TELEVISION STUDIO LIGHTING EQUIPMENT

by

K.R. Ackerman, B.Sc

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BRITISH BROADCASTING CORPORATION
ENGINEERING DIVISION

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Television Studio Lighting Equipment

By K. R. ACKERMAN, B.Sc. (Eng.), *(Diploma Member)*

Summary

The paper summarises the present state of development of lighting equipment for television studios in Great Britain, with particular reference to the studios of the B.B.C., and outlines the rapid progress which has been made in recent years in the mechanisation and flexible control of this equipment. This development has included improvements in mechanical handling of luminaires, the introduction of remote controlled dimming and switching systems, and improvements in studio luminaires themselves.

The difficulties in lighting a television production effectively are outlined and the paper shows how these difficulties can be minimised by equipment specifically designed for the purpose. The equipment used is shown to have developed logically from that designed for filming and for the stage, but modified to meet the special requirements of television.

Light sources are discussed and the paper shows that the tungsten lamp remains the most suitable for this application, though fluorescent lamps and carbon arcs are used for special purposes.

(1) Introduction

In order to appreciate the basic considerations underlying the design of a television studio lighting installation it is necessary to have an understanding of the workings of a television studio. Fig. 1 shows in sketch form a studio and ancillary areas with the principal equipment and personnel. The hub of the complex operation which creates a studio programme lies in the production control room, where the producer directs all activities, flanked by his secretary and the vision mixer and in close contact with his two chief aides the technical operations manager (or T.O.M.) and the lighting supervisor. Frequently in this room will also be the scenic designer and representatives of make-up, wardrobe and special effects. Pictures from all the three or four cameras in use will appear on the producer's monitors, and he it is who decides which shall be selected and form the transmitted picture at any instant. The principal feature which characterises television and is shared by neither theatre nor film production is the shortage of studio time; studios are seldom available for more than two days for camera rehearsal, and the whole programme must of course be shot continuously without error, as in a live programme there can be no retake. Each character in every shot must be covered by cameras, by sound, and by lighting, and the adjustments this entails must in no way be apparent to the viewer. Every set must be fitted into the one studio, and room left for technicians and equipment to manoeuvre. It is not surprising therefore that to the lay visitor "chaotic" is the first adjective that comes to mind. (Fig. 2). The discussion that follows, though general in nature, contains examples drawn primarily from B.B.C. practice, with which the author is most familiar.

The author is with the British Broadcasting Corporation. The manuscript of this paper was first received on June 11, 1957, and in revised form on August 26, 1957. The paper was presented at a meeting of the Society held in London on December 10, 1957.

(1.1) The lighting problem

The design of television studio lighting facilities is inevitably bound up with the problems which face the lighting artist, whose job it is to produce a satisfying pictorial effect in the transmitted programme. I have described him as an artist by intent, for although he must have a thorough understanding of the technicalities of television, it is his ability to achieve in terms of light the producer's concept of pictorial effect that is usually the measure of his competence, and this pictorial effect is always dynamic, changing from instant to instant throughout the length of the production. In the B.B.C. this man, known as the lighting supervisor, is required to have a high standard of technical knowledge and to have gained four to five years' practical experience in television before taking up the full responsibilities of the post.

Every production has a lighting supervisor allocated to it and his work begins in the early planning stage of the production, when, in consultation with the producer, the scenic designer, and the technical operations manager (in charge of studio cameras and associated equipment), the programme begins to take shape. He attends outside rehearsals, where necessary, for the producer and his team must have planned precisely

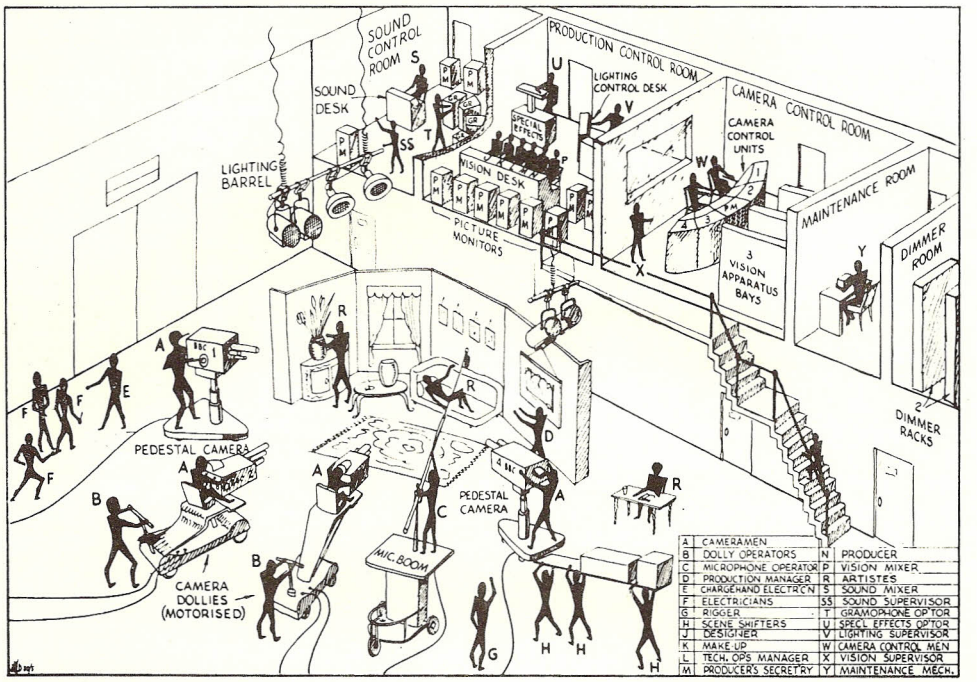
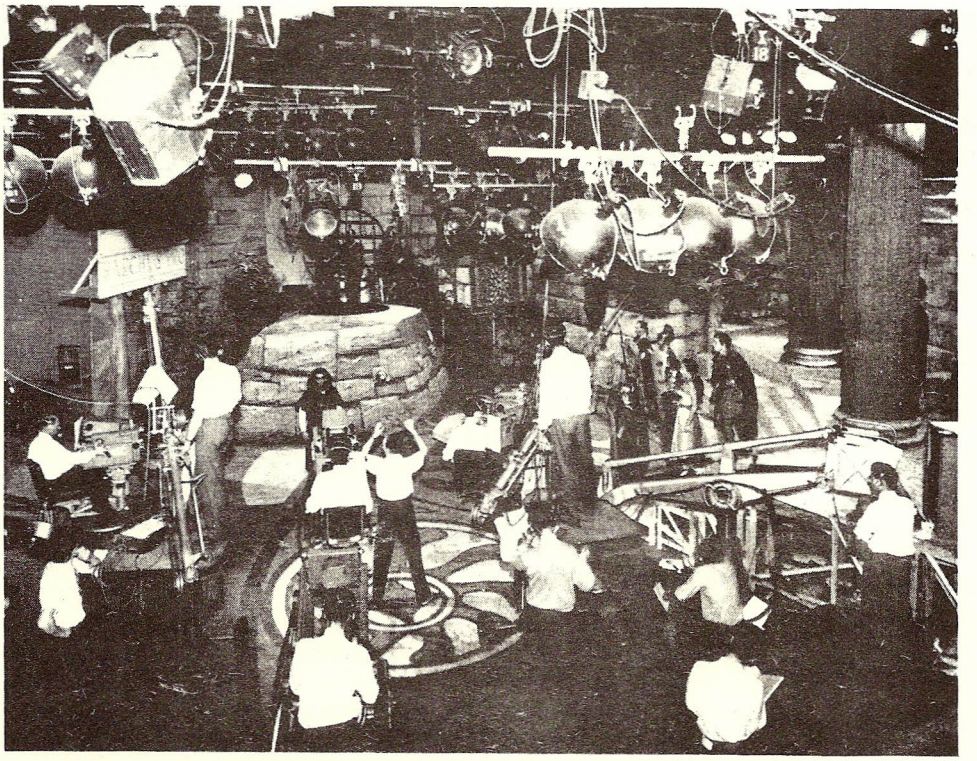


Fig. 1. A pictorial sketch showing the personnel and facilities in a television studio.

