"BETTER PROJECTION"

II—PROJECTOR CARE

The second of a series of lectures prepared by the Theatre Division Committee of the British Kinematograph Society, for presentation, through the branches of the Cinematograph Exhibitors' Association, to projectionists throughout Great Britain.

THE BRITISH KINEMATOGRAPH SOCIETY
Dean House, 2, Dean Street, London, W.1.
GERrard 7368

NOTES TO LECTURER

Before presenting this lecture, please read it carefully, be sure that every point is clear, and that you are prepared to answer any questions on it.

You should have a blackboard, on which the following and other points may usefully be written or illustrated by sketches :

Diagram of Projector
Principle of Maltese Cross } see sketches hereunder :

Causes of Film Damage :

Take-off and Take-up : Buckled spool—incorrect tension—fire-trap rollers—dirt in fire-trap.

Sprockets and Rollers : Worn teeth—rollers sticking—rollers incorrectly set—film strippers.

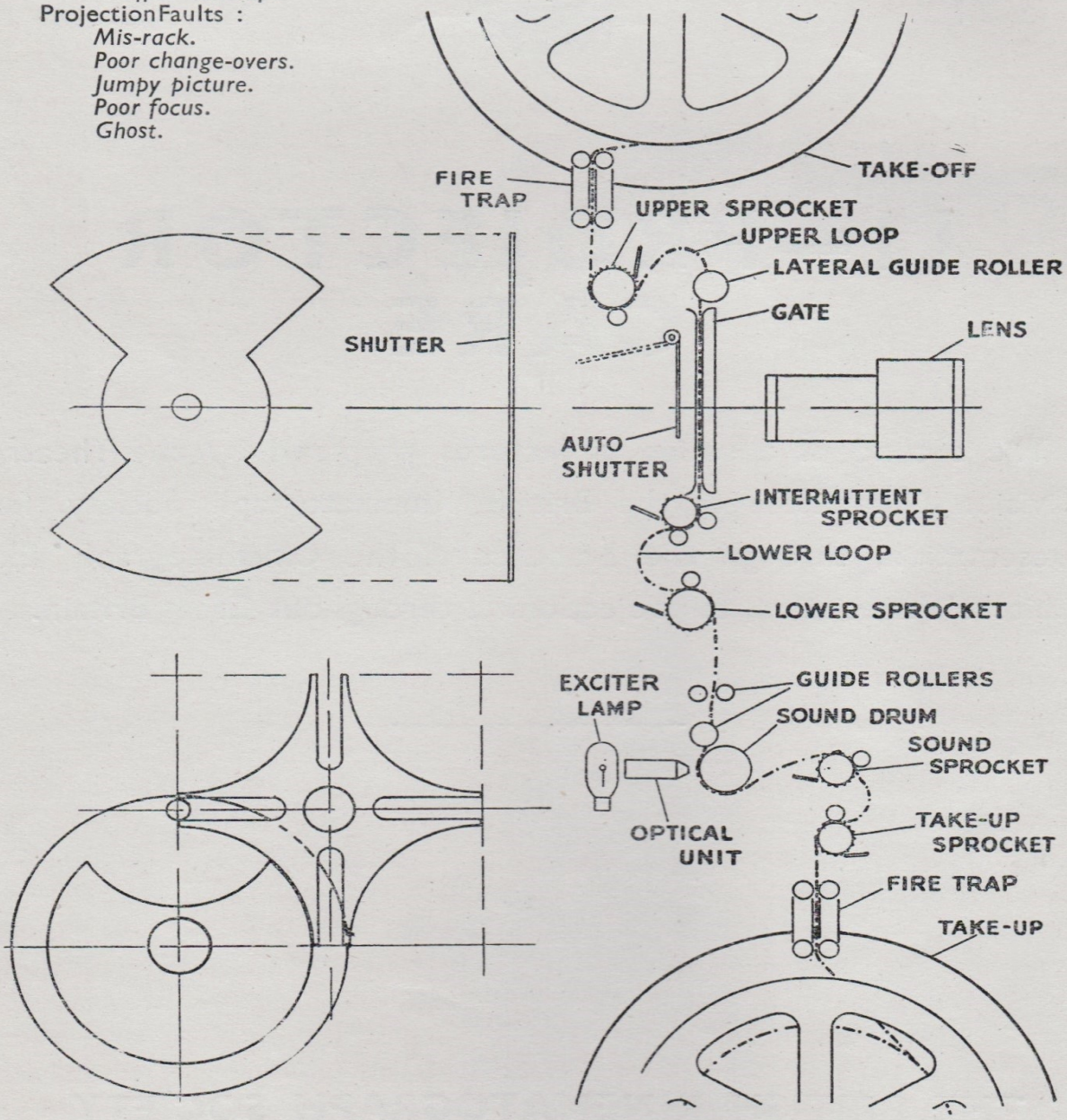
Gate : Lateral guide roller—excessive tension—emulsion pick-up—worn runners.

