LIGHT CONSOLE INSTRUCTION MAN.
FROM THE COLLECTION of JIM LAWS

THE STRAND LIGHT CONSOLE

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THE STRAND LIGHT CONSOLE (PATENT)

I. GENERAL NON-TECHNICAL INTRODUCTION AND DESCRIPTION

THE STRAND LIGHT CONSOLE IS DESIGNED TO GIVE TO AN OPERATOR, SEATED IN FULL VIEW OF THE STAGE, ABSOLUTE CONTROL OF ALL THE LIGHTING CIRCUITS THAT MAKE UP A MODERN STAGE INSTALLATION, WHATEVER THE SIZE OF THE THEATRE.

It is claimed that the Light Console system has special advantages over all other lighting controls (whether direct operated, remote control, or multi-scene preset) for ballet, opera, spectacular revue and musical productions in which many elaborate lighting changes are required. Using the console, slow or rapid changes can constantly follow one upon the other without pause;and furthermore, as the whole installation is under the fingers of one man, the exasperating delays for trial and co-ordination of plotting during rehearsal are not experienced. The producer gives his instructions to one man; a man who can be sitting by his side at the console placed, for rehearsal, in the stalls.

The defects of the old direct-operated types of grand master-board when used on the modern large stage lighting installation of 100, 150, 200 or more dimmers are self-evident. Lighting cannot advance when controlled by several men working giant boards which, owing to their size, must be placed in the wings with little or no view of the lighting. Modern invention in remote control has succeeded in reducing the various dimmer levers and switches to miniature proportions, and with this the stage board control panel for 120 dimmers becomes five foot by three instead of eighteen foot by seven. The reduction in size of control panel means that only one man can have ready access to it instead of calling in extra hands to help with complicated cues, as had been Grand Master practice. The provision of a second duplicate set of levers enables the lighting in use and that for the next cue to be set up at the same time and the change-over effected by operation of one fader.

In this two-scene preset board we find an ideal control for the lighting of today's straight plays in their box sets. A change from one group of meticulously set intensities to another and plenty of time to reset the levers between whiles for the next change. However, for spectacle it is another matter: a scene may be one continuous change - there is no lull. A recent production at the London Palladium required fifteen lighting changes on dimmers and switches in the opening three minutes.

Attempts have been made in America to solve this problem by increasing the number of preset levers; a recent installatio

employing as many as 11 duplicate levers for each of a mere 44 dimmers! Applying the same logic to 200 dimmers and we get a board of 2,200 dimmer levers alone, to say nothing of accessory circuit switches and colour-change switches!

The Strand Light Console represents an entirely different approach to the problem of spectacular lighting control, and by its means one man would be seated in easy reach of the 200 dimmer controls, circuit switches, colour-change switches and whatnot. What is more, he can operate one lighting circuit or a group in immediate response to his thoughts or his instructions, written or verbal, expected or unexpected. This is achieved by giving the operator a single circuit selector switch to each stage lighting circuit, the name of the circuit being clearly engraved on the switches operating lever or tablet. The dimmer levers, position indicators, full-on switches, blackout switches, master locking devices and colour filter switches instead of being repeated for each lighting circuit are repeated only a few times as group and colour masters.

For every lighting change, great or small, the required lighting circuits, be they one or many, are locked to the master controls - operated and then unlocked to remain as they are until locked on for further change. The circuit selector switches are easy to put on or off - a sweep round with the hand and all are on, and so forth. Devices are fitted to move preset combinations of these switches, cancel them, etc.

As there is only one switch (simply On or Off) per lighting circuit, plus a set of masters used all the time, the console desk is very compact and the state of the controls clearly shown to the operator. With any other system an operator has to recognize the state of affairs by looking at a hundred or more dimmer levers, circuit switches, etc., plus the master controls which are necessary for simultaneous dimmer movement and to which the individual controls may, or may not, be locked at that time. With a multi-scene preset system he has an even larger forest of levers to interpret by eye.

An experienced console operator quickly learns to think of his lighting instinctively in terms of the console controls, and consequently operation becomes second nature, like driving a car. Lighting is no sooner thought of than it is translated into fact upon the stage.

MAIN POINTS OF THE LIGHT CONSOLE

(A) A Single operator seated within arm's reach of the controls

for any number of lighting circuits and accessories.

(B) Small size, enabling it to be placed with full view of stage. This, and the fact that the remainder of the apparatus can be stowed away under the stage or in some other position, often means that instead of the new switchboard as is usual occupying valuable stage space and requiring a new perch platform, the new console actually releases space for scenery or other stage purposes.

(C) It is movable, and can be fitted with a single flexible cable and plug to connect up in two or more positions.

(D) Duplicate consoles in different positions can work the same dimmer and relay bank.

(E) Dimmer bank need not be one unit, but can be split up to fit existing rooms available, all being operated as one from the console.

(F) Dimmers can be resistance, transformer, or any other modern A.C. type. The latter will dim any load up to their rated wattage, i.e. ½ check on a 4-kW model is the same whether 500 w., 1,000 or 4,000 w. is connected. They are specially suitable for dip plugs.

(G) Dimmers can be driven at any speed from 3 secs. full travel to 40 secs. Slower speeds obtainable by inching.

(H) Dimmers can be instantaneously stopped and reversed owing to lack of inertia in the clutch drive.

(I) Dimmers of different families (departments) can be driven at different or the same speeds. Foot pedal speed control is as convenient as, and more responsive than, a car accelerator. Pedals are balanced to remain where last placed, and indicators show their position without looking down.

(J) The amount of movement and speed applied to the dimmers can be seen on the master dials.

(K) The position of any individual dimmers can be read at will on the master dials.

(L) Pilot lamps can be fitted over each circuit key to reproduce the state of the lighting on the stage. These are of advantage where it may be preferred to place the console on a proscenium perch platform and the view of the stage may be at times interrupted by scenery.

(M) Dimmers of different colour masters can be driven in the same or opposite directions simultaneously. Provision can be made so that dimmers of the same colour master can travel in opposite directions simultaneously.

(N) Lighting circuits can be immediately switched full on or blacked out irrespective of the position of their dimmers.

(O) The switching can be momentary or sustained. In the former the flashing can be so responsive that the lights can beat rhythmically to dance music or a toccata.

(P) When switching as in (N) or (O) above is being carried out, the dimmers of those lighting circuits and on other lighting circuits can be moved to take up fresh positions, the switching (flashing) being operated by the fingers of one hand while the other works the dimmers. Sustained switching can be held by special keys, leaving both hands free.

(Q) By depressing a Master Key called 'HOLD' a second operation can be prepared in advance on the same set of circuit selector switches while the previous combination is still in use.

(R) The above (Q) is replaced on larger consoles by sets of push-buttons under the master keyboards. These can be preset on a miniature switchboard inside the console to move, on and off groups of the circuit selector switches as required.

(S) The apparatus under (R) above can be made fully automatic so that the operator, by pressing a single master button and an individual preset button causes the latter to memorize the combination of circuit selector switches in use. He requires no supplementary preset switchboard.

(T) Depression of a circuit selector switch beyond the normal 'On' position against a heavy spring allows that circuit to be connected solo to the master keyboard without the necessity of placing the rest of the stop-keys off. This second touch also connects the position indication dial to the dimmer in question.

(U) Depression of a single foot control push can run all dimmers down or blackout all circuits, or both together, without need to use master keyboards or circuit selector switches. This, plus a touch of the Cancel push causing all stops to fly 'Off', enables the whole board to be cleared to zero in three seconds.

(V) Any Spotlights, acting area floods, etc., fitted with remote

colour filter change are operated from the same set of circuit selector switches as the lighting circuits, by using the black keys in each master keyboard. This means that even in the unlikely event of all lanterns having colour change, no extra space will be taken up at the Console.

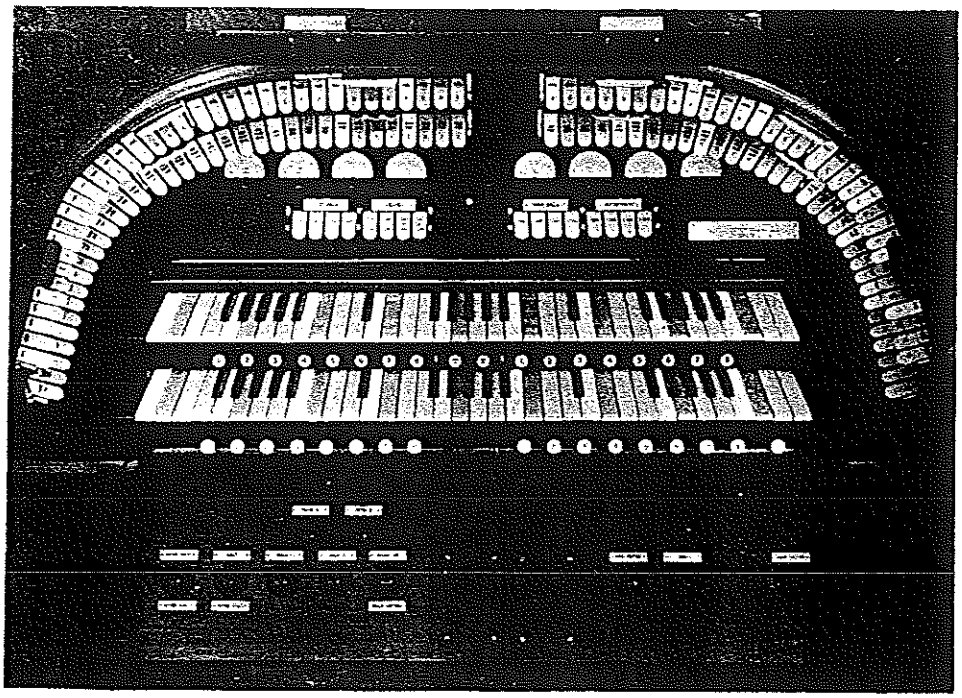
(W) Console is provided with indirect lighting (with a dimmer) of keys, stops and pedals, ample plot desk and sufficient space for accessory switches and house telephone.

(X) All keys and switches are silent in action. Even when a hundred or so are moved simultaneously by the combination action, rubber buffers dull the sound in approved organ fashion.

(Y) No complicated finger technique similar to that of pianist or organist is needed. Any reasonable person can easily acquire the technique in a week. To ensure that lighting will progress, the console should be in the hands of an artist (not necessarily an engineer) of imagination during rehearsals and initial performances. Subsequently a lower-grade deputy, who merely follows the lighting plot, can be employed.

THE STRAND LIGHT CONSOLE

(Patent Remote Control System)



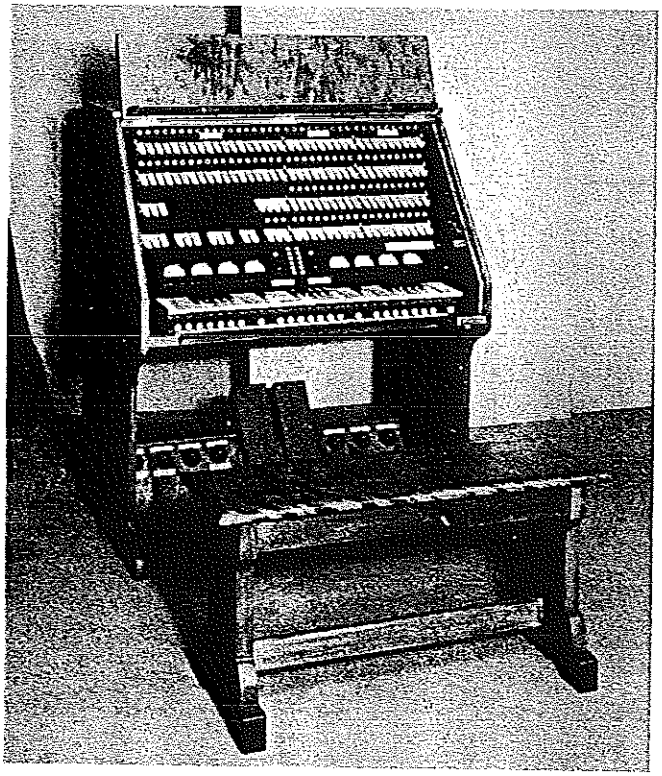


Fig. 1 (above)

Console for State Opera House, Ankara, Turkey

The capacity of this desk is 144 dimmer ways. Controls for remote filter change (4 colours and white) on Acting Area Floods and Front-of-House spotlights are also fitted. Console is placed in a "loge" in the auditorium and is 300ft. from the dimmer bank it operates.

Fig. 2 (left)

Console for Palace Theatre, Manchester

The capacity of this desk is 108 dimmer ways. As the Console is on a proscenium perch, pilot lamps reproducing the state of the stage lighting are fitted above the circuit selector keys. These keys are grouped to correspond more nearly to the colour and independent shafts of orthodox boards.