Fig. 2. Typical scene on the studio floor at Riverside Studios.



not only the dialogue and action of the programme but all camera angles, layout of scenery and lighting.

By the time the studio is available the lighting supervisor is unlikely to have more than about two hours in which to create the pattern of light which the programme requires, though for a large production a night shift may have been available to get the luminaires into their approximate positions. Even less time than this may sometimes be allocated for short, but none the less complex, productions.

The principal tasks which face the lighting man in the studio are:—

(1) To create the required illusion, particularly the missing third dimension.

(2) To provide lighting of photographic quality for every position of every subject involved, suitable both for "close-up" and for "long shot," at the same time allowing for the technical limitations of television camera pickup tubes. (The principal limitation of present-day cameras is a restriction on the reproducible contrast range of approximately 30 : 1.)

(3) To provide lighting effects, such as change from day to night, etc.

(4) To avoid unwanted shadows, particularly from technical equipment.

It is this last requirement which is frequently the most difficult, for in order to obtain satisfactory sound quality it is necessary for each performer to have a directional microphone close by. This is usually provided by a microphone boom rather like an extendable fishing rod, as illustrated in Fig. 3, with which the boom operator maintains a microphone at a distance of about 3 feet from the speaker. Lighting for television presents the supervisor with all the problems of his opposite number in the film industry with none of the opportunities for correcting his mistakes.

Even in the theatre it is seldom necessary to light for a new production each day, and certainly it is never a requirement that performers should look glamorous at a distance of a few inches as well as several yards.

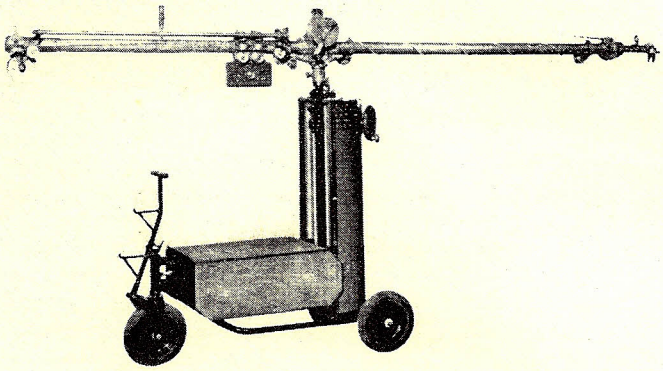
It follows that the utmost flexibility in lighting facilities is required, and it is therefore surprising that until very recently little work has been done in this country to provide such facilities. In this connection however, it should be borne in mind that the expansion of British television since the war has been extremely rapid, and that the principal problem on which attention has had to be focused is the increase in the sensitivity of the cameras and the development of associated electronic equipment. Now that greater sensitivity has been achieved, studio lighting is no longer just a question of obtaining a sufficiently high illumination level, and artistic considerations can be given more attention.

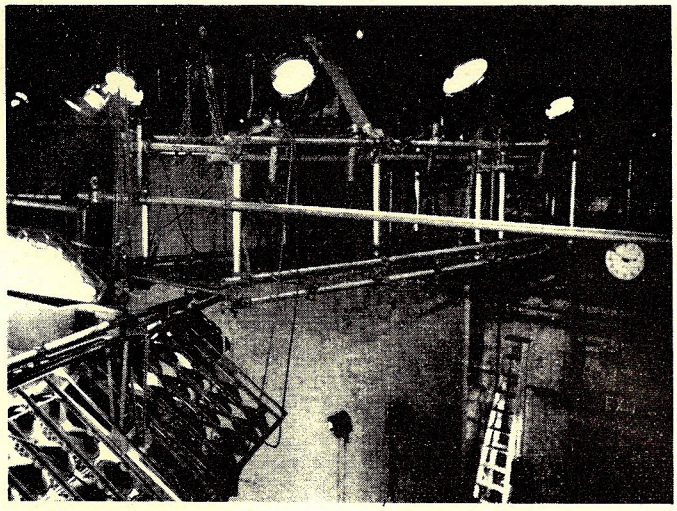
Many different types of camera tube have played their part in this development, but at the present time it is the most sensitive of these, the image orthicon, which is being used in the vast majority of British studios. The relatively low illumination levels at which this tube can comfortably operate (80 lm/ft^2 or less, depending on the required depth of focus) make it possible for the lighting supervisor to think less in terms of average illumination and more in terms of the brightness relationships of the various areas composing the picture.

For this, the older studio installations are not satisfactory, since the majority were designed for film photography and equipped with facilities which had been designed for that application. In these studios each luminaire has to be independently "rigged" and wired to a distribution board, through a dimmer or contactor box if required or if time permits. "Rigging" consists of fixing luminaires on to the galleries which run round the studios (Fig. 4), at a height of some 16 ft., or of suspending them from block and tackle fixed to RSJs at ceiling height (about 30 ft.), others being mounted on floor stands. This technique is flexible but is also cumbersome and time-consuming when up to 100 luminaires may be required for a single production, and as the demand for more programmes per week per studio increases, the necessity for compromise lighting increases with it. None the less, many B.B.C. studio programmes still emanate from such studios and by dint of hard work and improvisation results comparable with better equipped premises are achieved.

One of the most recent installations to come into service is at the B.B.C.'s new studios at Riverside, where a lighting system specifically designed to overcome the difficulties outlined above is now in regular use. In these studios elaborate switching and dimming control facilities have been provided, similar to those which have been developed for the theatre, but modified to suit the requirements of television. Rigging time has been reduced by the installation of remotely controlled electric hoists and by the use of lightweight luminaires, and a reduction in wiring time has been achieved by the provision of very large numbers of socket outlets of an improved design.

From the relatively brief experience so far available it is apparent that the Riverside Studio





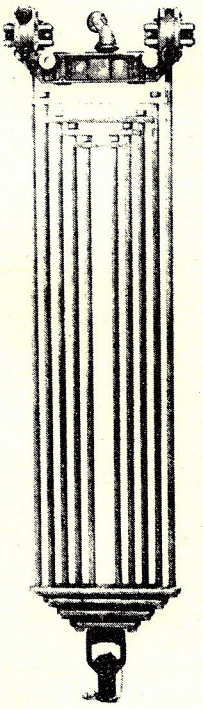


Fig. 3 (*above left*). *A microphone boom.*

Fig. 4 (*left*). *Lighting in a film studio converted for television operation.*

Fig. 5 (*above*). *A telescopic suspension device for studio luminaires.*

lighting installation is proving to be very satisfactory, resulting in improvement in lighting quality and reduction of manual effort. This is not to suggest that every problem has been solved, but valuable experience has been gained which should be put to good effect in future studios.

(2) Mechanical Handling

Of the many problems facing the designer of a television studio lighting installation that of mechanical handling ranks high. It will readily be appreciated that the individual rigging of luminaires is unsatisfactory for television studios with high programme loadings. Some means of rapid positioning of lamps must therefore be provided, and a number of alternative methods must be considered. These can consist either of a number of single-point suspensions judiciously spaced throughout the studio, to which individual lamps can be attached, or, alternatively, a number of barrels of convenient length, each designed to carry a complement of lamps. Both alternatives are provided with means for raising and lowering.

