'Q-File'—A Unique Electronic System for the Control of Stage and Studio Lighting

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This paper describes a new concept in stage and studio lighting control in which computer type techniques permit the most complex lighting effects to be achieved with the minimum of operator effort. Lighting plots including dimmer settings memorised during rehearsal can be recalled for use at rates as high as 2 cues per second. Any combinations of plots can be instantly added or subtracted either on the basis of a 'cut' or an automatic crossfade variable between 1 second and 1 hour with complete independence of fade up and fade down. Short term fades can take place during and independently of long duration fades. Full override facilities allow instant manual control of any dimmer at all times.

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THE name 'Q-File' was chosen as a title which, with some phonetic licence, expresses concisely the basic function of this equipment. This function is to file or memorize beforehand, the many lighting changes or cues which can occur during a stage or television studio production. Ideally, it should be possible during rehearsal to plan all states of lighting and their manner of change and subsequently to recall these changes by a single GO button operation manually synchronized with the action. The 'Q-File' system closely approaches this ideal but retains sufficient flexibility to enable the operator easily to accommodate the inevitable variations which occur 'on the night' during a live production.

The necessity for this computer type approach to lighting control is particularly evident in television studios where the rapid turn around of rehearsals and productions demands the maximum expediency in planning the lighting of shows. It is also attractive in the case of theatres presenting ballet and opera with complex lighting effects, and also where repertory productions involve night-by-night change of programme.

In television applications, the more exacting lighting demanded by colour television provides further justification for the use of modern electronic technology.

Briefly, the 'Q-File' system enables the brightness level of up to 390 dimmer controlled lighting circuits to be memorized instantly at any time in one of 100 electronic files. These files may be selected sequentially or in random order. Thus, the use of all the files will provide the choice of 100 independent lighting patterns or plots, each of which can utilize some or all of hundreds of lighting channels. These channels may be at the same or different brightness levels. Any filed plot can be brought into operation instantly and any number of files can be added to or subtracted from each other with equal ease to form additional composite plots.

The use of new or additional file information can take place as a rapid switch action i.e., a cut; or as a crossfade which, when initiated by a push-button, will proceed automatically in a time which can be adjusted between 1 second and 1 hour.

This basic function is augmented by many special facilities, the use of which gives full scope to the imagination of the lighting designer. For example, in a crossfade, the fade-up and fade-down time of lighting channels can be adjusted independently and the two fade processes can be started separately. A second operation of a start-button will interrupt the corresponding fade which can be restarted when required.

It is of interest to note that the time required to complete a fade is the same for all channels, irrespective of their starting and finishing levels.

An important feature of this equipment is that once a fade has been initiated, it proceeds automatically, leaving the operator free to introduce other lighting effects. He can for example bring in other lighting channels not included in the fade. A typical practical case is an indoor scene lit by fading daylight seen through a window. The intensity and colour of the simulated daylight changes slowly as an automatic crossfade, and at an appropriate moment an actor enters and switches on a practical light, e.g. a standard lamp. This lamp, with its associated backing or fill lights, is brought into operation by one button which adds in a file containing the necessary information. This addition is not affected by the fade process, which still continues to run.

Alternatively, in a different application, new file information can be added in as a continuation of the fade. For example, a night to dawn transition can be culminated by a realistic impression of sunrise as a later and overlapping stage of fade. Separate fade up and fade down meters indicate the percentage completion of a fade at any time and enable the introduction of special effects to be correctly related to the main lighting level.

Even those channels involved in a fade can be instantly removed from the fade process and placed under manual control. For example, an incorrectly positioned lamp can be manually faded out without affecting the other lights which are subject to the automatic fade.

Because of the independent fade facilities and the ability to add and subtract any number of individual files, the effective memory capacity for lighting cues is well in excess of one hundred. Also, although a hundred files has been adopted as standard, there is no reason why this number should not be increased if this is felt to be necessary.

