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ASSIGNMENT SWITCHERS

INTRODUCTION

Television broadcasting has not yet reached a stage of static maturity, but is still growing, and constantly revising and improving its basic engineering and operational philosophies. The introduction of colour has added an impetus to this growth and many techniques considered as nice to have in the monochrome days have become a necessity of today. The equipment used for colour transmission is more sophisticated, designed to much stricter specifications, and as a result more costly. Therefore the systems employing this equipment must ensure its maximum utilization so that no expensive machine remains idle for too long. Similarly much greater attention should be paid to inter-connections in order not to limit the performance of the equipment.

The modern television studio centres are not all alike because each of them has to serve slightly different local needs, however they all incorporate some common basic design philosophies. Most vision units like camera control units, colour coders, vision mixers and switchers, sync. pulse generators pulse and video distribution equipment etc. tend to be centralized in one area (Central Apparatus Room) with Video Recording and Telecine suites in close proximity. All the main vision signals, once they have been originated, do not leave this central area except for transmission or monitoring. This arrangement permits the physical distance between various units to be reduced to a minimum thus easing the task of delay equalization which for encoded colour signals has a tolerance about 50 times smaller than for monochrome.

Additional advantages of this centralization of the equipment are:

(a) Maintenance staff can be used more efficiently by not being spread over a number of technical areas;

(b) Stocks of spares (plug-in modules, etc.) can be reduced;

(c) Easier provision of efficient air conditioning to ensure uniform temperature for all units and cables;

(d) Reduction in length of coaxial cable and number of cable correctors resulting in a better performance.

Another trend, aimed at improving the staffing efficiency, is stricter separation of different technical functions into three broad groups: programme production, engineering control, and maintenance. All the controls necessary for programme production can be remoted to the studio control rooms, e.g. starting and stopping of the machines, colour balance controls for artistic matching of pictures, etc. All the engineering control functions such as assignment of Sync Pulse Generators adjustment of Line Clamp Amplifiers, selection of sources to vision mixers, etc. are remoted and centralized in the Master Control area leaving the central apparatus room to the maintenance crew. In this way each group can perform its function in its own area with a minimum cross-reference to other groups.

SCOPE OF ASSIGNMENT SWITCHERS

One of the equipments that implement the above design philosophy is an assignment switcher. The need for such an equipment has been felt for a long time, but only the introduction of colour has provided an economical justification for a complex and comparatively expensive switcher. During the last three years six assignment switchers have been designed for Independent Television studio centres. Each of these switchers is different and designed specifically to fulfil the local needs of each station. The scope of this article does not permit a description of each switcher even in outline, but an attempt will be made to highlight the most important features and illustrate them with practical examples.

An assignment switcher ensures the maximum utilization of all signal sources available on a station by establishing a two-way link between sources and destinations only for the time when a given source is required at a destination. By providing a central control point with a suitable display of the state of connections any emergency situation requiring an unscheduled rerouting can be taken care of efficiently and with a minimum possibility of errors. The assignment switcher can incorporate machine assignment (selection of telecines, VTR's, slide and caption scanners to assigned lines in studios), remote inputs and studio to studio assignment, VTR recording switcher (for selection of sources for recording), viewing room switcher, test signals distribution, etc. The complexity of the switching crosspoints employed for different parts of the assignment switcher can vary greatly from the simplicity of a forward vision and sound switch in a VTR recording switcher to a complex switch having

SOURCES	DESTINATIONS: STUDIO 1 (1 2 3 4 5 6)	STUDIO 2 (1 2 3 4 5 6)	STUDIO 3 (1 2 3 4 5 6)	MCR & PRESENTATION (1 2 3 4 5 6 7 8)	VTR (1 2 3 4)	QUALITY	VIEWING ROOMS (1 2 3)
TC1	A A	A A	A A	B B B	D D D D	E	E E E
TC2			A A	B B B	D D D D	E	E E E
TC3	A A	A A	A A	B B B	D D D D	E	E E E
TC4	A A	A A	A A	B B B	D D D D	E	E E E
TC5	A A	A A	A A	B B B	D D D D	E	E E E
CAP1	C C	C C	C C	C C C		E	
CAP2	C C	C C	C C	C C C		E	
CAP3				C C C		E	
VTR1	B B	B B	B B	B B B	D D D	E	E E E
VTR2	B B	B B	B B	B B B	D D D	E	E E E
VTR3	B B	B B	B B	B B B	D D D	E	E E E
VTR4	B B	B B	B B	B B B	D D D	E	E E E
REM1	E E	E E	E E	E E	E E E E	E	E E E
REM2	E E	E E	E E	E E	E E E E	E	E E E
REM3	E E	E E	E E	E E	E E E E	E	E E E
ST1			D D	D D	D D D D	E	E E E
ST2			D D	D D	D D D D	E	E E E
ST3			D D	D D	D D D D	E	E E E
PRES					D D D D	E	E E E
INET					D D D D	E	E E E
TEST1	F F	F F	F F	F F	F F F F	E	E E E
TEST2	F F	F F	F F	F F	F F F F	E	E E E

CROSSPOINT DESCRIPTION

	SOURCE	DESTINATION
A	FORWARD VIDEO	
	FORWARD AUDIO	
		RETURN VIDEO
		RETURN AUDIO
	TALKBACK	
		TALKBACK
	TRACTION CONTROLS	
	VIDEO CONTROLS	
		ON AIR CUES
		CODED PULSES
B	SAME AS A LESS VIDEO CONTROLS	
C	SAME AS A LESS FORWARD AUDIO	
D	FORWARD VIDEO	
	FORWARD AUDIO	
	TALKBACK	
		TALKBACK
E	FORWARD VIDEO	
	FORWARD AUDIO	
F	FORWARD VIDEO	

Fig.1 Assignment map of a studio centre

up to 60 contacts for machine assignment. But whatever the complexity of the crosspoint all functions should be switched together. Attempting to switch the vision and sound outputs of a telecine machine by pushing a button and assigning machine controls by a manual patch can lead to errors especially during emergencies and is of course inefficient in manpower.

