" on the other; "Friday 13th," "Little Friend," "Tudor Rose." There was the Arliss series: "The Iron Duke," "The Guv'nor," "East Meets West," "His Lordship." There were the musicals with Jack and Cicely Courtneidge, Lilian Harvey, Jan Kipura, Evelyn Laye and the one and only Jessie Matthews—"Evergreen" was perhaps the best of the lot. There were the Tom Walls farces. There was "The Good Companions," the first talkie to be seen by King George V and Queen Mary. Hitchcock was making an international name for himself with such films as "I was a Spy," "The Man who Knew Too Much" and "39 Steps."

Looking back on the titles, one would imagine that they meant a healthy thriving industry. So in a few years' time, remembering titles such as "Hamlet," "Great Expectations," "Fallen Idol," "Odd Man Out," "Red Shoes," "Oliver Twist," "The Winslow Boy," "Scott of the Antarctic," "The Overlanders," "Passport to Pimlico," it will be hard to explain why there should have been, at the end of the nineteen-forties, a film production crisis. We have learnt the lesson now, that it is not enough for the primary producer to make good and successful films for him to remain solvent. We were beginning to find out in 1936 when financial crisis hit Gaumont-British production and work ceased.

The Influence of Sir Alexander Korda

In the nineteen-thirties, Sir Alexander Korda hit the British film industry like a tornado. He exerted the most lively and stimulating influence on British films, for he is one of those rarities, a man who combines great business acumen with a personal creative talent. No review of past years could be complete without reference to the magnificent contribution made by him: "Wedding Rehearsal," "Henry the Eighth," "Catherine the Great," "Sanders of the River," "The Ghost Goes West," "Four Feathers," "Scarlet Pimpernel," "Elephant Boy," "The Drum," "The Divorce of Lady X," etc.—films which are genuinely of the international calibre.

It was to the studios he had caused to be built that I went after the temporary cessation of Gaumont-British production. Metro-Goldwyn-Mayer asked me to take charge of their production here and, with some misgivings, I accepted. First I went to Hollywood, there to prepare the first film, "A Yank at Oxford," to be made at Denham. I have much admiration for American production methods, but I found it difficult to integrate myself into them, and after "A Yank at Oxford" I decided I should prefer to take a chance on independent production, and the M.G.M. lion and I parted company. By a curious coincidence, my first two partners in business became involved in this. Victor Saville took over producing the films for M.G.M.; Reg. Baker proposed that he and I should again unite. We are still together at Ealing in 1949.

Undertones of War

This partnership began in 1938, the year of Munich, a year of much hesitancy in all commercial enterprises and—inevitably—another year in the film crisis calendar. We started very modestly at Ealing with a second feature re-make of Edgar Wallace's "The Ringer" under the title "Gaunt Stranger," and later, "The Ware Case." I have always believed that the type of film with which we have become associated started with "There Ain't No Justice" which, I may say, was made for less than £15,000 and still contrived to show a loss.

There is no question that the greatest influence on British film making, and certainly the greatest influence on the Ealing type of film, was the impact on our native cinema of the second world war.

Because of the rather irresponsible plunge that in the 'thirties' the city
had made into film finance, with the inevitable accompaniment of adventurers with little or no qualification to produce films—because the first Quota Act had been more or less brought into disrepute by the "quickies" which flooded the market—the prestige of the film industry generally was then at a low ebb. It is no secret now, that in the early days a move had been made to disband the machinery working the Quota Act, and it looked as though the history of the first world war would be repeated as far as British film making was concerned. There was no immediate protection of studio personnel, who were joining up or being called up at a fast rate.

The American production interests here, anticipating no doubt the collapse of the renters' Quota, ceased production. The Government's attitude towards the industry was undefined, but there seemed to be a vague idea that the G.P.O. film unit could furnish all that was required of wartime production; indeed, the G.P.O. unit—later to become the Crown Film Unit—did a very fine job, but their mandate in the main was to make propaganda shorts, instructional five-minuters and so on.

Wartime Role of the Film

Were production of commercial features to have been abandoned, the production industry would have really gone down irrevocably, as I maintain it could never have survived a hiatus of six years.

Fortunately, the war found even film producers in a fighting mood. It did not require much imagination to realise the post-war consequences economically (and, indeed, from every other point of view) of being without a national film industry. But even if any of us lacked that imagination, the lesson was quickly drummed into us by such enemy films as "Baptism of Fire," that there was an actual and practical wartime use for films, which meant that a closing down of the industry meant the immediate loss of a potential weapon of war.

And, in retrospect, it is no idle claim to make that British films did play their part in rousing American opinion, in relations with allied and neutral countries, in keeping up the morale of the troops, and, more particularly, of the civilians in a war in which the civilians were more fully involved than ever before.

Wartime Film Production

Two factors emerged, both of the greatest importance and the widest implications. The first, of course, was the purely psychological effect of the conflict on film-makers, as on all creative people. It is a comment on the human scene on which I am not qualified to enlarge that, as flowers grow on bombed sites, so out of the horrors of all wars all arts begin to blossom.

The second was an understandable external influence on the type of film produced. It was an understood thing, since personnel was reserved and materials in short supply were required for manufacture, that only films could be made which were considered "worth while." This did not mean that all films had to be propaganda: the question of keeping up morale was rightly considered as being within the category. Yet the total effect was salutary. Every subject that came up for discussion in the studios had to be examined in the light: was it right to use much needed timber for this purpose—much needed metal for that—much needed personnel for the other?

This was a spur which gave film producers, as at no other time, a sense of their deep responsibility towards the State and towards their fellow citizens. From this spur sprang such films—at Ealing alone—as "The Foreman Went to France," "Next of Kin," "Nine Men," "San Demetrio, London" and in other studios "49th Parallel," "We Dive at Dawn," "The Way Ahead," "The Way to the Stars," "The First of the Few," "In Which We Serve,"
etc. There was a definite common denominator in these films—an approach to film making in which the tinsel of pre-war production was replaced by a form of fictional realism which owed much to the documentary school of film making, but which primarily became a form of film journalism, in which the kinema held a mirror to the strange and fearful world in which we found ourselves living.

In the 1939-1945 war, the British film production industry really found itself. The question is—what have we built so far on this splendid foundation—and what, in the future, are we likely to build?

The Problems of Peace

It was my view during the war years, when the J. Arthur Rank Organisation was undergoing its rapid process of development, that Mr. Rank was making a bid to secure a virtual monopoly in the film industry. Events have proved me wrong. True, Mr. Rank was building up a vertically integrated combine, but it was in competition with others which were developing and (most important of all) it was in competition with the American influence on our kinema. Here was the real bid for monopoly, and monopoly on a world scale.

We began to realise at Ealing that only by building up large production-distribution-exhibition units could this country put itself in a position to talk terms with American film companies, and we attached ourselves—through a distribution contract—to the Rank group of companies. It was not a question of the principle of vertically integrated groups, but of practical issues.

The peace was not long advanced when the soundness of the position from the practical point of view showed itself. The combine, like the protective Quota, proved itself a necessary expedient. Only the strength of the British groups has enabled us to hold our position. The real conflict—and the key to our future—is the Anglo-American film war for markets.

The position today is that America maintains a virtually complete monopoly of her own domestic exhibition, and though statutorily allowed only 60% now of British screen time, in fact must possess more nearly 70%. It will be seen from this that American films can obviously be costed at a much higher level than our own, and our rivalry begins on this basis. I have often said, and always believe, that brain power and not money power is the most important factor in the manufacture of films; but even I cannot ignore that there is a great difference between making films with a theatre potential of 15,000 to 20,000 theatres on the one hand, and 5,000 theatres on the other. (These are not actual figures, but I use them to illustrate roughly the relationship between British and American exhibition potentials.)

The Causes of the Crisis

What is the result? Much of the present crisis in British film production may be laid at the feet of the policy of costing films on an expectancy of proper American returns, thus making films with star and production values to compete with the best American product in our own domestic market. It is easy enough to advocate that we should make films costed on an expectancy of domestic returns only, but inevitably this diminishes the appeal of such films in our own British kinemas.

These are the problems we have to face in a future as uncertain as any I can remember in thirty years of production. Uncertain, yes, but was there any time when the hopes were as high as they are today for British films? One factor we cannot ignore in our assessment of the situation: we have proved repeatedly we can make films as good as the best from any country, America included, and (so I believe) with as great an international appeal.

But our problems cannot be over-simplified as being vis-à-vis our American competitors. Nothing I believe is quite so complicated as the film industry
is internationally. For instance, the problems of the British and the American primary producer are in fact identical vis-à-vis distribution and exhibition. In Britain as in America, producers bear witness that the primary producer is not getting a fair share of the film’s ultimate revenue.

In Britain this is largely the cause of closed studios, unemployment, retrenchment of every kind. In America the unemployment is even more serious than it is here; production is at a low ebb; there is retrenchment as stringent as any here. In France and, I believe, in Italy, in spite of some excellent product, there is a similar situation. As far as Hollywood is concerned, what a lesson can be learnt from the fact that, despite a virtual world domination of markets, the American production industry suffers from depression.

**Hopes of the Future**

At long last there is the welcome sign that the worst aspects of the struggle are over, that prejudices are being overcome and that some attempt will be made to take a long view of English-speaking film production going forward with the goodwill of two peoples. We can only hope that these talks will resolve many outstanding problems for the future. Rightly, the Americans have condemned the quota system; I say rightly, although nobody is a greater champion of the Act than I am. But it is right in the long term view to dislike the Quota system and to look upon it as a temporary expedient.

May I sum up briefly the hopes that I hold for the future, with the warning that my fears are implicit in my hopes?

1. An Anglo-American rapprochement.
2. A rationalisation of film production costs, accompanied, I fear, by continued sacrifice on the part of the top-grade personnel.
3. A resolution of the primary producer’s problem as to a fair share in a film’s earnings.

4. A streamlining of the trade-union problem—i.e., some attempt to bring about a unified representation of the workers’ interests.

Finally, I believe that the greatest hope that can be held out for our industry is that there are men in it who do not regard film-making merely as a means of livelihood, but who have a passionate interest in film-making as an art and who hold a passionate belief that in no civilised country today should this medium of national expression be allowed to perish, or lose its freedom.

DISCUSSION

Mr. T. S. Lyndon-Haynes: Would bilingual films, such as those made in Germany, have any importance to-day?

The Author: It is difficult enough to make a good picture in one language, but when you try to make two versions it is generally impossible. I do not look upon it as a solution to any problems, for the purely theoretical and commercial approach is not any solution to film making.

A Visitor: I should like to pay tribute to Sir Michael’s work in a branch of film production, the film poster. I am very pleased to see the work of Barnet Freedman, John Piper and other dignified photographers and artists in your posters. What reaction has been received on this aspect of film publicity?

The Author: We have a very unusual contract for the distribution of Ealing films: we have the right to say something in the exploitation of our films up to their West End presentation. It has always been my view that film posters are not worthy of the industry. Two men have had a large part to play in this matter; they are Monja Danischewsky and John Woods, old and very valued colleagues.

Many societies and institutes all over the world are sending for these posters. They have been borrowed for exhibition at the Victoria and Albert Museum and for Exhibitions in other places. But the view is held by some people in the industry that our posters are not ticket sellers; they are, of course, entitled to their point of view and I have mine.

Mr. Ralph Bond: What are the possibilities of achieving the American rapprochement which you mention in your Charter and on what basis would it be of value to the British film industry?

The Author: Negotiations are in a certain stage and I do not want to say anything that would affect them. I have always thought the quota good enough as a temporary expedient. One cannot go back on one’s political belief and I was brought up in a Gladstonian atmosphere and am a hardened free trader. We want to see the manufacture of a certain number of good films in America, in this country
and in other countries. Some world patent has to be worked out whereby there is a free world exchange of those films.

Miss Frances Cockburn: What about co-operation between this country and others within the Commonwealth?

The Author: This question gives me a chance to elaborate on the English-speaking film. The over-riding consideration is co-operation between England and America. It has always, however, been my ambition to make a contribution in building up film production in any of the English-speaking countries. I look forward to the day when there is film production in Australia, Africa and Canada.

A Visitor: Would Sir Michael give his opinion of Independent Frame film production?

The Author: I cannot do it, because I have never worked on I.F. It is a logical extension of processes known to many of us for a number of years. The whole of my personal approach to film making is in the opposite direction to I.F. We like working on actual locations and I personally would like to make films without working in studios.

A Visitor: What are your feelings with regard to television and the future of film production in Britain?

The Author: Television must come in the public interest. As to its impact on cinemas I am not sure. I am a viewer myself and find the outside broadcasts fascinating. But the general studio production is handicapped by limited technical facilities. Television men are beginning to express themselves in their own medium. In America, some people say it has had an effect on cinema audiences and others say it has not. I really do not know. Television will not be able to provide all the entertainment needed without the aid of the film industry.

Mr. Leslie Knopf: For some years the proportion of British first-feature films has been approximately six “A” films to one “U” and, on the other hand, British second-feature films have been in the proportion of about 10 “U” to one “A.” Is not this ill proportion somewhat prejudicial to film production, bearing in mind that exhibitors prefer a programme of either all “A” or all “U” films?

The Author: Any form of censorship is unacceptable in general terms. The B.B.F.C., however, operates admirably and the problem is the silly categories, “A” and “U.” They do not really serve the purpose which is intended, i.e., keeping children from films which are unsuitable for them. That is largely the responsibility of the parent. I believe discussions are taking place as to the possibility of changing their categories.

BOOK REVIEWS

Books reviewed may be seen in the Society’s Library

HOW TO DIRECT AS AN AMATEUR, by Tony Rose, Focal Press, 6s. net. Introduction by Roy Boulting. Illustrations by John Halas.

Remembering that this book is primarily intended for the information of the amateur, the contents reveal the absolute suitability of choice of an author. Tony Rose is himself an amateur director, who is still sufficiently in the experimental and learner stage to understand absolutely the problems of his contemporaries in the field. With that knowledge he combines a balanced artistic sense and a power of expression that are invaluable. Somebody once said that Shakespeare was full of quotations; in the same sense, I can anticipate Rose being quoted freely whenever and wherever amateur film makers meet in conference.

Admitting—and the author admits it too—that the examples given from amateur productions are a little “corny,” there is very real appreciation of the problems involved in bringing a picture to the screen. A reasonable proportion of the book deals with the pure mechanics of the process, but the most important and illuminative is devoted to the equally important imponderables—those questions of characterisation, situation and interpretation that really constitute film making. Yet at no time is it over the head of the relative tyro.

Every amateur director can learn something from this book and—dare I whisper it—so might some of the makers of our less successful second features.

G. H. Sewell.


This forbidding title is the Dutch translation of the popular Focal Press book, Working for the Films, published here in 1947 and reviewed in the November, 1947, issue of this journal. Nineteen specialists in film production tell the reader about their particular work, and their success in doing so is indicated by the world-wide demand for the book and the popularity of this new edition.

A. W.
CURRENT PRACTICE IN 16mm. SOUND PRINTING

M. V. Hoare, B.Sc., F.B.K.S., F.I.B.P.*

Read to the B.K.S. Sub-Standard Film Division on February 9, 1949

ALTHOUGH I have nothing new to announce nor can I even claim to be a technical expert in the field of 16mm. sound, I feel that a survey of the position and a summary of the problems and difficulties encountered in producing 16mm. sound prints, may help the user to get better sound, and possibly to avoid unnecessary expense.

I. THE S.M.P.E. STANDARD

The 16mm. field suffers, in comparison with the 35mm. field, from the great variety of methods and procedures by which 16mm. prints can be produced\(^4\). In some cases 16mm. prints are required as a by-product of a film in which the main release is in 35mm. In other cases, the main release will be in 16mm., but a few 35mm. copies will be needed, whilst in other cases again, only 16mm. release is contemplated. This, inevitably, has led to a confusion of practice as compared to 35mm. work.

When the S.M.P.E. drew up standards for 16mm., they considered it was largely an amateur medium and that the reversal process would be largely used. A reversal original, since it is exposed in the camera, should be laced emulsion towards lens, and the S.M.P.E. standard laid it down that this was the standard emulsion position on 16mm. prints.

Today 16mm. is almost entirely a commercial field, and often large numbers of copies are required, so that the camera original, whether it be a negative or a positive, should never be projected or used for editing, and the original basis for the difference in emulsion position has gone. However, the S.M.P.E. re-affirmed the standard emulsion position when they re-examined the standard in 1947 and re-issued it as A.S.A. Z22-16.

II. METHODS OF PRINTING

A print with the emulsion in the required position is produced if reversal material is exposed in the camera, and release prints are made from a duplicate negative made from the original. This procedure has advantages. The grain of reversal materials is low\(^2\), and if the negative is damaged in printing (which easily happens with perforation on one side only) the original is always available to make a new dupe. However, two printing operations are involved, leading to some loss of sharpness.

If the standard 35mm. negative-positive method is adopted, only one printing operation is involved, but the print is now non-standard, and it must be laced emulsion towards light. In fact, the production of an S.M.P.E. standard print necessarily involves the use of one reversal stage, and from an original 16mm. negative involves either printing through the celluloid with the negative upside down on the printer, with consequent risk of damage to the negative, and loss of definition in the print; or printing a master, making a reversal print from this master, and then printing a dupe from this, a total of four printing operations\(^3\).

Non-standard Prints from 16 mm. Original Negatives

Thus, it is usual from 16mm. negatives to make contact prints to be laced on the projector the wrong way round. When this is done, unfortunately,

*Kay Film Printing Co., Ltd
the sound track is also on the wrong side, because if the print is held in the
standard position for S.M.P.E. lacing, it will now have the track towards
the operator, not away from him. This is the track position laid down in the
old D.I.N. standard, and the print required is, in fact, a D.I.N. print with
the picture laterally reversed!

Unfortunately, it is not possible to print such a track from an S.M.P.E.
standard sound negative without printing through the celluloid of the negative
with the negative upside down. This leads to some loss of quality in the
sound due to loss of treble frequencies, and also to some increase in back-
ground noise, due to fine celluloid abrasions being printed. Reasonably
satisfactory prints can be made in this way, provided that a suitable printing
machine is used, with good contact and reasonably specular printing light.
But obviously a D.I.N. negative should be recorded if prints are to be made
in this way.

Non-standard Projection

Another problem is presented by the mobile van, which back-projects
on to a transparent screen in the rear. In back-projecting, the picture is
laterally reversed.

There are three solutions to this problem. One is to project via a process
prism with the projectors fitted sideways in the van; this produces the

![Fig. 1. Sound-track position for 16mm. Sound Film in front projection, emulsion towards lens (S.M.P.E. print). Reproduced from A.S.A specification Z.22-16-1941.](image)

required second lateral reversal, and a standard S.M.P.E. print is then
required. The second is to equip such a van with D.I.N. projectors, if
such machines can be obtained; a standard S.M.P.E. print is then required,
which is laced emulsion towards lamp and the required reversal so produced.
The third and commonest procedure is to use S.M.P.E. projectors and obtain
a D.I.N. print, which is laced emulsion towards light; such prints may be
produced by printing a normal mute negative from the end (since the positive
stock cannot be reversed on the printer owing to the single row of per-
forations). This is practicable, but may involve replacing the printer
control clips or notches on some systems of light change control, that is,
it may involve a considerable amount of work on the negative and increased
wear and tear. Therefore it should be avoided with 16mm. negatives if
possible. In any case, a D.I.N. sound track will be required or an S.M.P.E.
16mm. sound track will have to be printed out of contact, through the base.

In all cases where the film is laced the wrong way round on the projector,
the question of refocusing the projector optics arises, as the sound track is
displaced by the thickness of the film base. To avoid loss of treble, it appears
that this should be done.
III. FUNDAMENTAL REQUIREMENTS FOR GOOD SOUND

The fundamental requirement for good quality sound in any system is that the treble frequencies should be retained and reproduced free from distortion and spurious frequencies. The length of film available for recording a frequency depends on the speed of travel of the film in the recorder or projector. With 35mm. film travelling at 18in. per sec. a 6,000 c/s note is recorded on three-thousandths of an inch of film. 16mm. film travelling only at 7.2in. per sec., only 1.2 thousandths of an inch of film are available.

This is the basic problem of 16mm. sound recording compared to 35mm. Top tends to be lost by irradiation, lack of sharp focus and finite slit width in the recorder, by slippage, lack of contact and irradiation on the printer (or lack of sharp focus in reduction printers) and by flutter, lack of sharp focus, finite slit width, and errors in azimuth in the projector.