Principle of Operation

Fig. 1 shows in block form the main functional elements of the system. The centre block, labelled 'files', represents the permanent record of information. The

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blocks on either side represent temporary or holding stores whose information can be copied into or out of the files.

These stores are named as the output and preset store respectively. The information in the output store directly controls the state of the dimmers and therefore determines the actual lighting situation. The preset store does not normally have direct control of the dimmers but provides a number of functions which will be explained later.

To set up a lighting pattern, the channel selector is addressed to the output store and information regarding the choice of lights and their brightness levels, is fed into this store. Since this information controls the dimmers, its effect is immediately apparent as a pattern of lighting. This may be permanently recorded at any time simply by selecting one of the hundred files and pressing the ' File ' button.

The selection of a channel illuminates an appropriately numbered window in a mimic diagram, and the brightness of this illumination varies with that of the corresponding lighting circuit. An accurate indication of the selected level is provided by a meter.

Once its information has been filed, the output store

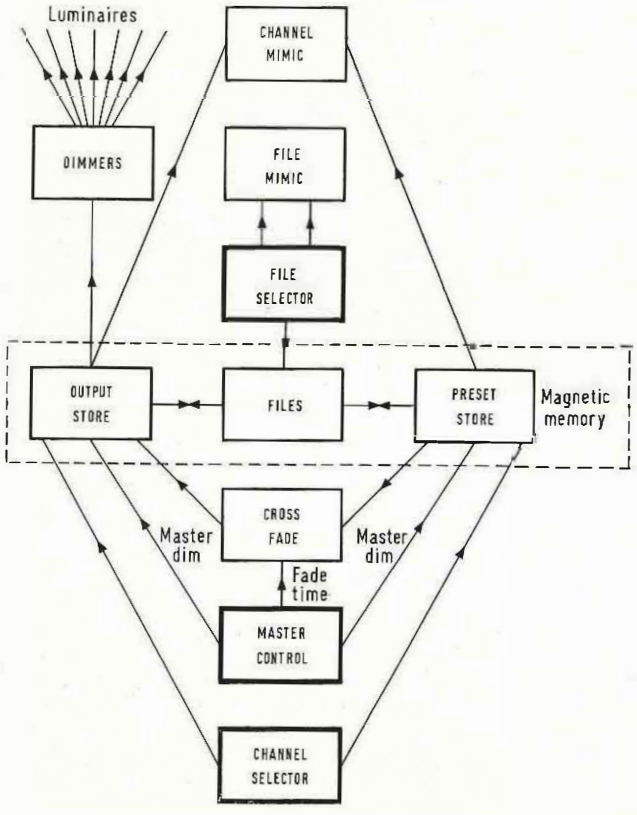


Fig. 1. Lighting control system

can be reset to zero and a new plot developed and filed. Alternatively, it may be advantageous to file variations of the original plot in order to choose the optimum artistic effect. Since a filed plot can be instantly recalled, comparisons of this kind are extremely easy and this feature represents one of the major advantages of this system.

It may be appropriate on occasions to retain an original pattern of lighting for use during a rehearsal but at the same time to plan the next lighting cue in advance. This can be done by retaining the output store information and using the channel selector to feed data into the preset store.

Since this does not directly control the dimmers, the existing lights are not disturbed. However, the mimic diagram indicates the channels selected and the operator is able to adjust the brightness level information in terms of the meter reading. When completed, this ' blind ' plot may be filed, and subsequently ' cut ' into the output store for live adjustment. The corrected plot can then be re-filled for use.