Of the many methods favoured in this country and abroad the following are the most important.

(2.1) Counterweighting

Eight 8 to 10-ft.-long barrels mounted in rows across the studio and spaced some 4 to 6 ft. down the studio length have been widely installed in the United States and are frequently controlled by small winches and counterweighted at one wall. They have not, however, found favour in this country for the loss of one studio wall and some 3 ft. of floor space is entailed, and weights must be

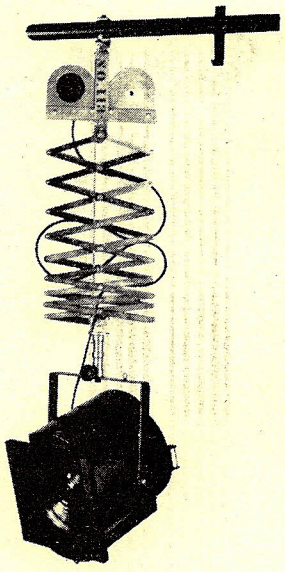


Fig. 6. A pantograph for suspension of studio luminaires.

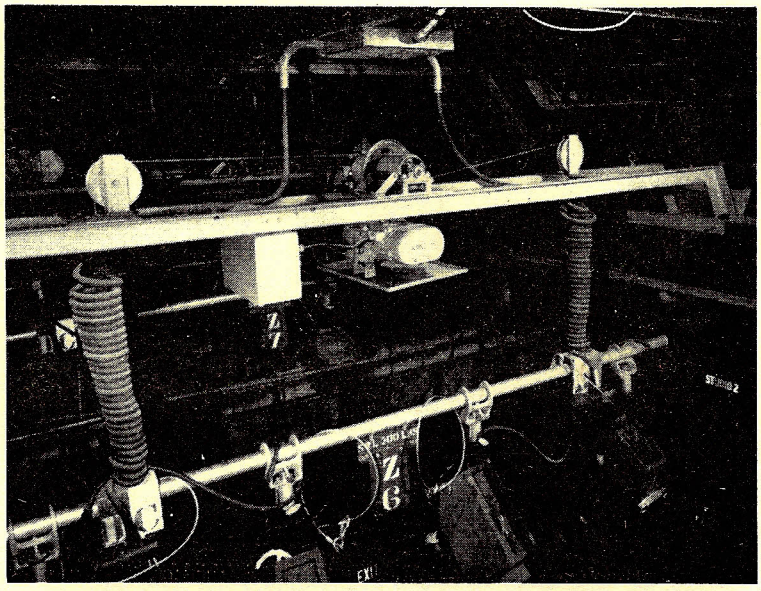


Fig. 7. An electric hoist and barrel unit for raising and lowering studio luminaires. Note the use of selfcoiling cables and rubber moulded plugs and sockets.

altered to balance changes of loads on the barrels. A further limitation is that the load on the building structure is doubled and the gain in rigging time is limited as one operator can lower only one barrel at a time. Furthermore, the roof structure is filled with wire ropes and pulleys, which present a maintenance problem and impede the installation of other services.

(2.2) Manual winching

The barrels described above can be directly controlled by winches of the type used in street lighting with a self-locking mechanism which prevents the load running away. Thus the load on the structure is reduced and the necessity for adjustment of the counterweights is obviated, but the labour and maintenance problems remain, and the mechanical advantage obtained results in low speeds of movement.

(2.3) Telescopes

Fig. 5 shows a point-suspension method which uses manual winching but which has the advantage that individual lamps can be lowered into sets where a barrel might be obstructed It should be borne in mind that if single point suspension of luminaires is used, means of restraining the support from rotation must be provided.

(2.4) Pantographs

Being spring counterbalanced, the pantograph supplies a point-suspension system without the necessity for wire ropes or winches. The device consists of an extendable lattice with adjustable spring tension which has to be varied for varying loads. When adjusted, a pantograph will remain at the height to which it is set. The example illustrated in Fig. 6 is designed for a load of 35 lb. and has no provision for load adjustment.

(2.5) Electric hoists

These, like the winches mentioned above, are used for raising barrels 8 to 10 ft. in length, and though they are likely to be the most expensive method described, they have many operational advantages. They lend themselves to remote control, singly or in groups from any convenient position. If designed as self-contained units they have installation and maintenance advantages over alternatives (2.1) and (2.2) but primarily their merit lies in the time and labour saved. Such a unit as installed in the Riverside Studios is illustrated in Fig. 7.

Any of the above methods in conjunction with a generous allocation of light-weight luminaires and flexible plug and socket arrangements serve as important time savers in television studio lighting installations, and, by reducing the number of floor stands in use, ease the competition between technical equipment and scenery for studio floor space; for the congested space in which camera operators and microphone boom operators have to manoeuvre has to be seen to be appreciated.

Table 1
The relative merits of remote controlled dimmers for television studio use

Dimmer Type	Cost	Reliability	Power Economy	Space Requirement	Suitability for Remote Control	Load Dependence
Motor driven Resistances	Medium	Satisfactory	Good	High	Excellent	Large
Motor driven Autotransformers	High	Satisfactory	Excellent	High	Excellent	None
Thyratrons	Medium	Fair	Poor	Low	Good	Small
Saturable Reactors	Low	Good	Fair	Low	Fair	Large
Magnetic Amplifiers	High	Good	Fair	Medium	Good	None
Motor driven Shutters	Medium	Unsatisfactory	Good	Low	Fair	None

(3) Light Control

This section covers the dimming and switching of luminaires and not the control of the light distribution from them.

(3.1) Dimmer systems

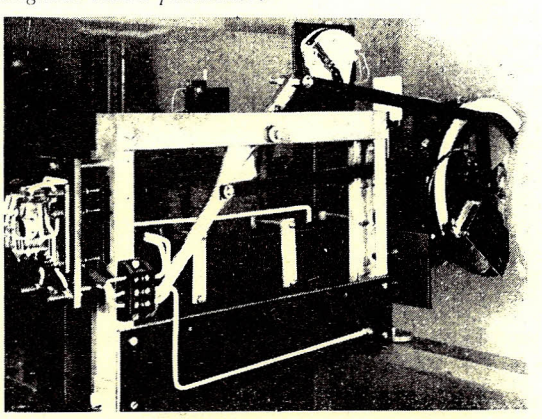
Where the programme loading of a studio is heavy, it is becoming clear that a contactor and dimmer system designed to control all the lamps required for a large production from a centralised control point is a considerable asset. As mentioned in the introduction, this is a new departure in this country, and many studios still reduce the intensity of luminaires either by fitting layers of a diffusing material to the front of the luminaires or by laboriously connecting up portable resistance dimmer trucks. Many forms of dimmer are available for use in television studios and these are listed in Table 1, with an assessment of their relative merits under a number of performance headings.

Many factors have been taken into account in drawing up this table, and there is hardly space to go into all of them. Some explanation, however, is necessary. When considering the application of dimmers to television it should be noted that dimmers are used for the balancing of relative intensities, over a range of 100–40 per cent. light output, which for tungsten filament lamps is achieved by a drop of less than 20 per cent. in supply voltage. This explains the fact that the power economy of a resistance dimmer is considered good, as it has no losses in the fully-on position. It follows, therefore, that it is the heater and arc volt drop of the thyratron that tends to make it inefficient for this application.

The distinction between saturable reactors and magnetic amplifiers is a fine one, but here the term saturable reactor is used to indicate a single stage choke with d.c. saturating current where the control current is relatively large. The magnetic amplifier, being a more complicated two-stage device with feedback circuitry, uses small control currents.