PLANNING AN ASSIGNMENT SWITCHER

In order to achieve the most economical solution an overall survey of the whole station requirements should be made without trying to split the assignment into functional blocks. First all the available sources and destinations to which those sources have to be connected are listed. Then a decision must be taken as to which connections have to be established between sources and destinations. This information can be best presented in the form of an assignment map shown in figure 1. All available sources are shown on the left and all destinations at the top. A letter defining the crosspoint (i.e. all the functions that require switching) is inserted at the intersection where a connection is wanted. For example Telecine machine No.3 can be assigned to line 1 or 2 in one of the three studios or to line 1, 2, or 3 on the Presentation and Master Control Room switchers. At the same time TC3 can be selected as video and audio only to any of the five VTR's for recording and to three viewing rooms. When a telecine is assigned for programme production, traction controls (e.g. stop, start, etc.) and sometimes video controls (e.g. lift gain, colour balance, etc.), can be remoted to studio or presentation control room. Therefore this type of assignment must be limited to one destination at a time. On the other hand a machine can be assigned as a video and audio only to any number of destinations.

The assignment map shown in figure 1, does not represent any particular case, it only illustrates how the initial requirements of a station can best be presented. In practice the map is usually more complicated, but before a design can begin many more decisions have to be taken.

REMOTE CONTROL OR MANUAL PATCH

One of the facts which is not very apparent at first sight is that with a complex assignment system, remote control costs only 30% more than the slow and unsightly manual patch. Before any decision is taken the frequency of assigning operations for each type of source should be estimated. Manual patch can only be considered for sources which will

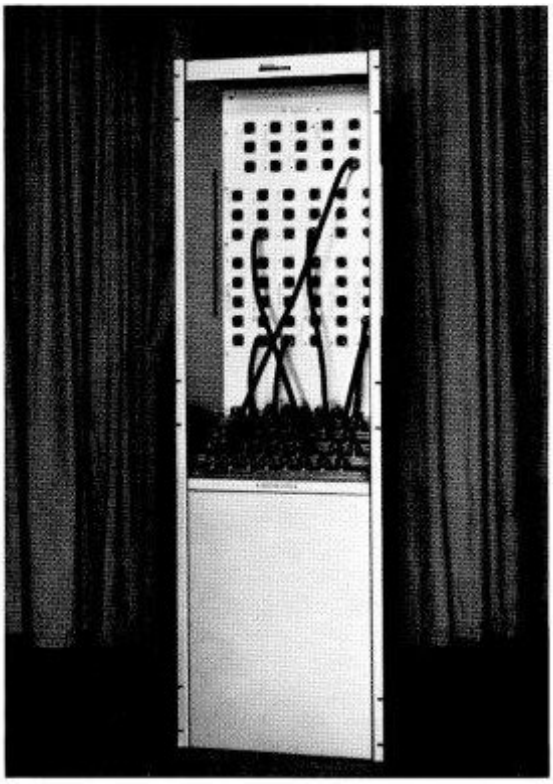

Fig.2 Input assignment patch panel – Granada Television.

not be frequently reassigned and which require only a limited number of contacts.

Figure 2 shows an Input Assignment Patch Panel for connecting eight remote and nine studio sources to 40 destinations (studios, Central Control Room, VTR for recording, etc.). The destination plugs, attached to flexible cables are resting on a horizontal panel and the source sockets mounted on the vertical panel. The patch consists of vision, programme sound, lines to light the source indicators at the destinations and in the case of studio sources only, two talkback pairs.

FUNCTIONS TO BE SWITCHED

The complexity of a switching crosspoint, employed to connect a source with a destination, depends of course largely on the type of source. Consider first a telecine machine which is likely to require the largest number of functions to be remoted. Assigning a telecine to a studio should establish the following connections:

(a) Programme vision and sound from telecine to studio;

(b) Return vision and sound from studio to telecine machines or telecine central control for cueing purposes;

(c) Two-way talkback between studio and telecine machine or telecine controller; sometimes separate talkback lines are provided to studio production and to vision control;

(d) Studio pulses to telecine to ensure synchronism; to reduce the complexity of switching matrices, pulses coded into a single signal are used[5];

(e) Traction controls – the number of functions switched depends on the type of the machine employed and the degree of the remote control desired in the studio. Some or all the following functions can be remoted; forward, reverse, show, stop, automatic stop override, magnetic, optical or separate sound, inch, remote framing, footage counter, selection of projectors in case of multiplex machines, etc. In most cases only the basic controls are remoted, but of course, there is a slight variation of opinion as to which are the basic controls;

(f) Video controls – The remote functions can include white level, black level, positive or negative (monochrome or colour) colour balance controls, colour masking selection, etc. In many cases video controls are not remoted at all to studios, the picture matching being carried out from the Telecine Control Desk;

(g) Source identification information to studios (e.g. to light alpha-numeric indicators);

(h) 'On-air' cues from studio to telecine and any other additional control functions (e.g. subcarrier phasing, manual or automatic).