Apart from its use as an electronic notepad for the blind plotting of future cues, the preset store also provides the means for examining, and if necessary, modifying, the contents of files without disturbing lights already in use. However, the most important role of this store occurs during a fade when it is fed with information representing the state of lighting required at the end of the fade. This information will normally result from ' cutting ', i.e. copying the next file into this store. When the fade is initiated, the preset store information is progressively copied into the output store in a time determined by the setting of the fade time controls. It is important to note that during a fade, the only channels which will change are those for which new information exists in the preset store. Channels for which no new level is selected will remain as they are. Thus, in a crossfade where original lights have to be extinguished, it is necessary to select the corresponding channels in the preset store and set these at zero level. This can be achieved by depression of the ' Remainder Zero ' button which operates on all unselected channels simultaneously. In a straightforward production, the crossfade is initiated and operator function is then limited to depression of a single button which simultaneously cuts the new file into the preset store and sets unselected channels to zero.

The incorporation of an automatic sequence facility simplifies operation still further. Provided that the files are programmed in numerical sequence, use of this facility automatically selects the next file whenever a cue button is operated. Since the fastest crossfade is equivalent to a cut or switched change, it is literally possible to light a straightforward multiple cue production by a succession of operations of a single button coupled with adjustment of the fade time levers. While a fade is in progress, new information can be added or subtracted from either store, using either the channel selector or the file add and subtract buttons. In the case of the output store, the added information is immediately effective as a pattern of lighting. Thus, in the example referred to earlier a day-to-night fade can be initiated and at some stage, a practical light and its associated fill lights can be brought into use by adding the appropriate filed information to the output store, this information not being affected by the fade process. In the event of the new data containing channels which are already fading, these channels are automatically removed from the fade and immediately brought to the level represented by the new data.

If the new information is added to the preset store, it is made effective as a continuation of the fade, and will be transferred to the output store in the time set by the fade time controls.

These fade facilities will themselves be adequate for many users, but a further ' fade within fade ' function can be added if required. By providing a second set of fade controls, it is possible for information to be progressively added to the output store directly from the files while a normal fade is taking place between the output

store and preset store. In this way, two automatic fades can take place simultaneously at different speeds.

Notwithstanding all its automatic facilities, the 'Q-File' system retains means of performing a simple manual crossfade. This is achieved by the incorporation of a pair of master faders operating respectively on output store and preset store information, together with a 'Mix Stores' button which gives both stores control of the dimmers. Thus, with a different lighting plot in each store, a manual crossfade is simply achieved by appropriate use of the two master faders.

A further manual control facility is offered by an auxiliary control panel. In its standard form, this mounts ten manual faders, each of which, by means of a miniature patch panel, can be given control of any channel or combination of channels. The association of channels and faders is simply a matter of inserting a small plug into the appropriate hole in a plug matrix. These auxiliary faders can be given control of any lighting circuits which for some special reason are best manipulated by direct manual means. Also, should a failure ever occur in the electronic control system, a previously established emergency lighting plot can be immediately brought into use by means of a single fader.