THE STRAND LIGHT CONSOLE

(Patent Remote Control System)

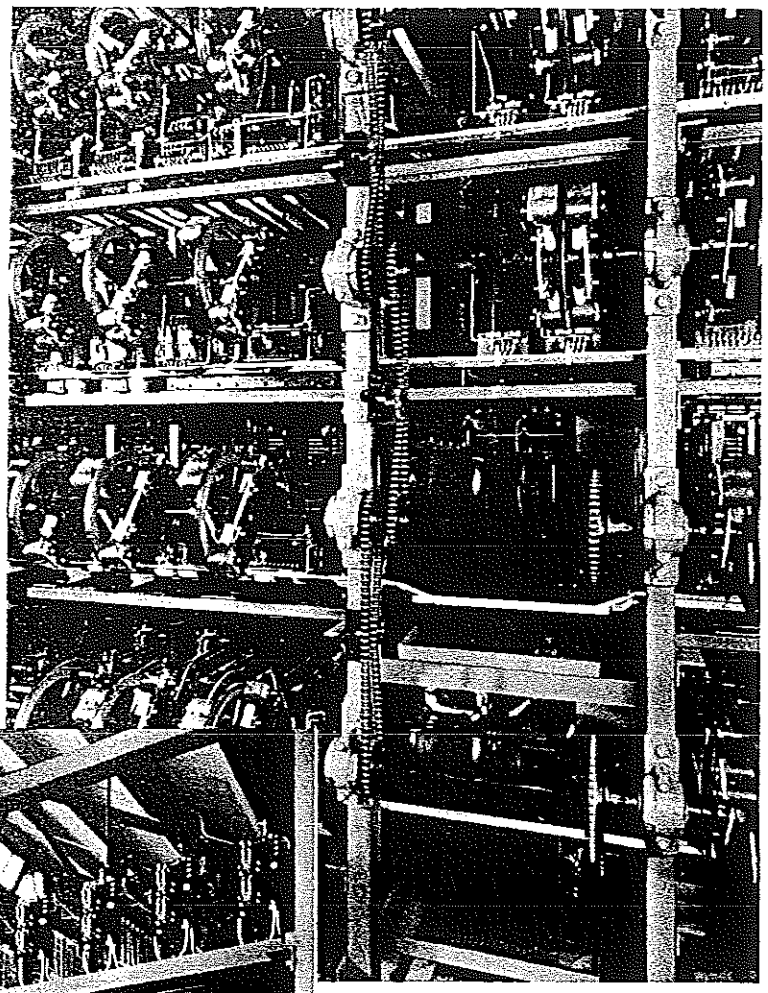


Fig. 3 (above)

Dimmer bank. Motor drive and standby motor with four single clutch setter units above and dimmer driven by pairs of clutches on the left and right. 15 volt action wiring and terminal blocks are this side.

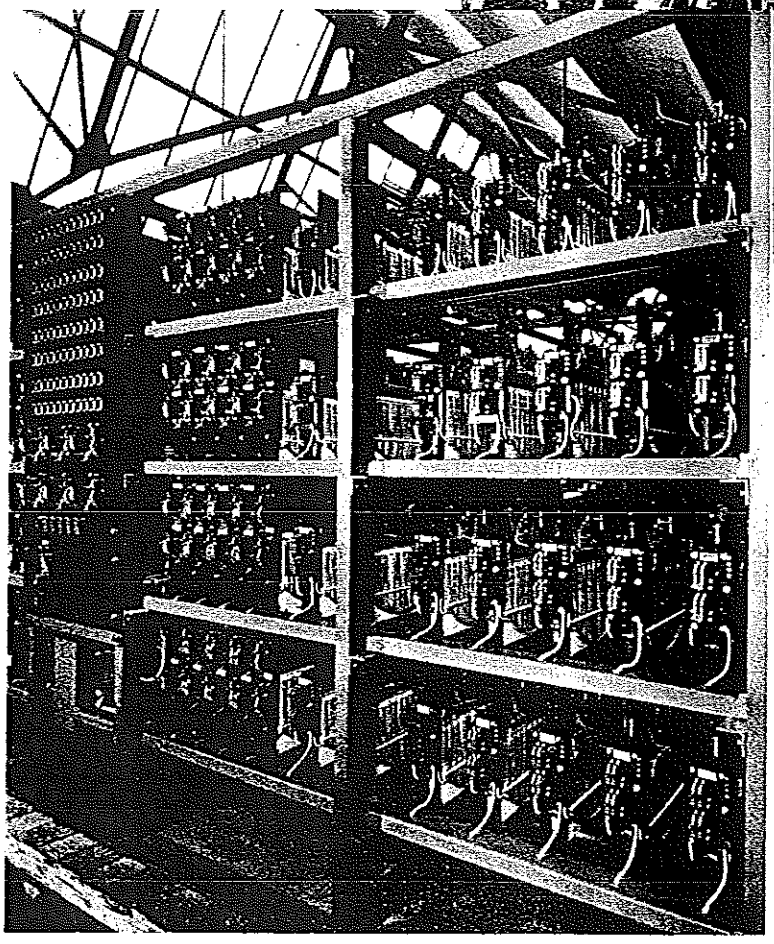


Fig. 4 (left)

Dimmer bank. High voltage side. Pairs of 10 amp. contactor switches and the circuit fuse are mounted on each dimmer. The large contactors on the left hand-dimmers are for the heavy cyclorama loads. The panel on the left carries the neutral links and shaft motor speed contactors. Horizontal trunking to each row is for outgoing lighting wiring.

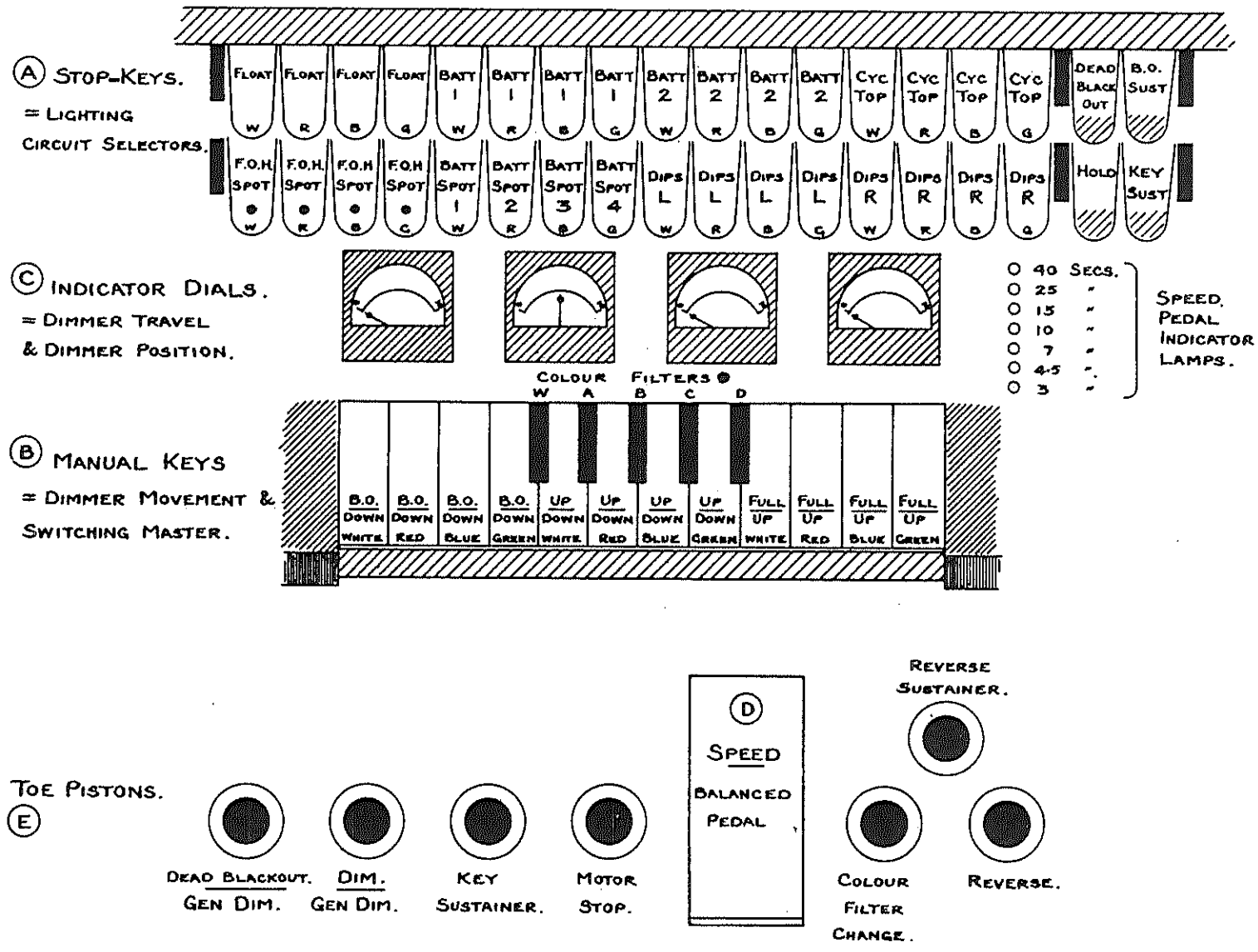


FIG. 5. BASIC CONTROLS. (ONE MASTER ONLY) (TO FACE BEGINNING SECTION II)

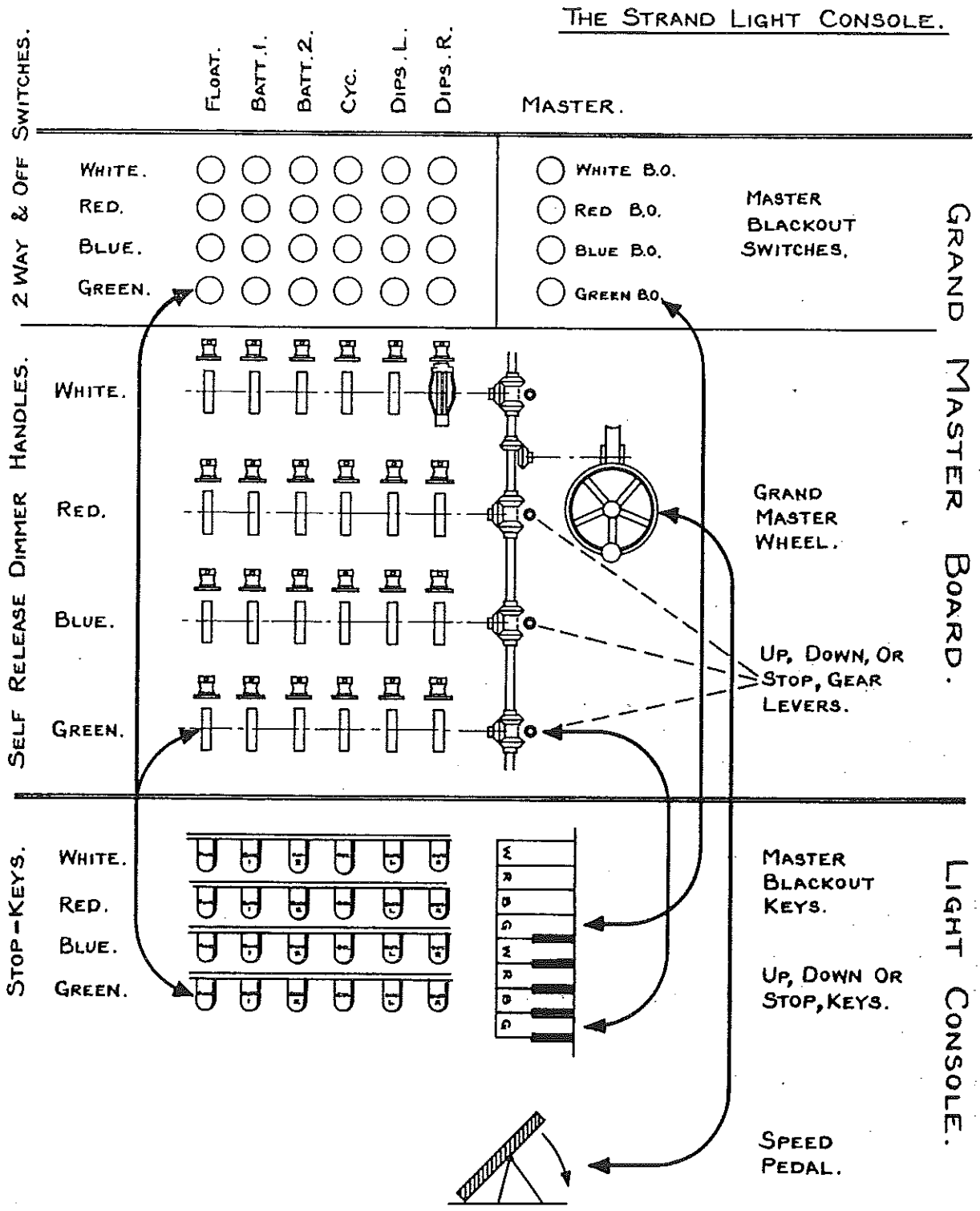


FIG. 6. GRAND MASTER & LIGHT CONSOLE CONTROLS COMPARED.