Telecine machines themselves tend to be virtually unmanned, one or two film loaders serving a number of machines. A block diagram of the telecine control system is shown in figure 3. A local control panel is useful only during loading and maintenance. Operational control is carried out from either a centralized Telecine Control Desk (e.g. when a film is being recorded on VTR, or when a telecine is assigned to a Master Control Switcher) or from Studio Control Rooms. The Telecine Controller may sometimes have an option to assign the controls to a studio or to retain all or only some of them under his own control.

Figure 4 shows the Telecine Control and Assignment Room of Tyne Tees Television in Newcastle. The Machine Assignment control panel is mounted in the centre of the desk with video and traction control panels for six telecines, one slide and one caption scanner to the left and right. Colour film balance control units are mounted in the wings of the desk. When a telecine is assigned to a studio, traction and colour balance controls are remoted to the studio but the Telecine Controller retains the control of traction in parallel with the studio, with the exception of the stop button, operation of which is inhibited during the time when a machine is on-air.

VTR machines must be supervised all the time during their operation. Therefore there is no VTR equivalent of the centralized Telecine Control Desk. VTR's can be either controlled from the machines or from Studio Control Rooms. Video controls are very

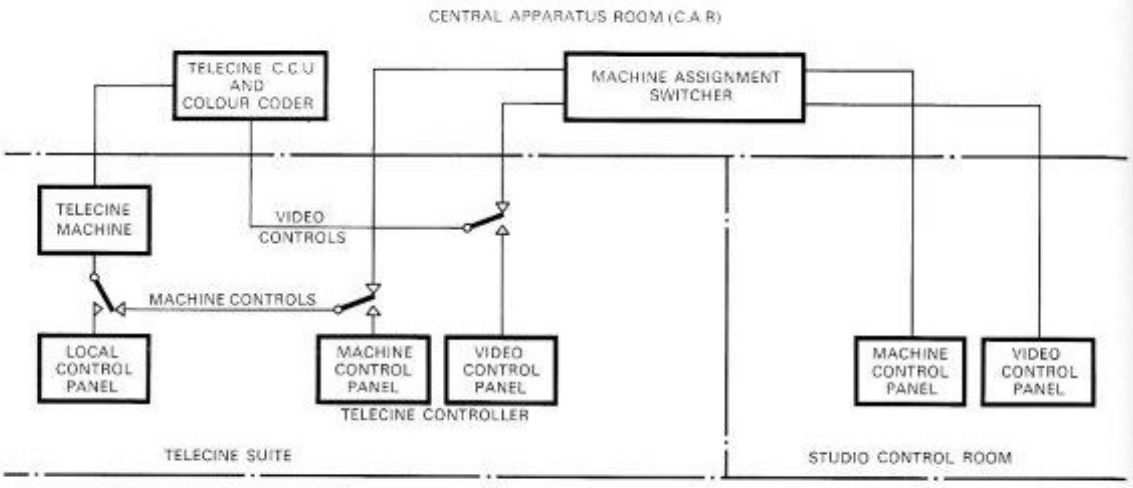

Fig.3 Block diagram of telecine control.

Fig.4 Telecine control and assignment room at Tyne Tees Television. (Tyne Tees picture.)

rarely remoted, and of the machine controls, only run and stop are usually assigned to studios. Provision of a remote footage counter in the future will enable control of rewind from studios.

CONTROL OF ASSIGNMENT

The control of assignment can be carried out from one or several points, alternatively it can be split between central point and destinations. Each of these methods has its own merits and the choice is dictated by the local needs of a station. Associated Television (Elstree) have adopted central control of all assignments, as have Tyne Tees Television, except that the selection of sources for recording is separate. In Granada Television telecine machines are assigned from the Central Telecine Desk, VTR's from the VTR area and the remotes and studios are patched on the Input Assignment Panel located in the Network Control Room. In Associated Television (Birmingham) telecines are assigned from the central Telecine Desk and the rest of the assignment from the VTR area. Independent Television News and Southern Independent Television have selected a split method of control.

Figure 5 shows the Telecine Assignment Panel (Granada). When one of the telecine buttons in the middle of the panel is pressed it lights and the output of the machine is connected to a Picture and Waveform Monitor, PPM, a small loudspeaker on the panel and the main loudspeaker. The destination is selected by pressing first an area button (e.g. ST3) and then a line button (e.g. C) at the bottom left-hand side of the panel. Both buttons light and the line feeding the selected destination can be monitored both in vision and sound. To make the actual connection between the machine and the selected destination a key at the centre bottom is moved up and the Assign button pressed. The code of the destination appears on the alpha-numeric displays above the telecine button and the illuminated buttons extinguish. When a machine is no longer required at the destination, it has to be returned home by assigning it to a position marked 'OFF'. Any telecine can be selected for VTR recording by assigning it to an input of the VTR assignment switcher. The assignment of VTR machines is carried out in Granada from a similar panel mounted in the VTR area (figure 6).