Intermittent sprocket : Worn teeth—rollers or shoe.

Dirty film path—faulty threading through traps or gate—incorrect loops—slack in take-off or take-up.

Projection Faults :

Mis-rack.
Poor change-overs.
Jumpy picture.
Poor focus.
Ghost.



At the end of the lecture, invite questions, and give an opportunity for discussion.

The Theatre Division Committee will be pleased to receive your views, and those of your audiences, on this lecture.

June, 1944.

II—THE CARE OF THE PROJECTOR

THIS is the second lecture sponsored by the British Kinematograph Society, and follows the previous one on film care. Our subject this time is the care of the projector, the prevention of film damage on the projector, and a few common projection faults.

First let's have a brief description of the projector mechanism, then we shall be better able to discuss how to look after it.

The showing of a motion picture is really an optical illusion. It's made possible only by taking advantage of a defect of the human eye termed *persistence of vision*—remember this term, for we shall meet it again later.

The image on the retina of the eye persists for a certain length of time ; which means that if you are gazing at an object and it's suddenly blacked out, you'll still see it for a short time afterwards. We don't project a moving picture ; we project a series of still pictures on to the screen at a certain rate, each of a different part of a certain movement, and persistence of vision causes the pictures to merge into one another, and your eye will see the movement carried out.

But these pictures *must* be held still while they're projected ; which means that the film must move in jerks. So that our projector has three jobs to do : it must hold a picture stationary for a fraction of a second while it's projected, and then jerk it on quickly to the next picture ; it must cut the light off while the film is moving ; and, although the film is moving at one point in a series of jerks, the projector must feed the film evenly from the top spool to the sound-head and to the lower spool.

Our film runs at the rate of 24 frames per second ; now, 24 frames are equal to 18 inches or $1\frac{1}{2}$ feet, and $1\frac{1}{2}$ feet per second is equal to 90 feet per minute. From this we can work out that a single reel of film, of roughly 1,000 ft., will run for 11 minutes, and a double reel for 20 or 22 minutes.

Most of us run double reels of between 1,500 and 2,000 feet. This film is wound on a spool, and the spool is placed on the take-off spindle on the projector, inside the top box. A reel of film is quite weighty, and when the projector is switched off, the reel would tend to overshoot and keep on unwinding ; to prevent this, there's a spring friction on the spindle, which acts as a brake.

In the early days of the pictures, spool boxes were not used. But several bad fires occurred, so the spool-box was introduced, and made compulsory, to safeguard the reel of film in the event of the film catching fire in the projector gate. In order to prevent any risk of the flame getting into the box, the film passes through an arrangement of close-bearing rollers and a narrow channel, called a fire-trap. Generally the fire-trap does its job very well—which is fortunate for some of us !

Now, the film's got to go through the gate in jerks ; but if we were to draw the film off our large reel in jerks, 24 times a second, something would quickly happen : either the sprocket holes would give way, or more probably the film would just rip in two. So we've got to pull the film off the reel smoothly. For this purpose, below the top box is a continuously running sprocket—the top sprocket or take-off sprocket.