Maintaining Resolving Power

To retain an effective resolving power throughout the whole process of 800 lines to the inch, or over 30 lines per mm., is a fairly formidable undertaking. It involves first, the use of film in which the resolving power is high and the irradiation low. Modern emulsions are capable of recording

![Fig. 2. (a) D.I.N. Print with laterally reversed image (laced on projector emulsion to lamp). This is the type of print produced from a 16mm. original negative with a D.I.N. 16mm. track. All diagrams emulsion side uppermost. Negatives to produce these are similar, but are then emulsion side downwards.](image)

![Fig. 2. (b) D.I.N. Print, as used for rear-projection (laced on projector emulsion to lamp). Producible from 35mm. materials or from a dupe from a reversal 16mm. original with a D.I.N. 16mm. track.](image)

![Fig. 2. (c) S.M.P.E. Print, producible from 35mm. materials or a dupe from a reversal 16mm. original, with a 16mm. S.M.P.E. sound track.](image)

the tracks with comparatively little loss, but it is to be expected that the slower stocks, such as 7302, will give better sound than the older, faster stocks such as 5301.

Secondly, it calls for really accurate and careful mechanical design and adjustment, in printer and projector—and recorder as well if a 16mm. negative is to be recorded. Unfortunately, the tendency is always for 16mm. equipment to be made to a price. The sound head of a 16mm. projector should always be carefully designed to give a low flutter content and to hold the film accurately located to ensure accuracy of focus.

In the laboratory more care is needed in the design and maintenance of 16mm. sound printers than 35mm. The difficulty is not that the film is incapable of recording frequencies of 6,000 c/s. or considerably higher—the resolving power of the film used is about 75 lines per mm., corresponding to a frequency of about 15,000 c/s.—but that the loss of treble is cumulative at each stage, and in aggregate is serious.

Variations in Frequency Response

One practical conclusion from this is, that the proportion of high frequencies
present in different prints will vary, even sometimes varying from print to print from the same negative, if the adjustment of the printers and projectors has been changed.

To give uniform good quality for all prints, it is therefore essential that a 16mm. projector should be fitted with really adequate tone controls. The amplifier characteristic should have a top lift corresponding to the average top loss in the normal print, and tone controls should be able to give either top lift, if the loss of top is above average, or top cut if an exceptionally good print has more top than the average. To deal with variations in auditoria, similar but independent control of bass is needed.

However, starting from a negative recorded with the normal 35mm. characteristic, there will be appreciably more loss of top in a 16mm. print than in a 35mm. This loss cannot entirely be made good by "peaking" the projector amplifier in the higher frequencies, because at the same time as the weakened top is amplified, the background noise level is raised as well. The loss of top results in a lowered signal-to-noise ratio.

Thus, whenever possible, a special recording characteristic should be used for negatives intended for 16mm. prints, so that the original recording has a gain, starting from about 1,000 c/s., rising to about 12 db. at 6,000 c/s. with a sharp cut-off above this frequency, as it is undesirable to record in the negative frequencies which will not be usefully reproduced in the final print. In considering means of obtaining 16mm. prints, the desirability of introducing this special 16mm. characteristic should always be borne in mind.

IV. RECORDING SYSTEMS

Turning now for a moment to the choice of recording system, variable area or variable density, the great problem of the former is image spread or irradiation in the recording and printing processes, and it is usually argued that the variable density system, which has less sharp boundaries between black and white, will be better on 16mm. because it suffers less distortion when image spread occurs.

In my personal view, this argument is fallacious. In the lower and middle frequencies, freedom from distortion is achieved by making the print to the correct density. If the printing exposure is judged so that the image spread in the printing operation is equal in amount to the image spread in the recording, the two spreads will cancel each other out, since the image spreads are in opposite directions. This is the usual principle of print "cancellation."

Signal-to-Noise Ratio

In addition to this problem of cross-modulation or "envelope distortion," 16mm. prints suffer from a lower signal-to-noise ratio than 35mm. prints, due to the smaller width of the track. An advantage of variable area prints over variable density is a higher signal-to-noise ratio and a lower percentage of distortion at full modulation. A variable density system depends for its freedom from distortion on the linearity of the overall reproduction curve of the photographic process. Although the reproduction curve is reasonably straight in the middle densities, it is curved at the lower densities of both positive and negative characteristics. Thus at full modulation, harmonic distortion is introduced. Furthermore, any error in the density of the print, altering the shape of the overall reproduction characteristic, will tend to lower the permissible percentage of modulation, and by introducing asymmetry will introduce second harmonic distortion on all heavily modulated passages.

In considering the treble response of the two systems, the question at once arises as to whether the special 16mm. recording characteristic is used
or not. If it is, as it should be for the best quality, then except at very low overall modulation, the highest frequencies will be nearly at full modulation at all times, especially when the general desirability of volume range compression compared to 35mm. is borne in mind. Thus in the upper frequencies, both systems give bars extending the full width of the track, but in variable area the bars have the best contrast between black and white that the film can record, whereas in variable density the contrast is less. Thus, I should expect a tendency for variable area tracks to retain more top.

Another factor, however, which is of importance, is the question of flare light, when an optical printer is used. In general flare light will increase with the proportion of clear area to dense area, and will tend to veil the whites of the print and increase background noise. In this respect, variable density prints are clearly superior to variable area.

My personal preference is therefore definitely for variable area negatives when contact printing from a 16mm. negative, but I am undecided when a reduction stage is involved.

V. METHODS OF OBTAINING PRINTS

Now we have a picture of the background, we can consider in more detail the various possible methods of making 16mm. prints.

First, we have the choice of four methods of printing sound:

1. Contact from 16mm. negative or dupe.
2. Optical reduction from a 35mm. negative or dupe.
3. Electrically by recording from a print.
4. Optically on a 1:1 printer from a 16mm. original.

1. The contact printing of 16mm. sound does not differ essentially from the contact printing of 35mm. sound, except in so far as extra care is needed in the design of the printer gate to ensure freedom from slippage and the best possible contact. Approximately parallel light, not diffused, should be used so that any slight lack of contact produces the minimum loss of top. At the same time, the printing aperture should be as narrow as possible to minimise the effects of slippage. One advantage of contact printing is that ample light is available, so that it is easy to print on 7302 with its higher resolving power. Often in optical printing at an economic speed, it is difficult to get enough light to expose this stock, especially on picture, so that prints have to be made on the faster but grainier stock 5301, with its lower resolving power. Although there is always a slight risk of damage to the negative due to its single row of perforations riding the sprockets, it is in no way serious, and we make 50 prints or over from a single negative without negative damage.

2. Optical reduction of a 35mm. track to 16mm. poses at the start a rather serious optical problem. The image of the 35mm. negative must be reduced in length in the ratio of 2:5, while the width of a 35mm. sound track is .055in. and that of a 16mm. sound track is .065in., so that the width of the track should be reduced only in the ratio of 85:65. Thus an optical system incorporating cylindrical lenses or their equivalent is required.

A suitable system can be produced with two cylindrical glasses provided that the working aperture is kept low enough to avoid the aberrations of the uncorrected lenses becoming serious, or by special computation, a corrected system can be obtained.

An alternative method of working is to use spherical lens systems, but to place a Fresnel biprism in the system. This has the effect of producing two images of the negative track side by side on the positive. If these are accurately placed, the total width is 68 mils and is thus only three mils too
wide, which can be accommodated in the lands without trouble. Naturally a highly corrected spherical lens can be used, but the azimuth of the biprism must be most accurately adjusted if it is not to cause loss of top due to relative displacement of the two tracks. Although some users do not like this form of track, it should have advantages from the point of view of freedom from distortion due to uneven illumination of the reproducer slit. Most variable area systems now deliberately use masks to give double or quadruple tracks for this reason.

There should be very little wear on the 35mm. negative on the printer, and large numbers of copies are possible. The major problems are the risk of slippage or flutter with the two films travelling at different speeds in different heads, and the losses in the optical system due to aberrations or maladjustment.

3. An electrically recorded track is obtained if positive stock is loaded into a 16mm. recorder in which the mask and the noise reduction are reversed, and the recorder is then fed with the output from any suitable sound head, usually 35mm.

This method can be employed only to produce a variable area track, since only in this system is it possible to make the output from a recorder into a positive, assuming, of course, that reversal processing is not used as well.

Fig. 3. Normal Optical Reduction Print and Twin Track of Debrìe Reduction Printer.

The great advantage of this method is that it can produce a 16mm. print directly from a 35mm. print without the necessity for making a dupe, and at the same time can introduce the necessary top lift in the amplifier. The amount of light available in the recorder is such that normally prints are made only on 5301.

The objection from a theoretical point of view lies in the absence of cancellation. Since it is the actual recording which is reproduced, there is no printing stage to introduce cancellation. This means in practice that the print must be kept light enough for the image spread to be small, and thus there is some tendency to increased background noise, especially with wear on the print.

Another interesting point which arises in connection with this method of making prints is the question of patent infringement. Theoretically at least, it seems that it might be argued that this is not a printing but a recording operation. Messrs. RCA Photophone, Ltd., offer their customers insurance against claims for patent infringement if the originals are not recorded by the RCA system. In actual fact, it seems doubtful whether such a claim for infringement would lie, since the result is a positive suitable only for projection. I am no lawyer, and as far as I know the position has never been tried in the courts, but millions of feet of prints have been made in
this way on various equipments from all kinds of negatives and no action has followed.

4. It has fairly often been suggested that owing to the difficulty of obtaining good contact between two 16mm. films it might be better to print sound optically, using a 1:1 optical printer. At first glance it might appear that the better optical contact would be obtained by focusing an image on the stock than by trying to place the stocks in contact. In fact, it is doubtful whether the imperfections of the lens system and the flare involved would give a sharper image than is obtained by contact, especially when printer slippage is taken into account.

The great advantage of the method is that it should then be possible to get good contact when printing D.I.N. prints from S.M.P.E. negatives and vice versa. A factor telling against this method is the relative costliness of such a printer compared to a contact machine, and the need for accurate focusing. In fact, as far as my information goes, there is no such machine in use in this country, although such a machine has been described in the S.M.P.E. Journal, and is claimed to be giving good results in the States.

VI. OPTIMUM WORKING METHODS

Now to turn to the best methods of working in the various cases which arise in practice.

1. 16mm. prints where the main release is in 35mm.—Here the original material available is a 35mm. master and 35mm. negative or dupe. For a small number of copies both picture and sound are commonly reduction printed, using the 35mm. originals. The sound was recorded, of course, with 35mm. characteristic, so that some loss of top is to be expected. By altering the direction of printing either S.M.P.E. or D.I.N. prints can be produced.

If the number of prints required is large, it is well worth considering contact printing. A 16mm. picture dupe is made from the master and a 16mm. track must be provided to match. Since the dupe is made optically, it can be reversed at this stage to give an S.M.P.E. print. The track negative may be produced by optical reduction on the reduction printer—in which case quite serious loss of top is to be expected since there are two 16mm. printing operations from an original recorded with a 35mm. characteristic—or the negative may be produced by re-recording. The advantage of making the 16mm. negative in this way is that a better negative of higher density is obtained, and that the 16mm. equalisation can be introduced. The question that arises is whether the improvement in quality justifies the extra cost.

2. 16mm. prints constituting the main release but a few 35mm. prints required.—This case is rather common with documentary and instructional films. If any 35mm. copies are required the film will be made in its entirety on 35mm., as the loss of quality on "blow up" should not be accepted other than in exceptional circumstances, so a 35mm. track will be recorded. At first sight, there appears to be no difference between this and the previous case. However, in such cases there are two possibilities which are worth considering. If the sound track is relatively simple, consisting of commentary and music only, or relatively simple sync. sound, so that not many takes are likely to be needed in recording or re-recording, it may be worth while recording a separate 16mm. track simultaneously with the 35mm. One firm, at least, can offer such a service at a small extra charge. Then the 35mm. negative would be recorded normally and would also serve to provide the protective master, whilst the 16mm. negative with the 16mm. characteristic would give contact 16mm. prints. Such a negative would normally be printed with a reduction dupe of the mute.
Another possibility, if the extra cost of a 16mm. negative is rejected, is that of recording the 35mm. track with the 16mm. characteristic. This will mean that the 35mm. prints will show an excess of treble, but not intolerably so, whilst 16mm. prints of better quality will be obtained either by reduction or from a reduction dupe.

3. **16mm. release only contemplated.**—Where a production is planned for release on 16mm. only, the whole question of production method must be reviewed. Very often such films are shot on 35mm. because of the superior quality obtainable and the greater ease of cutting, owing to edge numbers, and the better facilities for opticals, etc. In such a case, the release will usually be reduction printed for the mute. From the point of view of quality only I would prefer to record the track direct on to 16mm. and contact print it, even though the picture were reduction printed. Alternatively, the sound could of course, be recorded on 35mm. with a 16mm. characteristic and then reduction printed. The advantage of the latter procedure is that a 35mm. print from the 35mm. negative serves as protective master in case of damage to the negative, since 35mm. sound tracks can be duped without appreciable loss. Where a 16mm. negative only is made, it cannot be duped without loss of quality so that there is no effective protection against damage to the negative.

Another rather serious point at times is the problem of providing an occasional D.I.N. print for back projection. As has been previously mentioned, a D.I.N. print cannot be made from a S.M.P.E. negative without printing through the celluloid, with consequent loss of quality. If, therefore, any D.I.N. prints may be needed a 35mm. negative should be prepared.

For a large 16mm. release, it is desirable on the grounds of economy to make the prints by contact. In this case, prints should be made from reduction dupes of both sound and master negatives, the originals being used only to provide any D.I.N. copies that might be required.

If the original material is shot on 16mm., the question at once arises of whether negative-positive or reversal material is going to be used. Naturally in such a case, sound will be recorded directly on to 16mm., and if the neg.-pos. process is used, the company doing the recording must be warned that a D.I.N. track will be required, as the prints will have to be laced the wrong way round in the projectors. With the original shot on reversal material and prints made from a contact dupe, an S.M.P.E. sound track is needed. There are few greater irritations than finding a track has been recorded which is excellent except that it cannot be printed other than through the celluloid!

**CONCLUSION**

Such strides have now been made in emulsions, printers and projectors, that the former view of 16mm. sound, that intelligibility was all that could be asked for, is quite out of date. 16mm. can under favourable circumstances give sound which compares well with 35mm. However, greater care is needed at all stages to achieve the best results, and especially, a 35mm. track which gives an inferior result on 35mm. will generally give an unacceptably bad result when reduced to 16mm.

The author's thanks are due to the Kay Film Printing Company for permission to deliver this paper and for their encouragement and help in preparing the demonstration film, to Messrs. Leevers, Rich and especially Mr. Norman Leevers for providing the negatives from which the demonstration film was printed, and for advice on many points, to Mr. Smith of Merton Park Studios for re-recording the variable density negative at very short notice, and to Messrs. Sydney Wake, Ltd., for preparing the electrically recorded print.
At the conclusion of the paper a film was projected made up of sections of sound prepared by the following methods:

1. 35mm. print from a variable area 35mm. neg. (16mm. compensated).
2. A contact print from a 16mm. neg. recorded at same time as 35mm.
3. A reduction print from the V.A. 35mm. negative.
4. A reduction print from a V.D. negative re-recorded from the 35mm. print.
5. A contact print from a reduction dupe from the 35mm. V.A. negative.
6. A contact print from a reduction dupe from the 35mm. V.D. negative.
7. An electrical print from the 35mm. print.
8. A print from a contact dupe from the 16mm. negative.
9. A print from the original negative made through the celluloid and spliced in to be projected through the celluloid.

REFERENCES

DISCUSSION

Mr. H. S. HIND: Why does the negative suffer more damage in reduction than in contact printing?

Mr. L. H. DUNK: On a reduction printer there is no positive stock in contact with the negative, which is entirely open to abrasion.

Mr. W. LASSALLY: What is the difference between an optical reduction print and an optical reduction dupe?

The Author: With optical reduction prints all release prints are printed on the reduction printer from a 35mm. negative. With a reduction dupe the release prints are made by contact from a 16mm. duplicate negative which is made on the optical printer from a 35mm. print.

Mr. N. LEEVERS: Appalling chaos in 16mm. laboratory work centres round the S.M.P.E. Standard. You cannot get a standard first generation print with either negative or reversal stock in the camera. Should not the Society look into the question of whether it would not be better to alter this standard?

The Author: Making all release prints by reversal is probably prohibitively costly, so that any standard must favour either neg.-pos. or reversal as the original camera material.

Mr. LEEVERS: In your paper you favoured the original work being done on 35mm. I am suggesting that the standard be altered to suit these requirements. From the sound point of view, some time ago the position became so chaotic that I decided that the only solution was to record on magnetic tape, for transfer after the customer had made up his mind.

Mr. J. ROGERS: Have you any views on the densities of the negative and prints produced by electrical re-recording to give the best print with the least distortion?

The Author: The densities depend largely on the system employed, and especially on whether white light or ultra-violet is used for recording. Due to the higher resolving power needed the negative density should be lower than in 35mm. work. The print density should be such as is needed to give a normal cancellation as shown by cross-modulation tests, but will vary with the stock and the printing light used. With direct electrical recording for prints, the print density should lie between 0.9 -1.0, with 1.0 probably regarded as a definite top limit.

Mr. LASSALLY: You talk of focusing the projector for D.I.N. prints, but there is only one projector on which it can be done.

Mr. SUTTON: As a projectionist, I find it is quite usual to splice together several 400ft. lengths on to one reel to make up a programme. You may get black and white, Technicolor and Kodachrome together. It is very much easier to try refocusing than to listen to the horrible reproduction.

The Author: On the question of distortion, harmonics when dealing with top are unimportant as they are too high to reproduce. In many cases very serious flutter is present. In any case you cannot just lift top at the end, it must be done by stage.

On the question of refocusing, several projectors have provision for refocusing. The B.I.F. made for Pathé had change-over of the entire optical system to enable either print to be run correctly. It should be an advantage if a simple shift knob for the two lacing positions were available.

I am horrified at the suggestion of splicing reels together in this way. Should it not be brought to the attention of the film mutilation committee?
MOTION PICTURE PHOTOGRAPHY

Frederick A. Young, F.B.K.S., F.R.P.S.*

Report of address given to the B.K.S. Film Production Division on February 23, 1949.

As a preface to the projection of a number of reels of film for the photography of which he had been responsible, Mr. Young discussed some practical aspects of the work of the motion picture cameraman.

He first considered the relation of the cameraman to the director. Some directors, he said, were technically wise and helped the cameraman sympathetically with his difficulties by arranging action so that it was possible to light speedily, or possibly in arranging for a cut to avoid an otherwise complicated lighting problem. Nevertheless, the director must have the final decision, since the ultimate responsibility for success or failure of the film rested with him, and all the technicians—and even the stars—must bow to his judgment.

An experienced lighting cameraman would have learnt ways of saving time, and he was not experimenting in the same way as the beginner. But he must be careful to avoid turning out stereotyped photography, without artistry or meaning.

Not every picture gave the cameraman the opportunity to show artistic ability. Often he was put on his mettle to demonstrate his speed of working—yet was still required to produce a photographically acceptable picture.

Natural Lighting

Some cameramen strove for naturalistic lighting, the light appearing always to come from a correct source; others seemed to ignore this requirement, and allowed the light to fall from any direction, providing only that the general effect were satisfactory. The speaker emphasised his own preference for natural lighting, so that when the shots were edited there was a feeling of smoothness and correctness over the entire sequence.

This requirement, however, introduced a number of problems. A star often looked better with the key light directly in front, and not at all satisfactory with cross lighting; compromises were often necessary. Front key light was flattering to most faces, but it could be uninteresting to see an entire picture with the principal characters lit from the direct front, regardless of where the scene was located, or of the time of day. Some producers maintained that it was necessary only that the stars should look attractive, but good lighting was noticed, if only subconsciously, by audiences.

Questions of mood and atmosphere must not be ignored. Such factors helped to make a scene convincing, and to maintain a sense of reality, without which no film could be considered an artistic success.

Black-and-white versus Colour

In lighting for black-and-white photography, one sought to obtain a stereoscopic effect by a separation of the planes of the subject, so giving an impression of depth and roundness. A frequent method of producing this illusion was by the use of back-lighting. However, it was not always correct to have light emanating from the back of the set, and the use of back-lighting had in the past been overdone.

There was an infinite variety of methods of securing contrast in light and shade. A patch of light on a wall would throw into sharp relief a dark mass of furniture standing in front of it. A cunningly placed shadow made the perfect background for a light object. The co-operation of the art director

*M.G.M. British Studios, Ltd.
was valuable, in the careful selection of colours, and in avoiding placing dark objects one in front of another.

Colour photography was in some respects less exacting, for colours would separate from each other naturally. One would obviously avoid having a navy-blue dress in front of navy-blue drapes. All such factors would be appreciated by a trained artist, and it would be an excellent thing if every cameraman had had some art training, in order that he might appreciate the laws of perspective and of light and shade.

Light Sources

Just as it was necessary for an artist to have a variety of paints, and brushes of all sizes, so must a cameraman have lights of all shapes and sizes: powerful lights for the broad strokes, smaller lights for the fine detail. Every light had to be controlled, and spill or leak light must be kept from illuminating the shadows; all the units must have their barndoors, diffusers, or "goboes."