In Tyne Tees Television all machines are assigned from a single panel (figure 7), mounted on the Telecine Control Desk. The sources (eight telecines, five VTR's, slide and caption can be selected to seven lines in each of the four studios, to MCR and Home. All buttons are colour coded showing that telecines can only be assigned to lines 1 to 3 in each studio, VTR's to lines 4 and 5 etc. For the benefit of a colour blind or slightly careless operator an assignment validity interlock is provided (i.e. the assignment is locked out if an invalid destination is selected). Another type of interlock prevents selection of two machines to the same destination. When a machine is switched on-air by a studio the connec-

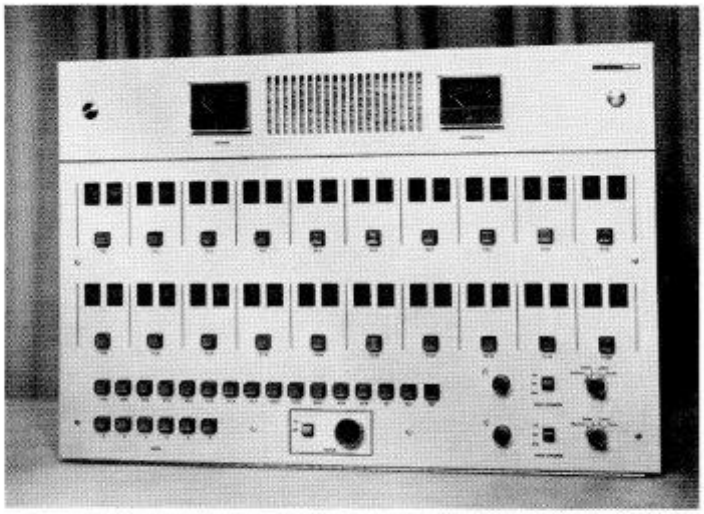

Fig.5 Telecine assignment panel – Granada Television.

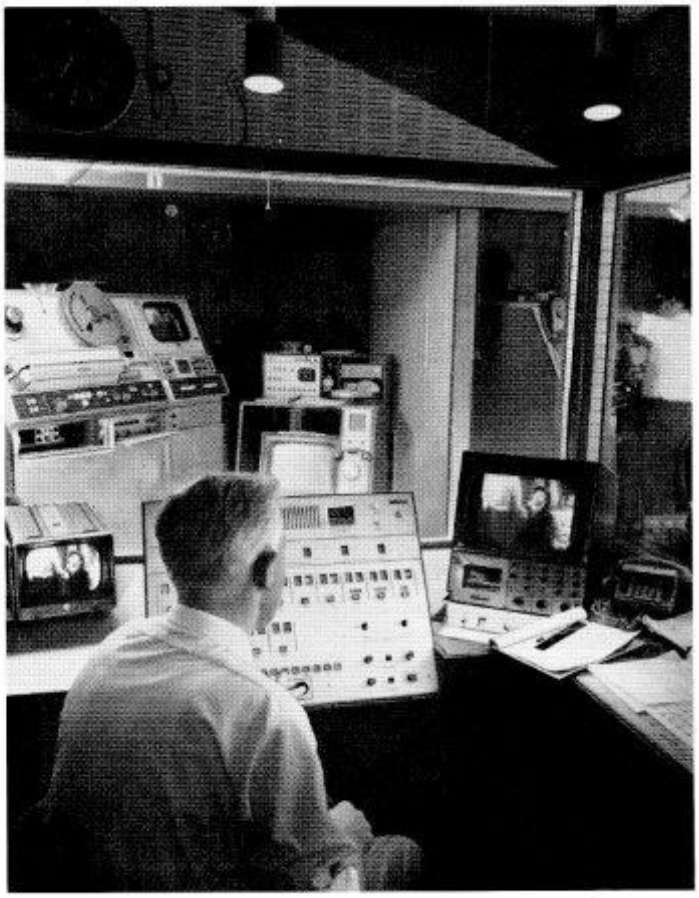

Fig.6 VTR area with VTR assignment control in foreground. (Granada picture.)

tion cannot be interrupted accidently because once again the assignment is locked out. It is assumed that if this machine develops a fault the vision mixer operator will automatically cut to a different source and release the lock out. All machines are connected permanently in vision and sound to the MCR switcher. The action of assigning a machine to MCR establishes other connections (e.g., two-way talkback, on-air cues, MCR pulses to telecine, etc.). There are no assignment displays on the panel. A single large alpha-numeric indicator is mounted 7 ft

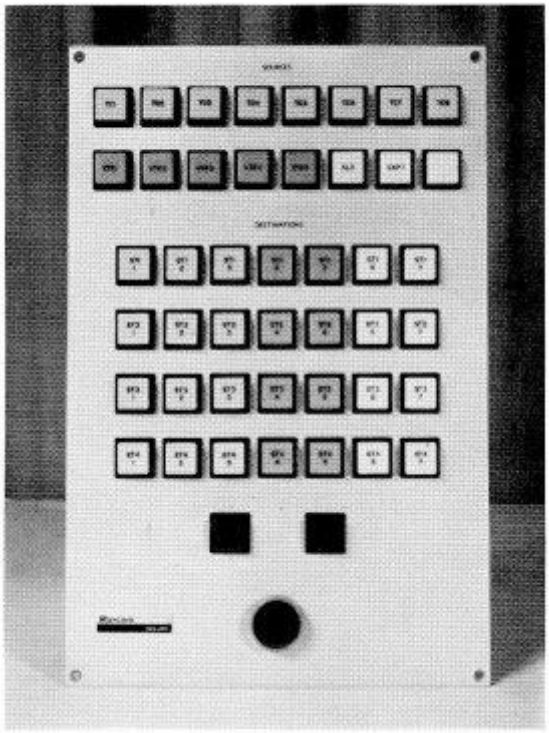

Fig.7 Machine assignment control panel – Tyne Tees Television.

from the operator. When any source button is pressed the code of the destination to which this source is connected appears on the indicator. Under each telecine monitor, in front of the telecine controller, there is a similar indicator showing the destination to which the telecine is connected. Thus the interrogated display need only be used for VTR machines and slide scanners.