To keep the film in contact with the sprocket teeth, idler rollers are used. Almost touching the sprocket, too, is a film stripper, whose job is to throw the film off the sprocket should it break, when it may try to wrap itself round the sprocket.

The next part to consider is the film gate ; it is from here that the images of the individual pictures on the film are projected on to the screen and here therefore that the film must be moved in jerks. The gate consists of a channel, into which the film is fed, with tension skates to hold it flat over the aperture, and to keep it steady after it has been jerked through the gate. The gate generally has a flanged roller to guide the film through it.

The film is moved in jerks through the gate by means of the intermittent sprocket, just below the gate. The intermittent sprocket is driven through the medium of a Maltese cross, and a cam with a striking pin ; the cam is driven continuously, one turn for each film frame, but moves the cross intermittently. Each time the cam turns, the cross, and therefore the sprocket, moves through a quarter of a turn. There are 16 teeth on each side of the sprocket ; a quarter of 16 is 4, so that for every turn of the cam, or every quarter-turn of the sprocket, one frame of film is pulled down through the gate.

Below the film-mechanism, or mute head, is the sound head, where the sound track is scanned, and the sound, recorded on the film, starts its journey to the loud-speakers. Now, in the sound head, our film must run absolutely smoothly ; all the jerks put into it in the picture gate must be ironed out. So before leaving the projector head, the film passes over another continuously running sprocket, and then usually between a pair of guide rollers into the sound head.

Having finished with the film, we must arrange for it to be rolled up again. So it's led to another sprocket, called the take-up or lower feed sprocket, which has its own idler rollers and stripper. Then the film enters the bottom spool-box, again through a fire trap, and is wound on to a reel again. Since it won't wind itself, the spindle in the lower box is power driven through a friction device, which compensates for the varying speed of the spindle as the size of reel grows.

Now we have the film being fed off the top sprocket of our mute head at constant speed, and on to the lower sprocket, also at constant speed, while the film stops and starts between these two positions. That's why it's necessary to have a loop of film above and below the gate. When the film is stationary in the gate, the top feed sprocket is increasing the amount of film in the top loop, while the lower sprocket is decreasing the amount of

film in the bottom loop. When the picture frames are being changed in the gate, the amount of film is decreased in the top loop and increased in the bottom loop.

The loops between the mute head and sound head serve two purposes : first of all, they help to iron out the jerks from the film before it enters the sound head ; secondly, they ensure that there shall be the correct length of film—20 frames—between the picture gate and the sound gate or drum. On most sound heads there's another loop between the sound sprocket and the take-up sprocket ; this serves to prevent any uneven pull from the take-up reel affecting the even speed of the film in the sound head.

It's important that the light should be cut off the screen while the film is being jerked through the gate, otherwise we should see white streaks down the screen in line with all the highlights in the picture. To cut off the light at the right time we use a rotating shutter, which may be either behind the gate, or in front of the lens (or in one projector both). This shutter turns at the rate of one revolution for every frame of film.

Now, the eye has this queer defect which we call persistence of vision, which means that if flicker is fast enough it won't be noticed, and the eye is completely fooled ; but the eye *is* sensitive to flicker at 30 cut-offs per second, and certainly won't be fooled by 24 a second. So we add another blade called the flicker blade, and this interrupts the light once during the time that each stationary picture is being projected on the screen. This makes the flicker frequency forty-eight cut-offs per second, which is normally above flicker perception—and the picture will appear flickerless to the eye.

The sprockets, intermittent movement, and shutter are all connected to a gear train driven by an electric motor.

There are just two other points to cover. The projection lens is housed on the mechanism, but is actually part of the projection optical system.

Just behind the gate—sometimes built as part of the rear shutter—is an automatic safety shutter. This is required by law, and its purpose is to drop and cut off the light—and heat—from the film should the machine speed drop below a certain level. A common name for this shutter is auto shutter, and a very old joke is that it's so called because it *ought to* work but doesn't always ; this is a little unfair to modern projectors, but at the same time, always be quite sure that your arc dowser or change-over shutter is not opened until the projector has got up to speed, and is closed before the projector is switched off.