(TO FACE BEGINNING SECTION II)

THE STRAND LIGHT CONSOLE

II. DESCRIPTION OF BASIC CONTROLS AND THEIR USE

At first sight the Light Console seems to differ considerably from one installation to another. There may be one keyboard with some straight rows of organ type stop-keys above it, or two or more keyboards with semi-circular rows of stop-keys almost exactly like the cinema organ. The two types are shown in Figs. 1 and 2. Then again, sometimes pilot lamps are fitted above each stop-key, and so on.

Basically, all Light Consoles are the same, and the various differences are governed in fact by the size of installation and the position of the console in the theatre. The basic control facilities provided by the console will be described herein and once mastered any console can easily be operated.

The minimum unit of the Light Console is shown in Fig. 5 and consists of:

A. The Circuit selector switches (known as 'Stop-keys'), one per lighting circuit: between 32 and 44 coloured switches.
B. Master keyboard (known as 'the Manual'): 12 coloured and 5 black keys.
C. Indicator dials: four - white, red, blue and green.
D. Speed pedal and indicator: one only.
E. Accessories: aids to control, but not essential.

Larger keyboards and more numerous stop-keys simply mean that the lighting installation requires more than 44 dimmers, consequently the above layout is repeated twice, three times, four times, or more.

Each lighting circuit is provided with a dimmer which is driven Up or Down by means of pairs of clutches connecting it to a motor-driven uni-directional shaft. A switch across the dimmer enables the light to be put full on irrespective of its position, and one in series cuts off the supply and blacks out the light.

In addition, a small auxiliary dimmer is provided which moves with each dimmer and provides a position indicating voltage at all times including when the main dimmer is disconnected (i.e. blacked out).

All these items are represented at the console as a singl

2 to 100% in one movement, the twelve stops are put down and the dimmer keys depressed to first touch, then as the dials pass 5 and 7, first the footlight then Batten 1 stops are knocked off (unlocked from the master) with the other hand and the keys finally released and the dials reset at 10. To do this with separate colours is even simpler, since it is only necessary to remove the finger from the coloured key concerned.

Sometimes, when bringing in a large number of dimmers, the combination to be knocked off at an intermediate point is rather tricky to do in an instant; for this a toe piston (button or push) is provided which while depressed stops the driving shaft and dials, thereby allowing the operator as much time as he needs.

3. TO CHANGE SPEED OF DIMMERS.

The speed at which the dimmers move can be increased by depressing the speed pedal; a variety of speeds up to 3 secs. dimmer travel can be obtained by this means. The pedal (unlike a car accelerator) is balanced to remain put when the foot is removed. Toe pressure increases speed - heel pressure decreases speed.

4. TO CHECK LIGHTING ON DIMMERS.

To dim lights (i.e. reverse the dimmers), the second heavy touch already mentioned is used. Thus, if Batten 1 dimmer is at 100% it is locked to the master by putting down its four stop-keys and the centre manual keys are depressed heavily to second touch. The dimmers will now move downwards, and the dials will travel from 10 to 0 (i.e. 100% to 10%). The dials actually read the position of dummy dimmers (one per colour) known as the Setters. These only travel the same distance as an ordinary dimmer and are arranged to drop back automatically to zero every time the manual keys are released. Therefore, it is important to release the manual keys properly at the end of each movement to allow the setters to re-set.

The reversed dial reading is obtained by feeding a separate indicator resistance on each setter. This resistance is short circuited at the "off" end instead of the "full on" end. Depressing the manual keys to second touch does not reverse the direction of setter travel and, therefore, the fingers must not be pressed through from first to second touch if the dial reading is important.

5. TO FIND DIMMER POSITION FOR PLOTTING

Although the best guide to the operator as to the state of the stage lighting is a glance at the stage, it will sometimes be necessary to plot dimmer positions for subsequent reproduction during a blackout or while the stage is concealed by the house tabs or something of the sort. The position of any individual dimmer can be found by pushing its stop-key to second touch against a heavy spring. This disconnects the dials from the device which measures movement applied to dimmers as a whole and gives a direct reading of the dimmer position. At the same time, the other stops of that colour which may be on are disconnected from the manual keyboard. Thus a dimmer can be jockeyed into position without having to place all stops at Off.

When the stop-key is released it returns to first touch and the normal working is restored.

6. TO MOVE DIMMERS UP AND DOWN SIMULTANEOUSLY

Dimmers whose stop-keys are of different colours can travel in opposite directions at the same time by merely pressing one manual key to first touch and another to second touch. For this reason not only is the usual magazine and cyclorama equipment given colour circuit keys but all lighting, even where, as in a spot batten, it is orthodox practice to group the dimmers on one shaft (known as 'Independent'). Thus in a spot batten, No. 1 spot will be a White stop-key, No. 2 a Red No. 3 a Blue, No. 4 a Green, No. 5 a White, and so on. Usually it can be made to fall out that spots which have to brighte while others dim are on different colour keys (though, of course, their filters may be any colour). Occasionally the circumstances are not so obliging and resort has to be made to the toe piston called 'Reverse'.

Stop-keys whose dimmers are to travel in the opposite direction to others of the same colour are pressed to second touch while the foot is on 'Reverse'; other stops are put down normally. Thereafter until the reversed stops are put off their dimmers will travel Down on first touch and Up on second touch instead of the Up at first, Down at second which the other stops on that colour key will be doing.

If any stop-key of that colour is later pressed to second touch (for example to obtain an indicator reading), it will trip the reverses because its effect is that of momentarily putting off all other stops of its colour. When it is

desired to avoid this, the foot should be put on the 'Reverse Sust.' toe piston just before and during second touching.

7. TO SWITCH FULL ON INSTANTANEOUSLY

Frequently the fast speed of 3 secs. dimmer travel is not fast enough and therefore provision is made to switch the lights on direct irrespective of the dimmer. To do this, to Batten 1, for example, the four stops are put down and the Right hand set of four manual-keys pressed to first touch. The lights come full on at once and remain until either the manual-keys are released or the stops are put off. To keep the lights on, the manual-keys are pressed to second touch and the speed pedal put over to Fast. After 3 secs. (shown by the indicator dials), the dimmers at full on take over instead of the switches and the manual-keys and stops can be released, the light remaining full on.

8. TO BLACKOUT LEAVING CIRCUITS INDEPENDENT

For this the procedure is the same as that for switching full on in the preceding paragraph. The stops are put down of the circuits required to blackout, thereby connecting them to the Manual-keys, of which the left hand set of four are pressed to first touch for a temporary blackout, to second touch for a permanent by running the dimmers down as well. Many blackouts are required to be held for a time while the dimmers of those circuits are readjusted to give fresh intensities. To do this, a single white stop-key called 'Blackout Sustainer'(B.O.Sust.) is put down. Once the Manual blackout keys are pressed to first touch the circuits selected will remain blacked out irrespective of whether their stops are put off or the manual-keys released. Only when the B.O.Sust. stop-key is put off are these lights restored.

9. TO BLACKOUT COMPLETELY (DEAD BLACKOUT)

A yellow stop-key labelled 'D.B.O.' will blackout everything irrespective of the position of manual-keys and stop-keys until it is put Off.

This is duplicated by a toe piston (foot push), which has the same effect as long as it is depressed to first touch; lights are restored when released. If this piston is pushed to second touch then all the dimmers will be run down as well. It is therefore a useful device to clear the board at the end of a scene.

10. TO CHANGE COLOUR FILTERS ON AUTOMATIC SPOTS

The console circuits are arranged to act in the same way whether the old solenoid type of colour filter change or the new motor drive with magnetic gear selection is used.

The stop-keys of any spotlights fitted with this mechanism are marked with a small circle. When these stop-keys are put down, not only are the dimmers, etc., connected in the usual way to the manual keyboard but also the colour change mechanism. The change is effected by touching the appropriate black key while the circuit stops are down. The left hand black gives white (i.e. it cancels the other filters already in front of the lantern); the filters are brought in separately or in combination by touching the other four black keys. In changing from one colour to another the cancel must be touched first to trip the previous colour and then the required key touched. The actual change of filter at the lantern does not take place until the filter motor toe piston is pressed and held for 4 secs. to give the filters time to travel. Thus, either the filters can be changed at once or stored to change later on by merely touching the filter change toe piston. As the colour-change mechanism (motor type) in the lanterns is not constantly rated, the foot must only be kept on the change toe piston just long enough for the filters to change.

11. MULTIPLICATION OF BASIC CONTROLS

So far we have considered controls suitable for an installation of no more than 44 dimmer ways. To control up to 88 dimmer ways the keyboard is lengthened to include three sets of masters (i.e. three sets of 12 coloured keys and 5 blacks), as in Fig. 2. The left-hand section then works up to 44 dimmers and the right hand another 44. The centre set operate both left and right sections at once. The same set of four dials and the one speed regulator serve all sections.

For up to 132 dimmer ways the centre set of keys operates its own section of 44 stops, the two outer sections being coupled when required by coupler stop-keys to the centre set. The stop-keys will be carried in straight rows over the manual

For up to 176 dimmer ways there will be two keyboards each with two sections left and right, the centre sections operating left and right together. Means are then provided to couple the two keyboards (See Couplers III, 15). In these examples the stop-keys are placed on semi-circular trays so

that the large number may be better accommodated within easy arm's reach of the seated operator. (see Fig.1).

As the number of stop-keys increases so it is advisable to provide aids to assist the operator in their control. These devices, known as Piston action, Cancels and Hold are described in III, 16 and 17.

When the console is situated on a perch on the side of the stage, a good view thereof may not exist at all times, and in this case pilot lamps reproducing the state of the lighting on the stage are fitted above the stop-keys. (See III, 10).

THE STRAND LIGHT CONSOLE (Contd.)

III. DETAIL DESCRIPTION OF CONTROLS AND OTHER GEAR

assuming an A.C.50 cycle supply of 200 volts or over.

1. BASIC PRINCIPLE OF OPERATION

The Console consists of a number of master controls to which the dimmers, etc., of individual lighting circuits can be connected, each by a single switch for operation.

The Light Console does not claim to be a preset board but aims instead at providing the trained operator with the means to carry out any lighting change or changes simultaneously in rapid succession on the instant they are conceived. The Light Console is in consequence able to carry out flowing changes continuously during a whole act without need for any pause while preset controls are reset. This "playable" quality is only found in the Strand Light Console (all models), and means that it can in addition to working the normal lighting for drama, opera, ballet, etc., be used for solo lighting recitals (commonly known as 'Colour Music') as an entertainment in itself. The instantaneous operation shows to great advantage at rehearsals, when the most exacting conditions are usually experienced.

2. BASIC CIRCUIT

This consists of a dimmer in series with the load; in series with the dimmer is a normally closed contactor switch, and across the dimmer a normally open contactor switch. The dimmer is connectible to be driven up or down, by pairs of magnetic clutches, from a uni-directional variable speed motor-driven shaft. Thus each dimmer can be raised or lowered at the required speed and it can be blacked out or short-circuited at will. The means for supplying the necessary energy to the various electro-magnets is contained in the console and its relay. This is referred to as 'the action', and its circuits as 'the action circuits' in distinction to the lighting circuits.

3. STOPS

The expression "stop", normally applied in organ practice to a row of pipes, has been adopted to cover a lighting circuit complete with its dimmer, full-on contactor, blackout contactor, and even (when fitted) the remote colour-change filters in front of the lanterns of that circuit. The control which locks a

stop to its master is a single switch, which is therefore known as a "stop-key", a more convenient expression than "lighting circuit dimmer, etc., etc., - selector key".

4. MASTERS

The expression "master" is taken from orthodox stage switchboard practice where the term 'master' is applied to the wheel for collective operation of dimmers, or to the switch for collective blackouts. On the Light Console, the term "master" is applied to the complete set of operation controls for a group or family of lighting, i.e. keyboard, the four indication dials associated with it and the balanced speed pedal.

5. STOP-KEYS (Figs. 1 and 2)

These operate like an ordinary lever switch; when the switch is up the stop is 'off', disconnected from the master; when down the stop is 'on', connected to the master. For convenience the switch lever and label are combined, which gives the stop-key its distinctive appearance. It also renders it easy to run the hand over or under a number of keys, thus putting a whole group on or off at one movement.

Every separately-controlled lighting circuit has a stop-key; for example, Batten 1 white, Batten 1 Red, Batten 1 Blue and Batten 1 Green. The colours - white, red, blue and green - are chosen as being distinctive and therefore easily identified; the Green key could, of course, control a lighting circuit in which there are amber filters. A master is used whether one spotlight or nine spotlights are to be dimmed. When a stop-key is put 'off', then that circuit will be unlocked from the masters and remain in the state to which it was last called by the master.