Lighting in a low key, such as moonlight or firelight, called for great skill and judgment; it was easy to under-expose and so lose contrasts. It was desirable to have somewhere in the picture one highlighted point—moonlight, a street lamp, firelight, or even a streak of light under a door. Reflectors might be used to give a soft radiance without any definite light source, but as a general rule there should be one high light in the picture, and one area of deep black.

The Light Meter

A light meter was used to obtain a consistent density throughout the film. The negative was developed by sensitometric control, and only a small latitude was allowable for incorrect exposure. If the laboratory were to be able to work to a constant gamma and obtain a fixed density throughout the entire negative, the cameraman was compelled to use a light meter.

It would, suggested the speaker, be foolish to try to judge by eye a quantity
that could be indisputably measured by means of a light meter. On the other hand, the cameraman must never allow the meter to become his master, but must use it as a servant to assist him technically to accomplish the final artistic achievement.

For interiors the speaker preferred to work at low light levels and a wide lens aperture, which more closely approximated the characteristics of the human eye. This also lent reality to practical lights used on the set, such as candle light, oil lamps, or electric lamps of low wattage, which, if a high key lighting were used, would be unnaturally dimmed.

Problems of Movement

In kinematography an entirely different set of problems was presented from those of still photography. The motion picture cameraman had to allow for the movement of his characters. If for instance an actor moved towards the key light, the brilliance might increase from perhaps 100 foot-candles to 200 or 300 foot-candles, and serious over-exposure would result. Dimmers must be provided to control the intensity of light throughout the scene. The dimmer controls must be checked by the cameraman with the aid of a light meter.

The first film projected was reel 1 of "Good-bye Mr. Chips," made in 1938; the speaker drew attention to the mellow atmosphere associated with a traditional English school. In contrast were reels 1 to 3 of "49th Parallel"; this film had an atmosphere almost documentary in style. It had been photographed during the early stages of the war, most of the exteriors being taken actually in Canada; these exteriors set the key, which had to be matched in the shots taken in a British studio.

The film "So Well Remembered" was set in a town in the North of England, and to create the atmosphere of squalor artificial rain was freely used.

DISCUSSION

Mr. Edric Williams: What would be the approach to obtaining brilliance without involving oneself in false shadows?

The Author: Brilliance is not necessarily obtained by using a lot of light. Balanced lighting to build up contrast
can be achieved by picking out various objects and possibly beam lighting on faces.

Mr. W. Lassally: How do you feel about more than one cameraman working on one picture?

The Author: Where joint working is concerned, I do not like pre-lighting. It is satisfactory neither to the man who is doing it nor to the man who has to follow on. Several cameramen working on a film is quite all right, however, if they do different sequences.

Mr. F. G. Gunn: Do you find it disturbing in lighting black-and-white pictures if you use light sources having a different colour, incandescent and arcs, or mercury?

The Author: Yes, I do. I have only used mercury lighting in black-and-white films for general flooding on backings; then the powerful green light upsets one's visual judgment and one has to rely on the meter.

A Visitor: What do you think of the use of the \( f \) scale compared with the old \( f \) value?

The Author: \( f \) calibration is not definite enough, and great errors have been found between different lenses whose \( f \) value marking is the same. The new method of calibrating lenses by transmission values will, I am sure, be welcomed by all cameramen. Difference in aperture can still be due to play in the iris of the diaphragm.

Mr. Ken Gordon: Can you expound a simple formula for high-key and low-key lighting in foot-candles?

The Author: If the director wanted great depth, I might set my lens stop at \( f/5.6 \) and use 300 foot-candles, whereas in the low-key set I would work at \( f/2.8 \) with 80 foot-candles, depending upon the colour of the set—that is a most important factor. For a high key of light the ordinary fair face with normal make-up would demand 100 foot-candles at \( f/3 \). If you wanted the face in a dingy light you could work down to 50 or 60 foot-candles at \( f/3 \).

Mr. Jordon: Can you tell us anything on the use of the S.E.I. meter in set work?

The Author: The S.E.I. meter is a very fine meter and is of great value for checking the various relative brightnesses. In the studio I use a Benjamin meter, or a Norwood Director. I use a Weston Master for exteriors.

**TECHNICAL ABSTRACTS**

**Most of the periodicals here abstracted may be seen in the Society's Library.**

**PROPOSED AMERICAN STANDARD.**


It is proposed to unify the perforation standard for negative and positive film stock, the draft standard showing a rectangular perforation .110 in. \( \times \) .073in. R.H.C.

**16MM. FILM PHONOGRAPH FOR PROFESSIONAL USE.**


Designated the "PB-176," this soundhead is similar in layout and appearance to the RCA PR-32 recorder, with a high quality reproducing optical system and a two-stage photo-cell amplifier taking the place of the light modulator in the PR-32 chassis. The photo-cell is mounted inside the film compartment. A brief technical specification is given.

N. L.

**EXPERIMENTS IN STEREOPHONIC SOUND.**


This report is based on a series of experimental films made with a three-channel stereophonic system. Brief reference to the special features of the recording and reproducing equipment is made, but the technique of handling the three microphones on the set is discussed in some detail.

N. L.

**A NEW CRYSTAL PHOTO-CELL FOR SOUND FILM REPRODUCTION.**


A new photo-cell consists of a small crystal only a few mils thick and a few millimetres long. No indication is given as to whether the cell generates an e.m.f. or has to be polarised; it has an output of 3 volts at 50 c/s and 0.7 volts at 10,000 c/s. The cell can be coupled directly to the grid of the first valve, as its impedance is only of the order of 30,000 ohms; its insensitivity to mechanical vibrations renders this particularly easy. The light sensitivity of the cell extends to 4,900 or 5,000 Å and then falls rapidly.

O. K. K.
FREQUENCY-MODULATED AUDIO-FREQUENCY OSCILLATOR FOR CALIBRATING FLUTTER-MEASURING EQUIPMENT.


The apparatus provides a 3,000 c/s signal which may be frequency modulated by a separate low frequency source of any wave form. The carrier tone is generated by a resistance-capacity oscillator and amplitude modulation is negligible.

N. L.

SILENT PLAYBACK AND PUBLIC-ADDRESS SYSTEM.


Designed as a means of transmitting playback recordings and director’s instructions to artists on a set without the signal being picked up by the recording microphone, the system comprises a 100 Kc/s transmitter connected to a loop aerial round the set, and miniature crystal receivers worn by the artists.

N. L.

IMPROVED 35MM. SYNCHRONOUS COUNTER.


A synchroniser is described having provision for altering the relation between the work print and the negatives. Illumination is provided for viewing the films.

R. H. C.

NEW AUTOMATIC SOUND SLIDE-FILM SYSTEM.


The picture changes in a film strip are governed by two low-frequency tones recorded on the accompanying disc. A 50 c/s tone saturates the control circuit and prevents change of picture. When this is replaced by a 30 c/s tone, the picture change relay operates.

The system is insensitive to random impulses.

N. L.

MAGNETIC DEVICE FOR CUEING FILM.


A magnetic cueing device eliminates the need for cutting notches in negative to actuate printer controls. Cues may be provided on each edge of the film, one set to actuate the tight change, and the second to actuate a fade-out device.

R. H. C.

THE COUNCIL

Meeting of September 7, 1949

Present : Messrs. A. W. Watkins (President), E. Oram (Hon. Secretary), F. G. Gunn, R. B. Hartley, H. S. Hind, B. Honri, T. W. Howard, I. D. Wratten, R. H. Cricks (Technical Consultant) and W. L. Bevir (Secretary).

The President referred to the loss sustained by the Society by the sudden death of Capt. A. G. D. West; members stood in silence for a minute. The Officers were authorised to consider a suitable form of memorial; a letter from Mr. Marcus Cooper was referred to them.

Deputy Vice-President.—On the proposal of Mr. Wratten, seconded by Mr. Honri, Mr. Oram was unanimously elected Deputy Vice-President.

Hon. Secretary.—On the proposal of Mr. Wratten, seconded by Mr. Gunn, Mr. Hartley was unanimously appointed Hon. Secretary in place of Mr. Oram.

Co-option to Council.—It was unanimously agreed to co-opt Mr. Marcus F. Cooper as a Member of Council, in place of the late Capt. West.

Fellowship Committee.—Messrs. F. G. Gunn and T. W. Howard were elected to the Fellowship Committee in place of the late Messrs. C. Cabiriol and A. G. D. West.

Journal Committee.—On the recommendation of the Journal Committee and in view of the time schedule to which it would be necessary to work, Divisions and Sections were to be instructed to submit papers in good time.

Library Committee.—Allocation of £15 for the purchase of books was agreed.

Divisional Lecture Programmes.—Divisional programmes for the autumn session were agreed.

R.P.S. Dinner.—The President reported that Mr. and Mrs. Oram would represent the Society at the dinner of the Royal Photographic Society.

EXECUTIVE COMMITTEE

Meeting of September 7, 1949

Film Copyright.—It was agreed to ask Mr. Wolfgang Wilhelm to represent the Society on the B.F.I. Committee on Film Copyright.
Elections.—The following were elected:—

PATRICK FILMER-SANKEY (Student), Signal Films, Ltd.
MICHAEL ARTHUR NUNN (Associate), Rayant Pictures, Ltd.
LESLIE RONALD FREWIN (Member), Associated British Studios.
PATRICK GEORGE BRYSON (Member), S. G. Brown, Ltd.
PAUL ANTONIO CHARLES BEESON (Member), Ealing Studios.

Resignation.—The following resignations were accepted with regret:—

LEONARD MAURICE LEACEY (Member).
ALBERT EDWARD BRIMMER (Associate).
JOHN ELWIN MATHIAS (Student).

LIBRARY COMMITTEE
Meeting of September 26, 1949

Mr. H. W. Preston was welcomed as a member of the Committee. The Chairman, Mr. M. F. Cooper, congratulated Mr. Rex B. Hartley on his appointment as Hon. Sec. of the Society, and was himself congratulated on his appointment to Council. Miss A. Walsh was appointed Hon. Librarian.

Whether the Library should continue to be kept open until 8 p.m. each Monday evening is to be considered at the end of the year. There had been few borrowers during the summer months, but it was hoped that patronage would increase.

THEATRE DIVISION COMMITTEE
Meeting of September 29, 1949

A report of the meetings arranged by the Division for 1949, was presented by the Deputy Chairman, Mr. S. A. Stevens, who presided. Arrangements were discussed for two 1950 papers, one on large screen television and another in the series of Modern Kinema Equipment, to take the form of a demonstration of the "Ross RCA" equipment.

BRITISH STANDARDS

B.S. 880 : 1949, Concert Pitch (2s. 6d.). The original version of this specification gave merely the requirement of a pitch for middle A of 440 c/s. The present revision outlines the historical background of the problem of pitch constancy, and stresses the growing need for international standardisation.

B.S. 1568 : 1949, Magnetic Tape Systems for Broadcasting. A tape width of .250in. and a speed of 30in./sec. are fixed; the full reel of tape shall have a playing time of not less than 21 minutes. Dimensions are given for the machine turntable and for the spool, the latter having a maximum diameter of 11.50in. Test frequencies of 1 kc/s, 8 kc/s, 4 kc/s and 200 c/s, shall be recorded at the beginning of every reel, a suitable level being 15 db. below the maximum level of the recorded programme.

The following specifications are shortly to be published:

1019 : 1949, Photographic Lenses (definitions and requirements for accuracy and marking). (2s.).
1587 : 1949, Film Spools for 2,000ft. 35mm. Release Prints (2s.).

B.K.S. BINDERS

A limited number of spring-backed binders for this Journal is available, price 3s. 6d. each. They are in blue art leather, with the letters B.K.S. in gilt on the spine; some are slightly stock-soiled.

Capt. A. G. D. WEST

The Editor offers his apologes for an error which occurred in the obituary of Capt. A. G. D. West, whose first name was Arthur, and not Albert.

PERSONAL NEWS OF MEMBERS

Members are urged to keep their fellow members conversant with their activities through the medium of British Kinematography.

ROGER LAMBERT is with the photographic department of Lever Bros. advertising service, "Lintas," engaged on the production of commercial shorts and sub-standard documentary films, as well as stills.

J. J. LEAK is in the U.S.A. exhibiting amplifiers produced by his company at the Audio Fair in New York, sponsored by the Audio Engineering Society of America.

JOHN C. TETARD is living in Johannesburg, where he is with Pathé South Africa Pty., Ltd.

PERSONAL ANNOUNCEMENT.

A vacancy exists in the camera department of a colour processing laboratory. This is an exceptional opportunity for a young technician who is interested in engineering as well as the photographic aspects of colour cinematography.—Dufay-Chromex Limited, Thames Ditton, Surrey

Small announcements will be accepted from Members and Associates. Rate, 4d. per word, plus 3s. for Box No. if required (except for Situations Wanted). Trade announcements, other than Situations Vacant, not accepted.
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INDEPENDENT FRAME FILM PRODUCTION

At a joint meeting of the British Kinematograph Society and the Association of Cinema & Allied Technicians, held on March 23, 1949, papers on Independent Frame film production were read by Messrs. David Rawnsley*, Donald Wilson, and Maurice Gorham†. In view of subsequent developments in the process, the following paper is printed in place of the first and third. The second paper is printed in abridged form, as illustrative of the practical application of the process.

International copyright of the first paper, or any extract from it, is reserved by the author.

I. NOTES ON A PRODUCTION TECHNIQUE

Kenneth Bellman‡

The Independent Frame system of film production has been designed with the following aims in view:

1. To reduce the cost of production.
2. To increase the speed of production.
3. To provide increased continuity of performance for the artistes.
4. To provide permanent employment for technicians and all craft labour.
5. To provide the director with greater control during the production period.
6. To achieve the above while maintaining a high standard of quality.
7. To establish a continuous production programme.
8. To prepare production servicing methods and equipment for the acceptance of television aids.

In order to attain these aims the following facilities and equipment are required, together with certain variations in practice and procedure.

Twin Stage Studio

The studio layout is designed to serve a dual unit of production, providing for the making of two films simultaneously, over-lapping in schedule to maintain an even flow of pictures through the various phases of planning, construction, shooting and post-shooting.

I. SET CONSTRUCTION

The settings must be prepared on the assembly line principle, starting from the timber stores which feed the carpenter's shop. Set pieces are assembled on flat cars and run down the line past plaster and paint shops—the finished section is then stored in the scene dock until required for assembly in the assembly bay.

Assembly Bay

The Assembly Bay is a covered area which provides sufficient space for the circulation of set floats (mobile rostrums) during assembly. It opens on to

*Formerly Director of Research for the Rank Organisation.
†Formerly Controller of Television Service, British Broadcasting Corporation.
‡Managing Director, Television Film Production, Ltd.
the scene dock at one end, the Waiting Bay at the other. On one side small finishing shops are provided. Set pieces are positioned on floats from the scene dock, and as they are moved down the bay towards the waiting area, finishing touches are added as required and finally the float is placed before the Property Department, where the set is finally dressed and then shunted into the waiting section, ready when wanted on the shooting floor.

The assembly of the settings takes place under the supervision of the Planning Department. The assembly crew, known as the Production Service team, is in the charge of an Assembly Manager and is composed of the following: carpenters, stagehands, plasterers, painters and property men.

This staff, although maintaining their normal lines of demarcation, must work as a team whenever required (the principle is working well at the Rank Studios where the system is in operation).

The Production Service staff have no relation to the making shops and are permanently working between the Assembly Bay and the stage.

Waiting Bay

This is a covered area opening directly off the Assembly Bay on the one side and into the stage on the other. The Waiting Bay is divided from the Assembly Bay by sliding doors which give partial acoustic insulation.

There must be sufficient room for the circulation of prepared or "live" floats going on to the stage and for finished or "dead" floats coming off it, together with those awaiting their call.

The entire overhead area is provided with a travelling bridge and two laterally running crab cranes for the positioning of heavy set pieces and properties.

II. THE STAGE

The Stage is divided into two sections each 200ft. by 175ft., with a collapsible partition giving insulation between the two halves. This provision allows two films to be in production simultaneously, giving way one to another when the full area of the stage is required for any exceptional shot. Each half must cover an area large enough to utilise process projection to its maximum, on screens up to sizes of 30ft. by 40ft. As many as three projection positions may be required on a normal set-up, and there should be space for two or three set-ups on the same stage so that the Shooting Unit can transfer from one to another without delay; each set-up is previously prepared by an Advance Lighting Unit consisting of assistant cameraman, sound engineer and gaffer with their necessary skeleton staff. Each section of the stage must have door openings into the Waiting Bay of a size sufficient to allow for the passage of the hexagonal floats, and up to a height of 30ft.

Floor Surface Treatment.—A hard finished non-abrasive surface covers the floor area on a concrete foundation isolated from surrounding buildings. Any fixing that may be necessary is done either by mobile jacked weights or flush floor plugs.

Acoustic Treatment.—This should provide as nearly as possible open-air conditions and insulation from exterior noise up to 80 decibels.

Air Conditioning.—An electrostatic method of air conditioning is used. A high pressure silent wind effects duct encircles the stage below floor level and can be tapped at various points when required.

Silencing.—All equipment together with doors and other apparatus is designed for silent operation. A talk-back system covers all principal operating points on the stage, so that instructions can be given quietly. Rubber wheels are provided for all mobile floor equipment.

Special Effects Studio.—This is provided for the construction of models and foreground miniatures and for matte painting.
Overhead Gantry System

The overhead gantry is designed in such a way as to allow complete freedom of movement for all overhead equipment and the flying of set pieces and settings in their entirety. A large part of the equipment is flown so as to keep the floor clear for shooting and for the movement of essential floor apparatus. The gantry system is composed of 5 banks of running bridges suspending laterally travelling cranes. The bridges are composed of 24ft. sections, each section operating independently and capable of carrying a point load of up to 3 tons. The crabs contain a braced wire lifting system carrying a device with a standard attachment for spot rails, camera platform, sun-arc platform, overhead sound boom raft, television control booth and any other apparatus which may need to be flown aloft.

There is an overhead runner encircling the outside edge of the gantry system from which are suspended the screens for both front projection, moving matte and backings. In order not to destroy the acoustic quality of the stage the backings can be run into a sheath faced with the normal acoustic treatment. On the far side of the sheath is the Scenic Painting Studio.

Lighting Systems

Satisfactory results have been obtained from a new system of indirect lighting referred to as "Frame Lighting."

Spot rails were not used as all lighting was achieved from the floor. There was no direct light source. The light from the lamps was re-directed from reflectors clamped on the heads of the flats and on stands in the vicinity of the setting.

The reflectors are composed of light balloon fabric stretched on a light
alloy tubular frame, the surface treated with varying degrees of diffusion. This frame is mounted on an adjustable elbow joint stand with spring-loaded ratchet joints. The reflector can be manoeuvred in any direction, angled or tilted to the required position by means of a specially designed boat-hook type arm from the floor level.

The following comparative readings were obtained on a medium size sitting-room set. Normal lighting required the set to be fully railed and spotted with 19 lights:

<table>
<thead>
<tr>
<th>Power (kw)</th>
<th>Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>24,000</td>
</tr>
<tr>
<td>4 &quot; Pups&quot;</td>
<td>2,000</td>
</tr>
<tr>
<td>2 &quot;Inky Dinkys&quot;</td>
<td>200</td>
</tr>
<tr>
<td>1 &quot;Basher&quot;</td>
<td>500</td>
</tr>
</tbody>
</table>

Total = 26,700 watts

With the new Frame Lighting method no rails were required. 8 reflectors were used and 6 lamps:

<table>
<thead>
<tr>
<th>Power (kw)</th>
<th>Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>10,000</td>
</tr>
<tr>
<td>1 &quot;Pup&quot;</td>
<td>500</td>
</tr>
</tbody>
</table>

Total = 10,500 watts

The general level of incident light on the set was raised by 15 foot-candles. The whole operation of lighting the set was achieved in a fraction of the time taken under the normal method.

Individual feature modelling was obtained from smaller reflectors with a surface of less diffusion, borrowing reflected light either from the overhead reflectors or from the direct light source.

Elimination of Unwanted Shadows

Artistically the results were more satisfactory as they were more realistic. Shadows were soft and only became apparent when the object was in close proximity to the wall surface. There were no problems with microphone shadows which by virtue of the reflectors and the low direct lighting were completely eliminated.

In the main, this form of lighting could be applied to any set, although under certain conditions the system might be supplemented from a direct source to a small degree.

This form of lighting has not been tried out in connection with any process projection shots, where the leak light might possibly deteriorate the projected image. However, as the amount of spotting necessary for the use of process is negligible, saving in time and money would be small.

III. EQUIPMENT

Spot Rails.—Twelve of these would be needed for a twin stage studio, each 24ft. in length; they are suspended from a central rotary pivot adaptation, which has its standard fixture to the braced wire overhead suspension system. A 5ft. section on either end of the spot rail platform is pivoted so that it can be angled when required. On the underside of the spot rail is a hanging bar from which back and front process projection and matte screens can be suspended.

Screen Frames.—Nine of these would be required in assorted sizes. They are of light alloy tubular construction and various types of screens can be supported under tension within these frames.