One more important point : it sometimes happens that the picture frame is not matched properly to the masking aperture, either through careless threading, or sometimes through careless joining of the film. So a control has to be provided that will enable the film frame to be racked in relation to the aperture. This is generally effected by turning the whole intermittent motion on itself, or in some projectors the gate and sprockets can be moved in the main casting up and down in relation to the gate aperture.

Well, now that you've got a clear idea of the purpose of each item on a film mechanism, you'll gather that film can easily be damaged if the machine has worn parts, or is not working correctly. And the worst thing a projector can do is to damage film. But before we consider the various mechanical faults that can lead to film damage, let's discuss those elementary but important questions, oiling and cleaning.

In the mechanism you have a gear train and several shafts which run in bearings ; unless they are of the ball-bearing type, they must all have oil, but not too much. Follow the manufacturer's instructions to the letter, and let oiling be " little and often." Subject to the maker's instructions, all high-speed shafts should be given a drop of oil once or twice daily, and low-speed shafts, such as the take-off and take-up sprockets, every other day. Make sure the intermittent motion box is kept filled to the right level. And—an important point—always use the right grade of oil ; don't just buy a can of cycle oil, but get the proper stuff from the projector makers.

On no account over-oil, so that the oil drips from the bearings—it will certainly get on the film and spoil your picture and ruin the sound.

Secondly, there's the question of cleaning. A projector must be kept absolutely clean—both the parts you can see and those you can't. It should naturally be cleaned *after* oiling, so that should the oil have dripped anywhere, it can be wiped off. Under no circumstances clean the machine while it's running ; if a rag catches in the moving mechanism a considerable amount of damage will be caused, and there's also a danger that you may get hurt yourself.

Now let's consider some of the mechanical causes of film damage, and what you can do to prevent it.

Take-off and Take-up : Let's start at the top—the take-off ; and since the same remarks apply to the take-up, let's include this also.

First of all, if a spool is buckled, every time it turns it will grip the edges of the film, and will cause it to buckle and ride sideways—it may even turn over the margin of the perforations. So, as you were advised in the previous lecture, *never* use a buckled spool.

On some projectors it's possible for the take-off box to be out of line with the top sprocket. Check this by feeling the tension on either side of the film, just above the top sprocket ; it should be equal on either side—if either side is slack, try to re-align the top box.

The top spool-box spindle tension should be carefully adjusted. If it's too light, then the spool is liable to run unsteadily and may even over-run, causing the formation of slack film, which will be taken up by the top sprocket with a sudden jerk, putting serious strain on the perforations. Sometimes the tension is even so slack that the film lies on the spool-box itself, causing fine scratching as it is taken up. On the other hand, too much tension will put excessive strain on the leading edge of the perforation walls, and will also wear the sprocket teeth unnecessarily.

Similarly in the take-up, the friction adjustment should be checked

regularly. If it's too fierce, it will cause the take-up sprocket teeth to become undercut, and will damage the trailing edge of the perforation walls. On the other hand, it must not be too light, or slack film will be formed and taken up with a sudden jerk sufficient to snap the film, or at least to cause break-down of the perforation walls.

The projectors in some theatres are fitted with a device giving audible warning near to change-over time, and this device employs a small ball-race which runs on the celluloid side of the film. Where it is necessary to run with emulsion out—as in the case of back-projection—a careful watch must be kept that the race does not stick. In fact, the danger is so serious as to suggest that the device should be scrapped in such cases.

Fire Traps. The rollers in the fire traps have to bear closely to the surfaces of the film—emulsion and celluloid alike—so that they may effectively smother any spread of fire. This very fact creates a danger of film damage, since the film may occasionally touch the centre of the rollers, due to weave causing a slight buckling. This weave may be caused through the use of a bent spool or spool box spindle. The film may easily get scratched in this way.

The fire trap is generally one of the most likely places for an accumulation of dirt ; it's sometimes very difficult to clean—so much so that it's apt to scare off all but the most conscientious of dirt chasers. In spite of this fact the fire trap must be carefully cleaned after running each reel.