The most satisfactory type of resistance and auto-transformer motor-driven dimmer which is

Fig. 8. An autotransformer dimmer with electro-magnetic clutch positioner.



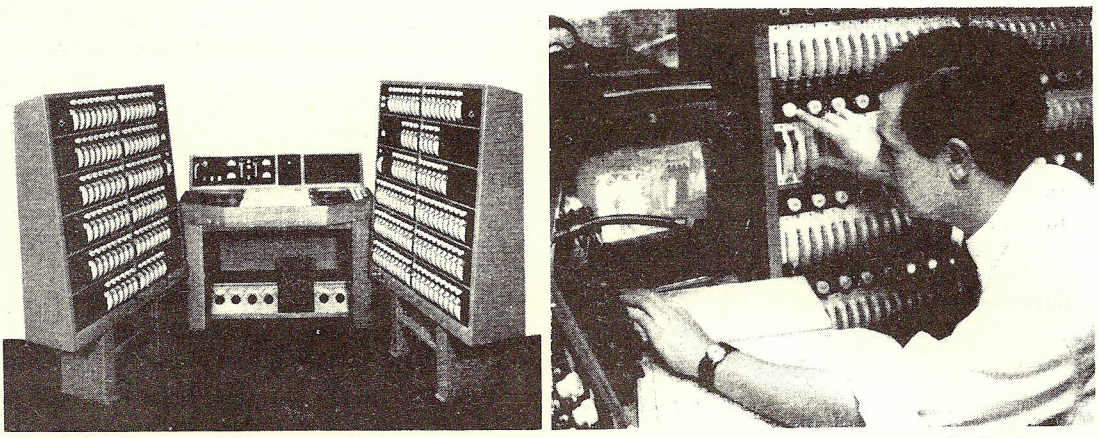


Fig. 9a (left). The lighting control desk installed at the BBC Television Theatre, Shepherd's Bush.
Fig. 9b (right). A similar desk in use.

available is illustrated in Fig. 8. It consists of shafts fitted with clutch plates driven off a single motor, which rotates in one direction only at variable speeds. Each clutch plate has a solenoid-operated clutch on either side, one to drive the dimmer up, the other down. These clutches receive their instructions from a Wheatstone bridge circuit which operates a polarised relay; thus the dimmer hunts to the position of a small control potentiometer. It is to this electro-mechanical system that Table 1 refers.

From the lighting supervisor's point of view the type of dimmer used is primarily important in so far as it affects the flexibility and size of the control desk facilities, but reliability and degree of load dependence are also matters of concern. By the latter is meant the ability to provide an equal percentage of full light output irrespective of load.

It has been found that a minimum of two, and preferably more, complete sets of controls are necessary in order to switch or fade from one series of light levels to another, since when light changes are required to follow in rapid succession there is no time for resetting control levers. When the design of intricate control systems for presenting a large number of scenes is envisaged, the electro-mechanical type of system has very real advantages; for once a dimmer has been run to its required position it requires no further instruction but remains there until told to move. With electronic systems, however, means must be provided for maintaining the control voltage, i.e. all potentiometers for a circuit which is not required to change must be set to the same level. This can be time-consuming. In general, therefore, for equivalent facilities an electro-mechanical system results in appreciably smaller control desks.

Whereas in the United States the most general practice in both theatres and television studios has been to have a small number of large capacity dimmers, the trend in this country in both fields of application is to a large number of small capacity dimmers, each unit being used to control one or at most two luminaires. This obviously leads to greater flexibility and greater scope for the lighting artist.

There are other dimmer control systems which have not yet been mentioned, as they have not been widely used in this country. These include the tracker wire controlled auto-transformer widely used on the Continent, well engineered but likely to be superseded by more up-to-date methods, and secondly the saturable reactor controlled by a small thyratron in order to reduce the control current. This system is not without interest. Finally, many attempts have been made to design a satisfactory remote controlled shutter dimmer which attaches to the front of luminaires. Under the extreme variations of temperature to which such a device is subjected the mechanical problems remain to be effectively solved.

The decision as to which type of dimmer should be recommended for any installation must be made on the particular requirements of that application. Since the degree of operational flexibility required, the reliability, and the money available are the most important factors, no single dimmer type can be claimed to be suitable for all studios.

Control desks of extreme flexibility and compactness have been designed for many types of

dimmer and are proving themselves most valuable in studio use. The technique of operation is gradually being established and the facilities provided are being used not only for the provision of lighting effects and the saving of power due to the flexibility of dimming and switching available, but also for the improvement of picture quality. It is now possible for the lighting supervisor to compose and balance pictures in a few seconds the moment they appear on his television monitor, without the many minutes' delay which had previously been necessary while an electrician adjusted and fitted diffusers to a luminaire. One of the most flexible of these control desks (illustrated in Figs. 9a and 9b) is that installed in the B.B.C. Television Theatre at Shepherd's Bush, London, which controls 176-2 kw. and 12-5 kw. dimmers, and has a mimic diagram in the desk surface which indicates the state of dim of every circuit.

(3.2) Position of lighting control desk

The layout of equipment and personnel in studio control rooms is a subject on which unanimity of opinion has not yet been achieved. It is believed by many that the lighting desk should be in the producer's control room so that an effective production team can be formed. Another view is that the logical place for the desk is in the apparatus room with the men who finally adjust the camera controls. Each approach has been tried in the two studios at Riverside but it is too early to say which position is finding most favour. Yet another approach used has been to isolate the lighting desk from all other facilities by installing it in a separate cubicle. This question is closely related to general studio operational techniques which are beyond the scope of this paper.

(3.3) Circuit selection

Having decided on the form of dimmer and of control the designer of a television studio lighting installation is still left with a problem if the studio is fairly large (over 3,000 square feet). He may well require 300 to 400 or even more studio outlets but quite apart from the economics and space requirements of this number of dimmers, at the present stage of development a board designed to control more than 250 circuits tends to become quite unmanageable. It should further be noted that more than 100 outlets are seldom required for any one production, the large number installed being intended to reduce the number of extension leads and thus rigging and wiring time. Hence the necessity for circuit selection, i.e., equipment for connecting a large number of circuits to a smaller number of dimmer or switch channels.

Like many engineering problems no ideal design has yet been developed, but four different solutions are in regular use:

(3.3.1) *Patch cord selection*

Fig. No. 10 illustrates such a device for a 300-outlet studio. This method has the merit of extreme flexibility, but there is a tendency for the operation of a patch panel to be both tedious and confusing when a large rig is required, and appreciable time delay can result from the necessity to convey instructions for a change of (or addition to) circuits and the essential logging on a record sheet. A further practical limitation is that no lamp can be switched on before the day's patching has been completed.

(3.3.2) *Rotary selectors carrying full lamp current*

These tend to be cumbersome and tedious to set and must necessarily restrict the freedom of choice.