Overhead Sound Boom Raft.—This is designed as a Perspex platform from which the boom is suspended on a universal pivot, allowing for its manipulation
from overhead. The standard suspension attachment allows it to be fitted to the braced wire suspension system.

Still and Motion Picture Projectors.—Three motion picture projectors, two in operation and one in reserve, should be provided for the two sections of the studio. Four still picture projectors should be provided to operate between the two sections.

Standard Motion Picture Camera.—This should be equipped with varifocal lenses and remote control.

Double Magazine Camera.—One of these is required for static matte.

Split Beam Camera.—One is required for moving matte with electronic synchronous control.

Mirror Holders.—These are provided with adjustable mounting, and serve to deflect the projection beam where the direct throw is not practical.

Floats.—Twelve self-powered mobile rectangular floats are required with jacking device for varying elevation and extension frame—18ft. square.

Three mobile self-powered hexagonal floats with jacking apparatus for varying elevation, one equipped with a turntable for the speedy interchange of set pieces, and to be used as a silent traveller.

Electronic Aids

Electronic equipment is still in process of development, but with an ideal twin stage studio there should be two television assemblies, which consist of the following:

Cameras.—Six high definition television cameras with electronic viewfinders giving a field of view 25% larger than that of the camera itself. Two of these cameras will require to be fitted with variable focus lenses controlled either from the camera or remotely.

Director's Control Booth.—Should accommodate the Director and six other people. The Director's console must be equipped with vision and sound mixing controls. The vision controls can provide electronic cuts, dissolves, wipes and fades. The booth is to be equipped with 4 viewing screens (transmission, preview, and two advance) of 30in. diagonal, the screens being fed either from the cameras or from pre-shot film.
**Studio Control Room.**—Is for the monitoring of pictures and for the operation of all vision electronic equipment associated with the studio.

**Master Control Room.**—Is equipped for feeding 2 picture channels from each studio to the Vision Recording Room.

**Vision Recording Room.**—Contains equipment for the continuous recording of pictures from any or all channels, 2 viewing screens, optical systems and special cameras for each channel. This room must have direct access to the laboratories so that the film recorded can be speedily processed and returned on a Telecine.

**Telecine Room.**—Contains 4 film scanners in order to feed the pre-filmed picture to the Control Rooms and monitors.

**Two Moving Matte Machines.**—Are for electronic superimposition of live action on pre-recorded film, live action on live action, or film on film, without loss of quality. This equipment must be capable of providing dissolves from one film record to another in order that the background may be changed while the film is being recorded.

**Eight Picture Monitors.**—Each should be provided with 2 viewing screens. These monitors must be on mobile stands for speedy positioning.

**Stage Planning**

Stage planning is controlled from the Assembly Planning Department which should operate directly under the Art Department.

The frame supervisor supervises all technical servicing on the stage. Ideally he should be empowered by the appropriate Unions to maintain discipline and arbitrate on all technical discussions.

The first assistant, although working in conjunction with the frame supervisor, who is also responsible for seeing that all necessary departments are provided with their respective planning data, confines his activities to the shooting set-up.

The floor layout plans used in positioning of set pieces and other apparatus, lighting plans and so on, are laid out in conformity with the grid system, which marks out the stage and overhead gantry system in standard units of 3ft.

It is also the responsibility of the frame supervisor to see that the Advance Lighting Unit is properly staffed and provided with duplicate equipment to prepare the advance set efficiently.

**IV. PRODUCTION METHODS**

The importance of maintaining continuity of production for the shooting stage cannot be underestimated. This must be regarded as the first essential to efficient and economic output. A production programme which will allow for continuous production must be established in order that the system can operate to its maximum advantage. In this way the various sections of the production plant are able to adjust their departments for the continuous and full employment of staff and equipment. The number of pictures which should be in preparation at the same time is dictated by the speed at which they can be shot in continuity on the production stage. All other departments must adjust their staff and facilities so that an even flow of pictures can be maintained through all phases of preparation and post-production work. Provision must be made in the layout of these departments for expansion as speed of production increases by experience. This means, therefore, a continuous level of employment on a permanent basis throughout the entire production plant.

**Preparation for Production**

The methods of preparation are a vital part of the system and call for the delivery of the treatment, which can be in as full a form as required, up to
six months prior to the projected shooting date, depending on the complexity of the subject. From six to nine pictures might well be in preparation simultaneously in order to maintain continuity of shooting on the stage. After delivery of the treatment the preparation of an individual film must go forward through a series of logical phases.

Phase 1: Scripting.—This might cover a period of 4 to 6 weeks of script discussion by what is referred to as the Scripting Unit. This is composed of the following:

1. Director.
2. Writer.
3. Designer.
4. Editor (if required by the Director).
5. Director of Sound and Music.
6. Cameraman (available for consultation).

This phase should produce full agreement on all points covering the requirements of the director in his interpretation of the story. All decisions are made in regard to the manner in which these are to be implemented. The picture is planned in detail and in relation to the agreed budget figure, fully costed and timed. The script is laid out with the technical page facing story and dialogue. On this page is recorded all technical information pertaining to the shot, a pictorial illustration and musical and sound effects instructions.

Should the subject or any sequence in the subject call for more accurate analysis a story reel can be prepared from script sketches accompanied by commentary, key dialogue and in certain cases effects and sketch music.

Phase 2: Preparation of the Frame.—The Frame is composed of all the elements of production which lend themselves to advance preparation without involving the production group in costly contract commitments with principal artistes and studio space.

The Frame is therefore independent from these elements, and is prepared as an identity independent from the final shooting. The Frame may be utilised for "Live Action" purposes or used and re-used for various language version films, because the principals, being independent from it, can be varied accordingly. It is composed of all scenes where artistes are not involved or where they are sufficiently distant from the camera to allow for "doubling." It represents permanent material which can be stored in the Library and be available for use in whole or in part whenever required at no more cost than its staging. Still, motion and matte backgrounds are shot on selected locations together with all scenes not requiring the principals, or pre-staged either on a specific exterior or interior location or as planned in the studio. The completed Frame will consist of:

1. All background plates for special process work.
2. Transparencies.
3. Photographic material for process recording, superimposition and projection purposes, including still and motion plates, foreground transparencies, matte paintings, miniatures and the effect obtained by the use of bi-focal and vari-focal lenses.
4. Sound effects and music tracks where practicable.
5. Collected essentials, properties and set pieces.
6. Constructed models and foreground miniatures.
7. Collected wardrobe.
8. Make-up essentials.
9. All specified pre-staged settings and location building.
10. All necessary designs and drawings for the foregoing together with plans for their use.

A period of between three and nine months must be allowed to complete this phase.

Phase 3: Artistes and Technical Rehearsals.—1st Stage. At the outset, these rehearsals should only involve the principals and will take place in the
Rehearsal Room which will be marked out and dressed with essentials. First-stage rehearsals will require three to four weeks.

2nd Stage. This will take place on one of the twin stage sections of the process stage closed off for the purpose, and will be conducted over a period of three to five days. During this stage all equipment, settings and floor personnel, together with artistes and principals, are put finally through their paces under the actual conditions that will exist during final shooting.

After all adjustments have been made and agreed upon, and on the hour that the previous picture leaves the shooting floor, this film can at once be put into production.

Phase 4: Shooting.—Shooting takes place on the production floor properly equipped with certain facilities, and with equipment all of which has been designed for mobility, speedy positioning, manoeuvrability, and silence. The Shooting Unit is reduced to the bare minimum of technicians and the

Fig. 4. Moving Process Projector. [Courtesy of British Acoustic Films, Ltd.

best possible conditions are provided for the director and artistes in their final making of the marriage of live action to the prepared Frame and pre-recorded film material. This phase should occupy the production floor for no longer than four weeks on an average picture. It should be borne in mind that the shooting speed is dependent on the efficiency of the staff and equipment in operation, in order to give the maximum service to the shooting scene, continuity and the hourly footage recording rate.

Phase 5: Post-Production.—As normal procedure but reduced in duration by the virtual pre-editing and framing of the film already described.

V. SUMMARY OF FIRST STAGE OF INDEPENDENT FRAME SYSTEM

It is estimated that with facilities and services as outlined in the foregoing
it should be practical to produce up to 24 full length feature films from the twin stage studio per year.

Production must be planned to allow for the requisite personnel of producers, directors, technicians and craft labour to operate continuously throughout the year, turning their attention to the various phases of production and from picture to picture so as to absorb all idle time.

It is estimated that production carried out in this way should budget at between £30,000 and £75,000 per picture, excluding any phenomenal costs on principal artistes and story.

VI. SECOND STAGE IN INDEPENDENT FRAME SYSTEM

This stage demands the same studio design, equipment and planning methods as those already described, with the addition of the electronic aids as previously listed. These aids are now in development and the first prototypes should be available during 1950, although it is estimated that the production models would not be ready in under two years from then.

The object of the introduction of television aids to the system is to simplify and accelerate the technical processes of making films and give more freedom to the creative elements and greater control to the director. It is estimated that the speed of production could be increased from 24 films a year to something in the neighbourhood of 34 as soon as technicians and equipment have become experienced.

Equipment

Television cameras are substituted for standard film cameras on the studio floor, and their pictures are conveyed electronically and instantaneously to
the control and recording rooms. The equipment can be briefly described as follows.

1. **Cameras.**—Television cameras working on a standard of definition high enough to produce pictures of the same quality as is now provided by standard film cameras. These television cameras are fitted with the same facilities as film cameras, but in addition, they have electronic viewfinders enabling the camera operator to view the picture he is transmitting and control remotely the variable lenses attached. From one to six or more cameras will be used at one time on one half of the twin stage unit.

2. **Monitoring.**—The images transmitted from the television cameras are fed simultaneously to the monitoring screens in other parts of the studio, offices, theatres, etc. In this way the key personnel can at any time examine transmission in process.

The control booth contains microphones communicating with headphones worn by the camera operators and key technical staff on the studio floor, through which the director can issue instructions during actual shooting. He can also talk through loudspeakers to the artistes on the stage during rehearsal and between scenes.

As in ordinary television production, the director can therefore exercise continuous control during shooting. He directs the camera operators, judges their pictures on his pre-view screens, approves them before they are passed to the recording room, calls his cuts, mixes and superimpositions, which are performed electronically and instantaneously, and sees them on his transmission screen exactly as they are being recorded.

**Continuity of Performance**

Artistes working under Television Film Production methods will be able to play with far more freedom from arbitrary limitations and technical restrictions. The process of lengthening scenes instead of breaking every performance up into takes of a few seconds, which is already begun on the first stage of Independent Frame Television Film Production, will be extended. There will be much more opportunity for the artistes to enter into their parts and give a sustained and convincing performance.

The productivity of the technicians as well as the artistes will be increased by the production unit system, the concentration of work on any one picture into a shorter time on the floor, and the increased possibility of identifying themselves with the production that will result.

**II. PROGRESS REPORT ON INDEPENDENT FRAME**

Donald Wilson*

**M**ANY writers have interpreted Independent Frame as a mechanical process with definite limitations. My own conception, derived from actual experience of its operation, is that it is a rational approach to the planning of film production on a long term basis.

**Principles of Production**

On September 20, 1948, studio shooting began on the first of four feature pictures to be made by the Independent Frame method, and on April 13, 1949, the last of the four was completed. Thus in seven months' continuous production, the second stage of a very large scale experiment had been completed by the Aquila unit.

The minimum number of pictures which could prove the principle of continuous production was agreed to be three; but the programme was later increased to four, when it was found that the preparation of a fourth subject could continue simultaneously with the completion of the first three, using the same staff.

*J. Arthur Rank Productions, Ltd.*

Fig. 7. A Practical Door in the same plane as a projected image (from "Stop-Press Girl").

8. John Brown's Shipyard (from "Flood tide").

Back projection replaces built sets. Smaller illustrations show portions actually built. Stills by Harry Gillard.
The second principle which the use of the Independent Frame process sought to establish was that while it cannot make a cheap picture more cheaply, it does provide a method by which the basic cost of any feature film can be controlled. It gives the producer the opportunity of enormously increasing his production value while keeping his costs down. The production of subjects which would otherwise be prohibitively costly is also made possible, and the more expensive the production the greater, proportionately, is the saving.

In endeavouring to establish these particular advantages of the Independent Frame, it would obviously have been foolhardy to have launched into high budget pictures with valuable stars at this early stage. With these considerations in mind, I was entrusted to ensure the following:

2. Using only one stage with an assembly bay. No sets were to be built on other stages, and all construction was to take place off stage.
3. Ensuring that studio shooting schedules were to vary between six and seven weeks on the floor with one week's acting and technical rehearsal.
4. Delivering a married print of each picture within eight to nine weeks after studio shooting was completed.
5. Choosing subjects so varied as to prove the flexibility of the Independent Frame method.
6. Without employing stars, to cast the pictures with the best available feature artistes comparable to those employed in other films of the scale envisaged.
7. During production to use all known and experimental devices to obtain maximum economy in set construction simultaneously with increased production value.
8. Evolving a scheme capable of continuous production and susceptible of expansion when full-scale production was agreed.
9. Taking no artistes except doubles on location.

All the other principles of the method are inherent in these rules except one, which becomes necessary as a result of these—namely, the principle that a final and detailed shooting script must be completed six months before any picture goes on the floor.

The films themselves must, of course, stand as evidence as to whether the first rule was kept, but in an analysis such as this, it may be stressed that technical quality was the objective aimed at. In an article which appeared in the Investors' Chronicle after "Warning to Wantons" was first shown, the writer stated that, in his opinion, the picture was indistinguishable in production quality and scale from one costing £200,000. The stupendous fact, and that of interest to investors, was that the picture cost only £120,000.

All other rules and conditions enumerated above were adhered to strictly throughout. In fact, in considering rule 7, I should state that during this production we deliberately set ourselves problems and experimented with new technical devices. Their solutions, while adding to our difficulties at the time, proved of great benefit in the subsequent planning of such films as "Boys in Brown," "The Astonished Heart," "So Long at the Fair," and "Prelude to Fame," which is the latest Independent Frame picture to go on the floor.

It is worth while noting that for the first four pictures these rules were adhered to strictly to see whether the job could be done. This does not mean that all pictures made by this method must fall into a rigid pattern. Each subject must be taken on its own merits, and if, for example, it becomes economically or artistically necessary to take certain artistes on location for certain specified shots, this would be done. The principle stands that all methods of solving a particular problem must be explored in advance and the best can be selected while choice is possible.
Pre-planning and Budgeting

When production is continuous and a unit is organised on that basis, many costs which normally are variable become constant—or nearly so. These comprise chiefly: rental, equipment, film and laboratory charges, set designing and operating, production salaries, overheads and insurance; and the elimination of idle time shows a big saving in these items. Other costs remain variable according to the subject and the amount to be spent on the picture. These are, chiefly: cast, wardrobes, music and script.

It is therefore possible for a producer to decide, when he has a final shooting script, what he can afford to spend on variables according to the particular subjects; furthermore, when the decision as to the variables has been made, the method of production makes it unlikely that these costs will go over budget. I am not ignoring the fact that many producers make pictures to their budgets; what I would suggest is that with an Independent Frame unit, it becomes far easier to do so.

Independent Frame, therefore, is an attempt to make the technical, mechanical and financial aspects of production run smoothly enough to relieve the creative artist of financial and technical distractions.

I would be the last to deny that the work of the creative artist is what keeps the breath of life in the film industry. I would add, however, that the medium in which he works is necessarily the medium of machinery, since the end product is a piece of celluloid covered with photographs and sound track.

To be afraid of a stereopticon projector or a mobile spot rail is out of date. A film actor might as well say that he cannot work within a few inches of a camera, or a screen writer complain that his "deathless prose sounds all funny through those peculiar horns." For a director to say that his best work cannot be done when a picture is planned in detail beforehand is to deny the principle in which great artists have always worked. True, a great film director must not be restricted either in his method or his budget—but there are very few great film directors.

The first-class cameraman will say that he cannot achieve his finest effects while using process projection. The answer is that he has not tried because in most studios process work is regarded as a novelty and something to be avoided whenever possible. The emphasis laid on process projection—the purely mechanical side—by both the supporters and detractors of Independent Frame is the most unfortunate angle that could have been taken.

I can imagine making a picture where no sets were built and I can equally visualise a subject which required no process projection. They could both be Independent Frame films. What would keep them in the same family would be the fact that they were part of a long-term programme and the details of their planning would be carried out with the same mental approach and by the same group of technicians.

Independent Frame, therefore, is not the use of machinery; it is not the imposing of rigid restrictions on artistes; it is not a system of producing cheap films more cheaply.

Independent Frame is an attitude of mind—an enquiring mind constantly seeking more expert and more economical ways of producing the same or a better product.

DISCUSSION

Mr. W. S. Bland: The proposal to mix the pictures during the process of shooting seems to me like a glorified dubbing session, with the added cost of having artistes on the job. With four or five cameras you are going to lose all dramatic lighting, as is already the case in television, because you have to light for every position at once. At the same time, the sound perspective is going to lack something, because the microphone has to be far enough away not to get in
the field of the long-shot. I fear, therefore, that quality is going to suffer.

Mr. Maurice Gorham: The answer to the first question is that the director does not have to mix if he does not want to. The editing process is still open to him, only he will know at the time of shooting exactly what is on his film because he will have seen it going through. But if it does suit him better not to interrupt his action, he can shoot continuously with several cameras, and I think this method will establish itself. The point about lighting is a very important one, and lighting experts may have to devise some new methods, but I should like to say that you cannot judge television lighting by present productions done with such primitive resources. Sound perspective difficulties can be overcome by skilful use of the boom and concealed microphones, as they are often overcome in television even now, as well as in films.

A Visitor: Is it necessary always to use a long-focus lens on the camera for back-projection?

Mr. David Rawnsley: The development of screens giving better diffusion, and of short-focus lenses, has made it apparent that one will be able to use a shorter throw on the projector and a shorter focus lens on the camera.

Mr. F. G. Gunn: It seems to me that in the development of this very expensive apparatus, the requirements of the colour film have been completely ignored, to the extent that at the present time, if it were wished to make a colour film by the Independent Frame method, it could not be done. Is this deliberate or is it lack of foresight?

Mr. Rawnsley: The process has limitations in respect to colour, which have been borne in mind ever since Mr. Rank took an interest in promoting the system. Attention is being given to it with some degree of priority, because it is realised that ultimately the majority of films will be in colour. Maybe television can provide an answer, to the extent even of electronic colour moving-matte systems.

Mr. T. S. Lyndon-Haynes: Has any consideration been given to the shooting of appropriate sequences in ordinary films by an Independent Frame method? As it is the system could easily be applied to sequences which do not really lend themselves to the process.

Mr. Rawnsley: I absolutely agree. There are many elements in Independent Frame that could be used in normal production. It is a collection of all the tools of the trade calculated to assist in production, and to be applied where it is most practicable. In a normal picture, if you want to use process, you have facilities for getting better process work than you would have had before these developments. But the initial capital expenditure is not one that could be undertaken by the majority of studio companies, and certainly not one that could be undertaken by producers.

Mr. Wilson: To quote what actually happened: in one case there was a set built on mobile rostrums, so that each part could be struck and put together as required. Six months ago, when we had this problem to face, of something like 110 set-ups within this composite set, we had to decide which of the many methods of doing it would be most economical. It would have been very simple for us to have gone out and found a real house and to have made plates to cover every one of the 110 set-ups, but because we got to this problem early enough, we could analyse it, and it was proved that the time spent in changing the set-ups and switching the screens and getting the projector set more than offset the saving in construction. Naturally outside the doors and windows we used moving plates as required.

Mr. Lyndon-Haynes: When you have your production meetings, what degree of control is exercised over the application of this process?

Mr. Wilson: That is why the producer sits in on the technical script conference. He has the Special Effects department to give their views as to the best method of settling any problem that the director poses. The primary requirement is that the director must be satisfied. If we can satisfy him by using process or moving matte or by building a wall, that is what is done. The cost question is in the hands of the producer. Somebody has got to say, “That is good enough,” and that is the producer’s function.

A Visitor: After the films were shown, I felt frustrated by the lack of reverse angles. There seems a fear of preoccupation with technique, the story coming last.

Mr. Wilson: The first point is a valid criticism of “Warning to Wantons.” But to say that we reduced the number of cross-cut angles is not correct. As regards the second part of the remark, I do not think there is any danger of that.

Mr. A. W. Watkins: We have discussed only the technical aspects of the Independent Frame method. Do the
SCREEN ILLUMINATION WITH RESPECT TO OPTICS AND ARC CHARACTERISTICS

A. G. Duerdoth, B.Sc., M.B.K.S., A.R.C.S.*

Read to the B.K.S. Manchester Section, on December 7, 1948.

THE study of projection optics has been dealt with in a number of papers¹,²,³,⁴ of recent date, but the subject is sufficiently wide for another, approaching the problem from a different angle, not to be amiss. The elliptical mirror has been chosen for detailed analysis.

Apertures of Collecting System and Projection Lens.