If the rollers stick, they may wear flats, which again may cause film scratching. The rollers are sometimes plated, and a watch should be kept to see that this plating does not start to flake.

Sprockets and Rollers. Next we come to the top and bottom sprockets. I'm afraid these days most of us know what a worn sprocket tooth looks like ; if you let it wear long enough, the tooth gets under-cut, and picks at the perforation edge as it engages or dis-engages. The sprocket teeth should be examined regularly with a magnifying glass.

Sprockets are generally cleaned with a tooth-brush ; but it's unwise to do this while the machine is running, because of the risk of damaging the teeth. Be careful that the brush is not too worn, or you may catch the teeth in the bristle holes.

Idler rollers must turn freely ; if they're too close to the film they will exert a braking action on it, and will themselves tend to stop rotating, while if they're set too far away from the film, there's a danger that it will jump the sprocket teeth, with the familiar sprocket marking as a result. Adjust the roller with two thicknesses of film on the sprocket, so that it just bears on the film ; this allows joins to go through safely.

Film strippers can cause direct damage to the film if they're allowed to work loose, and indirect damage if they're allowed to run against the sprocket. They will grind off minute particles of metal dust, which will scratch the film, or if touching the sprocket teeth will wear these to a sharp edge, which will again damage the film.

Gate. These remarks on rollers apply with even greater force to the little roller at the top of the gate—the lateral guide roller. If this should stick, the film will wear a groove down the inside of the flanges, and in due course the sharp edges may even slice a little bit off the edge of the film. Always be certain that this roller turns freely. The roller must be adjusted to guide the film into the gate without buckling it, or feeding it off-centre to the intermittent sprocket.

But the most obvious cause of film damage is of course excessive tension in the gate, or film trap as the Americans call it. If you adjust the tension too tightly, you increase enormously the strain on the film perforations and on the teeth of the intermittent sprocket—you reduce the life of both films and sprocket. When adjusting the tension, first set it so that you see a slight jump in the picture on the screen, then gradually turn the screws until this disappears. If owing to a piece of troublesome film you find it necessary to increase the tension, don't forget to slacken it off again afterwards.

An even worse trouble than excessive gate tension is what we call emulsion pick-up. If you're running a " green " print—that is, a print straight from the laboratory—the emulsion surface may be rather soft and easily scratched, and small lumps of emulsion will tend to lodge in any cavity or roughness in the gate runners. The little bit of emulsion picked up in this way bakes hard in the heat from the arc, and chisels out a groove down the side of the perforations. You might say : it's only the perforation edge—what does it matter ? It matters, because all the time this groove is being gouged out, extra strain is being put on the perforations, and again on the intermittent sprocket teeth. If you ever find a piece of film with the forward edge of the perforations slightly turned up, you will generally find the marks of emulsion pick-up in the perforation margins.

It's very important to prevent this, because once the perforations are so strained, that piece of film will never again show a steady picture. You can generally tell when emulsion pick-up is taking place, by the increased clatter from the machine ; but stopping it is another matter. It's far better to prevent it by waxing the film before showing—we discussed this in the previous lecture—and by cleaning the gate runners thoroughly every time you thread up.

One very important point : *never* clean the gate with anything made of steel. Brass, copper, bone are all right. A useful tool is a toothbrush with the end of the handle filed square like a chisel ; the brush serves to clean the sprocket teeth, and the sharp end to clean the gate runners.

Worn gate runners must not be overlooked. The danger is that wear on the runners may cause the film to touch the recessed portion carrying the aperture plate, if there is any tendency in the film to buckling.

Removable gates or film traps should always be tried in the closed position after replacement, and before any film is threaded, as some types can be put in without being seated properly.

Intermittent Sprocket. Next we come to the intermittent sprocket below

the gate. All the points we previously discussed apply with even greater force to the intermittent sprocket, which is the hardest worked part of the whole projector. Its teeth sooner or later wear and get undercut, and if something isn't done, will very soon damage film.