This constant unlocking and locking to the master keyboards is effortless; the stop-keys are easy to operate and are placed convenient to the hand. A second touch against a heavy spring is provided to every stop-key. If a stop key is held against the spring, then any other stop keys of that master which may be on are unlocked, to be restored as soon as the stop-key is returned to first touch. Any stop-key pressed to second touch also gives a reading, on the appropriate master dial, of the position of that individual dimmer (III, 9).

The stop-keys are mounted in semi-circular or straight rows (if there are 132 stops or less) above the master keyboards. These rows are known as 'stop-key sweeps', not as 'keyboards'. Generally, the stop-key colours alternate, but in some instances it is more convenient to allocate the stops to colour rows (particularly in a master where magazine equipment predominates).

6. KEYBOARDS (MANUALS) (Figs. 1 and 2)

There may be one or more keyboards, similar to those used for a piano or an organ, each of which forms the main operating number of a master. A keyboard is known as a 'manual' to distinguish it from the pedal portion of the master or other keys such as stop-keys. A manual is subdivided into Left, Right and Centre master groups. The left master has its own group of 32 to 44 stops to control; the right master has another such group; the centre master operates the stops of left and right masters simultaneously. Usually one set of indicator dials and one speed pedal is associated with each manual. The group of stop-keys operated from a particular manual section take their name from that section; for example, "Manual I Left", "Manual I Right"; or for a second keyboard "Manual II Left", "Manual II Right".

Each manual has 36 coloured keys and 17 black keys. The former, which take the place of the normal white organ keys, are coloured alternately White, Red, Blue, and Green. The latter, arranged as three groups of five and two single keys, are similar to the sharps on an organ keyboard. They serve as landmarks, so to speak, enabling the various groups of keys to be easily picked out, and in addition perform the operations described under Items 16 and 20.

All 36 "coloured" keys have two distinctive touches: a first light touch of 2½ oz. causing the key to drop 5/16 inch, and a second heavy touch of 12 oz. causing a drop of a further 3/16 inch. These keys, unlike the stop keys, always return to the 'Off' position as soon as the fingers are removed.

The "coloured" keys in each of the three keyboard sections are as follows:-

1 to 4	(1st Touch. Blackout contactor	White, Red, Blue, Green
	(2nd Touch. Run Dimmer down to 'off' (in addition)	" " " "
5 to 8	(1st Touch. Run Dimmer up	White, Red, Blue, Green
	(2nd Touch. Run Dimmer down	" " " "
9 to 12	(1st Touch. Full on contactor	White, Red, Blue, Green
	(2nd Touch. Run Dimmer up (in addition)	" " " "

Once a Dimmer key reaches 2nd touch the corresponding Indicator dial reads from 10 to 0 instead of 0 to 10.

From this it can be seen dimmers can be moved up and down, short-circuited by contactors across them and blacked out by contactors in series with the dimmer. These movements to

affect such circuits as are "locked on" by the stop-keys. By depressing a white colour to first touch and a red the second, red circuits can be raised while white are lowered.

Much of the lighting, such as battens, footlights, cyclorama and stage plugs corresponds to the colour circuits of the keyboard; spotlights, acting area floods and other circuits usually described as "independents", do not fall so easily into colour groups. The practice with these latter is to allocate lanterns to different colour keys; for example, in a spot batten of 12 spots - Nos. 1, 5 and 9 are white; 2, 6 and 10 are red; 3, 7 and 11 are blue; 4, 8 and 12 are green. The colour filters in the spots can be set to suit the production required.

With a little forethought when setting the spots for a particular scene the operator can arrange that spots which on cue have to be raised simultaneously with the dimming of another set of spots, belong to different colour keys.

7. REVERSE

Sometimes, in spite of careful planning, spots of the same colour keys may have to be raised and lowered simultaneously For this purpose a special reverse toe piston is fitted which, if depressed at the same time as the stop-keys are selected, will cause the dimmers of these stops to move in the reverse direction to normal until the stop is put off, when it reverts to its usual action. This device is fitted to the master group controlling the spot batten and similar independent circuits not fed from dip plugs. Dimmers whose stop-keys are second touched while the foo is on the Reverse piston will travel in the opposite direction to normal. As soon as the stop-keys are put off, they revert to normal practice. Except for two toe pistons, no additional controls are needed at the console. One piston is for Reverse and the other, Reverse Sustainer to hold reversed stops when the second touch temporary cancel is used. (See also II, 6).

8. PEDALS (SPEED CONTROL) (Figs. 1 and 2)

There is one speed pedal to each keyboard, balanced to stay in any position to which it is put. The pedal gives a series of dimmer travel speeds 3 secs., 4½, 7, 10, 15, 25 and 40 secs. Slower speeds are easily obtained by inching at the slowest shaft speed, (using the motor stop toe piston: See III, 9).

The operation of these pedals is even simpler than a car accelerator, and lamp indicators immediately above the top keyboard give the position of the pedals without the need to look do

Usually there is one speed pedal to each manual, i.e., the manual left and right masters have to operate at the same speed. As most consoles have two manuals, generally one is allocated to the flooding circuits such as battens and cyclorama; the other to spots and acting areas. Where there is only one manual, then the left and right manual sections may be split over two speed pedals in certain instances.

9. INDICATOR DIALS.

Associated with each single speed pedal are sets of four dials mounted on a dashboard between stop sweeps and key-boards.

As already explained (in III, 5), when any stop-key is held to second touch a reading of the particular dimmer position is given, which can then be plotted in the usual way. At other times the dials automatically register the amount of movement applied to the dimmers in each colour group. For example, if Battens 1, 2, 3 and 4 are selected and the appropriate white key depressed to first touch, the dimmers will be raised and the dial will register successively 0 to 10, which is full on. It is thus possible to tell to what amount the dimmers are moved when, for one reason or another, (such as setting up in a blackout), the lights themselves cannot be seen.

Immediately the finger is removed from the key the dial returns to zero. The dial may be held at an intermediate position if desired by using a toe piston called "Motor Stop". Suppose the dimmers of several stops are to be brought up and some of these are to be left at intermediate intensities; the motor stop may be used at those points and the hands removed from the keys to unlock the required stops, then returned to the keys to continue movement beyond that point. The need to begin again at zero is thus obviated.

When the manual keys are pressed to second touch (i.e. to take dimmers down) the dial needles, provided they are at zero, swing over to 10 and travel downwards to zero instead of upwards to 10.

10. PILOT LAMPS (Fig. 2).

A low-voltage lamp can be fitted above each stop-key to repeat the state of the lighting on stage. Where the console is situated in the auditorium in such a position as to give the operator a good view of the stage, this device is unnecessary. On the other hand, with a side-of-the-stage

position, however good, scenery may partly obstruct the operator's view, and therefore the pilot lamps form a valuable guide as to what may be happening "round the corner". Dimmers and blackouts cause the pilot lamps to behave in the same way as the lighting they represent. Pilot lamps are coloured to correspon with the colour of their stop-key. A set of four similar lamps - white, red, blue, and green - burn at full intensity on the dashboard so that the state of check of the circuit pilots may b judged.

11. BLACKOUTS AND SUSTAINERS

By using the stop-keys in conjunction with the blackout keys on each manual, any combination of circuits can be blacked out while others remain on. Only those circuits whose stop-keys have been selected will black out.

The moment the fingers are removed from the blackout-ke or the stop-keys are put off, the lights are restored. A perma ent blackout can be obtained by pressing the manual blackout-ke to second touch, whereupon the dimmers are also run down to the "off" position. Alternatively, the blackout keys can, in effec be held depressed by putting the key Sustainer on. When this later put 'Off', the lights will be restored at their previous intensities.

If, however, under cover of a partial blackout the dimme are required to take up fresh positions, then the Contactor Sustainer is used. When this stop-key is on, any blackout contact ors once operated in the normal way by stop-keys and manuals are held out direct and will not return until the Contactor Sustaine is put off. This device frees the manual-keys and stop-keys fo other jobs, such as further partial blackouts, or for dimmer movement of the stops blacked out, or of other stops in that master group.

12. DEAD BLACKOUT (D.B.O.)

Although, by putting all stops on, coupling the manuals (See III, 15) and operating the blackout manual-keys a dead blackout may be obtained, a more direct method is required for such a common theatre cue. Therefore, a set of Dead Blackout (D.B.O.) stop-keys is provided - one to each manual division. Where there are more than four such divisions, they in their turn are mastered to a single stop-key. These stop-keys are placed in a prominent position and coloured yellow. When put 'On' the lights are blacked out irrespective of manual-key and stop-key position: their overriding power is absolute. They d

not, however, cancel any partial blackouts, etc., held by sustainers: these remain untouched. Thus a scene may open from a dead blackout to a partial blackout, which is later removed when the Contactor Sustainer is put off.

13. FULL ONS AND FLASHING

Flashing to blackout may take place on any group of stops "on" by flashing the manual blackout-keys to first touch without the key sustainers (See III, 11). Such flashing can be as rapid as desired: a mere lightning flicker or a rhythmic jazz beat. The intensity of the flash can be regulated simultaneously by working the dimmers up and down.

Flashing or switching full on suddenly can also take place even if the dimmer is 'Off', the Full On keys being used for this purpose. If such switching is required to be held, then either the keys can be depressed to second touch to run the dimmers up in parallel to the Full On contactors, or the key sustainer can be used to hold in the contactors after the fingers are removed from the manual. These contactors will then fall out when either the sustainer or the stops are put off.

Toe pistons duplicate the key sustainer stop-keys, since the foot often may be more convenient for short-term sustaining.

14. CALL

A single yellow stop-key may be provided to sustain a full-up combination of lighting suitable for the theatre in question. In a variety or revue theatre, this might bring in the white and red battens and footlight, also put the circle spots full on at the same time as removing their colour filters. When the key is put 'Off', the lighting reverts immediately to any effect set up previously or set up during the 'call'. Even in a straight theatre such a device may be useful, being set to give white battens or something of the sort between acts, or at rehearsals when more light than batten pilots is required.

15. COUPLERS

The fact that the centre set of manual-keys operates the left and right sets renders a coupler left to right unnecessary. The following couplers are therefore provided to a two-manual console:-

Man. II Left to Man. I Left
II Right " " I Right
II Right " " I Left
II Left " " I Right.

Where there are three or four manuals, the complement of couplers is somewhat different: separate couplers (e.g., II Left to I Left) are no longer required, since on a very large installation of 216 ways or more, families of equipment such as "spots" tend to occupy a whole manual rather than a manual division.
A set of couplers for a three-manual job would be:-

Man. I to II
III to II
III to I
Speed-pedals I and II to Pedal III.

A coupler is provided for the speed pedals in this instance. Two pedals (two-manual console) can be operated together by placing a foot over both: where there are three or more, a coupler is required.

Couplers are all-embracing: the coloured keys and colour filter black notes and even the sustainers being affected; thus if Manual II is coupled to Manual I, then any sustaining of the latter will affect the former. On the other hand, couplers only work in one direction; in the instance cited above playing on Manual I will operate both Manuals, but playing Manual II will have no effect on Manual I, nor would the former sustain (assuming Manual I Key sustainers are on) unless played from Manual I. This is very convenient: for example, it is possible to couple all manuals and carry out a general colour change using one hand while the other puts in (say) some rapid flashing over some of these circuits on the other manual.

When there are more than 88 stops, but not sufficient (above 132) to justify a second manual, the centre set of keys will be used as an independent manual master, instead of as a master set of keys working left and right divisions. In this case, couplers are fitted: "Left to Centre" and "Right to Centre".

In all sizes of Light Consoles no matter what other couplers are provided it is always possible to so couple the job that all lighting can be operated with one hand from a single manual division; for example, pressure on four adjacent keys only will, when coupled, operate all the dimmers.

16. PISTOL ACTION (Stop-key present and cancels) by Switchboard.

All stop-keys controlling lighting-stops (See 3) are fitted with pairs of electro-magnets to cause them to move "on" or "off". This does not apply to stop-keys outside this definition; for example, D.B.O's, Key Sustainers, Couplers, etc. The piston action is purely an aid to the movement of large numbers of stops "On" or "Off"; but, of course, such stops can always be operated by hand.

Under each manual keyboard are two sets of buttons known as "thumb" pistons; the left-hand set controlling the stops of the left-hand division, and the right-hand set those of the right-hand division. If any piston is pressed to second touch against a heavy spring, then the corresponding piston at the opposite end of the manual will be operated, in effect.

A series of miniature two-way and off switches are provided on a preset switchboard inside the back of the console desk. There is a complete set of these corresponding to each stop-key. Each set contains a switch for each piston; for example, seven pistons, two generals and a cancel would require 10 switches. General pistons affect all masters, i.e., all lighting stop-keys, simultaneously; the cancels are permanently set to "Off" and are operated by a black key to each master.