An elliptical mirror system with a projection lens—for simplicity, a single convex lens—of correct aperture is illustrated in Fig. 1. A smaller lens involves light loss as the outer parts of the mirror are not utilised. A larger lens is a useless expense as the mirror is already covered.

The correct lens aperture, defined by the ratio of the focal length to the diameter, is related by simple geometry to the mirror aperture as follows:

\[
\text{Lens aperture} = \frac{f_L}{d_L} = \frac{f_M - t}{d_M}
\]

Other collecting systems give corresponding relationship.

Properties of the Elliptical Mirror.

Applying the laws of reflection to rays of light originating at one focus of an ellipse and reflected by the ellipse, an image is accurately formed at the second focus. This convenient property for the collection of light from a source applies to a point source of light only. A finite light source such as a carbon crater, when only that part of the mirror in front of the crater is of value, will give a blurred image at the second focus unless the mirror is very small, and may best be illustrated by an envelope of the reflected light

*Ship Carbon Co. of Great Britain, Ltd.
rays. Fig. 2 illustrates the varying form of this envelope as the crater is moved to or from the mirror. The crater "image," which is very imperfect, moves along the axis in the opposite direction to the crater by a distance roughly 25 times the crater movement with typical mirrors in use. The need for accurate crater positioning is illustrated when a displacement of crater position of 1mm. involves an image shift of about 1in.

**Magnification Factor of the Mirror.**

The magnification factor is given by the ratio of the image distance to the object distance from the point of reflection. Thus, considering the centre of the mirror, we have:

\[
M_o = \frac{f_2}{f_1}
\]

**Fig. 3. Geometry of Ellipse.**

From the geometry of the ellipse the magnification at any angle (see Fig. 3) may be expressed in terms of \( M_o \) as follows:

\[
M_\theta = k_1 + k_2 \cos \theta
\]

where \( k_1 = \frac{M_o^2 + 1}{M_0} = \frac{M_o - e}{1 + e} \) and \( k_2 = \frac{M_o - 1}{2M_o} = \frac{1}{1 + e} \)

where \( e \) is the eccentricity of the ellipse.

Thus, the variation of \( M \) with \( \theta \) is the same for all mirrors of the same magnification and is independent of their actual dimension, e.g., any mirror of central magnification 6x will drop to 3.85x at \( \theta = 75^\circ \).

**Fig. 4. Annulus of Mirror.**

The size of the light-spot so formed must be adequate satisfactorily to cover the film-gate, the crater size being considered in conjunction with the magnification.

**Distribution of Light across the Film-gate.**

Neglecting any minor influence the projection lens may have on the distribution of light across a screen, if a picture can be obtained of the nature
of the light spot on the gate then the screen distribution is directly related.

Bearing in mind the variation in magnification in different zones of the mirror, to analyse theoretically the light spot, a zone of the mirror must be considered over which the magnification factor is constant, i.e., a narrow annulus of the mirror with the pole of the mirror as centre (Fig. 4). A theoretical crater, perfectly flat, uniform in brightness, and obeying the cosine law of emission will be considered. From a position $P$ on this annulus, corresponding to an angle $\theta$, the view of the crater will be an ellipse and the image will also be an ellipse of major axis $M_\theta d$ and minor axis $M_\theta d \cos \theta$ where $d$ is the diameter of the crater. The plane of the image can be taken as approximately lying in the plane of the gate as even with the largest aperture mirrors in use, $\cos \phi$ may without great error be taken as unity.

![Image 5. Images due to Annuli and resultant Intensity.](image5)

![Image 6. Intensity of various Annuli.](image6)

The image will be of uniform brightness and as $P$ rotates round the annulus, the major axis of the image will rotate with it, but will be otherwise unchanged. Summation to give the resultant image due to the annulus is shown in Fig. 5 where we have a centre spot, diameter $M_\theta d \cos \theta$, of uniform intensity given by

$$I_0 = 2\pi B \sin \theta \, d\theta/M_\theta^2$$

where $B$ is the intrinsic brilliancy of the crater. Outside this bright central circle the intensity falls off in the manner shown, reaching zero outside a circle of diameter $M_\theta d$.

The summation of the resultant effect of all such annuli of varying angle $\theta$ has been found too complex for any but a graphical solution. Fig. 6 illustrates the curves for a few such annuli and their graphical summation for a 7mm. crater with a mirror of magnification factor 6X. From this theoretical screen distributions of the appended table have been derived, which figures are quite close to those obtained in practice with a corresponding set-up, illustrating that the prime factor producing a bright centre and duller corners to a screen is the nature of the optical system, the distribution of light across the crater being a secondary effect.
Effect of Carbon size on Screen Distribution.

The curve of Fig. 6 may be used to anticipate the results to be expected with carbons of different sizes which will be assumed to be loaded to have identical crater brilliances and to be used in the same optical system. Fig. 7 (b) illustrates the condition for least light wastage round the gate, but results in too severe a drop in brightness towards the corners and allows no tolerance in the mirror adjustment. Such a condition would be given by a 4½ mm. crater with a 6\times magnification system, e.g., a 6mm. high-intensity positive at low loading. A smaller crater as in Fig. 7 (a) is obviously useless. The ideal case for practical purposes is illustrated in Fig. 7 (c) where sufficient coverage is given by a larger crater (6 to 7mm.) to obtain an adequate corner brightness, and tolerance for imperfect mirror or carbon alignment. A 7 or 8mm. high intensity positive would give this condition. Use of a still larger crater involves greater heating of the gate and increased running costs, with no advantage except a small improvement in screen distribution. It will be observed that the central brightness is the same for all sizes, but a small advantage in screen lumens will be obtained with the larger carbons owing to the higher corner brightness.

### PRACTICAL VALUES OF SCREEN DISTRIBUTION

<table>
<thead>
<tr>
<th>Type of Arc</th>
<th>Collecting Angle Degrees</th>
<th>Crater Size</th>
<th>Relative Screen Brightness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Centre</td>
</tr>
<tr>
<td>Low Intensity</td>
<td>150</td>
<td>7mm.</td>
<td>100</td>
</tr>
<tr>
<td>High Intensity</td>
<td>150</td>
<td>7mm.</td>
<td>100</td>
</tr>
<tr>
<td>A.C.</td>
<td>150</td>
<td>6mm.</td>
<td>100</td>
</tr>
<tr>
<td>Theoretical</td>
<td>150</td>
<td>6mm.</td>
<td>100</td>
</tr>
<tr>
<td>Theoretical</td>
<td>150</td>
<td>7mm.</td>
<td>100</td>
</tr>
<tr>
<td>Theoretical</td>
<td>135</td>
<td>7mm.</td>
<td>100</td>
</tr>
</tbody>
</table>
Effect of Magnification on Screen Distribution.

Using a constant crater size and varying the magnification factor of the collecting system the curves of Fig. 8 are obtained. Fig. 8 (c) gives the same crater size and magnification as Fig. 7 (c), whilst a higher magnification as in (d) improves the screen distribution, but lowers the brightness as the same quantity of light is spread over a larger area. Smaller magnifications improve the brightness, but have no practical value. If maximum aperture is already used in case (c) the lower magnification would involve a larger aperture, i.e., the effective diameter of the mirror will be restricted by the projection lens and the improvement in brightness largely lost.

\[ \text{Fig. 9. Horizontal Distribution of Brilliance over Crater.} \]

Effect of Crater Brilliance Distribution on Screen Distribution.

Fig. 9 (a) illustrates a typical distribution of brightness obtained with a low-intensity carbon, the central depression corresponding to the stabilising core. Applying this to the theoretical screen distribution curve for a crater of uniform brightness, some improvement in screen distribution should be expected.

With the high intensity A.C. arc the crater is smaller than the corresponding D.C. arc, i.e., the crater is little bigger than the core, which is now the bright part of the carbon. Thus, a relatively uniform brightness is obtained over the crater (Fig. 9 (b)) which would result in a screen distribution closer to the theoretical curve. In practice, however, the smaller crater obtained with the sizes of carbons normally used, offsets to some degree the flatness of the screen.

The more peaky distribution of the D.C. high intensity crater is shown in Fig. 9 (c) and results in a poorer screen distribution.

The above remarks are illustrated in the table opposite of screen distributions obtained in practice. All central screen brightness has been reduced to a nominal 100 units to facilitate distribution comparisons.

Movement of the Crater from True Focal Position.

Fig. 2 illustrates that if the crater is moved either towards or away from the mirror the light-spot on the gate is enlarged. The distribution therefore improves but at the expense of brightness. It can be shown by tracing individual light-rays that the light reaching the screen centre originates from positions nearer...
and nearer the rim of the crater, as the crater drops back from the mirror, until a dull central spot indicates that no light from the crater is reaching the screen centre. During this movement more and more light is collected from the flame surrounding the crater and the typical blue tinge on the screen is to be expected.

Movement of the crater towards the mirror produces a similar effect, but this time less light reaches the screen from the flame and more from the walls of the carbon, which being at a lower temperature impart a pink tinge to the screen. Thus any de-focusing of the mirror to improve the distribution at the expense of screen lumens is limited by the effect on the colour.

Practical figures relating the variation of screen distribution to lumens are given in Fig. 10. They show the very critical positioning of the crater required to maintain the optimum light output. A movement of as little as 2mm. with a large aperture mirror can drop the lumens approximately 20% while giving only a 10% improvement in distribution.

Collecting Angle, Aperture and Magnification of Mirror.

These three factors are fundamentally related and no one can be altered without affecting one or both of the other two. For example, in Fig. 11, if the collecting angle $\theta$ is increased, to retain the same aperture as represented by $\phi$, the value of $f_2$ must be increased, i.e., a larger magnification is obtained.

The aperture of the mirror is given by $\cot \phi$, and $\cot \theta$ may be termed the collection aperture. They are related by the formula:

$$\frac{\cot \phi}{\cot \theta} = \frac{f_2 - f_1}{d}$$

$f_1, f_2$ and $d$ may be varied in proportion without influencing either $\phi$ or $\theta$ or the magnification. Thus, the mere diameter of a mirror is no indication of its efficiency.

Other Collecting Systems.

The other two popular systems, the condenser lens and the parabolic mirror-condenser lens, may be analysed in an analogous way. Similar reasoning may be applied to obtain the light distribution across the screen and the effect of different sizes and types of carbons.

Magnification, collecting angle and aperture again have a similar relation and are inter-dependent.

In the parabolic mirror system the magnification is given by the ratio of the focal length of the condenser lens to that of the mirror, and is popularly arranged at 4.7 x. This lower magnification requires the use of larger carbons to give good coverage of the screen. The aperture of f/2.0 with this lower magnification restricts the collecting angle of the mirror, and therefore limits the efficiency.
An elliptical mirror of suitable dimensions would give the same magnification, etc., having the advantage of no light loss due to the large condenser.

The condenser lens normally used with the large rotating carbons operates at a magnification of the order of \(2\frac{1}{2} \times\) which again reduces the collecting angle and therefore the efficiency. Again, an elliptical mirror could be designed to give similar results, but the focal lengths and diameter would have to be sufficiently large to allow for the long carbons, to reduce the obscuration of the rather bulky lamp mechanism, and to prevent excessive heating due to the high wattage arc, and would, therefore, prove impracticable.

Scope for Improvement of the Optical System.

The overall efficiency of any kinema projection system is notoriously poor\(^1\) and any demand for more light on the screen can only be satisfied either by improving this efficiency or by increasing the amount of light available.

The past has seen some steps forward in improvement of apertures, the use of aspherical condensers to reduce light wastage round the gate, an improvement of shutter transmissions, and lastly, the blooming of lenses.

It has been seen that the aperture of the optical system has been restricted by the aperture of projection lens, \(f/1.9\) being the fastest available in the range of focal lengths normally required. We heard recently\(^5\) that the coating of lenses permits the use of more elements in their construction and considerably faster ones will in the future be potentially available. This would enable the large collecting angles of modern elliptical mirrors to be used with magnifications lower than the present nominal \(6\times\). This, in turn, would permit the efficient use of larger carbons, with their higher candle-power more concentrated on to the gate.

In any case, however any increase in screen illumination may be obtained, whether by optical improvements or by increasing the brilliancy of the carbon crater, it must inevitably involve complications to embarrass the projector designer.

REFERENCES.


THE LIBRARY

Many of the current film trade journals from all parts of the world, available for reference in the Society’s library, are afterwards bound. The assistance of Members is requested in helping to supply missing issues to complete sets for binding.

Certain bound volumes, of which there are duplicate copies, are available for reference, including the Journal of the Society of Motion Picture Engineers. Reference copies are available from Volume 16, 1931, onwards, and lending copies from Volume 26, 1936, onwards, with the following exceptions: Vol. 20, No. 6, June, 1933; Vol. 21, No. 6, December, 1933; Vol. 25, July to December, 1935; Vol. 46, January to June, 1946.

Other magazines required to complete sets for binding are: Science et Industries Photographiques, March to October, 1946, and January, 1947; Monthly Film Bulletin (the British Film Institute), Vol. 14, No. 165, September, 1947; Funk und Ton, July, 1948; American Cinematographer, January to April, 1948.

Anyone who can supply these missing periodicals or indicate where they may be obtained should inform the Hon. Librarian at the B.K.S.
THE CRATER ARC FOR SOUND RECORDING

Dr. James A. Darbyshire, M.Sc., F.Inst.P., A.M.I.E.E.*

Summary of paper delivered to the B.K.S. Manchester Section on March 1, 1949.

The first portion of the lecture consisted of a general description of various electronic devices of interest to the kinematograph industry. These included the carbon arc, filament lamps, high pressure gas discharge tubes and photo-electric cells. The lecturer then went on to describe the various forms of crater lamps as used for sound-on-film recording.

These crater lamps operate in some cases with cold cathodes, and in other cases the source of the electronic stream is a hot cathode. The cold cathode tubes were illustrated by a description of the Sylvania R.1130B and the Osram W.3 and Osram NGD. The hot cathode tubes have the advantage of a lower striking voltage and a more linear characteristic in terms of light output for various values of current through the tube.

Hot Cathode Arc.

The second portion of the lecture consisted of a detailed description of the latest Ferranti development in the range of crater lamps of the hot cathode type. This tube is known as the GMC6. It consists of an indirectly heated oxide coated cathode mounted in a bulb at the lower end of a straight glass tube of 3 mm. diameter and 40mm. long. A drawing of the GMC6 is given in Fig. 1.

There is a striker electrode (S) mounted just above the cathode (C) and the anode (A) consists of a disc of nickel with a central aperture of 3mm. diameter. This disc of nickel is attached to the upper end of the glass tube and situated at a distance of approximately 40mm. from the cathode.

The striking voltage is approximately 250, but it is recommended that a voltage of 300 should be available. The tube is filled with a mixture of mercury and argon and the discharge current may be varied over the range 4ma. to 100ma. The light output over this range is linear to within approximately 1.5%. The discharge is particularly suitable for photographic recording and very good sound track records have been made with these lamps.

*Ferranti, Ltd.
Crater Arc Characteristics

The lamp can be modulated at frequencies up to 12,000 c/s., but there is an appreciable fall in response at frequencies about 8,000 c/s.

A typical characteristic curve of the GMC6 is reproduced in Fig. 2. This curve indicates the extent to which the light output varies in proportion to the current through the lamp.

A demonstration was given at the end of the lecture to show the mode of operation of the GMC6. The output from a record playing unit was used to modulate the crater lamp and a photo-cell was set up at the other end of the lecture bench. This photo-cell received the modulated light from the crater lamp and the signal was then passed into an amplifier unit and fed to a loudspeaker. Although the lamp does not respond very well to the highest frequencies, nevertheless the quality of reproduction was excellent.

BOOK REVIEWS

Books reviewed may be seen in the Society's Library


Volume I of this series covered the period 1896-1906, the birth of cinematography and its first use as an entertainment medium—in fairgrounds, penny gaffs and as a last turn at music halls. Volume II continues the story up to 1914, telling of the evolution of the cinema theatre, the first British producing companies and the rapidly developing technique of picture making, marketing and presentation.

The days when Barker, Urban, Hepworth, Clarendon, Cricks and Martin were the mainstay of the British film industry, make engrossing reading.

Here is a book which is not a "Romance of the Cinema," nor a collection of pioneers' anecdotes. Miss Rachel Low has given us a human account of our industry when it really was in its infancy. It is a book to read and re-read, and quite definitely it should be in the personal library of all B.K.S. members.

BAYNHAM HONRI.


The Report on the Second Annual Congress of the International Scientific Film Association, which was held in London last year, has now been published by the Scientific Film Association and comprises a very full résumé of the Congress, and is a useful record of this important meeting. The Report contains a lot of material, including a list of the countries participating and their delegates, the proceedings of the General Assembly and reports of the films shown during the Congress. Those interested in any aspect of the scientific film will find the Report invaluable, and copies can be obtained from the Scientific Film Association in London.

R. McV. WESTON.

"INDEPENDENT FRAME"—Discussion.

Continued from p. 154.

artistes themselves find any difficulty in working with this process?

Mr. DEREK BOND: I am working on the composite set which Mr. Wilson has described, so I cannot talk much about back-projection. But since the war I have done a lot of films, and I have not yet done one in which there was not a lot of back-projection. It makes no difference whatever to the actor.

Mr. R. JUSTICE: I would take a much more utilitarian note. With Independent Frame you get a schedule at the beginning of the film, and know when you are going to work.

A VISITOR: As I understand it, capital expenditure is amazingly high. Has Mr, Harold Wilson been approached with a view to spending some of the taxpayer's money on equipping independent studios, so that independent producers can have the benefit of this equipment?

Mr. RAWNSLEY: It has occurred to certain people that some of this money might well have been permanently invested in the industry as applied research and development, rather than to paying bank debts.

Mr. K. GORDON: I would rather say that the development of stereoscopic films would bring more business to the kinema than the development of the television side in the studios. Independent Frame can be a great help to us; but colour and stereoscopic pictures are still going to be saviours of the industry.
TECHNICAL ABSTRACTS

Most of the periodicals here abstracted may be seen in the Society's Library.

REPORT OF S.M.P.E. PROGRESS COMMITTEE.

This summary of progress is presented under the headings of photography, sound recording, picture and sound reproduction, television, and standards, with further divisions relating to 35mm., 16mm., and 8mm. film. A valuable feature is the lengthy list of references.

R. H. C.

INFLUENCE OF THE REDOX POTENTIAL AND OF pH ON THE ACTIVITY OF DEVELOPERS.

From a study of development by ferrous fluoride it is concluded that the redox potential required to induce development depends upon the emulsion, e.g., < 98mV. for positive film and < 55mV. for fast negative film. The influence of pH on metal and hydroquinone developers was studied and it was observed that at a given initial pH the emulsion speed and contrast obtained were greater if the buffer capacity of the alkali was greater.

G. I. P. L.

ON COLOUR DEVELOPMENT IN THE PRESENCE OF DYE-FORMING COUPLERS.

An historical survey is given of the use of colour-forming couplers in subtractive colour processes.

G. I. P. L.

ADDITIVE COLOUR SYSTEMS APPEAR IN CYCLES.
R. H. Cricks, Ideal Kinema, April, 1949, p. 17.

A brief review of the various additive systems of colour kinematography. The three principles considered are the consecutive frame system, the miniature-image system, and the colour element process, the latter divided into the réseau and lenticular systems.

AUTHOR'S ABSTRACT.

MATCHING OF PROJECTION OPTICS.

The authors are in agreement on the fallaciousness of the popular view, that an equal f value of arc mirror and projection lens ensures maximum light transmission. Calculations based upon the necessity for the lens to collect the cone of light formed by the corners of the image give conflicting results, owing to different mathematical treatment. R. H. C.

PHOTOMETRIC AND SPECTROGRAPHIC STUDY OF THE CRATER AND FLAME OF THE HIGH-INTENSITY CARBON ARC.

The experiments were made with particular reference to military searchlights on a Sautter-Harle arc using Orlux carbons, the 16mm. positive being horizontal and the 11mm. negative being inclined at 45 degrees.

G. I. P. L.

OPTIMUM PERFORMANCE OF HIGH-BRIGHTNESS CARBON ARCS.

An arc lamp with water-cooled silver positive jaws and water-cooled copper negative jaws burning 16mm. carbons at currents up to 500 amperes is described. Both positive and negative carbons protrude only a short distance from the jaws, and when specially designed carbons are burnt in this lamp, brightnesses in excess of 2,000 candles/mm.² can be obtained, burning at 13.6mm. positive at about 500 amperes. Water-cooling reduces the current efficiency of the carbon, but enables it to carry more current, the net effect being an increase of brightness.

F. S. H.
EFFECT OF CARBON COOLING ON HIGH CURRENT ARCS.

Measurements were made on the arc formed between carbons projecting only a small distance from water-cooled heat shields. An 11mm. special H.L. positive with a 9mm. negative was used, and the relations between arc current, crater brightness, net arc voltage, arc wattage, light efficiency (candles/watt) and positive burning rate are plotted for both water-cooled and uncooled arcs. It was found that no arc property was unchanged by water-cooling, due to the different temperature gradients behind the crater, and in particular there was a decrease of the anode volt drop.  