On most projectors, fortunately, it's possible to reverse the intermittent sprocket on its shaft, so that having worn one side of the teeth, you have the other face to start afresh. But remember you can't reverse it a third time : when the second face is gone, make sure you get a new sprocket. When changing the sprocket, be careful not to use so much force that you bend the shaft. In the case of sprockets held on by taper pins, fitting a sprocket is really a job for a skilled mechanic, with proper tools, and not for the projectionist.

If the film is kept on the sprocket by means of idler rollers, then the same remarks apply as to other rollers. If a shoe is used, keep a particularly close watch on it. Misalignment of sprocket shoes is a cause of damage to the perforation walls ; if the shoe is allowed to wear to a sharp edge, it may scratch the film, and even rip joins apart. The shoe is of hardened steel, so don't attempt to file it ; replace a shoe if it develops a sharp edge.

Sound Head. Sound heads are of so many different types that it's difficult to give much general advice on them. They all use sprockets, and the same remarks apply to these sprockets as to those on the mute head.

Some older types of sound heads have a tension gate, like the projector mechanism ; the tension here can be quite slight—don't try to tighten up the springs because they feel slack. Always clean the gate regularly.

More modern types of sound heads have no gate, and the drum which they use instead rarely gives any trouble.

At the top of the sound head there is usually a pair of rollers which guide the film from the projector into the sound head. Be sure these are turning freely, otherwise they may develop flats.

A final point while we're on this subject : when you get any spares for your projectors, always check them before fitting them, and never take them at face value. In these days it's not beyond the bounds of possibility that they may have flaws, or have got damaged in transit.

Well, so much for the care of the projector. But even if your projector is in perfect condition, there are still several ways in which your film may be damaged.

First of all, always clean down the film path before threading. Not only will dirt at any point get transferred to the film—worse still, emulsion stuck on the gate runners will, as already explained, lead to emulsion pick-up on a slightly green film.

Don't when you are threading let the leader trail on the floor—it will get dirty, and possibly get trodden on and torn.

As you thread your film through the fire traps, make sure it's running

freely, and not caught between the two halves of the trap. As you put the film on the sprocket, feel the teeth through the perforations, to make sure they are properly engaged. In the gate, be quite sure the film is threaded centrally on the runners, and not caught on one side. Make sure your loops are large enough, so that there is no fear of their tightening up and straining the perforations, and on the other hand, not so large that they will flap about, and possibly come in contact with other parts of the machine.

Always thread with the START mark of the leader in the picture gate, " inch " a few frames through by hand, and then run through to the correct footage number for change-over—don't, that is, thread on this number. The reason is that by running these few feet of film, you can be sure that the machine is properly threaded.

Always, before you switch on your motor, take up any slack in either spool box, otherwise the sudden snatch may snap the film.

With the " fixed optical centre " type of racking, in which the intermittent sprocket rotates, it is necessary to turn the racking handle carefully, otherwise a sudden movement may cause a kink in the film between the bottom of the gate and the sprocket.

Having discussed the various causes of film damage, let's consider briefly other projection faults. We won't discuss faults due to the arc lamp, nor faults in the sound, which will form the subject of later lectures.

Two very elementary faults which seriously mar the presentation of a film are mis-racks and poor change-overs.

Now, a mis-rack is due to a fault either in joining or in threading, and there's no excuse for either. There's only one exception to this : occasionally the racking knob of a projector will slip ; try and get it tightened up to avoid such difficulties.

As was explained in the last lecture, perfect change-overs are practically assured if the leaders of your film are correct, if the change-over cues are correct, and if you work to them. But nothing looks worse than for your audience to be dazzled by queer flashes on the screen, representing your own private ideas of change-over cues. Whatever you do, don't mutilate film in this fashion.

Possibly the most serious projection fault is a jumpy picture : it's serious because it causes eye-strain. We've already discussed some of the causes of it : most usually insufficient gate tension or strained film perforations. It can also be caused by dirt on the intermittent sprocket teeth, a damaged intermittent sprocket, or play between the Maltese cross and the cam. Make a point of examining your picture from somewhere near the screen, and if there's any trace of picture jump, do something about it by ascertaining the cause and applying the proper remedy.