Special Q-File control panel at Studio 8, BBC Television Centre, London

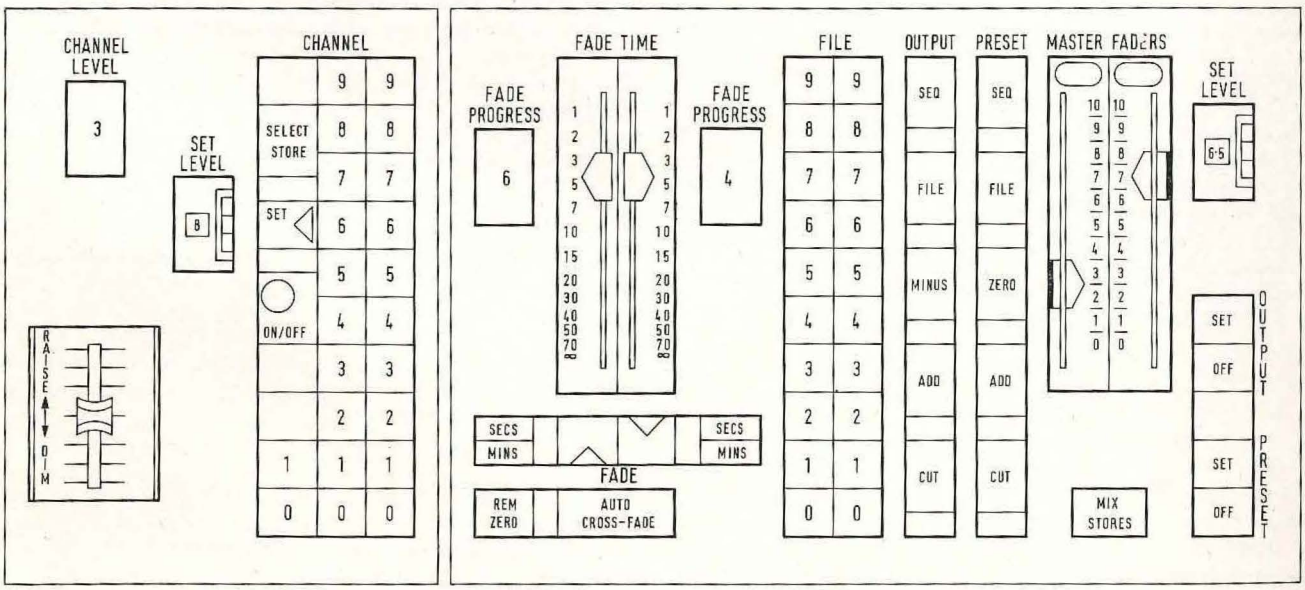
Physical Presentation of Equipment Control Panel

In what one might call the Mark 1 version of 'Q-File', particular attention was given to the needs of television studios and it was apparent that conventional installations often caused embarrassment in view of the space required to accommodate the large number of individual channel control levers. The answer to this was an alternative approach which enabled all the controls for hundreds of channels to be mounted on a control panel which is only two square feet in area. Referring to Fig. 2 the sub-panel on the left-hand side is the channel selector which mounts a group of decimal coded push-buttons. Operation of the appropriate buttons in the hundred, tens, and units columns, gives the operator control of any channel or group of channels. The starting levels of these channels can be preset by means of a simple thumb wheel calibrated 0-10 and the use of a 'Set' button. Successive operations of the 'On' button then switch the selected channels on and off. In addition to the set level facility, the brightness of the selected lamps can be adjusted at any time by the use of the raise and dim control. Deflexion of this control lever from its central position causes the original channel level to increase or reduce at a rate dependent on the degree of deflexion. The position of the lever for the slowest rate of change is immediately evident by its feel, due to a detent mechanism whose resistance has to be overcome before a faster change takes place.

Whichever method of adjustment is used, the electrical information corresponding to channel level is continuously fed into the output or preset store as determined by use of the Select Store button. Whenever the channel selection is altered, the final form of the preceding data is retained in the store.

The stored information is at all times indicated by the illumination of channel indicator lamps on the mimic diagram. Different colours are used to show the state of the output and preset stores; in the case of the output store, the brightness of the mimic lamp provides an approximate indication of the level of the corresponding

Fig. 2. Q-File control panel



channel. An accurate indication of the level is obtained from a meter which monitors the channel for which channel selector buttons have been depressed. The active buttons are at all times indicated by internal illumination.

The right-hand panel carries the master controls. These include the file selector buttons and the action buttons. (Sequential, File, Minus, Plus and Cut). These latter buttons are duplicated in order to direct the file action to the appropriate store. Also included are the fade controls comprising the crossfade button, the individual up and down fade buttons the remainder zero button and the fade time control levers. Successive operation of a fade button alternately starts and stops the corresponding action, enabling any stage of fade to be interrupted and subsequently continued. Each button is internally illuminated when in its ON state. The fade time control levers are calibrated 0 to 70, which figures can represent seconds or minutes as determined by operation of the range buttons. The end stop position is marked as infinity, and returning the levers to this position provides an alternative method of stopping the fade, or manually delaying its commencement.