F. S. H.

TEST-FILM CALIBRATION—PROPOSED STANDARDS.

The wide discrepancies in the characteristics of frequency test films are discussed and a new method of calibration proposed, in which frequency response of the reproducer is calculated from an oscillogram produced from a square pulse.

N. L.

DISC RECORDER FOR MOTION PICTURE PRODUCTION.

A high quality disc recorder for synchronous operation is described, in which the heavy turntable is supported on a thrust bearing whose surfaces are separated by a pressure-maintained oil film. Other special features include a two-speed gearbox of the planetary type, and a viscous damped mechanical filter of the vane type.

N. L.

SYNCHRONOUS DISC RECORDER DRIVE.

The main turntable thrust bearing of this drive is of the heavy oil film type in which the pressure is developed by the rotary motion of the turntable. A dashpot mechanical filter and a rubber coupling are used and the gear box provides two speeds.

N. L.

POSSIBILITIES OF A VISIBLE MUSIC.

An instrument known as the "Sound Spectrograph," built by the Bell Telephone Laboratories, translates complex sounds into two-dimensional patterns that show frequency by horizontal and intensity by vertical signs. Motion picture records of such patterns made by music played by a full orchestra have been used to provide a laboratory-type "visible music," though admittedly in a non-aesthetic form. The author considers that audiosural unison necessitates a two-dimensional presentation with one dimension in the direction of observation and the other in a lateral direction. The author concludes that the possibilities of our having a visible music are excellent.

A. C.-C.

FILMS IN TELEVISION.

A résumé of television from film sources and film from television sources. In the first section it is noted that film, both 35mm. and 16mm., is used to supply programme material in television stations. A number of stations make their own newsreels with 16mm. professional camera and associated equipment; the principal requirements being lighting, gamma and the general composition to suit television transmission to American standards.

In the second section the requirements for a camera for photographing the pictures on cathode-ray tubes are given. The advantages of the 16mm. versus the 35mm. film are discussed and the spectral characteristics of the emulsion to give the best results are classified. A very complete bibliography is included.

T. M. C. L.

LARGE-SCREEN VIDEO MOVES FORWARD.

In the Paramount intermediate-film television system, installed at the Paramount Theatre, New York, the film, after exposure to the negative image of a cathode-ray tube and the recording on it of a conventional sound track, is processed, dried and projected within 60 seconds.

R. H. C.
Meeting of October 5, 1949.

Present:—Messrs. A. W. Watkins (President), L. Knopp (Vice-President), E. Oram (Deputy Vice-President), Rex B. Hartley (Hon. Secretary), I. D. Wratten, B. Honri, R. E. Pulman, M. F. Cooper, H. S. Hind, R. H. Cricks (Technical Consultant), and W. L. Bevir (Secretary).

Education Committee.—Mr. Wratten accepted the Chairmanship in succession to the late Capt. West and Messrs. Cooper and Cricks were elected to the Committee.

Papers Committee.—Methods of notification of meetings were discussed.

THE COUNCIL

EXECUTIVE COMMITTEE

Meeting of October 5, 1949.

Present:—Messrs. A. W. Watkins (President), L. Knopp (Vice-President), E. Oram (Deputy Vice-President), R. B. Hartley (Hon. Secretary), and Miss S. M. Barlow (Assistant Secretary).

Journal Revenue.—Plans to counteract any increase in deficit were approved.

Elections.—The following were elected:—
Nicholas Meldrum Banton (Associate), R.N. Air Station.
Arthur Henry Johnson (Member), Kinematograph Insurance Assessor.
Douglas Slocombe (Member), Ealing Studios, Ltd.
John Edward Pain (Member), G.E.C., Ltd.
Bertie James Davies (Associate), Kodak, Ltd.

Transfer.—From Student to Associate: William Elliott Kelly.

Resignation.—The resignation of Victor Stanley Hindley was accepted with regret.

Expulsions.—Two Members and three Associates were expelled from the Society through non-payment of subscriptions.

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EZ40 I.H. Full-wave Rectifier.
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PERSONAL NEWS of MEMBERS

Members are urged to keep their fellow members conversant with their activities through the medium of British Kinematography.

CHARLES H. CHAMPION has been elected Chairman of the Board of the Ship Carbon Co., Gt. Britain, Ltd., for which the firm which bears his name handles the distribution and sale of the product.

A. A. FASKI (formerly Charlozinski) and A. A. RICHARDSON, both former students in the Polytechnic course, are making industrial films in Kodachrome, under the title of Family Films, Ltd.; they have been working at Torquay.

H. MANDIWALL, a member of the R.P.S. Council, visited Campa dei Fiori, Italy, during August, to attend the eleventh annual congress of the Union Internationale du Cinéma d'Amateur as representative of the British Amateur Cinematographers Central Council.

WILLIAM NORMUS, who as studio manager at Nettlefolds, has done so much for the B.K.S., is leaving with his family for South Africa, where he takes charge of the African Film Productions studios at Killarney, Johannesburg.

GRAHAM NOWELL has temporarily left the film industry after completing his work on film production in Manchester.

H. C. STRINGER is now Managing Director of Charles H. Champion & Co. and Joint Managing Director of the Ship Carbon Co.

P. G. A. H. VOIGT is making a gradual recovery from the spinal complaint with which he has suffered for the past two years.

TED DE WIT and G. RAUCAMP, formerly of the K.I.L.M. Photographic Unit, are now trading as Carillion Films.

THE INDEX

Next month’s issue of British Kinematography will contain the Index to Volume 15. It is customary to bind together two volumes, a year’s Journals, and the index of the present volume is designed to be bound following the index to Volume 14, which is in the June, 1949, issue. However, for those who bind each volume separately, extra copies of the title page are available on application, to give a uniform appearance to Volume 15.

Small announcements will be accepted from Members and Associates. Rate, 4d. per word, plus 2s. for Box No. if required (except for Situations Wanted). Trade advertisements, other than Situations Vacant, not accepted.
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LECTURE PROGRAMME—SPRING 1950

Meetings (except those of May 2nd and 13th to which admission is by ticket only), to be held at the Gaumont-British Theatre, Film House, Wardour Street, London, W.I., commencing at 7.15 p.m., Sundays, 11 a.m. Meetings of the Sub-Standard Film Division in the Gaumont-British Small Theatre.

SOCIETY MEETINGS

Jan. 4 "Musical Treatment of Films," by ERNEST IRVING and MUIR MATHIESON.
Feb. 1 Newman Memorial Lecture.
"Mechanical Accuracy in Kinematograph Equipment," by J. BRANDT.
Mar. 1 Title to be announced.
(AJoint meeting with the Royal Photographic Society.)
Apr. 5 "The Evolution and Development of the Newsreel," by HOWARD THOMAS, M.B.K.S.
May 2 A. G. D. West Memorial Lecture.
"Motion Picture Film for Television," by Dr. O. SANDVIK and T. G. VEAL.
To be read by I. D. W writ ten, Hon. F.B.K.S., F.R.P.S. (Joint meeting with the Royal Photographic Society and the Television Society, to be held at the Royal Society of Arts, Adelphi, London, W.C.2.)
May 13 Visit to Ealing Studios and exhibition of equipment (arranged by the Film Production Division in conjunction with the Incorporated Association of Kinematograph Manufacturers.

SUB-STANDARD FILM DIVISION

Mar. 15 "Films for Africans, 1910 or 1950 ?" by NORMAN F. SPURR, M.B.K.S., A.R.P.S.
(Joint meeting with the Colonial Committee of the Scientific Film Association.)

THEATRE DIVISION

Feb. 12 "Improvements in Large Screen Television Projection," by T. M. C. LANCE, M.B.K.S., F.T.S.
Apr. 16 "Modern Kinema Equipment" : IV. Ross-RCA.

JOINT MEETINGS WITH A.C.T.

Jan. 25 "Technical Requirements of a Mobile Studio Unit for Feature Films," by BAYNHAM HONRI, M.B.K.S.
Mar. 29 "Electrical Devices as applied to Special Effects," by JOHN GOW and FRANK GEORGE.
Apr. 19 "Motion Picture Camera Development," by GEORGE HILL.
IMPROVEMENTS IN LARGE SCREEN TELEVISION PROJECTION

T. M. C. Lance, F.T.S., M.B.K.S.*

Read at the International Television Congress at Milan on September 13, 1949. The paper was followed by a demonstration of the equipment, in conjunction with Marconi transmitting equipment.

At the International Television Conference held at Zurich last year, Captain A. G. D. West read a paper in which he described the project which he had formulated for providing large screen television to kinemas in London. In this paper he discussed the sources of programme material, the distribution plan, the installation in the kinemas and other features, including the need for higher definition and the study of audience reaction.1

It has been my responsibility to organise the technical work of putting this programme into effect under the leadership and inspiration of our late chief.

Captain West had always been a pioneer in the electronic fields of radio, broadcasting and sound films, and I recall that even in 1933 when he invited me to join the Baird Television Company he had formed the conviction that large screen television was necessary and would become an adjunct to the kinema.

Like most of the problems in television, the development of our large screen system has been obtained by the co-operation of a team of experts, each of whom contributed his part, these parts being slowly added to the expanding framework of the project. Details have been fitted firstly as experimental units, then as engineered items, and finally a complete equipment emerged from the laboratory which we felt could be demonstrated as a working whole.

Previous Demonstration

After Captain West had read his paper at Zurich he pressed ahead with the objective of showing realistically the salient points of his plan for kinema television in a series of demonstrations to many interested bodies at a kinema in Bromley, Kent.2 Each of these demonstrations included programmes built up partly from the B.B.C. transmissions and partly from our own film scanner and studio at Sydenham.

The Press comments were highly complimentary, and Captain West was extremely enthusiastic over the opportunity given to Cinema-Television to bring our equipment to Milan and demonstrate it in co-operation with the Marconi Company at this great Exhibition.

During the last year our technicians have had many second thoughts, some of which have been incorporated in this first design of equipment and others have still to be further experimented with in the laboratory. We have also learnt much about the performance of this unique type of equipment in theatres, about the presentation of television programmes and the problems of meeting the stringent conditions imposed by the public safety authorities.

It is against this background that I am presenting my paper to-day. I propose to indicate the general arrangement of the projector being demonstrated here in Milan, to describe some of the improvements made since last year and to consider future work for the extension of these improvements.

Reception Requirements

The first essential requirement for the projector was to be able to receive either programmes of national or sporting interest through the B.B.C. Tele-

*Cinema-Television, Ltd.
vision Service, or supporting or similar programmes over the kinema organisations' private circuits.

While the Television Advisory Committee has laid down that in England the standards of transmission for the broadcast television service will remain fixed for a number of years, the standards selected for the kinema's own circuits are at present their own concern. The opportunity will, therefore, be taken to increase the number of lines and the bandwidth in order to reduce the cause of the major criticism of large screen projection.

The dual transmission necessitated the receiver operating first on the 405 line, 2/1 interlace standard transmitted from Alexandra Palace in North London on 45 Mc/s., and alternatively on the 625 line 2/1 interlace standard transmitted from the Crystal Palace in South London on 480 Mc/s.

We have approached this problem in two ways. Firstly, the receiver has been designed to receive the 480 Mc/s. as a superheterodyne having an intermediate frequency of 45 Mc/s., which can be brought into operation as a straight receiver by changing aerial inputs when programme sources are changed. Such kinemas would be fitted with a double aerial system such as is shown in Fig. 1. In this system the choice of programme is the responsibility of the individual kinema exhibitor.

Short-wave Relay System

The second and more interesting proposal is to receive the B.B.C. programme from the Alexandra Palace at a conveniently placed relaying station and re-transmit both programmes to the kinemas over the 480 Mc/s. circuit. This may prove a solution to the problem of interference from automobiles, electric signs and machinery in the West End theatre district, because on the higher frequency a better signal-to-noise ratio may be expected through the use of directional aerial systems, particularly if at a later date a higher frequency is allocated to this new service.

This second system has the great advantage of bringing the whole television circuit under the control of one programme director, so that pre-selected introductory material can be transmitted before an eagerly expected event the nature of which does not allow of accurate timing. Thereby one of the criticisms of instantaneous projection in comparison with the intermediate film method of large screen television is removed.

The relay station chosen for the first experiments stands on the highest ground in the South of London, and our aerials are located on the top of a water tower in the grounds of the Crystal Palace, giving an undisturbed coverage of the London basin containing most of the suburbs, and particularly the West End area.

I would like to remark that it is a peculiarity of English television that, while being so eminently modern, it seems to be located in nineteenth-century palaces, the Alexandra Palace and the Crystal Palace, neither of which is in fact a palace and one of which does not now exist.
The Receiver

The 480 Mc/s. receiver employs two R.F. stages with grounded grid triodes built into tuned lines, tuning being effected by varying a capacity probe in the anode end of the line. Mechanically these stages are identical, but they are tuned to different frequencies to obtain the required bandwidth.

The local oscillator is crystal controlled. The crystal frequency is multiplied in four stages to 492 Mc/s., the final stage being another grounded grid triode in a tuned line.

The R.F. and oscillator frequencies are fed into a tuned line for mixing, the line being terminated with a silicon crystal rectifier feeding into the 45 Mc/s. intermediate frequency amplifiers.

In the 45 Mc/s. receiver the detector unit has been designed as a normal low-pass filter having a cut-off frequency of 3.5 Mc/s., the subsequent video stages having a flat frequency characteristic. In setting up the receiver

the frequency response of the detector stage is adjusted to be uniform from 0—3.2 Mc/s. when a modulated carrier having both side bands is fed to the diode. The radio frequency amplifier is then tuned to produce the same overall response, the sound rejector circuit being, of course, permanently connected. The output of the detector is applied to a cathode follower valve which feeds the main video equipment over a short length of concentric cable.

The circuit of the receiver and the video chain of the projector are similar to those being described by Mr. J. E. B. Jacob in a separate paper to this convention. 3

Construction of Equipment

Fig. 2 is a block diagram of the projector which shows considerable simplification over that shown last year.

Fig. 2. Block diagram of Projector System. Power supplies and stabiliser are omitted for clarity.
To meet installation requirements the equipment is divided into four groups of units:

(a) The units contained in the projector itself, which is located in the auditorium and should for this reason contain as little equipment as possible.
(b) The units contained on the racks in the television operating room, which can be remote up to 100ft. from the projector, and by virtue of the separate picture monitor and indicating instruments need not be in a place where the large screen can be seen by the operator.
(c) The high-tension unit which can be located anywhere within the kinema building, and
(d) A small control unit which can be installed in the auditorium or the projection box at which small adjustments can be made to the picture quality, brightness, electrical focus and sound volume.

Video Chain

The function of the main units in the video chain is self-explanatory from an examination of the diagram. It will be noted that a gamma corrector is included. This is only at present an approximate correction for the non-linear characteristics of certain studio cameras used in the transmission and can be cut in and out at will by the operator. Further work is planned in the design of this corrector as it may be desirable to have a variable gamma control.

The output amplifier has been designed to provide a drive to the projection tubes of the order of 500 volts, with a uniform frequency response over the required band. The output stage consists of three tetrodes operating in parallel. The video signal is applied to their grids with positive polarity so that the signal which appears on their anodes has negative polarity and must be applied to the cathode of the cathode ray tube to modulate it.

The advantages of driving a cathode ray tube by this method are as follows:

1. The valve anode current/grid volts characteristic can be used more efficiently as the valve can be biased back to its bottom bend and the whole of the linear part of the characteristic can be used for amplifying the video signal. The synchronising signal part of the waveform suffers amplitude distortion, but this is of no importance as this signal is not needed at this point.
2. The power dissipated in the anode load at zero signal is lower than would be the case if this were a positive signal in the anode circuit, since the mean level of the signal is relatively a small fraction (approximately one-quarter to one-tenth) of the peak white value. The valve dissipation is, of course, the maximum at the middle half-tones.
3. The residual curvature of the valve characteristics is such as to tend to compensate to some extent for the fluorescent screen saturation effects in the high lights. The reverse is the case when the anode signal is positive.

The disadvantages in this arrangement are:

1. The projection tube has to be heated by means of a specially designed low-capacity transformer.
2. The capacity into which the anodes of the output valves feed is considerably larger than if the tube were modulated on its modulator electrode, due to the relatively large input capacity (approximately 50 pf.) of the tube, its associated heater transformer and the monitoring transformer for the filament voltage stabiliser.

Position of Projector

The design of this projector was commenced with certain experience and knowledge gained from operating a smaller projector with a half-scale Schmidt system.

We knew that larger optical systems could be designed and manufactured,
and would give a resolution good enough for 625 line definition, and we also knew the luminous efficiency of our phosphors.

We decided that as much of the electrical equipment as possible was to be placed outside the auditorium for reasons just given, but where should the projector itself be placed? A survey was made of a large number of London kinemas; as Captain West showed last year, most London kinemas have a circle, and the film pictures are projected down from the operating box at steep angles to the screen, having sufficient depth of focus to accommodate the variation in projection distance and sufficient illumination to allow the use of non-directional screens. The Schmidt system for television, however, cannot be more than 10° off normal axis to the screen, so that in most kinemas the television projector must be located either on the front of the circle or on the floor of the auditorium. The front of the circle or balcony is, of course, the ideal position, but the throw distance is peculiar to each kinema and such an installation would in general call for individual "tailored" design of the optics. The cost and time occupied to complete and manufacture each optical system would, under these conditions, be prohibitive.

The suggestion has been made that to maintain projection normal to the screen the projector could be hung from the roof on an hydraulic cylinder, which would lower it into position when required and retract it when the film projector was operating; but there are very few kinemas in London where this device would not obscure the viewing of at least 20% of the audience.

Optical System

The decision to standardise on a 40-ft. throw from projector to screen was therefore the right one, and the system finally designed by Messrs. Imperial Chemical Industries, Ltd., to our specification, consists of a mirror 27ins. (68.5cms.) diameter, and a correcting plate which has an aperture of 18ins. (45.7cms.). The speed of the system is /1.14, the magnification being 27.7, which, to cover a screen diagonal of 20ft, requires an image on the cathode ray tube of 8.66ins. diagonal. The angular field of the optical system is 14° each side of the axis.

Fig. 3. Cathode-ray Tube and Optical System.
In one theatre we have taken advantage of the central gangway, which can be widened out to meet safety requirements by the removal of only 10 seats. In this particular theatre, although the stage is quite short, there is a dummy orchestra pit so that the projector is only 5 rows back from the front of the audience. This is rather important, because, with the 405-line definition pictures, the line structure is noticeable to viewers sitting nearer to the screen than the front of the projector.

We have taken advantage of the central gangway in another way. The projector is fitted with wheels and can at the end of the programme be rolled down into the orchestra pit where it is out of the way of the audience, and particularly out of the way of small boys who know all about television!

**Cathode-Ray Tube Assembly**

Figs. 3 and 4 illustrate the general assembly of the cathode-ray tube and optical system.

1. The 27in. diameter glass mirror with the front surface aluminised and weighing 85lbs. (38.5kg.) is supported in rubber-lined clamps. These clamps are arranged so that the lower two which bear the weight of the mirror are spaced at 45° each side of the vertical, as with this disposition there is the minimum distortion of the mirror due to its own weight.

2. Is a black shield of the same diameter as the face of the tube placed on the axis of the mirror to prevent reflection of light back from the tube on to its own face, thereby reducing contrast in the picture.

3. On the centre of this plate is a selenium photo-cell which measures the average brightness of the picture and the reading of which is indicated back on the control equipment. This cell is used to indicate the average beam current, as all tubes are calibrated in the laboratory and marked with the reading of the photo-cell current corresponding to 1 milliamp. beam current of the tube.

4. Is the face of the projection tube. This is an optically polished hard glass disc, the radius of which is approximately half the radius of the mirror. This plate carries the phosphor which is bombarded by the electron beam on one side, and to restrict the temperature rise of the phosphor, air
at room temperature is blown across the face from an air nozzle. In the future it is planned to treat the outer face of the tube with an anti-reflecting coating.

5. Is the air nozzle, the design of which is quite critical to give uniform cooling over the whole face without noise. These two requirements go against each other, and a compromise has been found which is reasonably successful on normal television programmes.

6. Is the anode connection to the tube made through an internal wire connection welded to a large platinum disc pressed in to the inner surface of the glass envelope. The size of the disc is sufficient to ensure a low resistance contact to the graphite internal coating of the tube. The tube is exhausted through the side tube carrying the anode connection.

7. Is the lead-in cable which is polythene insulated. The diameter of this cable is surprisingly small, but on D.C. conditions is adequate for 60 Kv. without trouble.

8. Is one of the two getter tubes. This one contains 12 batalum getters which can be fired by high frequency. The first is fired when the tube is manufactured and first sealed to the pump. At certain periods during life two or more additional getters are fired to maintain a good vacuum.