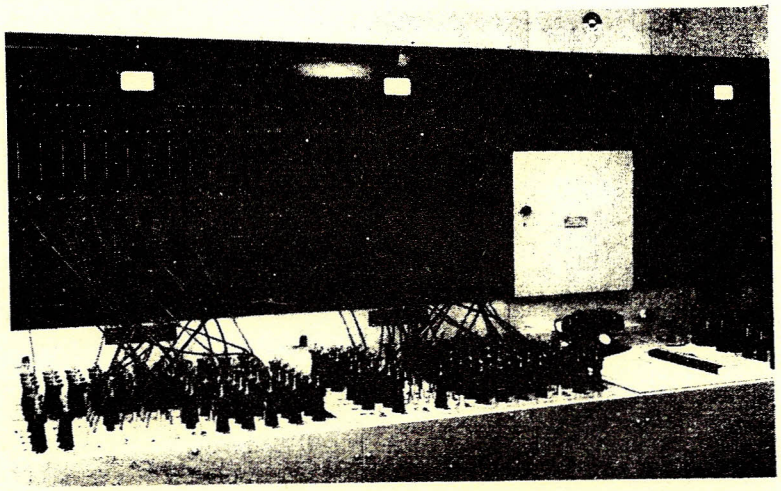
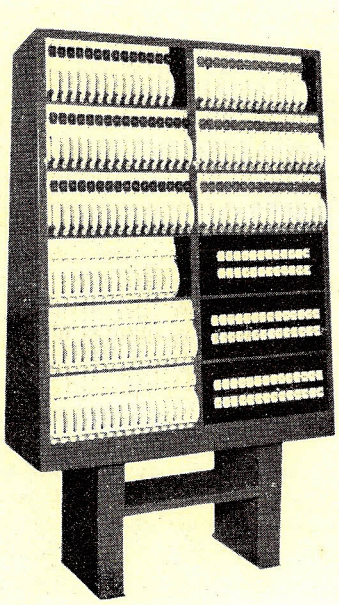


Fig. 10. A 300-circuit cord patching panel as installed in Riverside Studio No. 2.



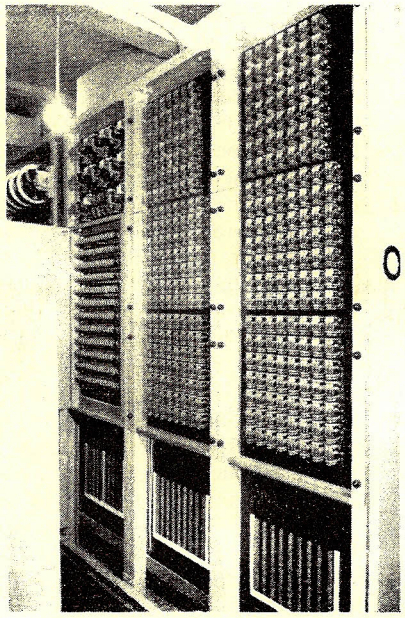


Fig. 11 (left). The control panel for a remote operated circuit selection system as installed in Riverside Studio No. 1.

Fig. 12 (right). 350 of the 1,400 relays used in the remote operated circuit selection system installed at Riverside Studio No. 1.

(3.3.3) *Remote relay selection*

An example of this system is illustrated in Figs. 11 and 12 and uses a quadrant type of switch with eight positions which can be rapidly set and cleared for the next day's production. Freedom of choice is restricted, but if a sufficiently generous allocation of dimmers is made this may not prove serious. In practice this system seems to be proving simple to operate. It results however in a wastage of dimmers for appreciably more dimmers must be installed than are necessary for any one production. Requiring as it does a large number of relays, maintenance time must be included as one of the disadvantages.

(3.3.4) *Selection in the studio*

This method is particularly suited to a studio which has a walkover type ceiling grid, where the extension leads necessary can be kept out of the way of other studio services, and where the work can be carried out without recourse to the studio floor. In a fairly small studio this can prove an effective solution.

The provision of circuit selection facilities can prove expensive and it is always worth investigating whether a small increase in the number of dimmers installed or a reduction in the number of studio outlets might be effected in order to provide a control channel for each outlet. For television theatre installations where one area may be used for a multiplicity of scenes it is usual to provide a dimmer channel for each studio lighting circuit.

(4) Luminaire Design

Apart from the reduction in weight of luminaires mentioned earlier very few radical innovations in studio spotlights have been made in recent years. The fresnel lens film-type spotlight in 6-in. 500-watt, 10-in. 2-kilowatt, and 14-in. 5-kilowatt remains the basic sources of hard (focusable) light in studios. Due to the relatively low lighting levels for monochrome television the new larger sizes available, i.e., 10-kw and 20-kw, are not used, though in experiments on colour television 10-kw lamps have proved valuable.

(4.1) Softlights

The so-called softlight is a problem which has not yet been satisfactorily solved though a number of different types has been tried. From a summary of the basic requirements for this source it will readily be seen that even a satisfactory compromise is difficult to achieve. These requirements are:

(1) The light shall be diffuse and relatively shadow free.

(2) The light pattern from the softlight should have a fairly defined cut off, i.e., diffuse or shadow-free light is required over the scene but must be able to be cut off at the bottom of walls or back projection screens.

(3) The softlights concerned should be light in weight and easily manoeuvrable.

The emphasis on extremely shadow-free light may not be immediately appreciated if the

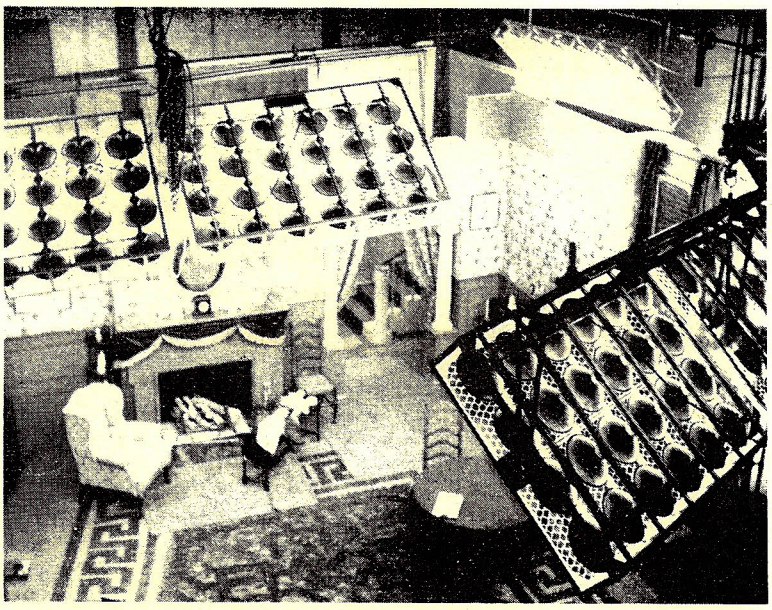
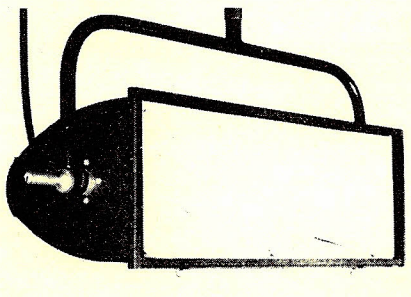


Fig. 13. Multilamp "Softlights" in use in Studio D, Lime Grove.

Fig. 14. A "Fivelight."

Fig. 15. A "Fourlight."



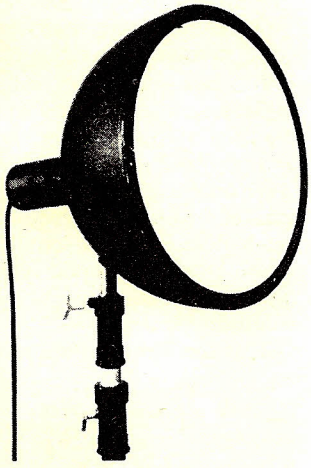


Fig. 16 (right). A "Scoop."

question of the microphone boom (Fig. 2) is overlooked. It is shadow from this device that is the lighting men's principal nightmare.

A type of fitting now rapidly losing favour due to its unwieldy size is the softlight bank illustrated in Fig. 13. Though this provides a source of diffuse light it is cumbersome and completely without means for beam pattern control.

The most popular softlights to-day are "five lights" "four lights" and scoops. These are illustrated respectively in Figs. 14, 15 and 16.