The number of pistons provided depends on the size of the job, but on an average there are 8 pistons per Manual Master, and two generals (duplicated by toe piston).

Using the preset switchboard any combinations of stops can be set to move on or off, and by putting switches in the centre position some stops can be set neutral and be unaffected by a piston.

Except where stops are set neutral, as just described, the effect of a piston is to substitute its combination of stops for these in use - it is subtractive. If the foot is placed on PISTON ADD toe piston while a piston is depressed then that combination will be added to those stops already on. REVERSE SUST., must be held down before and during PISTON ADD if "reversed" stops are not to be tripped.

The piston action, controlling as it does the stop-keys only, will not effect any change in the lighting unless either the black-out or full on manual keys are sustained. If this condition is fulfilled then switching or dimmer preset of the lighting is possible at the touch of one button; 10 such changes being possible.

17. PISTON ACTION BY AUTOMATIC PRESETTER RELAY.

An automatic relay can be fitted to function in the same way as the preset switchboard in 16 above, but without the operator having to leave his seat.

Pistons are set as follows:- First the stop-keys are placed in the positions required, and the master "Presetter" thumb piston is depressed and held, followed by the required piston; then both are released, the presetter last. Thereafter, whenever the piston is used the stops will take up that arrangement moving "on" and "off" as required.

A "neutral" setter toe piston, whereby some stops can be set to be out of action in regard to a piston is also provided. The uses of this device are less obvious than the normal setter but it is sometimes convenient to be able to make an addition to, rather than a substitution for, an existing formation of stops.

The stops required to remain neutral must be put down first followed by depression of the Neutral toe piston, Setter thumb piston and the manual piston required. These are released in the following order:- Neutral toe piston, manual piston and setter. This last need not be released until the setting of the remainder of the stops to move on and off is completed. Stops which have been set neutral must remain down while the ons and offs are being set.

For example, if the reds of a manual division are to be neutral, the whites and blues "off" and the greens "on", procedure in setting Piston No. 1., is as follows:-

Put down:	Red stop-keys.
Depress:	Neutral toe piston.
	Setter piston.
	Piston No. 1.
Release:	Neutral toe piston.
	Piston No. 1.
	Setter Piston.
Put down:	Green stop-keys.
Depress:	Setter piston.
	Piston No. 1.
Release:	Piston No. 1.
	Setter piston.
Depress:	Neutral setter piston again for a moment and release.
Put Off:	Red and Green Stops.

Subsequently, No. 1. piston will, when pressed move Green stop keys on, White and Blue off and have no effect on the Reds whether they are on or off.

Neutral setting is obviously more complicated than normal On and Off setting, but it is only required occasionally, most setting taking the normal form.

18. HOLD (substitute for Piston Action in Small Consoles)

Piston action is not provided in small Consoles because the fewer number of stops (up to 88) does not warrant the expenditure of two magnets per stop-key and the switchboard or presetter relay on which the combinations are set. Stop-keys are in themselves far easier to control than a similar series of switches, however small. The hand can be run over or under the keys of a department, thereby putting on, or cancelling, large numbers in one movement. A key can be flicked on with one finger while its neighbours are flicked off. Also, the stop-key second touch allows the operator to single out a dimmer for movement without the necessity of cancelling all the stops of that colour in the manual division. Nevertheless, there are occasions when an awkward change from one large combination of stops to another is required, and to overcome this the device 'HOLD' is used.

When the stop-key labelled 'HOLD' is "off", the stop-keys take effect normally. However, when 'HOLD' is "on", then the combination of stops selected at the moment is held at the relay for use. During this time a new combination may be set up on the stop-keys, but this will not take effect until 'HOLD' is put "off"; whereupon the held combination will immediately be replaced by the new one.

The absence of pairs of magnets to each stop-key effect considerable reduction in console weight, and in consequence the Console is easily carried by two men.

19. TOE PISTONS (Motor Stop, General Dim, D.B.O., etc.)

Large push-buttons, known as "toe pistons", are fitted, many of which merely duplicate thumb pistons and controls already described.

The usual complement of toe pistons includes:-

Motor stop (See III, 9)
Key Sustainers (See III, 11)
General Pistons (See III, 16)
Dim and General Dim (runs dimmers selected by stops down at first touch; and everything, selected or not, at second)
D.B.O. (Blacks out everything, selected or not, at first touch, and also runs all dimmers down at second)
"Setter" (for stop-key preset) (See 17).

When specified, there may be in addition Reverse and Reverse Sustainers (See III, 7); also Filter Change (See III, 20

20. COLOUR FILTER CHANGE

Where the lanterns of a lighting circuit (such as circle spots) are fitted with remote colour-change mechanism, whether solenoid-operated or motor-driven, the circuit stop-key connects this mechanism to the manual division. Each manual division has five black notes, which if depressed with a heavy, deep touch will set the circuit to bring in filters A, B, C, D (or a combination of these) or "no filter" in any lanterns of the circuits whose stop-keys are "on". The foot may simultaneously be placed on the filter change toe piston, whereupon the filters will move into the required position. This system has many advantages and actually enables the filters to be, so to speak, "played", and except for the sets of five black notes on the manuals requires no further switches. Elaborate changes of filters can be prepared in advance while there is a lull in other activities to be brought in later by a single foot pressur when the hands may be occupied with dimmer work.

For rapid work, the stop-key pistons are available, and in fact under this system all the stage lighting circuits could be fitted with remote colour change mechanism without inconvenience to the operator.

As the remote colour-change mechanism (motor type) at the lantern is not constantly rated, the foot should only be kept on the filter change piston just long enough to carry out one change at a time (4 to 10 secs.)

21. SAFETY DEVICES

It will be apparent that in many instances there are

various ways of carrying out a particular operation. Inevitably this may lead to a state of conflict, especially in the early stages of an operator's training. For instance, while the foot is on "general dim" running all the dimmers down, the hand may be on the manuals running all dimmers up. Or again, the full-on keys may be sustained at the same time as the blackout-keys or D.B.O. All such conflicts are provided for in the console mechanism and in each case a certain movement has priority. Thus, an operator trying to send all the dimmers up at the same time as sending them down, will find the latter action take precedence the motor will not stall, neither will the sprockets shear nor the chain-drive break.

.22. ACCESSORY LIGHTING CIRCUITS

House Lights: These may be operated from an orthodox motor-driven dimmer to work in the usual way from push-buttons in various situations, including the console. A cheaper alternative, often used on small Consoles, is to fit a clutch-driven dimmer on the console dimmer bank, which is then operated by a pair of stop-keys - "House Up", "House Down" - direct, without using the manuals. The dimmer can only be worked from the console, but the lights may be brought in by a short-circuiting contactor switched at various salient points.

Batten Pilots: These are best controlled from switches in the Prompt corner; supplementary switches are sometimes fitted at the console to dowse lights accidentally left on, and are known as "Down stage pilots off", "Up stage pilots off".

Independent Stage Dips: These serve two purposes: the first being the orthodox duty of feeding small loads such as decorative fittings; the second, to provide auxiliary points to which stage hands can connect their lanterns for testing and setting up, without resort to the console. Switches to blackout these points are provided in the console.

All the above accessory points should be so wired that they can remain live, even when the console is not switched on.

Where motor-driven optical effects, such as clouds, are included in the stage installation, provision can be made to control these from the console. Rotary selector switches are fitted in the jambs under the bottom row of stops. These switches operate relays in the dimmer room which cut out resistances inserted between the 165-volt D.C. supply (for shaft motors: see III, 28) and the cloud-effect motors. Five resistance steps are usually sufficient, and a supplementary rheostat should be mounted on each effect so that when several are in

parallel, their performance can be matched as far as fractional horse power D.C. motors permit.

23. "SPECIAL EFFECTS" CONNECTION

Where a "special effects" point is provided, it should be fitted with contactor blackout in a similar manner to the "independent dips". Attention is drawn to the need to allow a sufficient number of dimmer ways at the outset, even if these only exist at the console and as spaces on the dimmer bank. A theatre with variable requirements can be catered for by a manual division of (say) 40 1,500-watt plus or minus 1/3 dimmers (See III, 27) terminating in fly rail connectors; backed, perhaps, by 16 4-Kw. variable load transformers in addition to the usual stage dips. These will pay for themselves in increased efficiency at rehearsals and time saved.

24. MAIN CABLE (AND PLUG)

The remote console desk is connected to its dimmer bank by 100 ft. of multicore cable in a flexible metallic hose, usually of 1½" diameter. Lengths longer than this can be supplied if required. When alternative operating positions are required, a multiway plug is fitted. The flexible hose also contains the low-voltage D.C. mains to the console.

25. CONSOLE LIGHTS, PLOT DESK, etc.

Low-voltage festoon lamps are concealed over stop-keys, dials, pedals, and in the front edge of the plot desk. These lamps are fed independently of the D.C. supply in order to avoid voltage fluctuations when sudden heavy demands are made by the piston action. The transformer supplying these lamps is tapped so that they may be dimmed in dark scenes. A 5-amp., 3-pin A.C. point should be installed adjacent to each console position. This point provides a supply for an inspection lamp and soldering iron when installation, maintenance and cleaning are undertaken. The point would normally feed the console lights transformer.

(The console is constructed of polished birch, and a stool or bench is provided.)

26. LAYOUT OF DIMMER BANK AND ASSOCIATE GEAR.

The wiring from console desk terminates at the main relay in the dimmer room. To this relay is brought the principal positive supply from the 15-volt rectifier; the principal

negative supply goes to the dimmer bank. As far as possible the low-voltage negative is unbroken throughout the dimmer bank, no switches or fuses being inserted therein.

The main relay cross connects the electrical impulses received from the steps and manuals and at the same time provides the heavier current needed by the magnetic equipment on the dimmer bank. The relay is connected by multicore made-up cable to the dimmer bank and to the auxiliary relay in which the blackout contactors sustainer relays, reverse relays and colour filter relays are housed.

Both relays are provided with covers, and all low-voltage connections are brought to labelled test-boards where the individual pieces of apparatus have their internal connections soldered to the external cables. There are the following test-boards:-

A. inside the console desk
B. Main relay incoming
C. Main relay outgoing
D. on dimmer bank (one to each dimmer bank if not in one unit)
E. Auxiliary relay.

All low-voltage relay contacts are silver and all connections are soldered. All electro-magnets are shunted by condensers or wound with anti-spark windings.

27. DIMMER BANK (Figs. 3 and 4)

This may be erected in one unit or in several units in the same room, or even in different rooms. Generally it is preferable that the bank is not split below the number of dimmers controlled from one manual keyboard, approximately 72 (maximum possible is 88). In exceptional circumstances a manual division of roughly 36 (maximum 44) dimmers may be built separately. A dimmer bank for 72 dimmers of not more than 5 Kw per way is 15'0" x 3'6" deep x 7'2" high approximately. Access is required to front and back and at least one end.

A dimmer bank is usually arranged with four tiers of dimmers; each tier corresponding to one of the four colours - white, red, blue and green. All shafts are chain coupled together and driven by a geared motor unit in the centre of ample power to start when loaded with all dimmers at all speeds. Clearance is allowed so that the motor may be unbolted and removed from the bank for inspection.
The shafts are provided with self-aligning ball-bearings. The

III (Contd.)

motors are variable speed 165 volt D.C. units, giving a range from 3 seconds dimmer travel to 40 seconds. Mounted in the centre of the dimmer bank above the motors are the four "setter" units which are normally coupled to the indicator dials in the console, and which measure the amount of travel imparted to the dimmers of each colour shaft.

Dimmers are of the Type 'A' Element Sunset, with the resistance wire (nickel copper alloy) wound on formers for the lower wattages and the Type 'D' open coil for the larger wattages which use heavier gauges of wire. There are 100 contacts devoted to the resistance steps, the studs at the full on and blackout ends of travel being additional. Dimmers are constantly rated so that they may be left in intermediate positions for any length of time. Loads of over 5,760 watts (230 volt) require two or more dimmer units gauged together. Dimmers can be wound for a tolerance of plus or minus 1/3, which means, in fact, 1,000/2,000 watt or 2,000/4,000 watt, and so on.

Mounted on each dimmer is a small low-voltage rheostat which moves with the dimmer arm and always remains live. This rheostat is introduced into a Wheatstone bridge circuit and enables the position of any dimmer to be read on the indicator dials at the Console, whether the main dimmer is alive or not.

When pilot lamps are fitted, then each dimmer carries a small voltage transformer.

Dimmers are driven by pairs of magnetic clutches (Fig.3) Strand Electric Patent, to move "up" or "down" from the unidirectional shaft. Micro limit switches are fitted at each end of travel to cut out the clutch automatically.