The master control panel also mounts the two master faders and the mix stores button which gives the preset store temporary direct control of the dimmers. The pair of buttons on the extreme right provides a further facility. Each button operates on all channels selected in either store. One button enables all selected channels to be simultaneously switched off, while the other resets all levels to that determined by a calibrated thumb wheel.

In addition to the channel mimic diagram, the system includes a file mimic or display panel, which at all times indicates which file or files is responsible for the information in the two stores. Both these display panels may be mounted as an extension to the control panel, or, alternatively, installed on a wall facing the operator.

Since all the electronic equipment is remote from the control panel, the latter takes up very little space, and if required can be unplugged and removed to an alternative location.

Control Equipment

This is normally housed in three or possibly four 19in racks mounting individual sub-units employing printed card assemblies. These racks may be mounted several hundred feet from the control panel and dimmers, and because of the very low internal heat dissipation, no special ventilation is necessary.

Dimmers

These are of the thyristor type designed to a very rigid specification. Current types have power ratings of 5 or 10kW and a 2kW version is under development. The efficiency of these dimmers is 98 per cent of their full load rating and special consideration has been given to their stability, enabling individual dimmers to be interchanged without introducing output voltage variation of more than 2·5 per cent.

The control circuit provides a basically square law relationship between control voltage and light output when using tungsten lamps.

A degree of compensation for mains voltage variations is incorporated, enabling this to be reduced by about 50 per cent over most of the control range.

Each dimmer includes a specially designed filter choke which minimizes lamp sing and sound circuit interference by limiting thyristor current rise time to a minimum of about 0·8msec. This prevents difficulties where microphone cables have to be run in proximity to lighting power wiring.

Both 5 and 10kW dimmers have the same physical dimensions (8in × 5¼in × 15in) and plug into cabinets accommodating twenty 5kW units or any mixture of 5 and 10kW dimmers having a total power handling capacity not exceeding 100kW. The dimensions of these cabinets are approximately 2ft × 2ft × 6ft high and each cabinet is fitted with a fan and filter which can be omitted if forced underfloor ventilation is provided. If sufficient airflow is available, an input air temperature as high as 60°C can be tolerated.

Electronic Principle of the System

The 'Q-File' system employs semiconductors throughout, and includes no moving parts or electromechanical devices other than the panel controls. All data processing and memorizing is by digital means, using magnetic core stores and well-established computer type techniques. The two stores use core memories associated with registers which enable the core store information to be sequentially read out, modified if necessary and rewritten. The files employ magnetic core memories into and out of which the stored information can be copied.

Channel information is initially set up in terms of an 8-bit word which includes the ON/OFF state and 80 discrete brightness levels. This data is filed as a 5-bit word on a 20 step basis, permitting recall of the original information within a maximum non-cumulative tolerance of 2½ per cent of full brightness. All 80 steps are employed during a fade between filed levels. If required, the number of filed steps could be increased from 20 to 32 and the original stored steps from 80 to 128.

The design of the equipment makes provision for multiplex operation of the data storage system. This enables two or more studios or stages to share common control equipment but at the same time to retain complete operational independence. Multiplex operation offers obvious economies in capital cost where several separate systems are physically adjacent. The functions described do not by any means exhaust the possible applications of the equipment. For example, the position of colour change wheels can be memorized and included in a file. Also, the use of the programmed information need not be restricted to lighting and in the case of a television studio could include routing instructions for video and sound circuits, selection being under the control of the appropriate engineer.

Conclusion

The 'Q-File' system can be simply summarized as a means by which the normal processes of stage and studio lighting can be performed with extreme ease and speed. Also, because of the many independent facilities, it provides a means of achieving lighting effects which are quite impossible with other types of system. Even so, it is not claimed that this equipment represents the limit of what can be achieved by modern methods. Operational needs are still being studied, and, particularly in the case of the theatre, still further improvements in control techniques can be expected.

Acknowledgments

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