The "five light" consists of five 1,000-watt G.E.S. lamps either pearl or silica coated. These are mounted in line and backed by a bright anodised aluminium reflector. The "four light" has four 500-watt E.S. photographic pearl lamps mounted in line and the reflector is either matt anodised or painted white.

With mechanical handling receiving more attention the "scoop" or 18-in. diameter matt anodised aluminium spinning is at present being widely installed. This luminaire is light, relatively inexpensive, and when used in groups of three or four gives a fairly diffuse light. Even when fitted with spill rings, however, it does not lend itself to the provision of a controlled pattern of light.

It has been found that microphone boom shadows can be satisfactorily reduced if the light

distribution from the softlight is diffuse in the plane at right angles to the axis of the boom, i.e., the major axis of the source. The transverse plane or minor axis in this connection appears to be relatively unimportant. Hence the popularity of the rectangular "five lights" and "four lights." It is the polar curve in this transverse plane, however, which requires careful control in order to provide the requisite cut-off. Most softlights at present available give a symmetrical distribution in the minor axis whereas what is required is a distribution rather similar to a unidirectional street-lighting luminaire, i.e., a distribution so designed as to provide reasonably even illumination on the horizontal plane from beneath the softlight to some 20 to 30 ft. in the direction of the acting area.

Fluorescent softlights are not generally favoured for general purpose studios for the following reasons:—

(1) They tend to be large and cumbersome for the intensities required,
(2) They do not readily provide a controlled beam pattern, and
(3) They require heavy control gear and special dimming arrangements.

For small interview studios, however, where dramatic lighting effects are unlikely to be required and a fixed pattern of basic soft light is acceptable, fluorescent lighting comes into its own. Even in this latter case it will always be supplemented by incandescent modelling light. Many small demonstration studios have been lit solely by fluorescent tubular lamps, providing enough light quite irrespective of the artistic quality of the resultant picture.

This has led the uninitiated to assume that the fluorescent lamp is the panacea for all television studio lighting problems, but this unfortunately is not so. In fact, there is more than one studio in this country that has installed fluorescent soft lighting units initially on grounds of saving in ventilation and lighting power, but has found them so inflexible in operation that they are now used solely as "houselights."

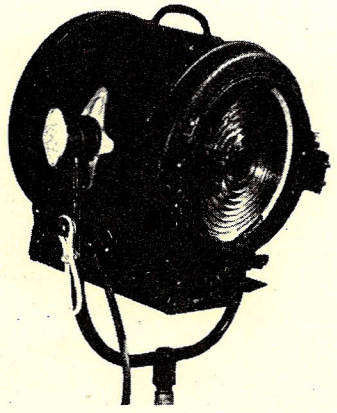


Fig. 17. A 2kW Fresnel lens spotlight.

(4.2) Spotlights

The other principal type of luminaire used is the spotlight, which usually houses a projector lamp in front of a mirror and behind a fresnel or "stepped" lens. (Fig. 17.) These are focused by movement of the lamp carriage, to which the mirror is attached, relative to the lens. The requirement for these are principally:—

(1) Robust, but light construction.
(2) Smooth and flexible focusing.
(3) An even pattern of light, free from filament striations.
(4) Wide angle of flood.

This last requirement is the only one not fully met by presently available spotlights, the reason being that, unlike the film camera, the television camera seldom requires heavily focused light, and the development of new fresnel lens types is an expensive and lengthy affair. A reduction in weight of conventional spotlights of some 40 per cent. has been achieved by aluminium construction in place of steel.

One of the most time-consuming operations which has not yet been eliminated from TV studio practice is the necessity for the angling and focusing of each luminaire to be carried out manually from a pair of steps. Work is in progress, however, on the development of luminaires which can be directed and focused from the floor with the aid of a pole.

From the above, it will be apparent that although luminaire design has been relatively static for some time past, there is room for design work on improved types for television use.

(5) Lamp Types

The type of lamp in most general use for spotlights is the bi-post Class S with a spherical bulb, the filament being planar. Prefocus projector lamps are used in wattages below 500. In general, softlights are fitted with General Lighting Service lamps, with Edison screw caps in the range 500 to 1,500 watts. For the past two years, manufacturers have been supplying these inside silica coated, which has effected a marked improvement in the softness of the light.

Ventilation can prove a major problem in

studios, and for that reason more efficient light sources have, at various times, been considered and used experimentally. Compact-source mercury-cadmium lamps were given a large-scale trial, but it was considered that the efficiency gain was more than outweighed by the higher cost, higher maintenance, higher weight, and poor restart characteristics of these lamps, with their associated control gear.

The Xenon gas arc has been considered for monochrome television use, but since its efficiency is little higher than that of high wattage tungsten filament lamps, the additional complication of control gear which these lamps require rule them out for this application.

Modern cameras can operate with fluorescent lamps on a.c., even single-phase, as the decay time of the fluorescent powder reduces the light modulation to approximately 45 per cent. Fluorescent lamps are the only other light source (apart from carbon arcs) which have found an appreciable application in TV studios. Their use is restricted primarily to small interview studios for the reasons given in 4.1 above, where they effect an appreciable reduction in the heat dissipation.

Carbon arcs are still occasionally used where a high intensity single source, or a "following spot" is required. Back-projection of simulated backgrounds is almost entirely obtained with this source, no other of similar arc size and brightness being available.

(6) Wiring of Luminaires to Power Supply

(6.1) Power supply

It is usually advisable to have separate production lighting transformers and off-load or preferably on-load voltage control is an advantage. With the improvement in the constancy of supply voltages this facility may become less necessary, but it must be borne in mind that a 5 per cent. change in voltage results in a 17 per cent. change in the light output from a tungsten filament lamp. Transformer regulation with large loads being switched on and off, also cannot be ignored. In addition a standby transformer in case of breakdown or need for maintenance, is a reasonable precaution.

A rule of thumb for the installed power capacity to a studio is 25 to 35 watts/sq.ft. of total studio floor space, assuming the use of image-orthicon cameras, which are the most sensitive and most widely used cameras today.

The B.B.C. has standardised on 115 volts a.c. or d.c. for studio production lighting, thus keeping in line with film studio practice. This has the further advantage that where 3-phase a.c. is installed, the phase to phase voltage is less than 220 which, in studios where separation of lighting phases is impracticable, serves as a useful safety precaution.

(6.2) Wiring

In line with the improvements in lighting facilities already mentioned it is no longer considered adequate to provide a small number of large capacity outlets and to feed luminaires from these through distribution boxes and many yards of trailing cable. Quite apart from the untidiness of this system, remote control lighting requires a large number of socket outlets each independently fed.

One of the neatest installations from this aspect is that at Riverside, where the majority of luminaires are mounted on 9-ft. barrels controlled by electric hoists. Round each of the two wire ropes supporting the barrel is a five-core rubber sheathed self-coiling cable which is moulded at its lower end into a two-way rubber back-to-back socket outlet and can be seen in Fig. 7. Thus each hoist carries four 2-kw. independently fed circuits. All luminaires have 6-ft. leads with rubber moulded 2-kw. plugs. Further socket outlets are mounted on the walls at regular spacings both at floor and gallery levels. Over 300 circuits are thus distributed. A small number of extension leads have been supplied and these, too, have both plugs and sockets moulded in rubber. The use of moulded plugs and sockets leads to a marked reduction in maintenance.

(7) Conclusion

There are many facets of this subject which, through lack of space, have been only briefly mentioned in this paper, and others such as the application of the above ideas and equipment to colour television have not been dealt with at all. Like most surveys of a large and interesting subject this one is incomplete and probably biased towards the experience of its author. It is to be hoped that further publications will soon be added to the very meagre literature at present available on this subject.