Another fault which can cause eye-strain is poor focus. It may be due to quite simple things—probably the most common difficulty is that on a

long throw, it's not easy to see from the box whether the picture is quite sharp ; try using a pair of binoculars. A steamy lens or projection port may cause it. In cleaning your lens, first brush off any dust with a camel-hair brush, then polish the glasses with a soft clean cloth ; if the lens is oily, moisten the cloth with suitable spirit or carbon tetrachloride. Incidentally, *never* take a lens to pieces.

But there are other causes of poor focus, more difficult to deal with. One of them is film buckle. If a green film is projected for the first time in front of a powerful arc, it may buckle, and every time it's shown after that, the picture will appear to be going in and out of focus in the centre of the screen. In an emergency it's possible to improve this by guiding the edges of the film just above the gate between your finger and thumb—rather a tedious job—but failing this, there's nothing you can do except get a new copy.

Another annoying fault is *ghost* : this is the term given to the streaks of white which you sometimes see above or below the white letters of a title. Remember first that ghost has nothing to do with focus ; it's caused solely by the shutter not being properly phased with the intermittent motion, and so allowing part of the film movement to show on the screen. On most modern projectors you have a little knob for adjusting the shutter phasing—otherwise you may have to loosen the shutter blade on its boss, and adjust it by trial and error. You can remember the word BRAT—for *B*ottom ghost *R*etard, *A*dvance for *T*op ghost.

In conclusion, never forget that film stock is expensive, and hard, if not impossible to replace. It's up to every projectionist to make perfectly sure that no damage is caused through his neglect. Give constant and thorough examination to the film-handling equipment under your charge, observe the rules of correct film handling, and acquire that sixth sense of impending damage.

BRITISH KINEMATOGRAPH SOCIETY

President ... A. G. D. WEST
Vice-President ... I. D. WRATTEN
Hon. Secretary ... E. ORAM
Hon. Treasurer ... P. H. BASTIE

Members of Executive Committee :

C. CABIROL
R. B. HARTLEY
C. H. CHAMPION
A. W. WATKINS
R. T. DEALEY
F. WATTS

Organising Secretary :
R. HOWARD CRICKS

Executive Offices :
Dean House, 2 Dean St., London, W.1.

Australian Representative :
ALAN WILLIAMSON,
General Film Distributors, Ltd.
Liverpool House, Sydney, N.S.W.

Indian Representative :
Y. A. FAZALBHOY,
Fazalbhoy House,
9, Marine Lines, Bombay, 6

THEATRE DIVISION COMMITTEE :

Chairman : C. H. CHAMPION *Deputy Chairman :* R. T. DEALEY

T. CHILTON
R. V. CROW
F. E. DURBAN
I. FAULL
C. G. HEYS-HALLETT
S. T. PERRY
J. X. PRENDERGAST
R. PULMAN
J. L. STABLEFORD
H. C. STRINGER
V. WHITEHOUSE
I. D. WRATTEN.

B.K.S. MEMBERSHIP

Membership of the British Kinematograph Society is open to :—

(*a*) persons who have been engaged for more than one year in any technical branch or technical department of a film company, or kinema theatre in the British Empire ; or

(*b*) persons who have been engaged for more than one year in any branch or department of any engineering, electrical, chemical, photographic or optical works serving the technical requirements of the film industry ; or

(*c*) persons who are or have been engaged in research in any recognised research laboratories or in any of the technical branches or departments of the film industry ; or

(*d*) executive officers of any recognised film company or

(*e*) any person who is or has been an Active Member of the American Society of Motion Picture Engineers.

All members are entitled to attend meetings. The *Journal* is supplied free of charge to Active and Associate members ; Special rate to Student members 10s. per annum. Only Active members are entitled to hold office or to vote.

SUBSCRIPTIONS AND ENTRANCE FEES

Grade of Membership	*Entrance Fee*	*Annual Subscription*
Active	2 2 0	1 10 0
Associate	1 1 0	15 0
Student		5 0

The subscription of Active and Associate Members joining after June 30 of any year is halved for that year.

Proposal form and descriptive brochure may be obtained on application to the Organising Secretary.