The design of the clutch is such that a dimmer can always be moved by hand without the necessity of going to the console.

Mounted on the back of each dimmer (i.e. the end remote to the clutch and driving shaft) (Fig. 4) are pairs of contactors of a suitable size to control the load, magnetic blowouts being fitted for currents of over 20 amps. These contactors are normally open electrically closed and are wired in series with the dimmer and in parallel, the former being the blackout contactor and the latter the full on.

The contactors are carried on bakelite panels which also house the phase fuses; one to each dimmer in the case of single circuits; one to each dimmer and additional circuit fuses where there is more than one circuit to a dimmer. The dimmers and contactor switches are wired in the phase side as required

by the L.C.C. and I.E.E. regulations, the number of fuses being also determined by these regulations.

Fuses are of Dennis sliding type /or equivalent patterns, arranged to lock in position and which cannot therefore be shaken out by vibration.

Neutral links for all circuits are mounted together on a panel conveniently sited for the return wires, in a bus-bar chamber at the end of each dimmer bank. Here also are purmel connectors for all lighting circuits and the main terminals. All contractors H.T. connecting takes place in this chamber.

Variable load A.C. Transformer dimmers are not fitted as standard owing to their extra cost. The heat losses of a resistance dimmer are by no means great enough to justify the initial outlay which the more expensive auto-transformer dimmer requires. It is, however, recommended that some transformer dimmers should be installed where, as in the case of stage dip plugs, the variable load factor is important. An auto-transformer dimmer will dim to the same curve any load within its total rated capacity. Thus, 250 or 4,000 watts may be connected to a 4-Kw. transformer and the dimming curve will be the same.

The transformer dimmer fitted to the Light Console is a unit with a radial commutator wound for an output of 2 Kw, 4 Kw, or 6 Kw.

The clutch drives are compensated so that whatever type of resistance or transformer dimmer is used the result to the operator at the Console is the same, speeds and travel at the keys and indicator dials being identical.

Special arrangements are made for mounting contactors where transformers are used and these are mechanically interlocked to ensure that the winding will not be short-circuited by the full on contactor.

Low-voltage action wiring to clutches, limit switches, contactor coils and indicator rheostats is rigidly mounted on each dimmer frame and brought to a connector block at the clutch end. From these blocks a specially made-up cable runs to the dimmer bank test-board where all wires are labelled and where the various circuits can be provided with main for testing without going to console or relay.

Dimmers can be easily removed and replaced since their

wiring is tied out so that it cannot be reconnected wrongly. Dimmers are provided with coloured ivorine labels giving circuit (stop) name and wattage.

28. D.C. RECTIFIER

A three-phase selenium-type metal rectifier and transformer unit (Standard Telephone Company or equivalent) is supplied with a suitable output of 100 amps. or more, depending on the size of the installation, at 15-17 volts for the action: console, relays, clutches and contactor coils. A rectifier-only unit provides 165-volt D.C. for the shaft motors and also for any solenoid-type colour-change lanterns. Where the mains differ from 230-400, a transformer is supplied. The rectifiers should be wired direct through their own switch to the stage intake busbars.

29. DIMMER ROOMS

Should be well ventilated: on large installations an extract fan brought in by the main stage lighting switch is desirable. Care should be taken that the room is reasonably soundproof, the principal source of noise being the larger wattage contactors. No special treatment or soundproofing has been required in any installation yet.

A good washable paint to the walls and an anti-dust finish to the floor is advisable in order to reduce the amount of cleaning required. The door to the room must be kept locked to prevent unauthorized access.

30. TRAINING OF OPERATOR AND MAINTENANCE

The theatre's own operator may attend at our Works during the last two weeks of construction in order to gain an inside knowledge of the apparatus, its testing maintenance and operation. Our own operator attends during the first month the Console is actually working in the theatre, to operate the lighting and train the theatre's own operator.

Contracts for regular maintenance and cleaning of the apparatus, also to provide a deputy operator for holidays can be entered upon.

A complete set of wiring diagrams, together with a description of the way the various circuits work, how to work them and suggestions for maintenance and testing are supplied on completion of the installation.

IV. DESCRIPTION OF CONSOLE AND DIMMER BANK CIRCUITS AND THEIR MAINTENANCE

1. DRAWINGS

The following drawings and diagrams are required for study along with this section:-

Ref.	No. 1	General layout of apparatus in dimmer room.
"	Nos. 2A and B.	Dimmer bank.
"	No. 3	Main relay contact layout.
"	" 4	15-volt action circuits diagram.
"	" 5	Auxiliary relay layout.
"	" 6	Colour-change relay layout.
"	" 7	Dimmer terminal block (L.V.)
"	" 8	Presetter relay and piston circuits.

2. DIMMER BANK CIRCUITS AND APPARATUS (Drg. Nos. 2A and B)

From the console control point of view, the dimmer bank may be regarded as consisting of the following units:-

1. Motor drive and shafting.
2. Setter units (dummy dimmers to measure amount of drive)
3. Dimmer units with operating clutches, contactor switches, indicator resistance and perhaps pilot lamp transformer.

3. MOTOR & SPEED CONTROL.

The motor drive employs a 165-volt D.C. geared motor unit, the supply being obtained from a three-phase metal rectifier unit connected through a transformer; output about 20 amps.

The motor is a compound machine and regulation of speed is obtained by varying the voltage in the armature circuit. The voltage is obtained by switching the armature to various points on a potentiometer resistance connected across the mains. A set of six or seven contactors are fitted for this purpose, the contactors being electrically interlocked to prevent more than one being closed at a time. The control circuits from the console are shown in Drawing No. 4, centre top.

4. The motor control, relays, contactors, resistances and rectifier may be mounted as a separate unit away from the dimmer bank. The second contacts of the contactor relays are wired back to pilot lamps on the console to show which speed is in use

The rectifier can be switched on or off from the console to prevent wastage in the form of heat from the potentiometer resistances.

4. DRIVE SHAFTING, ETC.

The motor drives the Setter units and Dimmer units by means of chain coupled $1\frac{1}{4}$" shafting carried on self-aligning ball-bearings. The shafts are fitted with iron wheels opposite each unit to be driven, the operating arms of the units being connected electro-magnetically to these wheels. One motor drives one or two masters, i.e. between 32 and 44 dimmers, or between 64 and 88 dimmers.

5. SETTER UNIT.

There are four of these to each motor, that is one per colour. They are dummy dimmer frames driven in one direction only by a single electro-magnetic clutch. Movement of the setter arm operates two indicator resistances. At the top end of travel a limit switch (Burgess Micro Switch) is opened and a fixed resistance is inserted into the clutch circuit and permits it to slip but retain its position against the limit. The setter arm is weighted to return to zero when the clutch is switched off. An air cylinder shock-absorber is fitted to the arm.

As there are only single clutches to the setter units only two driving wheels are required, pairs of setters sharing wheels.

The setter is fitted with a 5-way terminal block to which the following connections are made (from left to right):-

1, 2 & 3.	Indicator resistance.
4.	Clutch positive.
5.	Clutch negative.

6. DIMMER UNIT.

This is a framework carrying either a tapped resistance or a tapped auto-transformer. In the former case the connection is made by means of a radial brush arm and a series of stud contacts; in the latter case by brush and commutator. Pairs of electro-magnetic clutches are used to connect the dimmer unit to its driving wheel; a reversed crank or inverted rack giving the reversal of motion from the uni-directional wheel. For loads of more than 5.76kW. two or more dimmers are ganged to operate together. For a pair of ganged dimmers it is

IV (Contd.)

sufficient to replace the counterweight at the top end of the clutch arm by another electro magnet, the gripping power of the clutch being doubled. For larger ganged dimmers (triple or quadruple) clutches are duplicated. The opposite end of the dimmer to the driving shafting is reserved for high-voltage lighting circuits, and on a panel carried from the dimmer unit frame is the dimmer fuse (and subfuses when size of load demands) to which the busbar connection is made; also the full on contactor and the blackout contactor, both normally open, electrically closed. The low-voltage wiring is brought to a terminal block at the shaft end of the dimmer unit. Each dimmer has mounted on it a down limit and an up limit (Burgess Micro switches); an indicator resistance, and sometimes a voltage transformer to reduce the full on mains volts to twenty-four for the pilot lamps. The moving clutch magnets are connected by tough rubber sheathed flexes.

The terminals on the dimmer unit connector blocks are as follows (Drawing No. 7):-

No. 1	Down clutch negative	No. 1	Up clutch negative
2	Down clutch positive	2	Up clutch positive
3) & 4)	Indicator resistance	3	Up limit switch
5	Up limit switch	4) & 5)	Indicator resistance
6	B.O. contactor	6	B.O. Contactor
7	Down limit switch	7	Contactor common (negative)
8	Contactor common(negative)	8	F.O. contactor
9	F.O. contactor	9	Down limit
10	Up clutch positive	10	Down clutch positive
11	Up clutch negative	11	Down clutch negative
		Above centre of panel:	
		12	Pilot common
		13	Lamp circuit.

The external connections from the dimmer unit run as a multi-way made up cable to Testboard D on the dimmer bank frame. Here the circuits will be grouped as vertical rows of staples, separate rows being allocated to Up clutch, Down clutch, F.O., B.O., etc.

Possible faults: These are mechanical and therefore easily revealed by inspection. Examine clutch flexes frequently to make sure insulation has not worn through rubbing on clutch wheel.

7. MAIN ACTION CIRCUITS FROM CONSOLE TO DIMMER BANK

The supply for these circuits is obtained from a 15-17 metal rectifier and three-phase transformer unit in the dimmer room. The principal positive supply is taken to the Console Desk, Main relay and Accessory relay. A negative supply is also needed in these units to supply the relay magnet return commons. The principal negative supply goes to the dimmer bank.

Thus the various relays are devoted to feeding positive to the individual magnets on the dimmer bank, these magnets being commoned to a busbar connected to the rectifier negative. With one or two small exceptions, all switching is in the positive, a fact which greatly simplifies testing and tracing circuits. Fuses are limited to a few positive mains, as except for major faults they are useless on a supply involving high current at such low voltage.

Possible faults: If one phase of the three-phase supply to the rectifier cuts out, then the D.C. volts on load will drop to about 10. It is possible still to operate the console but use of items demanding large additional current, such as the console preset pistons and cancels must be avoided.

8. CIRCUITS, CONSOLE TO MAIN RELAY (Drawing No. 4, bottom half)

The main relay consists of a unit for each master; thus on a single keyboard console with three masters there will be three units, or on a two keyboard with four masters there will be four units. The units are mounted on a frame and are arranged to swing out for access to the back. Both back and front covers are completely removable in one piece.

Each unit consists of a grid formed by rows of horizontal silver contact bars and vertical strips of bakelite, each carrying rows of contact wires as shown in Drawing No. 3. The bars and strip contact wires are arranged into four groups, one per colour - white, red, blue, and green.

9. STOP-BARS

The horizontal bars are fitted with magnets to lift them, but they are lifted insufficiently to complete circuit with the contact wires. The vertical strips can be pulled down by magnets, and when this is done the contact wires are released sufficiently to make contact with any horizontal bars which are lifted.

Putting down a stop-key to first touch makes a single contact and energizes the relay magnet and the horizontal stop-bar is raised. These bars are fed with positive by a spring contact at the left-hand end (facing them).

10. KEY STRIPS

The manual keys pull down the vertical contact strips from left to right; blackout contactors, full on contactors, up clutches and down clutches.

The manual keys of a master make one wire contact at first touch and an additional contact when pushed against the spring to second touch. This suits the second touch on the full on and blackout keys as the up clutches and down clutches are added respectively. Second touch on the dimmer keys has to disconnect the up clutches and connect the down. This is done by making the down clutch strip at this Main relay break a contact at the top which takes negative from a fixed bar and feeds it to the return side of the up clutch strip magnet. Thus, as the down clutch strip descends, the up clutch is automatically tripped.

11. DIAL CHANGE-OVER.

Each down clutch strip is fitted with an extra contact collecting positive from a fixed bar and feeding it to the coil of a change-over relay (one per colour) in the accessory relay. This relay normally feeds positive to the up resistance of the setter unit but when energised it feeds the down resistance instead. The change-over armatures of these relays receive their positive main from a normally made contact broken by descent of the Indicator strips as described below in IV 12 or from a normal closed relay which is opened by an open contact made by the Indicator Strip.

The wire contacts of the vertical strips are connected by a multiway made-up cable to rows of connection staples on Test-board C. Here they are labelled as Blackout (B.O.), Full On (F.O.), Up clutches (Up) and Down clutches (Down).

12. INDICATOR STRIPS

When a stop-key at the console is pushed to second touch the main is removed from the remaining stop-keys of that colour (described in IV 39 Second Touch temporary cancel. This means that only the bar of the stop-key depressed will at that moment be raised in the Main relay. The second touch contact

makes a magnet (wired in parallel with the cencel relay) which pulls down a strip containing contacts for the dimmer position "indicator" resistances, one of which will receive positive from the raised bar. The same strip breaks a contact on a fixed positive bar at the top feeding the indicator resistance of the Setter (See IV 5 & IV 11). All these wires appear as staples on Test-board C.