An example of a fully centralized control of assignment is shown in figure 8. The source includes telecines, slide scanners, VTR's, studios, and test signals; destinations are assigned lines to studios, viewing rooms, home and VTR machines for recording. Full monitoring of sources and destination lines is provided. Alpha-numeric displays in the top corners of the panel give the code of monitored sources and destination lines. The state of assignment is shown on a display panel (not shown in the photograph), which will be mounted above the assignment panel. Destination indicators are also provided near each machine. When any studio is on-air red lamps light above all indicators corresponding to machines assigned to this studio and the assignment of these machines is locked out. To disconnect any machine that might develop a fault during the time when a studio is on-air a Release Lockout button is provided at the top of the left-hand panel.

Any machine assigned to a studio receives studio pulses. In all other cases, that is when the machine is used only for recording or viewing, it must be returned to a home position when it is fed with home pulses (master pulse generator or any other SPG that is not likely to be genlocked can be used for this purpose). On multi-standard stations it is required to change the line standard of home pulses.

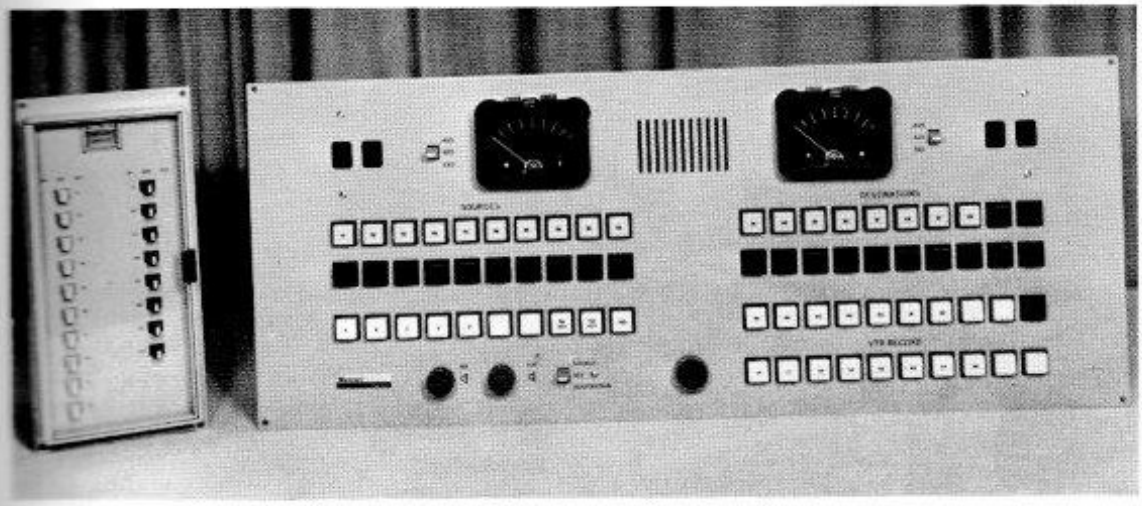

Fig.8 Central assignment control panel – Associated Television.

For this purpose 18 three-position keys are provided on the small panel in figure 8 so that home pulses for each machine can be selected between 525/625/spare.

ASSIGNMENT LINES TO STUDIOS

Inputs to a studio vision mixer usually consist of permanently connected sources (e.g. cameras) and assigned sources (centrally located machines, remotes, test signals, and other studios). Sometimes it is more convenient to allocate a fixed number of lines to each type of source, e.g. three lines to telecines three lines to VTR's with two lines for remotes, test signals, and other studios. Using this system the vision mixer operator has always the same type of assigned source on a given button and the remote control of machines is made easier allowing each line to be connected to a specific machine control panel.

The alternative is to provide multi-purpose assignment lines so that any type of source can be assigned to any mixer input line. In this case it is essential to have in all studio control rooms clear indication of the identity of the source assigned to each line. Each machine could be equipped with a Source Identity Generator[1] producing electronically generated characters that are superimposed on the machine's vision output. The source identity will then appear on all preview monitors. The remote control of machines can be solved by placing on