(8) Acknowledgments

Finally the author wishes to thank the Chief Engineer of the B.B.C. for permission to publish this paper, and the following manufacturers whose equipment has been described and who have supplied photographs: The Strand Electric and Engineering Company; Mole-Richardson (England) Ltd.; The General Electric Company Ltd.; Geo. W. King Ltd., and British Insulated Callender Cables Limited.

Discussion

Mr. R. KOPLICK: In view of the lamentable lack of information on television lighting as a whole this paper has been extremely interesting. There seem to be so few technical books and papers published on this subject in this country; in fact there are only those of the B.B.C., which are not for general publication. I feel, therefore, that this paper is doubly interesting for those of us who are interested in television lighting and for those interested from a layman's point of view.

There is one point on which I feel I must really take Mr. Ackerman to task. I notice that he is biased towards the B.B.C. system of mechanical handling. I have seen the plant and can commend it, but would ask Mr. Ackerman whether the cost of such a plant is justified in view of the vast number of illuminators required to achieve this system of saturation suspension. It means that for one 6,000 sq. ft. studio with eight lamps per barrel, and 72 barrels being used, a total of 576 illuminators is required for a single studio whereas the same studio would probably require approximately 150 lamps if the studio were rigged with single point suspensions. Is the cost of the B.B.C. system comparable with that of single point suspension even including the additional labour required, in order to carry out the task of rigging? I realise that the time element is important, but given sufficient labour one can overcome the time element to some extent. Perhaps Mr. Ackerman has more figures at his disposal with which to clarify this point.

Mr. A. C. SIMPSON: I congratulate Mr. Ackerman on his paper which shows a great understanding of the operational requirements of the studio, and I am glad to see he has called the lighting man a lighting artist. This seems to me a new view coming from a technical man. Having done lighting myself I know what is involved and how much it can add to a production. I think more and more that the technical side is coming to the fore and that lighting can add enough atmosphere to a production to enable scenery to be dispensed with. All the difficulties which Mr. Ackerman has mentioned in his paper, such as shadows from microphones, numerous camera angles, etc., make it perhaps the most exciting job in the operational chain. It is a job with great responsibilities.

I can see the advantages of the electric hoist system, but I am wondering whether the studio he mentions is in fact the only suitable studio for this system. Would it work in a studio with a high ceiling where, perhaps, the last-minute adjustment of lamps might be difficult? In this connection I wonder whether, in future, grids or gangways could be built on to the ceiling so that men, during the rehearsals, could make the last-minute adjustments which are very necessary during the short rehearsals we have to contend with.

The position of the lighting control desk, I agree, should be in the control room so that the production team is all together.

Softlights are a question that has worried me in the past both as lighting man and producer. It will always be a problem when the studio floor is so cluttered up with microphone booms, camera cables and the like. In this connection I wonder if an experiment tried at Alexandra Palace could be taken up again. I remember softlights being put in front of the cameras themselves so that when the camera moved into close-up the face became softened and one could take more close-ups than at the present time. Could not four small lamps on the camera itself be connected with the control desk? I admit that perhaps this does not apply in the case of telephoto lenses where the camera is some distance from the subject, but if the producer wished to go in for a good close-up he could then direct his camera close to the artist and get a degree of good frontal lighting.

These are all the comments I have to make on the paper. I am extremely conscious of lighting in musical productions on television where there is no spoken word—no message going out to the audience. In order to make music positive in the visual sense we should, I think, use lighting to an increasing degree, but we are trying to achieve the same thing as an art photographer without having the time to do it. However, it is interesting to see what some people are achieving in this way.

I have always felt that one has to extend the system as far as possible. We are sometimes warned not to use too much contrast in pictures, "soot and whitewash" as some people call it, because receivers in outlying parts of the country do not get good enough reproduction. Whereas this may be true, I would not like this sort of consideration to thwart our production methods. I would rather see manufacturers of receivers come into line with the needs of transmission. I remember several times being blamed for producing sharp contrast in pictures and, I must admit, cheated a bit. Having been criticised by the control room operator I would come out to the studio and fiddle around a bit without doing much. I would go back and say "Is that better?" and

he would twiddle a few knobs, and lo and behold, the picture improved out of all recognition !

Mr. J. Siap : May I add something about our experience in Holland? Mr. Ackerman has told us that fluorescent lamps are scarcely used here. In Holland banks of fluorescent tubes are used as softlights, for black and white as well as for experimental colour TV, with rather good results. Each fitting contains six fluorescent tubes in trough reflectors. 40-watt lamps are used with 65-watt dual ballasts. The luminous intensity, which is nearly 6,000 cd. in the axis, drops to half that value at about 45 deg. to either side. In order to reduce the light-ripple and to obtain an even load on the mains, the three dual ballasts per fitting are distributed over three phases. The ballasts are mounted outside the studio. Each fitting is provided with a thin 7-core cable with a 7-pole plug ; 7-pole receptacles on the studio-walls are connected to the ballasts. In this way the fittings are easily manoeuvrable. The fluorescent fittings are supplemented by fittings with six 500-watt reflector type incandescent lamps. The lamps are mounted in line, distributed alternately over the three phases. For dimming, three of them can be extinguished.

Mr. F. P. Bentham : The control of television lighting from a centralised switchboard, although a feature of the 1936 Alexandra Palace studios has only recently become accepted in this country. There are at the moment of speaking 18 studios here equipped with some kind of compact panel or desk for the remote control of lighting. There are some others which make-do with the archaic electrical arrangements of the film studios or the out-of-date controls of the theatres in which they find themselves.

The object of these controls is as the author has stated, but of all these, the duty of turning a mere collection of circuits terminating in spotlights and floodlights into an expressive instrument is the most important. As the playing of, rather than the working of, lighting is a fetish of mine, and as I have had more or less to do with all the 18 studio controls, I would like to state my firm belief that the most important thing we have to do is to determine who the operator of the lighting control will be. There are those who say that these controls are but switchboards and in consequence the province of an electrician. Fortunately, however, both the B.B.C. and Granada TV have insisted on a quite different policy—namely that the lighting supervisor (the man who lights a TV show) shall operate his own control.

This I regard as essential. A picture has to be painted with light while viewing the monitor (shown in Fig. 9b) an intimate and delicate action requiring the trained eye of an artist illuminating engineer. The closing of switches and movement of dimmers is, as with playing of an electric organ, merely incidental—a means to an end. It is fantastic to suppose that these subleties of light and shade can be conveyed via an intermediary. It is difficult enough—often taking several days for one production—when the comparative coarse lighting changes of the theatre are in question. There we have to adopt plotting for repetition by an electrician because we shall have to repeat the show for weeks, maybe for years. But a TV show is once for all, and the man who devised the lighting is the proper man to carry it out—direct contact with his medium is essential to any artist. If this is true now, it will apply even more so in the future for I am certain that television is bound to lead to the use of lighting as colour music—that long delayed fusion of music and light.

This Society is the right and proper place for the lighting supervisors—men who represent a skill possessed hitherto by the few—the stage lighting eccentrics. Let us make sure that they become members.

Mr. P. T. Cahill : Has Mr. Ackerman any knowledge, either from experience or from tests carried out, of the relative efficiency of the three light sources, tungsten, xenon and arc light relative to the image-orthicon tube ? I would like his opinion also, as to the practice of measuring luminaire divergencies. We normally measure these to one-tenth maximum beam C.P., whereas it might be preferable for television purposes to measure to one-third or a half of maximum beam C.P. Could he then let us know which is the best divergency in the horizontal and vertical planes for general television lighting (spots and floods)?