When there are two masters sharing the same set of four indicator dials (for example, in the case of Left and Right masters of one manual) the positive break passes through a pair of series contacts in a similar position on the right-hand master before feeding the Setter indicator resistance. Thus, whether the right hand or left hand Indicator strip descends, this circuit is broken.

13. SETTER CLUTCH

In addition to the normal up and down dimmer clutches, the up and down strips both have an extra contact receiving positive from a fixed bar at the top of the Main relay. These contacts are wired in parallel and supply the single clutch coil of the Setter of that colour on the dimmer bank. Where two masters share the same four setters there will be four contacts (two up strips and two down to each colour) in parallel.

14. KEY SUSTAINER BAR

An additional moving bar is fitted to every master unit of this Main relay, operated by the stop-key "Key Sustainer". When this bar is raised, the magnets of the strips just described receive current from a contact made as their strips descend; the magnets are therefore sustained, after the manual-key contacts are broken, until the "Key Sustainer" is put off and its bar lowered.

15. COUPLER

On Left and Right master units, which are coupled by playing on the Centre Manual-keys, these latter keys merely carry two sets of contacts - two at first touch, two at second. However, when one keyboard is coupled to another, or when a manual operates its own set of stops on each of its three masters, then coupler mechanism is fitted.

This takes the form of extra bars fitted on the masters to which the others are coupled. When the coupler stop-key is put down the bar is raised and any key strip which is

operated will make a contact to this bar and feed positive thereby to the corresponding strip magnet of the other master unit.

16. REVERSE STRIPS

When Reverse is fitted, there are five extra strips - one fixed and four moving - wired in parallel with the Indicator strips, i.e. to operate by stop-key second touch. The negatives of the reverse strips are fed from a multi-contact block in the Accessory relay energized by the Reverse toe piston (See IV 25), and the coils energised by positive from contacts in the indicat. strips.

17. COLOUR FILTER STRIPS

On masters where the five colour filter change black keys are practical, there are five extra strips each fitted with a set of contacts for each bar whose lantern has, or will have, the necessary mechanism. The black keys only make one contact each and have only one touch, but to prevent accidental contact it is made as deep and heavy as a normal second touch key contact. Each key operates one strip.

18. HOLD STRIP

When the single preset for stop-keys known as 'Hold' is fitted, then there will be an extra strip to each master unit, brought down by the stop-key labelled 'Hold'. This strip connects the positive of bars which are raised to their own magnets which are then held. The strip also breaks a contact on the top fixed negative bar and makes another. This latter feeds a multi-contact block magnet in the console, the block closes and supplies positive to the four cancel blocks (See IV 39.,) of that master. Thus the stop-keys are deprived of their main after their bar coils are sustained. The stop-keys can now be rearranged, but this will not take effect until 'Hold' is released. The breaking negative contact is commoned to the four indicator strips. Therefore while 'Hold' is on, the fact that the cancel blocks, and therefore the indicator strip magnets are positively energized will have no effect since the latter are deprived of their negative. This circuit is essential to ensure that the Setter dial will not be tripped and instead several indicator resistances receive positive at once.

19. TEST-BOARD. A and B

These form the outgoing connection board from the console (A) and the incoming board for the Main relay (B). All

wires from or to the console are to be found on both these boards which are identical in layout. Even circuits such as the motor speeds which bypass the Main relay are to be found on these boards.

20. TEST-BOARD C

This is the outgoing board for the Main relay and all circuits for the dimmer bank direct or for the Accessory relay or for the Automatic filter change are to be found here. Circuits such as motor speeds which bypass the Main relay will be found on this board, a loop cable having been formed for them between test-boards B and C.

21. POSSIBLE FAULTS (in 8 to 20)

A. Dirty contact anywhere in the circuit due to lack of use. These can usually be cleaned by working the stops and keys a few times. To obtain better cleaning at the Main relay, it is better to raise the horizontal bar and pull down the vertical strip together. Therefore the stop-key and the manual-key of the defective circuit should be rocked simultaneously.

B. Incorrect travel of vertical strips of Main relay preventing either breaking or making of circuits. This may be remedied by adjusting the wooden stop-rail at the top of the relay against which the strip return springs strike when the strip magnets are energized. Two wood screws are provided for this purpose.

C. Distortion of individual contact wires may take place due to causes such as overload in F below. This either prevents a contact making or prevents it breaking.

D. The spring contact feeding the stop-bars with main may be making a bad contact with the bar.

E. When the silver stop-bars are so pitted (the fact that they are positive ensures that they take up the spark that the wire contacts make only poorly, the bars of one colour should be exchanged with those of another colour. This is unlikely to be necessary in less than 3 to 5 years, if then. By careful swopping and reversal of bars eight changes of surface are possible.

The bars are sprung into position and can therefore be easily removed, but make sure 15-volt main is off.

F. The clutch and contactor magnet coils are shunted by condensers to reduce the spark. If a defective condenser is giving an open circuit or a short circuit, a heavy spark will be produced, and in the latter case the contact wire may burn off completely. The relay should be examined, working occasionally to ensure that all contacts are breaking with "snap" sparks.

22. CIRCUITS MAIN RELAY DIRECT TO DIMMER BANK

From the Main relay outgoing test-board (Testboard C) circuits run as a multi-way made-up cable to the dimmer bank test-board (Test-board D on the dimmer bank) and thence to the apparatus concerned. For example, the Full On contactor wirin leaves the contacts of the full on strip and appears as a row o staples on Testboard C, then on D, and finally is connected to the F.O. terminals on each dimmer unit connection panel.

The Blackout contactors are not connected direct to the test-board D, but must pass through the Auxiliary relay bank. This relay bank has only one test-board E, but there are ingoin and outgoing staples thereon.

Up and down clutches will also pass through this relay bank if Reverse is fitted.

The Auxiliary relay bank consists of a number of horizo tal wooden bars to which multi-contact relays are fixed. Acces is from back and front. The relays have various contact arrangements and the layout is as Drawing No. 5. This relay assembly is often mounted on the end of each dimmer bank. In this case there is no test-board E, the staples of that board being added to the Testboard D. on each Bank.

23. BLACKOUT AND BLACKOUT SUSTAINER

The positive fed by the contacts of the blackout strip in the Main relay must have a relay interposed to convert the normally open contactors on the dimmer bank to normally closed. Each dimmer circuit has a supplementary relay which, when de-energized, feeds positive main through its contacts to the blackout contactors on the dimmer bank. The positive main to these relays is fed through a normally closed electrically opened contactor, the coil of which is fed by the Dead Blackout stop-key for that Master at the console. Putting down the

D.B.O. stop-key thus deprives the blackout contactors of main and they fall out irrespective of the position of their relays.

A dead blackout for all masters is provided by a toe piston feeding positive to the magnet of a multi-contact block which, in turn, is connected to each of the Master D.B.O. contactor coils.

When the blackout strip is pulled down in the Main rela any stop bars which are up will feed positive to their blackout relay coils. This will open the contacts feeding those blackout contactors, and the result is a partial blackout. As the relays open, they make a sustainer contact and may be sustained out provided the sustainers are fed from the multi-contact block closed by the "B.O. sustainer" stop-key at the console. There is one of these blocks to each master, i.e. t each 32 to 44 dimmer ways.

24. GENERAL DIM

A Multi-contact block (or blocks) is provided to feed positive directly to the down clutches on the dimmer bank. Its magnet is energized by the second touch on the D.B.O. toe piston and second touch on the Dim toe piston. First touch on this latter piston closes a multi-contact block which feeds all the Down clutch strips in the main relay. First touch on this piston thus takes down all dimmers whose stops are down and second touch all dimmers whether stops are down or not. Tho piston also works a negative relay to trip any Reverse relays held in.

25. "REVERSE" CHANGE-OVER RELAYS

On Masters fitted with this device the Up and Down clutch wires do not run direct from the Main relay strips to th dimmer bank; they have to pass through the Auxiliary relay.

Each dimmer circuit has a double pole change-over contact block. When the coils of these blocks are energized, the connections from Up and Down main relay strips are reversed, th Up going to the Down and the Down to the Up. A sustainer contact is also closed when the contact block is closed.

Electrical procedure is as follows:- Reverse toe pistor is closed and negative main closes the multi-contact block (centre of Drawing No. 4). This feeds negative main to th Reverse strip magnet in the Main relay and also to close a bloc feeding positive sustainer main to the Reverse relays. Any stop-bar which is up makes no impression on these relays, but

any stop-key which is second touched while the Reverse piston is held will cause the other stop-bars to drop (via temporary cancel block in console) and at the same time feed positive to the Reverse strip. This strip now descends and the Reverse relay corresponding to the stop second touched will go in and become sustained both by the fixed strip contact and by the sustainer multi-contact block. This latter provides that if another stop is second touched to reverse it, it will not trip out the first one due to its bar having descended during the temporary cancel. Once the Reverse toe piston is released, the reverse relays are held through the fixed contact strip and will therefore trip when the stop-key is put off.

This trip may be undesirable when second touching to get a dimmer position indication and therefore the sustainer block must be brought in when doing this by using the "Reverse Sustainer" toe piston.

.26. POSSIBLE FAULTS (in 22 to 25)

A. Dirty contacts. Clean by working, but adopt the following special procedure for Reverse:- Set meter at 40 secs., hold manual dimmer-key to first touch. Then flick stop-key several times from Off to second touch, each time depress Reverse toe piston. Repeat with dimmer manual-key at second touch. The point being that it is essential for the dimmer to be in motion for the cleaning action to be effective.

B. Contact distortion in the double pole change-over blocks for reverse, check if cleaning fails to cure fault.

C. All relays in the auxiliary bank are mounted on wooden bars which may shrink and cause an occasional relay to become loose.

D. General dim relays should be inspected from time to time to make sure that when the armature is raised it is clear of all the contact wires.

.27. COLOUR FILTER CHANGE

The relays for this are mounted with their 165-volt rectifier as a separate bank. The 15-volt test-board is known as Test-board F (Filter).

The colour change mechanisms on the lanterns are always grouped the same way as the dimmers. Lanterns with a single dimmer to each will have separate control to each filter change

mechanism. Lanterns bunched three to a single dimmer will hav their filter mechanisms similarly bunched.

There are two types of filter-change mechanism (direct solenoid and motor with solenoid-operated selection gearing). In each system the relays are arranged to give the console oper tor the same effect - immediate or delayed action.

28. RELAY CIRCUITS FOR MOTOR TYPE

There is a set of five relays which corresponds to the stop-bar in the Main relay. Four of these are 5-amp. relays closing a single 165-volt D.C. circuit to the gear selection coils in the remote lantern. The four relays also have a 15-volt sustainer contact fed from the fifth relay, a normally closed multi-contact block.

The coils of the 5-amp. relays run to the four-colour strip contacts in the Main relay and the fifth block is energized by the Filter cancel strip in the Main relay. Thus relays whose stop-bars are up will receive positive main when the black keys at the console are depressed, by bringing down the corresponding strips. This main will send in the correspondi colour relay or relays which is then held until tripped by the cancel strip and block. When the filter change toe piston is depressed, a contactor feeding 230 volts A.C. to the motors and 165 volts D.C. to the selector coils is closed, thereby starting the motors and energizing the selected coils thus carrying in or out the filters whose gears have been pre-set in the way described.

29. RELAY CIRCUITS FOR SOLENOID TYPE

This mechanism has been supplanted by the motor type, but where lanterns of the old type exist they are controlled as follows:-

To each stop bar there are four 5-amp. relays feeding 165-volt D.C. to the four solenoid coils of each lantern. These relays are also fitted with sustainer contacts supplied from a normally closed multi-contact block. Corresponding wi these 5-amp. relays are four preset wire type - normally open relays each feeding 15-volt positive main via a normally open coupler switch to the coils of the former relays. The preset relays also have sustainer contacts fed from a normally closed multi-contact block.

When the colour change strips at the Main relay are

pulled down, positive main is fed from any bars that are up to the preset relays which go in and are sustained. Depression of the Filter change toe piston closes the coupler switch and feeding the 5-amp. relays with positive main in the new preset combination, at the same time the sustainer block feeding these relays is opened, thus tripping any relays not included in the new combination.

The toe piston released, the sustainer comes on once more and the coupler is opened.

We are now free to trip any preset relay using the cancel strip and prepare a fresh combination.

30. POSSIBLE FAULTS (in 27 to 29)

1. The mechanism in the lantern and the leads between it and the relay bank should be suspected first. Particularly as the gear engaging solenoid and motor are not constantly rated they may be suffering from temporary overheating through the foot having been kept on the change toe piston too long.