9. The second getter tube contains a zirconium wire getter which is continually heated during the running of the tube and the use of which has been found very advantageous. Unfortunately since the getter is near the anode coating it is necessary to maintain it at anode potential which involves a heating transformer insulated to full anode volts and two extra H.T. connections.

10. Is the electron-permeable aluminium coating applied to maintain the phosphor at anode potential and prevent " sticking," and which also considerably improves the contrast of the picture by obscuring internal reflection of light. The presence of the aluminium film also enables us to use a bright tungsten cathode, and the light from this, which is considerable, is also obscured.

11. Is the gun assembly which will be described separately, but attention is drawn to the heavy connectors necessary to maintain stabilised heater voltage with the heavy current of 14 amps. required by the tungsten strip cathodes.

12. Is a small air jet, which is directed into the pinch, for the purpose of cooling the pinch and copper lead-out wires. Note that the assembly ends with an obscuring disc to prevent the light from the cathode falling directly on to the viewing screen.

13. A crucial point of the design is a thick polythene insulating sleeve tested to withstand 100 Kv. to earth, which provides the main insulation between the tube and the scan and focus coils which are at earth potential. Initially we relied on the glass neck of the tube to provide this insulation, but although each piece of glass was given a prolonged test at double working voltage we had many losses of tubes due to the puncturing of the glass after a few hours' run. The insulating sleeve is welded to a disc of the same material which protects the scan coils against flash-over from the outer surface of the glass on damp days.

14. Is the deflection unit. This consists of four windings on an iron-toothed stator having 30 teeth. In order to obtain the insulation required the minimum wall thickness of the sleeve under the scanning yoke is 6.5mm., and the problem of supplying sufficient scan current in these coils is very difficult, particularly at 15 Kc/s., which is the line frequency for 625 lines, and also as the coils appear at the end of a long cable.

15. Is the focus coil. This is a complicated and costly unit. It consists of a long solenoid embracing the electrode system of the tube and
having eight parallel windings so as to give the minimum practical resistance. The focus current is modulated at line and frame frequency, a worth-while improvement for high voltage tubes having large deflection angles.

16. Is two sets of deflection coils, one used to centre the beam in the focus coil and the other to centre the scanned area or raster, on the face of the tube with the optical system. This electrical method of centreing removes the need for accurate mechanical adjustments and greatly facilitates the re-alignment of tubes when these have been changed. In the same way we have found that only one in four of the tubes requires re-adjustment for the centreing in the optical system to allow for the axial alignment of the tube neck to face. When the centre of curvature of the tube has been placed on the axis then the adjustment to centre the raster on to the centre of the viewing screen is very slight and can be made electrically.

17. Is the correcting plate. This is held in four grooved rollers, the upper two of which are spring loaded and the other two are on eccentric rollers so that the plate can easily be centred on the optical axis while maintaining its parallelism to the mirror. In setting up these large Schmidt systems we have found that the spacing between the mirror and the correcting plate is uncritical, and we may in future make the correcting plate easily removable for tube changing, as this would simplify the internal arrangements of the tube mount.

18. The tube is held in position by being pressed into the polythene sleeve in the front and lightly clamped by the screws at the rear. Thus tube and focus coil mount are inserted into the optical system as one unit when a change is necessary. The focus coil mount is carried in the optical system on two girders made to be very rigid in the vertical plane, but designed to obscure as little light as possible. These girders are supported at the ends outside the optical path on adjustable supports.

**Construction of Cathode-Ray Tube**

The next most important item of the projector is the cathode-ray tube. Continuous improvement has been made in the performance of the projection tubes under the arduous conditions called for by the specification. The tube produces 900 lumens of luminous flux at 50 Kv. and a beam current of 5 milliamps. On a television picture the average current is generally about 1-1.5ma. with peaks between 10-15ma.
Fig. 5 shows the external appearance of the projection tube alongside the focus and deflection unit previously described. The optically polished and curved face, the double getters and the electrode system can be easily recognised.

The main body of the tube is a mould-blown glass bulb, and all the parts are constructed of the same boro-silicate glass manufactured by Chance Bros. and known as "Hysil." The face is sealed to the bulb in a special jig, gas fires being used in the normal manner. All the glass is given a preliminary E.H.T. test to double the working voltage, as many failures have been traced to minute bubbles in the neck ionising under working conditions and bursting.

**Electrode System**

The tube is a simple triode with the anode and modulator carefully cleaned and polished to reduce point discharges and cold emission at 50 Kv.

The main problem was that of obtaining sufficient emission to give a focused beam current of 15 milliamps, and of the many cathode structures tested the most satisfactory was the flat top filament tape of pure tungsten. This was superior in that the unfocused beam was substantially circular, and hence made better use of the available focusing and deflection aberration-free areas, and also the spot passed through focus in a more symmetrical manner.

The dimension of the flat plateau of the cathode is approximately 1.5mm. square, and the thick tungsten strip was mounted in a rigid assembly with filament support radiators, which were found essential to avoid overheating the pinch, with resulting cracking. This cathode gives 10ma. for a 0.0025in. spot at 50 Kv., and requires a heater current of 14 amps at 2.05 volts. The anode/modulator spacing is 3.5mm., which results in a 9° beam angle for a drive of 430 volts at 1,040 volts cut-off. These spot sizes are made at 10ma. as a point of reference, but it should be noted that very little swelling occurred on increasing the beam current to 15ma.

**Pulse Testing**

For testing the tubes and in particular for the measurement of focused spot diameter under full load conditions, a simple pulse modulation circuit was developed. It was desired to examine the spot sizes and shapes under a microscope for a series of experimental electrode systems. The specification calls for a 0.0025in. (0.063mm.) diameter spot for 10ma. beam current at 50 Kv. These projection tubes require about 1,000 volts bias, and to avoid screen burning with a stationary spot a circuit was devised which provided as a drive a pulse of quarter-microsecond duration, variable in amplitude up to 1,000 volts. In this a length of transmission line of 100 ohms characteristic impedance is terminated by a ladder attenuator of 100 ohms input impedance, through a spark-gap consisting of two points separated by an intervening gap, across which passes an electrically floating spoke rotated on a synchronous motor shaft. The line is charged through a high series resistance from a 3,000 volt source, and when discharged by the gap gives a square pulse across the attenuator. The latter is necessary to reduce the high charge voltage implicit in the spark-gap discharge, and is also convenient for applying varying grid drives as required.

Beam currents are measured by the standard slide-back method, with the modification that to avoid heavy loading of the tubes, the D.C. measurement is taken by applying a similar but broader pulse derived from a trigger circuit with cathode-follower output. The beam current pulse resulting from this modulation is readable on an oscilloscope suitably calibrated. The apparatus is simple and has given satisfactory service.
Cooling

A series of experiments have been made on liquid cooling and air cooling the face of the projection tube. It was found that the light output measured under peak white conditions dropped by about 10\% when the temperature of the outside face was raised from 20\°C. to 100\°C.; the temperature of the screen material itself under steady-state thermal conditions was then about 90\° higher than the outside temperature.

The main difficulty in the problem of cooling the phosphor is that the thermal conductivity of the glass is low. Unfortunately, in order that the tube shall withstand the atmospheric pressure with safety, particularly considering the bending moment on the glass seal, we have to use a plate 5mm. thick. From the point of view of thermal conductivity the phosphor layer corresponds to an extra 1mm. of glass. If, however, the face seal could be made in a manner whereby the stresses across the joint were normal to the radius at that point then the glass could be reduced to at most a third of this thickness, thus reducing the thermal conductivity so that the cooling of the phosphor would not be a serious problem, and an increase in luminous efficiency could be expected.

Experiments with an air blower have shown that there is a good possibility of obtaining adequate cooling by this means, and we are experimenting in the design of a silent nozzle to give an air jet to maintain the tube face at room temperature.

Effect of Heat on Phosphors

Experiments made 18 months ago on the effect of temperature rise, show that the efficiency of the yellow silicate dropped by 50\% at 120\°C., which meant that for satisfactory operation the outside face of the projection tube would have to be maintained at a temperature of less than 0\°C., and plans were seriously discussed for cooling the face by a liquid cell; the projector would then have to include a small refrigerator.

The improvement in the temperature effect brought about by 18 months' work in phosphor development is clearly shown in Fig. 6.

(a) Is for a blue sulphate which we were forced to use at that time in the absence of any other blue phosphor.
(b) Is the temperature characteristic of an early projection silicate, while
(c) Is the best projection silicate at present available.

It has become obvious to us that the design of the projection cabinet must be very carefully worked out to restrict the entry of dust and moisture. It may even become necessary that heaters will have to be included to prevent condensation within the cabinet when the apparatus is not in use.

If these precautions are not observed carefully, brushing and sparking will occur over all the high tension insulators and surfaces of the electrical equipment, as well as on the optical components.

Phosphor Development

To the non-technical observers of our projection demonstrations over the past 18 months, the principal improvement has been in the colour of the picture. Formerly the picture was a greenish-yellow, now it is a blue-white, giving a good colour contrast with the subdued red lighting demanded by the authorities for kinemas in England.

However, we still regard phosphor development as the most important item in our programme. We have to date produced two components which give the required colour with reasonable brightness when mixed, and which saturate to an equal amount, so that colour changes with modulation are
not noticeable. We have to a certain extent reduced screen burning, but there is still the serious disadvantage of outgassing of the phosphor during life to be overcome.

The control of particle size is also under investigation, as it is essential with a mixture of two phosphors to avoid colour separation in the screen and to produce a uniform thickness of screen to assist the deposition of the aluminium film which has to lie in close contact with the phosphor.

The particle size of the two phosphors is under 5 microns, and the blue component is under 1 micron. The screen thickness averages 100 microns, and the density is about 8 milligrams per square centimetre. The aluminium film has a thickness of 0.1 to 0.2 microns.

The two components of our screen are both silicates, and approximately 800 experimental phosphors were made before we obtained a formula which has produced a blue silicate which shows no saturation effect under test conditions at 50 Kv. and a focused current of 1.5ma. This is shown as curve (f) on Fig. 7. This test condition corresponds to a screen loading of 2 amps. per square centimetre; the peak white conditions will, of course, be ten times this.

The other two curves are (d) the most efficient blue silicate which can be obtained, which, it will be seen, has an efficiency roughly double our non-saturating phosphor at low beam currents, but also shows the highest saturation effect; and (e) which is the phosphor being used in the present tubes.

Ageing of Phosphors

During life under projection conditions the phosphor suffers from a change of body colour, and as this is observed as a darkening, it is known as "screen burning." This effect in some phosphors is reversible, and the darkening can be reduced by heat treatment; but there is also a darkening of the glass which is not reversible, and which has been assumed to be solarisation due to the X-ray action on the glass. We have proved that when the glass is in contact with manganese-free phosphors this effect can be reduced to within 10% of the light absorption for a screen life corresponding to a life of the tube determined by the evaporation rate of the tungsten cathode.

The problems for the future are to overcome these adverse effects and also aim for an increase in luminous efficiency. The best phosphor in Fig. 7 has an efficiency of only about 1 candle per watt. We have always set
the physicists the target of 5 candles per watt. We do not know if this is theoretically possible, but if it is then we can predict a big step forward in projection television.

E.H.T. Supply

One very important item on which considerable work is at present being concentrated is the E.H.T. supply. With a triode tube of the dimensions given the regulation and stabilisation of the E.H.T. demands very close tolerances if defocusing on load is to be avoided. At the same time precautions have to be taken to limit the energy from the power pack in the event of a discharge within the projection tube.

We are at present using large 50 c/s. voltage-doubling rectifier units which can give 10ma. continuous output at 55 Kv. These are pre-war in design and very cumbersome, but have given reliable service in a number of installations.

![Diagram of E.T.H. Supply Circuit]

The regulation of the rectifier is between 65 Kv. on open circuit to 55 Kv. on 10ma. load, which is not sufficient. Originally we had stabilisation on the primary of the transformer, but this does not eliminate ripple in the pack or take up rapid changes; a new circuit has therefore, been evolved, shown in Fig. 8, which gives a control to 1%. This is built around the development of a special high-voltage stabilising triode and a high-voltage limiting diode. The operation of these tubes is self-explanatory, but it is still essential to place the diode as close to the projection tube as possible in order to reduce the energy involved in the discharge of the cable capacity between the diode and the tube, within the tube.

Special high-voltage transformers of small dimensions have been evolved for this circuit. Their design has been made possible by the use of polythene insulated wire and the application of the new technique of welding polythene screens over the windings.
Conclusion

To summarise, this paper has briefly described some of the many problems which have been attacked in the development of our cinema television projector; improvements introduced during the last 18 months have been indicated and certain clues have been given to future developments.

In conclusion I wish to enumerate those of my colleagues to whom credit is due and gladly acknowledged for the solutions to the main problems involved in the cinema television projector. To Mr. T. C. Nuttall for general advice throughout our work; to Mr. E. D. McConnell for his consideration first of the optical requirements and then of the design of the whole of the electrical equipment excluding the receiver and video chain which Mr. J. E. B. Jacob evolved; to Dr. K. Samson and Mr. W. H. Buchanan for the development of the projection tubes and special triodes and diodes; to Mr. R. B. Head for his work on the phosphors and the many others within and outside our organisation, who played their part as the happy team directed by our late chief, Captain West.

I must thank Cinema-Television, Ltd. for making it possible for me to be here in Milan and for permission to read this paper.

REFERENCES

BOOK REVIEWS

Books reviewed may be seen in the Society's Library


This book is written by the Vice-President and Chief Engineer of the Brush Development Company who is well known as a pioneer in the sphere of magnetic recording on wire. It deals comprehensively with the various aspects of magnetic recording, starting with an historical survey and showing the developments from Poulsen’s Telegrafone to modern magnetic sound recording and reproducing equipment. Several chapters are devoted to the fundamentals of magnetism and the requisites for magnetic recording, including descriptions of the A.C. and D.C. biasing methods.

The early German magnetic recorders, in particular the Magnetophon, are described, as well as a large number of the latest American apparatus—the latter including many of the steel wire and steel tape type—whilst various forms of application of magnetic recording are mentioned, such as its adaptation to the motion picture industry.

The book concludes with a prophecy of the possibilities of magnetic recording eventually superseding the phonograph. It is easy to read and would appeal in particular to anybody desirous of obtaining a rapid review of the ground already covered by this subject, from the early beginnings up to the present time.

O. K. Kolb.


Albyn Press is to be congratulated on producing one of the first film publications to recognise the importance of television and its close association with all forms of documentary film production. Although only twelve pages are devoted to the subject, Mr. Bellamy Gardner has selected extremely useful information, unobtainable elsewhere in so compact a form.

With a new and very pleasing format other items not included in two previous editions are a list of French documentary film productions in 1949; film dispatch firms and organisations which distribute specialised films. Many members of the B.K.S. are mentioned in various sections of the book, but it is to be regretted that in the "Who's Who" section, so few have recorded their association with the Society.

A.W.
DISCHARGE LAMPS IN RELATION TO FILM PROJECTION

A. G. Penny, F.I.E.S., M.B.K.S.*

Read to the B.K.S. Theatre Division on April 24, 1949.

THIS paper may be looked on as an interim report on a development which has now been in progress for nearly fifteen years. The problem in brief was, and still is, to find some form of light source superior to the carbon arc for kinema projection.

The occasion which initiated the work was the realisation that the then recently invented mercury-discharge lamp, which we use so widely for lighting our streets, was capable of producing under favourable conditions, an arc which was brighter than the crater of the high-intensity carbon arc\(^1,2\).

Although referring particularly to the problems of 35 mm. projection, some of the remarks herein are equally applicable to sub-standard projection for the smaller film.

Requirements of Light Source

There is a wide variety in the size of kinemas, and a wide variety in the size of the screen which has to be illuminated. British Standard 1404:1947 specifies a screen brightness of 8 to 16 foot-lamberts, which may be averaged as 15 lumens per sq. ft. Assuming an average width of screen of 16 ft. or an area of 200 sq. ft., that is equivalent to 3,000 lumens in the beam. This has to pass through the optical system of the projector, which is surely man's crowning masterpiece of inefficiency; and through a not too highly transparent atmosphere. One-fiftieth of the light from the lamp transferred to the screen is frequently considered satisfactory. Thus a light source giving 150,000 lumens is needed.

What must be the size and shape of the light source? Optical engineers require it to be not larger than the aperture of the projector, and of substantially similar shape.

A vitally important matter, generally considered to be outside the field of research and development engineers, is cost: initial costs and running costs. The running of a lamp is the cost of the power consumed, the cost of replacement parts, and the cost of maintenance, whilst the initial cost is partly the cost of the apparatus and partly the cost of the installation. Clearly, therefore, a new type of lamp will be attractive if in any of these items it can effect a substantial saving.

Colour of Light

There are, of course, other requirements which must not be forgotten: reliability, constancy of light output, reduction of heat, and, very important to-day, suitability to the projection of colour films. Most people are content if monochrome film may be satisfactorily projected as a subjective black-and-white, but Technicolor film has to be considered "pleasing," quite irrespective of the actual colour renderings. Even if it were possible to adapt Technicolor to a light source of another colour than the arc lamp, the commercial difficulties of running two types of film—one for carbon arcs, and one for a different source—are sufficiently repellent for us to assume that any new source must make Technicolor film as we know it now appear "pleasing" when viewed in the kinema. This does not necessarily mean that it must give exactly the same rendering as the carbon arc, but it does mean that the rendering must be similar.

*General Electric Co., Ltd.
Details of compact source lamps have been published previously\textsuperscript{3,4,5} and it is not proposed to repeat them here; but it is worth while to review the characteristics of compact source mercury lamps which concern projection engineers.

**Utilisation of Light**

First, do they give enough light? The answer is they do. Fig. 1 shows a 25 kW lamp which will emit one-and-a-quarter million lumens, more than six times what we need, hence with an ample factor of safety.

One of the major problems connected with effective utilisation of the light is that, in the existing form, the light source is not as convenient as that of the conventional carbon arc. The light comes from the discharge itself and not from the crater, so that light is emitted in all directions. This distribution is not so effective with the normal optical system, and experiments with the less usual systems have not been very satisfactory. When one remembers the past experience which lies behind the existing systems this is perhaps not unexpected, but it would be optimistic to expect any developments in this direction which would help the compact source without also helping the arc.

It is possible, however, that the light source can be improved by re-design of the electrode arrangement, whilst the absence of fumes and sputtering, the difference in the distribution of heat radiation, and the practicability of a powerful fan immediately close to the lamp or optics, all make for a simple and cheaper optical system. It may be that this simplicity is preferable and will offset a less efficient collection of light flux.

**Comparative Costs**

Secondly, the question of economics. A compact source lamp has an efficiency of about 50 L/W, that is, comparable with an arc. Losses in the control gear should be about the same. There are also interesting possibilities of running the compact lamp on A.C. and switching it off each time the shutter is closed, which might save half the current. It can be assumed therefore that the current consumption is not likely to be increased.

As regards the cost of the replacement parts, the carbon arc needs new carbons, and the compact source lamp has a finite life about which not too much is known at the moment. A lamp of the type used in the film studios, giving about the amount of light required for film projection, costs about £30, and appears to have a life exceeding 500 hours. The cost per hour thus works out at only about 1s. 3d., with every prospect of further reduction as manufacturing techniques improve and quality rises, and thus compares with the cost of carbons.

Maintenance is limited to changing the lamp at the end of its life. The characteristics of defective or damaged lamps are helpful, in that if a lamp starts and runs for an hour or so, it seems very unlikely to fail prematurely. The end of life is usually signified by failure to start when switched on, so that failure during a show is therefore not a serious hazard. It is probably
considerably less likely than the breakage of a carbon or the jamming of the mechanism of an ordinary arc projector.

Operation can be effected by remote control if necessary, as in studio units.

**Power Requirements**

As regards installation, there are obvious similarities between the two sources, which are both arcs and need some form of ballast. But they differ largely in the approach made to their control. Carbon arcs have largely grown up in a world of mechanics, but compact source lamps have grown up in the hands of electricians; to the layman the arc is mechanically complicated, electrically simple, and the compact source lamp electrically complicated, mechanically simple. The actual mechanism of operation of compact source lamps for studio purposes has been described before and will not be described here except as regards adaptation to film projection.

A number of standard machines have been converted to compact source projection with considerable success, and it is clear that the problems associated with the use of such lamps under commercial conditions are capable of solution. These problems are mainly associated with the starting of the lamps, and whether operation on A.C. is practicable.

Starting needs a much higher voltage than is normally permitted in a projection booth, and although the applied voltage need only be in the form of a pulse of very short duration and of doubtful danger, it is probable that precautions not considered necessary in a studio may be insisted upon by the authorities controlling safety in cinemas. If A.C. operation should be possible, the simplification of the gear both for starting and running should be very considerable.

An important difference as regards installation costs is that as the compact lamp does not give off fumes, ventilating problems are less severe. A.C. operation, in addition to reducing current consumption, will also eliminate the use of rectifiers; this, however, is still something for the future.