Mr. Derek Phillips : I had assumed that this would be a highly technical subject about which architects like myself would have no comment to make, but the remarks of Mr. Bentham suggest that the subject could be broadened, and some of the remarks of Mr. Simpson touch upon a subject in which I am interested. I think it is important that the lighting artist should have arisen out of this sort of job, and as with stage lighting and theatre lighting generally I feel that the lighting artist has a tremendous fund of practical knowledge of how the emotions of an audience can be stirred by lighting effects, of how mood and atmosphere may be conjured up, and what

contributes to an impression of season, time of day and locality. I wonder if the author or Mr. Simpson or Mr. Koplick could comment on the sort of way they have approached this subject, because I think by knowledge of this sort we might possibly gain interesting information on comfort conditions for normal buildings.

Mr. A. G. PENNY (*written communication*): During a recent visit to Moscow I went to their Television Centre and had a look at the lighting equipment. There are two studios in use of roughly 2,000 and 2,500 sq. ft. respectively to which are attached five mobile and two fixed camera units—in the Bolshoi Theatre and Lenin Stadium respectively. Image-orthicon tubes are used in the studio which operate at a lighting intensity of around 30-100 f.c. (20-30 f.c. are used for rehearsals.)

One studio is largely lighted by 5 ft. 80-watt fluorescent tubes mounted six at a time in simple reflectors. A three-phase supply is fed into each fitting with two lamps on each phase. I counted 22 units in the studio, which was also equipped with 24 tungsten spots of 1- and 2-kW. looking like copies of early Mole Richardson designs. So far as I could understand the fluorescent tube lighting was not popular, either with technicians or producers. The other studio, the older one, was lighted exclusively by tungsten with 1,000-watt G.L.S. lamps in mirror reflectors overhead and 1- and 2-kW. Mole type spots on the floor. 1,500-watt pans of simple design were also in use.

Of the two million sets in use in Russia one million are in Moscow, a city of 6,500,000 people. Other centres of diffusion are Kalinin and Leningrad linked by cable and Stalinov by radio link. Future plans are on the usual scale, two more studios in 1958, 11 more in all. Building had already started on a new television tower which was to be 1,500 ft. tall. Picture quality as judged by sets in our hotel one to two miles from the transmitter was quite good but not outstanding. There are two alternative programmes described as "Light" and "Heavy" but the main preoccupation of the chief of the station seemed to be the problem of finding enough live material. As in other parts of the world old films appeared to be the all-too-frequent offering.

THE AUTHOR (in reply): In reply to Mr. Koplick's challenge in connection with electric hoist suspensions I think I should make one thing clear. It is true to say that in the early planning stages we did think of each of these hoists rigged with its complement of four luminaires. Thinking has changed since then and the hoists are being used as a means for suspending luminaires and sometimes for storing those not in use. They are not rigged with any fixed complement because one is faced in practice with the fact that whatever pattern of fittings is rigged, the lighting supervisor will want a different pattern. Electric hoists therefore serve as a flexible rigging system, providing readily accessible points for plugging in, and rapid alteration of the position of luminaires the number of which is determined solely by the probable requirements for the various types. Installation of this system of suspension is expected to repay its capital cost in less than five years in terms of reduced manpower. This does not take into account the very rapid programme "turn round" which is being achieved.

I would like to thank Mr. Simpson for his comments and will try to go through the points raised in turn. The fact that the Riverside studios happen to be short of height is more a limitation of the building than of the hoist system. The lights take up about the top 4 or 5 ft. of the studio, which has anyway only a clearance of about 23 ft. It is generally realised that for some productions this is a limitation, but I do not think it is inherent in the hoist system. Any system must use some of the studio volume, and if more height is required higher studios must be built. But conflict between designers and lighting is likely to continue on this point for their requirements are mutually incompatible. The producer and designer want the lighting mounted as high as possible to give them an unrestricted field of view. The lighting supervisor wishes to get his lights mounted as low as possible in order to get a satisfactory light pattern.

There remains the question of the adjustment of lamps. There is no reason so far as I can see why electric hoists should not be used in a 45 ft. high studio assuming our cable manufacturers can make cables for that height. Lamps would still have to be finally adjusted and would still have to be used in most instances at heights of 12-14 ft. At the moment, the final adjustment of pan, tilt, and focus is done by an electrician from a pair of steps. There is work going on at the moment on pole operation of lamps, i.e., the focusing, panning and tilting of them by means of a pole, which would obviate the ubiquitous pair of steps, and effect a further reduction in light setting time.

The question of camera lights is an interesting one. Some thought has been given to this from time to time and it should be brought up again, but there are very real problems from the point of view of control. To be effective you want these

lights switched on and off at the vision mixing panel, and you want the headlamp or eye light on only when the camera is "on-shot," but the different requirements for when the camera is in close up or long shot present a difficult engineering problem, though I would not say it is insuperable.

I am not really competent to comment on lighting for music, but I expect all of us working in this sphere of activity are very conscious of the fact that we are just on the threshold of the use of light for television as we are on the threshold of the development of lighting equipment for television. Sound radio has been going for a long time and I think the technique for sound radio is far more advanced than that for television.

I would like to join issue with Mr. Simpson on "soot and whitewash" pictures. As he has indicated, a large percentage of commercial television receivers tend to give a milky-grey result when a picture with inadequate a.c. content is transmitted. While having every sympathy with his resentment at restrictive limitations on picture content, it is my view that until such time as the majority of viewers have receivers which do not have this defect, we, on the production side, should turn out pictures which are satisfactory for the majority of viewers. Fiddling with the camera controls although it may improve one shot will in general cause a degradation of the average picture quality.

In reply to Mr. Cahill's point, namely the relative efficiencies of tungsten, xenon and arc lighting, it is true to say that most television cameras are blue sensitive. Foot-candle readings do not give really true results, and the bluer sources such as xenon and arc lighting do have about a 50 per cent. advantage, in other words 15 f.c. of tungsten is equivalent to 10 f.c. of xenon read on a colour corrected photometer. As far as the angle of flood of spotlights is concerned, the present agreed method of specifying the angle to one-tenth of maximum intensity seems to me quite satisfactory. It does not seem to me to matter how you specify, but as the international standard is down to one-tenth as long as we all agree what we are talking about there is no reason to change. I would however put in a plea for wider angle of flood for spotlights. For television the desirable maximum angle of flood is about 60 deg. and not all floodlights give this, particularly 2-kW. floodlights. Although it was once thought that an elliptical beam might be useful we have tried this out and come to the conclusion that a circular beam is what is wanted.

I am in complete agreement with everything Mr. Bentham had to say on the role of the lighting supervisor and in particular that the I.E.S. is the correct forum for the lighting supervisor. I think as the I.E.S. is out to extend its membership, particularly with its 50th anniversary coming along, here is a fruitful field for expansion. There is at present no adequate body for discussion of the subject of lighting technique, and I think this is the place for it.

With regard to the question of fluorescent lighting being used in Holland, as raised by Mr. Stap, we do use fluorescent lighting, as I mentioned in the paper, in interview studios and small studios where we do not do drama productions. The fitting described does sound an interesting design, but I think it has a disadvantage in that it cannot be plugged into any outlet. You have to have special fluorescent outlets, as opposed to tungsten outlets, and therefore there is a marked limitation in the overall design of your circuit selection and dimming systems.

Mr. Derek Phillips drew attention to the fact that the designer of interior lighting installations might well have something to learn from the lighting supervisor with regard to techniques for the creation of mood with light. Studio lighting technique is not a subject on which I can speak with authority but this point does, I think, reinforce the argument that this Society has much to gain from bringing these men into its fold.

Finally I would like to thank Mr. Penny for his very interesting written communication.