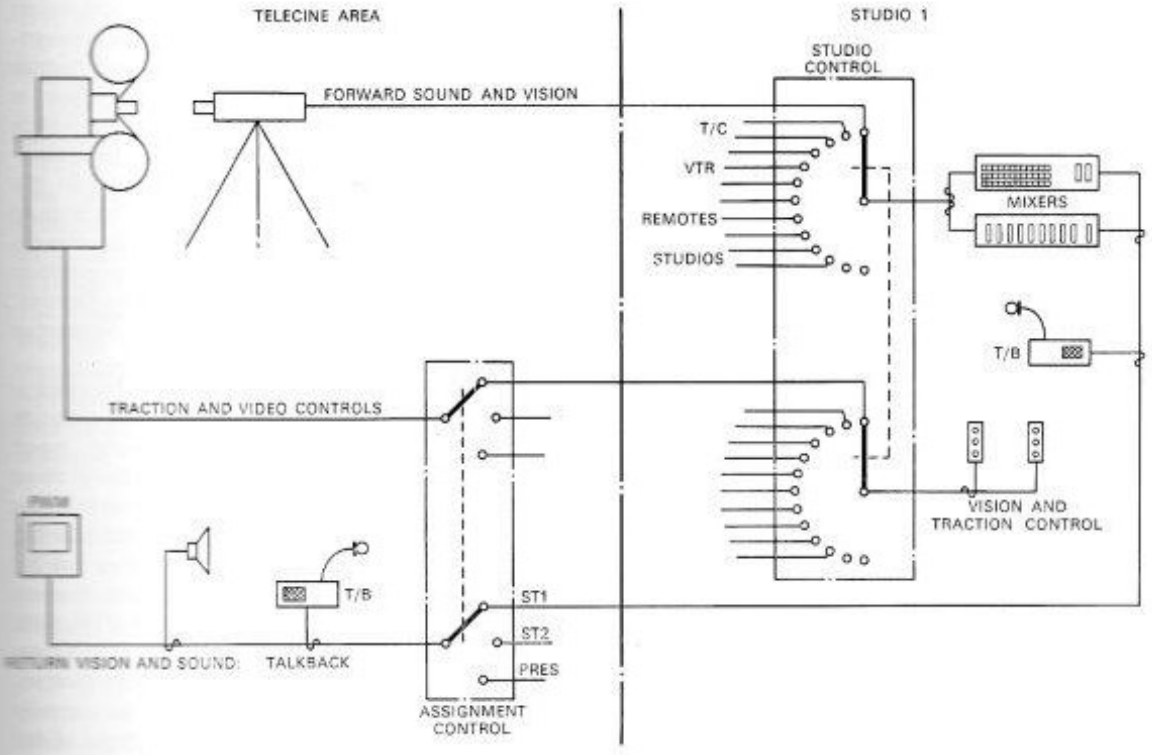

Fig.9 Principle of split control assignment.

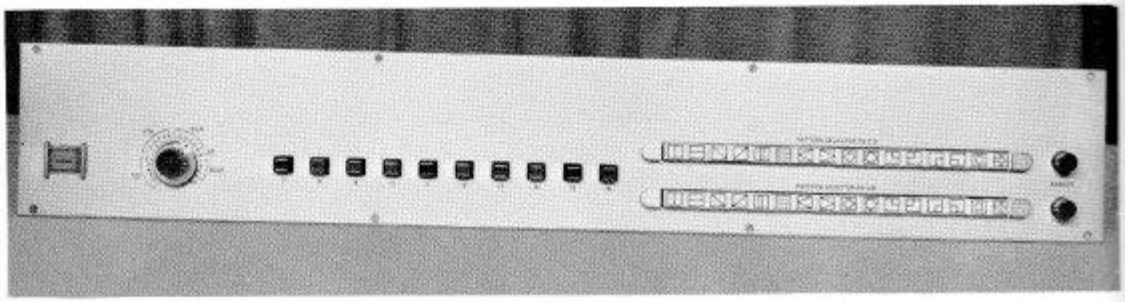

Fig.10 Studio input selector panel – Independent Television News.

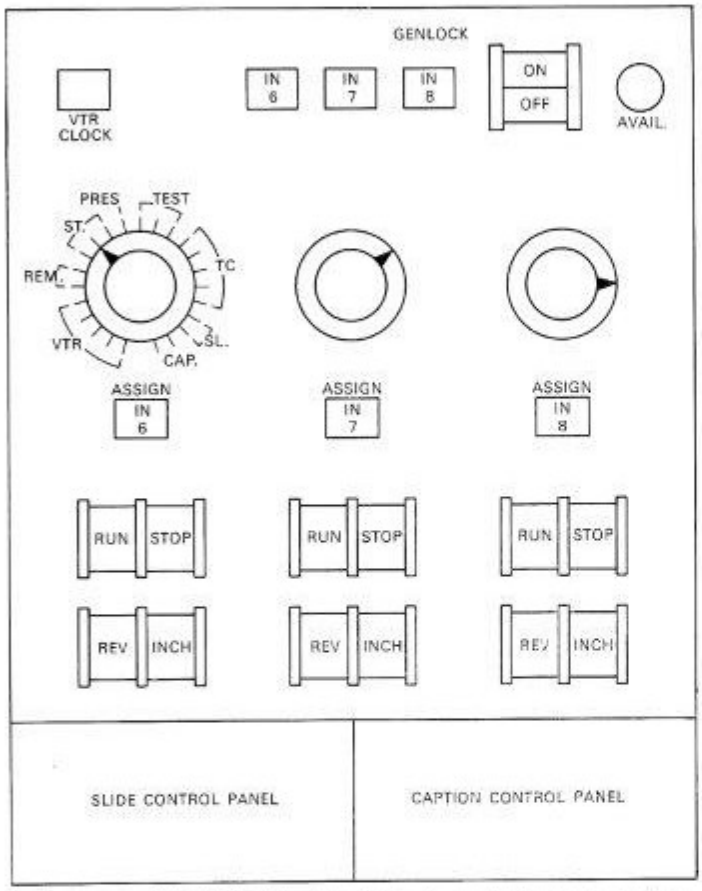

Fig.11 Combined input selector, genlock selector and machine control panel – Southern Television.

every assigned line a universal machine control panel from which any type of machine, be it a telecine, VTR or caption, could be controlled. An alternative, which in some cases may be more economical, is to provide remote control panels for all the machines that can be assigned to a studio, but make them operational only on assignment.