**Colour Corrected Lamps**

The most efficient and simplest compact lamp is one in which the arc is in mercury vapour. This is very attractive for black-and-white projection, and indeed clearly superior to the tungsten filament lamp, but not good enough for colour films, the deficiencies in the projection of which are obvious.

Of the many ways in which the colour might be improved, the most promising so far has been the introduction of other metals into the discharge. Most satisfactory is the effect of adding cadmium, zinc, or both. By such means it is possible to produce a light which contains all the main colours of the spectrum. A remaining problem is to balance the relative amounts of each so that they give an approximate match with the existing carbon arc. There are many ways of doing this—filters, for instance—but the difficulty is to do it without sacrificing other advantages which the lamp has over the arc.

Assessment of the colour of a source is very difficult unless it can be viewed actually under the correct conditions. The demonstration that follows employs a lamp which is already available commercially. It may be found acceptable in some circumstances, but the difference in colour rendition is noticeable. We do not think it is good enough for commercial film projection to critical audiences accustomed to arc projection.

Here I confess that we do not see our way ahead. There are many possibilities—one has only to read the patent literature to realize them—and we have tried most; but the carbon arc still remains the best all-round light source for kinema projection. With our growing knowledge of the behaviour of electric discharges it is our belief that this situation will change,
but we feel that some new discovery in the world of pure science is necessary before the arc relinquishes the supremacy it has held for the last fifty years.

To demonstrate the colour rendering of the compact source lamp, alternate sections of coloured films were projected with a high-intensity carbon arc and with a compact source lamp. Black-and-white films were also shown.

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2. Francis, V. J., and Wilson, G. H. Transactions of the I.E.S. (Lond.), 1939.
5. Aldington, J. N. "Bright Light Sources," Transactions of the I.E.S. (Lond.), 1946.

TECHNICAL ABSTRACTS

Most of the periodicals here abstracted may be seen in the Society's Library.

STANDARD QUALITY OF PHOTOGRAPHIC CHEMICALS.
Reports of a sub-committee of the A.S.A. charged with preparing specifications for standards of purity of chemicals for photographic use, and methods of testing. References are given to standards prepared or adopted for 52 substances used in photography.

M. V. H.

THE INFLUENCE OF THE SURROUNDING FIELD ON THE THRESHOLD OF VISIBILITY IN PHOTOMETRIC MEASUREMENTS.
The work of Abribat, Eggert and Pfund is discussed.

G. I. P. L.

NEW SERIES OF LENSES FOR PROFESSIONAL 16MM. PROJECTION.
Details of the design, mounting and optical performance of a new series of 16mm. projection lenses made by the Bausch & Lomb Optical Co. are given. Focal lengths are from 2 to 4in., all with speed of f/1.6.

M. V. H.

NEW SERIES OF LENSES FOR 16MM. CAMERAS.
Details of the optical design and mechanical construction of a new series of 16mm. taking lenses made by the Eastman Kodak Co. are given. Focal lengths range from 15 to 152mm. with various relative apertures from f/1.4 to f/4.0. The resolution obtainable is discussed in great detail.

M. V. H.

PRECISION SPEED CONTROL.
An electrical governing device for D.C. motors provides speed regulation to 1 part in 25,000. By means of a pilot tone from slip-rings on the motor, a bridge circuit, and a crystal controlled amplifier, control current is passed through an auxiliary field winding on the motor.

N. L.

AUTOMATIC TEMPO INDICATOR.
For musical playback recordings a 45 c/s. pulse is added to the recorded signal in time with the beat. The pulse is filtered from the music on playback and used to operate cue lamps, so that when loud speakers cannot be used, as on live microphone shots, the cue lights indicate the tempo of the music.

N. L.
PROVINCIAL SECTIONS

The Manchester and Newcastle-on-Tyne Sections of the Society have completed a third successful lecture session. The Leeds Section held its inaugural technical meeting on October 2, 1948.

MANCHESTER SECTION

Visit to S.E.I. Works
The Manchester Section met on November 2, 1948, at the works of the Salford Electric Instrument Co., Ltd., by kind invitation of Mr. H. Cobden Turner, managing director. Among a wide variety of equipment demonstrated, the S.E.I. exposure meter was of particular interest.

Screen Illumination
On December 7, Mr. A. Duerdoth, B.Sc., M.B.K.S., A.R.C.S., delivered a paper entitled "Screen Illumination with respect to Lamp Optics and Carbon Arc Characteristics," reported last month.

Safety-Base Characteristics
A paper entitled "Nitrate and Safety Film-base Characteristics" was read by Mr. G. J. Craig, O.B.E., M.B.K.S., on January 4, 1949. This was of particular interest in view of the cinema tests on safety base in progress at the time.

Television Time-Base.
"Time Base: Its Implications," was the title of a paper read by Mr. Jeff C. Evans on February 2.

Cathode Glow Tubes and Crater Lamps
On March 1, Dr. J. A. Darbyshire, M.Sc., A.M.I.E.E., F.Inst.P., delivered a paper in which he described a new crater lamp, developed by Ferranti, Ltd. This paper also was reported last month.

Glass in Projection Systems
At the meeting on April 5, Dr. W. H. Willott, B.Sc., F.Inst.P., read a paper in which he discussed the important part played by the optical components of the projector.

Discussion Meeting
The final meeting of the session, on May 4, was devoted to a technical discussion ranging over a wide field.

NEWCASTLE-ON-TYNE SECTION

Carbon Brushes for Electrical Machinery
The Newcastle session opened on September 7, 1948, with the paper by Mr. W. D. Harrison already reported in this Journal.

Light Production from the Carbon Arc
The second paper, read on October 5, by Mr. H. P. Woods, B.Sc., A.Inst.P., M.B.K.S., had previously been read to the Manchester Section.

Meters and their Readings
On November 2, 1948, Mr. D. H. Thomas, of the Rutherford College, Newcastle-on-Tyne, discussed the purposes and limitations of electric meters.

Light and Colour in Stage Presentation
The paper read on December 7 by Mr. P. Corry was substantially similar to that presented earlier in the year to the Manchester Section.
Breakdowns on Electrical Machinery

Mr. W. A. Burton on January 4, 1949, read a paper in which he discussed the maintenance and emergency repair of electrical machines.

Discharge Tube Lighting

Developments in fluorescent lighting were the subject of a paper read by Mr. G. Kingsley Lark on February 1.

Television Picture Projection

On March 2, Mr. George Dobson, whose previous papers on electronic subjects have been much appreciated, discussed big-screen television projection and its problems.

Reflectors—Types and their Uses

Various types of reflector—in particular are mirrors—formed the subject of a talk by Mr. F. E. Treliving, A.M.I.P.E., on April 5.

Heating and Ventilation

Mr. L. H. Henton, A.M.I.H.V.E., M.B.K.S., prepared a paper on cinema heating and ventilation which was read by Mr. A. B. Stuart on May 3.7

Discussion Meeting

The session closed on June 7 with a meeting devoted to technical discussion.

Annual General Meeting

Mr. E. Eadie, Chairman, presided at the meeting held at the C.E.A. Offices, Newcastle, on October 11, 1949. He said that the most important matter to discuss was the Head Office request to reduce the number of lectures of their section, to five this year compared with nine in the last season’s programme.

The Hon. Secretary, Mr. E. Turner, said in his report, that it appeared that publication of the Journal had swallowed most of the Society’s finances and he hoped that a change of printers would have the desired results.

Mr. A. Brown, a committee member, suggested that the Journal be issued once every two months and this proposal was carried.

Mr. A. B. Stuart pointed out that by spending even less than the 25% allowed the section from the subscriptions of its own Members the cost of nine meetings in the Season could be covered and it was decided to press that these be allowed.

The committee and officers were re-elected en bloc with Mr. R. W. Baker accepting the position of Assistant Secretary, and offering the use of his office, to assist Mr. Turner, who had expressed a desire to stand down, but was prepared to continue in view of the Society’s present position.

Mr. Stuart was appointed to represent the Section at London meetings, and the 1949/1950 Lecture Programme was approved.

LEEDS SECTION

The session of the Leeds Section opened with three papers previously delivered to the Theatre Division.

Unit Specialisation in Kinema Equipment

A paper by Mr. S. B. Swingler, M.B.K.S., read on October 2, 1948, by Mr. C. E. Perry, was followed by a brief discussion.8

A Visitor: Could the instruments recording variations of light and sound be made an integral part of the projection equipment?

Mr. Perry: No, the instruments referred to are installed as a separate unit in the Odeon, Blackpool.

A Visitor: In my opinion, technical classes for juniors are long overdue.

Mr. L. Mannix: Efforts made in the past have failed through lack of support from the projectionists themselves. The value of training is proved by the fact that key positions are now filled by men who had availed themselves of such opportunities.

Auditorium Requirements in Sound-Film Presentation

Part I of the symposium originally presented to the Theatre Division9
relating to picture projection, was read by Mr. R. R. E. Pulman, F.B.K.S. on November 6th. The following discussion ensued:

A Visitor: It has been found that after installing new equipment, complaints have been made that the picture is too bright. Is this possible? If so, it may be necessary to recommend less efficient equipment.

Mr. Pulman: Yes, this is definitely possible. But it is not necessary to choose less efficient equipment; it is possible to choose equally efficient lamps burning at a lower current.

A Visitor: Is there any regulation requiring a clock to be installed?

Mr. Pulman: I do not think so. The suggestion in the paper that the clock should be connected to a dimmer controlled by the screen curtains finds general favour.

Mr. R. Robertson: In view of the distortion caused by excessive rake, have any experiments been made to develop projection systems similar to the rising front used in photography?

Mr. Pulman: Yes, experiments have been made, but I cannot say with what success.

A Visitor: Has it ever been tried to perforate the screen only immediately in front of the speakers, in order to even out the light and reduce the falling off towards the sides?

Mr. Pulman: Yes, but it makes the perforations in the centre noticeable. In my view, too much emphasis is placed on the loss of light through perforations.

Mr. Asher: Would it be possible to arrange a number of photo-cells behind the screen, to register in the box any falling off in light?

Mr. Seall: My company has on order a number of photometers which when placed in the projection aperture measure the light from the screen.

The second part of the symposium, relating to sound reproduction, was read on December 4 by Mr. Leslie Knopp, Ph.D., M.I.E.E., F.B.K.S.

Home Office and Local Regulations

Mr. J. W. Barnett, chief constable of Leeds, speaking on January 8, 1949, discussed the interpretation of certain clauses in the 1923 regulations under the Cinematograph Act. He stated that an officer was being appointed to ensure compliance with safety regulations; electrical installations in particular would receive a thorough inspection. Close consideration was also being given to the number of staff necessary for the safety of the public.

In future, continued Mr. Barnett, when new machines were installed or alterations carried out, the opportunity would be taken to ensure strict compliance with the regulations in all parts of the building. If an exhibitor could afford new equipment he should, thought the speaker, not object to any further alterations thought necessary.

Mr. Barnett was accompanied by his visiting officers, who took part in answering a number of questions by members. Responding to the vote of thanks, he promised the close co-operation of himself and his officers.

Kinema Projector Design

The design of the projector was the subject of a paper (previously presented to the Theatre Division) read by Mr. R. Robertson, B.Sc., M.I.M.E., M.B.K.S., on February 5.

Light Production from the Carbon Arc

A paper previously read to the Manchester Section, relating to the optical and electrical aspects of the arc lamp, was read by Mr. H. P. Woods, B.Sc., A.Inst.P., M.B.K.S, on March 5.

A Visitor: What are the advantages of magnetic control?

The Author: To make arc burn more efficiently by controlling the flame.

A Visitor: Are discharge lamps likely to supersede the carbon arc?

Mr. Woods: I would not like to say definitely one way or another. Eventually it will become a question of economics.

Mr. Riches: Is it possible to flatten the crater of the positive carbon?

Mr. Woods: No advantage would be gained by doing so. If this was done, the arc would be too critical and become unmanageable.
Film Projectors for Television

The keen interest of members in all aspects of television led to a large attendance on April 2, when Mr. A. Buckley gave a paper on this subject. Mr. Buckley first explained the basic principles of television, from the Nipkow disc to modern systems. He then discussed the place of film in television programmes, and described the projection system developed by RCA to overcome the difference between film and television picture speeds.13

Bloomed Lenses

On May 7 a paper was read by Mr. D. F. Burnett, M.A., A. Inst.P., on the surface treatment of lenses.

Brains Trust

The session closed on June 4 with a "Brains Trust," when technical questions posed by members of the Section were answered by members of the Committee.

REFERENCES


THE COUNCIL

Meeting of November 2, 1949

Present: Messrs. A. W. Watkins (President), L. Knopp (Vice-President), W. M. Harcourt (Past President), Rex B. Hartley (Hon. Secretary), I. D. Wratten, B. Honri, M. F. Cooper, F. G. Gunn, T. W. Howard, H. S. Hind, R. H. Cricks (Technical Consultant), and W. L. Bevir (Secretary).

Circulating Information.—It was agreed that the Secretary should keep chairmen of committees acquainted with the relevant decisions of Council.

Accounts.—Estimated accounts for the year were considered.

Library Committee.—Consideration for purchase of a further steel cabinet was deferred until the next meeting, but Mr. Cooper was asked to obtain an estimate for having glass doors put on the existing bookshelves. It was agreed that a cleaner be engaged for the library.

Fellowship Committee.—Recommendations of the committee for the conferment of Fellowship and Hon. Fellowship were approved.

Journal Committee.—Regret at the intended resignation of the committee Chairman, Mr. Geoffrey Parr, was expressed. The co-option of Mr. R. J. T. Brown to the committee was endorsed.

Papers Committee.—Mr. Hind asked for certain alterations in the programme card. Mr. Knopp reported that the Spring, 1950, lecture programme was almost completed.

Branches Committee.—Mr. Knopp reported correspondence with the Hon. Secretaries of the Newcastle-on-Tyne and Leeds Sections; and re-iteration of the decision to curtail the number of provincial meetings.

Sub-Standard Film Division.—Mr. Hind reported that stewards had been appointed for each lecture meeting. It was felt that officers of the Society should make themselves known to members.

Overseas Students.—A letter from the Society's Indian representative, Mr. Y. A. Fazalbhoy, was read, which expressed concern at the A.C.T. ruling, refusing admission of students as observers into the film studios. Indian production needed trainees either in Great Britain or the United States. The President undertook to raise the matter with the Secretary of the A.C.T.

EXECUTIVE COMMITTEE.

Meeting of November 2, 1949.

Present: Messrs. A. W. Watkins (President), L. Knopp (Vice-President), W. M. Harcourt
(Past President), Rex B. Hartley (Hon. Secretary), I. D. Wratten, W. L. Bevir (Secretary), and Miss S. M. Barlow (Assistant Secretary).

Elections.—The following were elected:—

Richard Cecil Hardstaff (Associate), W. & E. Moore, Ltd.
David Henry Aylott (Member), A.B.C.P., Ltd.
Reginald Leslie Martin (Associate), Sound-Services, Ltd.
John William Bagnall (Associate), Sound-Services, Ltd.
Sydney Charles Pearson (Member), Ealing Studios, Ltd.
C. V. Ramaswamy (Associate), Central Studios, Ltd., S. India.
D. V. J. Raju (Associate), General Radio & Appliances, Ltd., India.
Michael Tim Covington (Associate), Riverside Studios.
Maurice Charles Davidson (Student), Denham Studios.
Alexander Lawrence Graham (Member), National Theatre Supply Co., Australia.
Tom Edward Nurse (Associate), Ealing Studios, Ltd., Australia.

Transfer.—From Studentship to Associate: John Meredith Haybittle.

Resignation.—The resignation of Robert Norman Parkinson was accepted with regret.

Expulsions.—Two Students were expelled for non-payment of subscriptions.

SUB-STANDARD FILM DIVISION COMMITTEE
Meeting of October 12, 1949

Seven Members, four Associates and one Student were enrolled in the Division. Plans for lectures in 1950 were agreed and a steward’s rota for meetings approved. Three stewards would be on duty each meeting having the duties of looking after the lecturer, seeing that members signed the attendance register, and introducing and welcoming new members.

JOURNAL COMMITTEE
Meeting of October 26, 1949

The advertising situation was considered. New editorial contents for 1950 were discussed and various additions and alterations in the typography of the Journal which will be effected with the new printers. Members were to be asked to co-operate in supplying more personal news of themselves and if this were forthcoming greater space would be devoted to the feature.

Mention of articles of special interest in overseas film journals, not technical enough for abstracting, will be made and the books will be available, as they are now, for reference in the library. Criticisms of the Journal, such as those made at the Newcastle-on-Tyne A.G.M., were welcomed and constructive suggestions requested.

THEATRE DIVISION COMMITTEE
Meeting of October 27, 1949

Two Members and one Associate were enrolled in the Division. Details of plans for the Spring 1950 Lecture Programme were reported by Mr. S. A. Stevens, the Deputy Chairman, who presided.

A discussion on the activities of the provincial sections, particularly Newcastle, took place.

LIBRARY COMMITTEE
Meeting of October 31, 1949

The acquisitions were noted and thanks expressed to Mr. Geoffrey Parr, for his consistent presentation of books, and Mr. Walter Buckstone, for the parcels of journals to complete sets for binding.

A discussion on the work Members should do on their duty night each Monday evening took place, and it was agreed that the decision on what most required attention should be left to the Hon. Librarian.

The need for extra space in the library was emphasised and an application for extra shelving submitted to Council. If expenditure could not be granted for this an effort to obtain wooden shelving might be made as a temporary expedient. Arrangements for cleaning the library books were suggested.

BRITISH STANDARDS
B.S. 1019: 1949—Photographic Lenses.—This very comprehensive specification is divided into three sections. Section 1 gives definitions both of lens components and optical terms; the precision of the latter is especially valuable. Section 2 deals with the marking of lenses, and specifies tolerances. Section 3 relates to the direction of rotation of the iris ring. Appendix A deals with the measurement of focal length, and Appendix B with the measurement of aperture.

B.S. 1613: 1949, Resolving Power of Lenses for Cameras and Enlargers. In determining the resolving power of lenses, a test object composed of radial and tan-
gential lines is to be photographed at various positions in the lens field. Four types of lenses are distinguished: process lenses, general purpose lenses (including kinematograph taking lenses), air camera lenses, and enlarger lenses; different procedures are laid down for each type. Resolving power is to be expressed in terms of lines per millimetre for radial and tangential lines.

**FILM COPYRIGHT**

Mr. Wolfgang Wilhelm is the Society's representative on the British Film Institute Committee, which is discussing the law of copyright in relation to the film industry. The first meeting was held on December 9th at the C.E.A.

**TRANSPORT FILM LIBRARY**

A catalogue of 16 mm. and 35 mm. films and filmstrip available for loan has been issued by the British Transport Commission. The films deal with all aspects of rail transport in Great Britain and the whole of the system of transport in London. The catalogue is available for reference in the Society's Library.

**MISSING VOLUMES**

The following journals are required by the B.K.S. Library to complete sets for binding: *Foto-Kine-Technik*, Nos. 4, 7, 12, April, July and December, 1948.

**THE INDEX**

The Index to Vol. 15, printed in the centre of this issue of the Journal, may be easily detached for binding. It is customary to bind together two volumes, a year's Journals, and the index of the present volume is designed to be bound following that of Vol. 14, printed in the centre of the June, 1949, issue. However, for those who bind each volume separately, extra copies of the title page are available on application.

**B.K.S. BINDERS**

A limited number of spring-backed binders for this Journal is available, price 3s. 6d. each. They are in blue art leather, with the letters B.K.S. in gilt on the spine; some are slightly stock soiled.

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**PERSONAL NEWS of MEMBERS**

Members are urged to keep their fellow members conversant with their activities through the medium of British Kinematography.

J. P. J. CHAPMAN, representative of the Swiss firm of Ganz & Co., has moved to "Gatesgarth, 89, Canford Cliffs Road, Bournemouth.

G. E. Cox, Secretary of Simplex-Ampro Ltd., is now resident at 2, Crowhurst Road, Brixton, S.W.9.

EZAT OZGUL has been appointed a director in the Government of Turkey Film Dept., and hopes to form a film society in his country.

E. D. RUNKEL is extended the sympathies of all members in the death of his wife, who played an active part in his business activities.

G. SALMONS has been appointed chief projectionist of the Newton Palace Kinema, Birmingham.

F. SELLMAN, formerly with Radiantcolor, has joined "Eclair" in Paris, where he is working on Anscocolor.

I. D. WRATTEN has left on a business visit to India.

**WILLIAM LEONARD JOHNSON**

W. L. JOHNSON, an Associate member of the Society for the past two years, died suddenly last month. Engaged at the Boro Cinema, Salford, he was a member of the Manchester Section. The Secretary, A. Wigley, writes, "Mr. Johnson was a well-known figure in the trade, and will be sadly missed in the Manchester area."

Small announcements will be accepted from Members and Associates. Rate, 4d. per word, plus 2s. for Box No. if required (except for Situations Wanted). Trade advertisements, other than Situations Vacant, not accepted.
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