2. Dirty contacts on the wire-type relays in the Colour change bank, particularly in the circuit for Solenoid-type lanterns where there is a coupler switch and the sustainer blocks affect all the individual circuit relays.

31. DIMMER POSITION INDICATION CIRCUITS

These are fed from a separate metal rectifier and transformer in order that the voltmeter dials will remain unaffected by the violent fluctuations of demand on the principal 15-volt supply. The transformer is tapped to give various outputs from the rectifier of round about 20 volts to suit the installation.

Every dimmer unit and setter unit is fitted with an identical variable resistance operated as the clutch arm moves. Each of these resistances can be inserted in a leg of a wheatstone bridge circuit and the amount of deflection of the volt meter dial gives the position of the clutch and dimmer arm. No deflection being 0% or off and full deflection 10, i.e. 100% full travel.

There are four bridges, one per colour, with four dials to each master. Two masters may share dials, but three or four masters will require a second set of bridges and dials.

The bridge is formed on one side by a fixed 100-ohm

resistance, and a variable 100 ohm; on the other side, a variable 50 ohm and the variable resistances to be measured, each of which is 48 ohm maximum (see centre of Drawing 4). The variable resistances are of the screwdriver adjustment type and can be set to give the correct deflection of the console dials. This apparatus is mounted under the Main relay and must be left as set.

The positive side of the bridge system is commoned onto the main positive 15 volt supply so that when a stop-bar is raised it can supply 15 volt to clutches, blackouts, etc., or 20 volts to the indicator resistances.

As already explained (under 'INDICATOR STRIPS'), the indicator strip normally connects indicator positive to the setter resistance, but when pulled down by 2nd touch temporary cancel this is broken and indicator positive is fed to the dimmer indicator resistance whose bar is up. The other side of all the resistances of that colour and master are commoned at the dimmer bank and connected to the appropriate voltmeter dial at the console. The negative side of the bridge is, of course, quite separate from the main 15 volt negative.

32. POSSIBLE FAULTS (in 31).

a. The principal fault indication is either a deflection left of zero in normal working, i.e., when the setter resistance is in circuit; or a similar deflection when a stop-key is depressed to second touch.
The cure is contact cleaning by working; in the case of an individual circuit by second touching its stop-key, and in the case of the setter by second touching any stop-key.

b. Working may not be sufficient, due to small current at contacts, and resort must be made to bar-cleaning at the Main relay (See IV 21E).

c. Violet disturbance of needle during travel means trouble on the resistance or its brush, and inspection at the dimmer unit will indicate the reason.

d. Incorrect travel of indicator-needle will be the result of unauthorized tampering with the main bridge resistances. This is likely to be the result of duster-and-broom cleaning.

33. PILOT LAMP CIRCUITS

These pilot lamps are not the normal ones used to indicate dimmer speed and other odds and ends, but a special group sometimes fitted to repeat the state of the lighting in that dimmer circuit.

The circuit is shown in Drawing C.1493. A small voltage transformer is fitted to each dimmer, and the full line voltage is reduced thereby to 20 volts. The transformer is double wound and one side of the secondary is connected to the main 15-volt D.C. negative. The other side is run via testboards D, C, B and A to 20-volt (2 watt) telephone indicator lamps in the console. The other side of the lamps is connected to the console negative busbar.

34. CONSOLE CIRCUITS FOR RESET MOVEMENT OF STOP-KEYS

This mechanism takes two forms. In both cases the stop-key levers which lock lighting circuits to the masters are formed as a soft iron armature and two electro-magnets fitted to pull the lever down to the "on" position or up to the "off" position.

35. STOP-KEY PRESET BY SWITCHBOARD

In the Switchboard System (See III, 16), the on and off coils for each stop are wired to two miniature busbars mounted on a plywood panel. For a 36-way master there will be 72 busbars on the panel. At right angles to the busbars run rows of 2-way and off switches, one row to each preset piston and one extra for the cancel (black key). The switches in each row obtain negative main from a multi-contact block which is closed on depression of its piston (push) in the keyslip under the manual-keys. The piston feeds positive to the contact block magnet. When the piston is not depressed there is neither main on that row of switches nor are the switches connected together. The switches in each row can now be set by hand - "on", "off" or "neutral" (neither magnet energized), and when a particular piston is depressed the stop-key arms will spring "on" and "off" as preset. In the cancel row all switches are set at "off".

The "On" magnets at the Stop-keys are permanently connected to the positive main, but the "Off" magnets are connected to the positive main via the stop-keys own switch contact. This then acts as a limit switch and ensures that only magnets of stop-keys which are On are energized to pull Off. This arrangement greatly reduces the current demanded by cancel pistons

which are of necessity set for all stop magnets. It also helps off any sluggish stop-keys, since once the quick ones are moved Off there will be less voltage drop on the mains in the main cable.

General pistons are similar to the manual master pistons except that a multi-contact block in each master group is wired to one piston. Sometimes, as with Left and Right masters of the same manual, pistons make a second contact on heavy second touch; this contact is wired to the corresponding piston at the opposite end of the manual keyboard.

Black note cancel-keys have a single heavy, deep touch equivalent to normal key second touch in order to prevent accidental use. (See also Second Touch Temporary Cancel IV 39).

The Preset switchboard and its multi-contact relays are usually placed inside the back of the console, but can be situated in a separate cabinet if access would be difficult.

Possible faults: (See IV, 38)

.36. STOP-KEY PRESET BY AUTOMATIC RELAY (Drawing No. 8.).

The mechanism for this purpose is situated partly in the Console desk itself and partly in the cabinet adjacent thereto. The 15-volt supply is obtained from the busbars inside the console which are fed from the 15-volt rectifier in the dimmer room.

The Presetter relay is in four groups on a frame, one to each Manual division, and is hinged for access back and front. The main feature is a grid of horizontal and vertical strips, each strip being moved "on" by a magnet and returned by a spring. The horizontal strips are one for each stop-key and run alternately White, Red, Blue, Green, from the bottom in the same order as the console left to right. Each strip consists of two contact bars riveted together, but insulated from one another. In each strip are 11 groups of three notches. The notches are in the front bar, the back bar and the insulating material respectively. The front bar is connected via a spring to the "On" coil of that stop-key in the console and the back bar to the "Off" coil. The eleven sets of notches corresponds to the 10 pistons and the Cancel for that Manual division.

Negative main is fed from a wire contact which may spring into any one of the three notches. All the wire contacts for one piston are pulled down by a bakelite strip operated by a magnet below. There are ten of these strips with magnets and one fixed (for the cancel).

IV (Contd.)

The horizontal bars can be pulled over to the left in two degrees by their magnets:firstly,as far as the neutral latch, or secondly when the neutral latch is drawn - right over.

The purpose of this grid mechanism is to capture the piston wire contacts in one of the three notches, thereby feeding negative to the "On" coil or "Off" coil of the stop-key or in the insulated notch to no coil at all, leaving the stop-key unaffected. The other end of the wire contacts are brought down on a series of fixed negative bars on the back of the relay; these contacts being pulled down to make by one of eleven magnets.

The procedure is as follows:- Each stop-key feeds positive not only to the main relay in the dimmer room, but also to its horizontal bar magnet in the Setter relay; this latter has no effect until the circuit is completed by a multi-contact block which is closed by depressing the Setter thumb piston, thus feeding the necessary negative to the magnets.

At this point the horizontal setter bars of all stop-keys which are "on" at the console are moved over to the left. If a piston is depressed, then positive will be fed to its pair of magnets operating the front and back contact wire vertical strips. Only the front magnet will operate because the setter has deprived the rear magnets of their negative by opening the normally closed block and has closed the open one to give negative to the front magnets.

The wire contacts are pulled free of their notches, and when the piston is released the wires will spring into the "on" notches in these bars whose stop-keys being "on" have been pulled over to the Left.

After the Setter piston is released the horizontal bars will spring back to the right without dislodging the wires captured in the On notches.

Subsequent depression of the piston without the Setter piston will bring down the rear vertical contact wire strips and feed negative to the front wire contact and thence via the "On" or "Off" notch to the Stop-key On and Off magnets.

The cancel has no front magnet, the wire contacts being permanently captured by the Off notches.

If the Neutral too piston is depressed, the neutral latch at the left end of the Setter relay is pulled clear and the Horizontal bars allowed to travel further over when the Setter

is pressed, the contact wires being captured by the insulated notch.

37. STOP KEY MAGNET COMMONS

The On magnets at the stop-keys are permanently connected to the positive main, but the "Off" magnets are connected to the positive via the stop-keys own switch contact. This then acts as a limit switch and ensures that only magnets of stop-keys which are On are energized to pull off. This arrangement greatly reduces the current demanded by cancel pistons which of necessity are set for all stop magnets. It also helps off any sluggish stop-keys, since once the quick ones are moved Off there will be a less voltage drop on the mains in the main cable.

The two General pistons are similar to the others except that the four pairs of strips (a pair in each manual division) are paralleled to one piston. The General Cancel operates a four-way block, which in turn feeds each of cancel strips as this is necessary to avoid a running between one divisional cancel (black note) and another.

38. POSSIBLE FAULTS (in 34 to 38)

A. Dirty contacts, usually through lack of use. Working the key or piston several times will often enable the various rubbing contacts in the circuits to clean themselves. The dirty contacts may not only be in the direct piston circuit, but may be in the second touch temporary cancel blocks, some of the stop-keys being deprived of positive common main thereby. (See IV, 39).

To clean or adjust a dirty piston contact it may be necessary to remove the piston push unit. The units are held in circular holes in the key slip (the rail under the keys). The circular bakelite barrel of the push is gripped by a wood screw which passes vertically through the rail. Before the piston can be removed the screw must be taken right out. To do this, the two manual-keys above the piston are lifted (by unlatching their springs and lifting the forward end of the key gently up and towards the seated operator) and then the felt is turned back from the rail and the screw head revealed.

In pulling a released piston out of its hole gentle methods must be used, otherwise the piston will come suddenly and pull the wires off the back. Sufficient

wire is left to allow of the piston being lifted clear and seen working.

B. Sluggish movement at the Stop-key is often the result of the pivot screws for the Stop-key armature becoming too loose or too tight. Alternatively, the contact on the back of the Stop-key may be breaking too early to allow the Off coil a chance to pull the armature off.

C. A wire contact in the Setter relay will sometimes be captured between two notches through operating the Setter piston erratically. This can only be freed by gently pushing the contact clear with the finger.

39. SECOND TOUCH TEMPORARY CANCEL

This does not move the Stop-keys and acts by opening the normally closed multi-contact block feeding positive to the stop-keys of that colour in that Manual division. The depressed stop-key continues to receive main because at second touch not only is the contact feeding the block magnet made but also connection to an independent positive supply. When the stop-key is no longer depressed to second touch, the main block closes again. It follows from this that if a piston is operated while a stop-key is held to second touch the others of that divisional colour group will be unable to respond as the necessary positive main to complete the circuit will have been removed.

PISTON ADD opens all these cancels thereby preventing the "off" coils working. It also makes relays in the Auxiliary relay to feed positive to the setter indicator resistances.

40. "HOLD".

One preset substitute for Stop-key Preset (See 18)

41. GENERAL CLEANING AND MAINTENANCE

Dimmer bank: This should be kept clean, as indeed any piece of electrical machinery should. The actual dimmer units will require a blower, and the rectifier cooling vanes will also benefit from this treatment to clear the dust.

The clutch arms must be oiled with lubricating oil through the holes provided every month.

The clutch wheels must be cleaned and fine powdered graphite rubbed in with a rag every six months or when necessary; i.e. when the dimmer bank becomes rather squeaky as the motor turns the shaft over. Or when dimmer or setter clutches tend

to stick to their wheels as if energized.

Examine shaft bearings every 6 months for signs of grease leakage, and if necessary remove caps and re-grease.

Grease chain drive every six months, and oil jockey sprockets every week.

Test motor-oil level every six months.

Low Voltage Action Relays, etc.

Don't oil anywhere, and cleaning should be by working the parts supplemented by vacuum removal of dust from the main settling surfaces.

Don't leave console and relay covers off, and don't clean with rag and brush.

Don't use interior of console or relay cabinets as a store for spare parts, odd screws, small tools, etc., as these have a way of travelling across contacts, busbars, and other places likely to cause trouble. It is recommended that these various closed cabinets are examined periodically for vermin. Rats have been known to nest in a noisy organ console, so why not in a cosy, silent Light Console?

IMPORTANT. WHEN A LAMP WILL NOT LIGHT OR FLICKERS, ALWAYS SUSPECT AND EXAMINE THE HIGH VOLTAGE CIRCUITS FIRST. THE LAMP MAY BE DEFECTIVE OR LOOSE IN ITS HOLDER: THE FUSE MAY HAVE BLOWN OR BE MAKING BAD CONTACT IN ITS HOLDER.