The use of multi-purpose assignment lines is necessary when the vision mixer employed has an insufficient number of inputs or when the type of production for which the studio is used demands an extreme flexibility of assignment (e.g. news programmes). When the number of machines required during programmes is normally greater than the number of assignment lines that can be provided, central control of assignment is not advisable. Studio control staff can best decide when different machines are required. To cope with this situation a split control of assignment is employed; before a programme, central assignment presets the routing of all the machines required and during the programme, studio control selects the machines as and when required.

The principle of split control of assignment is illustrated in figure 9. When the assignment controller presets a machine to a studio return vision and sound from the studio and two-way talkback is available without the need for the studio to select this machine. On the other hand the studio can select any source in vision and sound at any time without any action on the part of assignment control. Traction and video controls however, are only available to studio control when the machine is assigned to the studio and in addition the studio has selected this machine.

The Input Selection Panel that will be mounted over the studio vision mixer at ITN is shown in figure 10. Neglecting the bypass switch on the left and pattern selectors on the right, the panel permits the selection of ten assignable inputs to both vision and sound mixers. First the desired source is selected on the multi-position switch and then a button corresponding to the required mixer input is pressed. If a selected source is a machine which already has been preset to the studio by the assignment control then all the functions between the studio and the machine are established. The code of the assigned machine appears on the indicators on the vision mixer control panel, on the genlock selector, under the monitors in Production Control, in Sound Control and in the Central Apparatus Room.

A slight variation of the same system of control is used by Southern TV and figure 11 shows a sketch of a combined studio genlock selector, input selector, and machine control panel. Only three assignment lines are provided but an input selector switch is fitted on each channel. Once the sources are selected on all three lines the switches can be preset to the next selection. Run, Stop and Reverse buttons are used both for telecines and VTR, with the Inch button of course only for telecine. If a caption or a slide scanner is selected, one of the bottom two subpanels is used. When the machine controls are assigned to the studio one of the buttons of the group is alight.

VTR RECORDING SWITCHER

A VTR machine can be used as a source on replay or as a destination when recording. On assigning a machine to a studio, high quality video and audio return circuits are sometimes provided to the machine for cueing purposes and these return circuits can also be used for recording. Unfortunately this method uses a valuable assignment line to the studio which might be wanted for replay. Therefore a separate VTR recording switcher gives more flexibility. Such a switcher can form a part of central assignments as in Associated Television (Elstree) (figure 8), or the sources for recording can be selected at the machines.

Figure 12 shows a VTR Assignment Panel for Southern Television and the same panel is used at each machine for recording and for assignment of replay. To select a source for recording the selector switch is set to the desired input and the Assign button pressed; this will select vision and sound and establish talkback connections. The same procedure is followed when assigning a machine to a studio, but the studio will not obtain forward vision and sound, machine controls and other subsidiary connections until the studio in its turn selects the machine. The Assigned lamp will then light on the VTR panel.

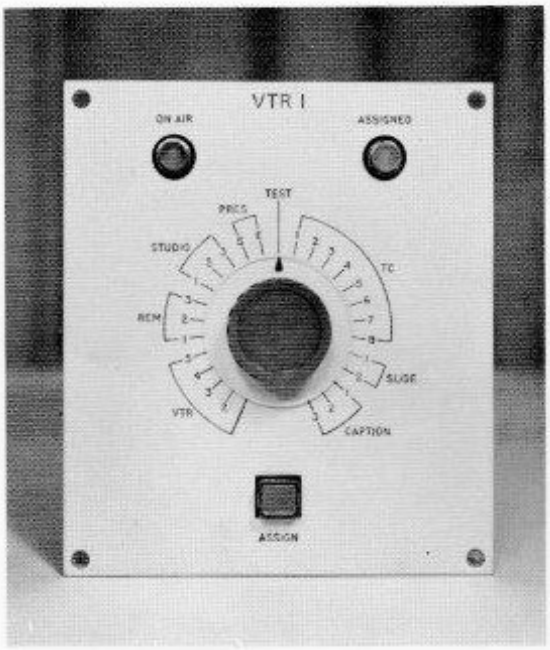

Fig.12 VTR Assignment panel – Southern Television.

SWITCHING ELEMENTS

In all the six assignment switchers mentioned previously the same switching elements are employed. Sound, talkback, machine traction, video controls, indicators and cues are generally switched by high-speed motor uniselectors (figure 13). Vision (both forward and return) and coded pulses are switched on transmission line relay matrices controlled from uniselectors. The same switching elements were used in network switching equipment[2] installed in 1967 in four GPO Network Swtiching Centres. During the first five months of operation out of 18,000 switching operations, 26 were faulty, but 19 of these were due to human error.[3]

The transmission line video matrix (figure 14) was developed specifically for large routing systems.[4] The relay matrix is built up from relay strips, each strip has one input and 10 outputs, and is easily expandable from four to over 60 inputs. The single input amplifier can drive up to four matrices, that is 40 outputs. The total gain of the matrix with its associated input and output amplifiers is 6 dB thus allowing passive equalization of incoming and outgoing coaxial lines up to 250 ft in length.

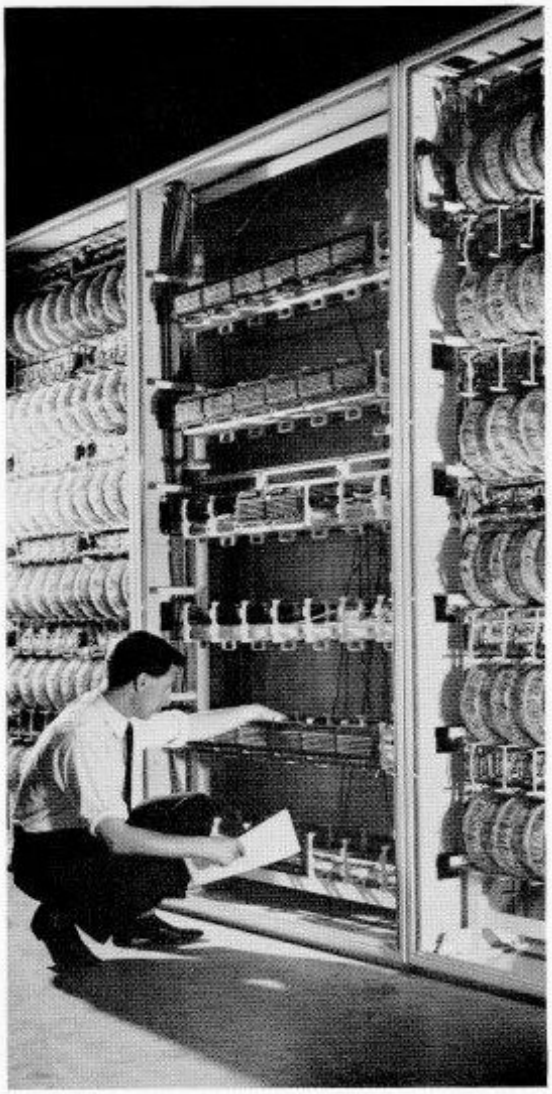

Fig.13 Typical bay of motor uniselectors used for assignment.

PERFORMANCE

In the longest path through a television studio centre a vision signal can pass three or four times through an assignment switcher. Therefore it is of the utmost importance to ensure that the performance of the switcher does not take up a large proportion of the total allowable tolerances. The following figures were obtained during acceptance tests of one of the installations:

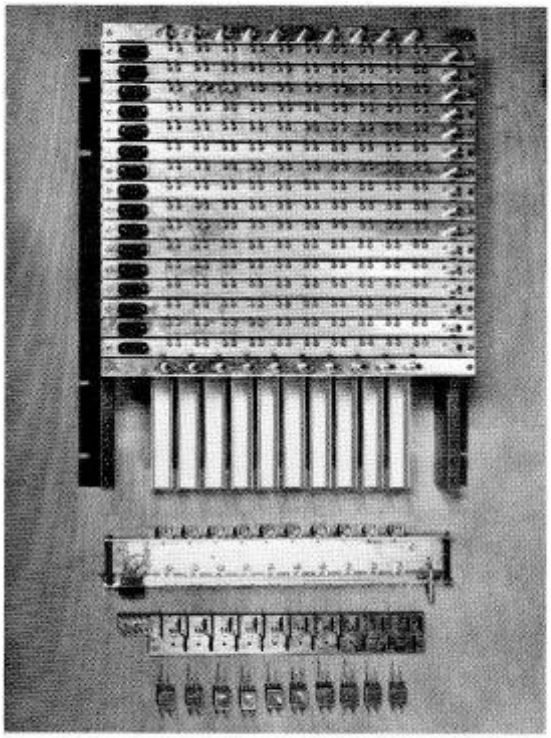

Fig.14 Vision matrix with constructional details.

Video performances:

Return loss:	(a) input 39 to 43dB
	(b) output 34 to 36dB
Random noise:	(a) luminance channel 80 to 83dB
	(b) chrominance channel 77 to 82dB
Periodic noise:	52 to 57dB
Crosstalk:	(a) at 1·8MHz – 67dB
	(b) at 4·43MHz – 59dB (worst case)
Non-linearity distortion:	(a) sync signal – unmeasurable
	(b) luminance channel – unmeasurable
	(c) chrominance channel – differential phase 0·06° to 0·4°
	Differential gain – unmeasurable
Linear waveform distortion K rating:	0·25%
Luminance/ chrominance inequalities:	(a) gain 0 to 1%
	(b) phase 2ns

Audio performance:

Frequency response:	(a) 50Hz to 10kHz +0·15 to −0·2dB
	(b) 10kHz to 16kHz −0·05 to −0·45dB
Harmonic distortion at 17 dBm:	(a) 100Hz, 46 to 57dB
	(b) 1kHz, 51 to 69dB
Random noise:	unweighted −66 to 69dBm
Crosstalk:	(a) 50Hz, 90dB
	(b) 1kHz, 100dB
	(c) 10kHz, 86dB
	(d) 16kHz, 82dB

CONCLUSIONS

The assignment switcher is becoming a familiar piece of equipment in modern studio centres. It supplies signals and controls where they are wanted and when they are wanted, thus permitting maximum utilization of all available resources both in terms of equipment and manpower. The future will no doubt see many improvements; automatic control of assignment and complete elimination of electro-mechanical devices. Even today completely solid-state assignment is technically feasible but unfortunately the cost would be prohibitive.

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