16-mm COLOUR TELECINE EQUIPMENT EP6/505

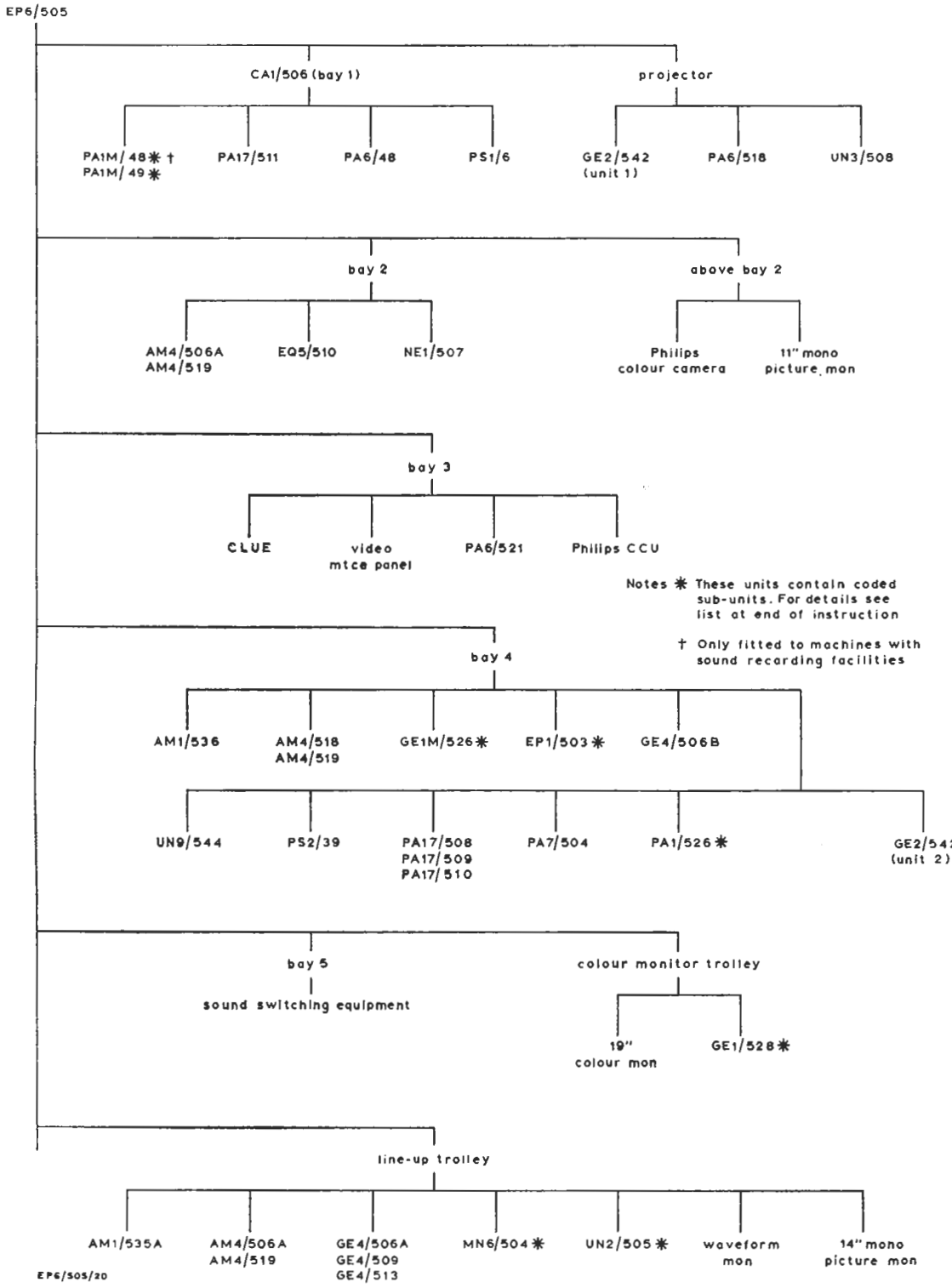

Fig. 1 Family Tree of the 16-mm Colour Telecine Equipment EP6/505

Introduction

General

The EP6/505 produces colour television pictures from the projected images of colour film by means of a three-tube Plumbicon television camera.

Each EP6/505 telecine installation consists of:

(a) A Bauer Selecton II O double-band 16-mm projector (described in Instruction FP1) fitted with a special projection lamp system.
(b) A CA1/506 cabinet which carries the telecine sound equipment (bay 1).
(c) A Philips 3-tube plumbicon colour camera channel (bay 3).
(d) An 11-inch Prowest monochrome picture monitor.
(e) Two video bays (bays 2 and 4) which carry additional electronic units and relay panels.
(f) A bay which carries relay panels associated with the remote control of the sound and projector circuits (bay 5).
(g) A power supply cabinet.

Description of Equipment

EP6/505 machines are at present (October 69) installed only in the News area in the Television Centre spur and it is these machines which are described in this Instruction. Any future installations, though utilising the same basic equipment, may differ in detail.

The telecine will reproduce up to 2400 feet of positive colour film with Comopt, Commag or Sepmag sound. When Sepmag sound is used, the sound film can be placed either on the traction mechanism which is part of the projector or on an external Sepmag machine which is synchronised to the projector by means of a Selsyn drive unit. Additional units have been added to one of the EP6/505 installations to provide Commag and internal Sepmag sound recording facilities. Details of the modifications required to add recording facilities to a machine are given in the appendix to Designs Department Specification No. 7.100 (65).

The projector main motor is driven in synchronism with field pulses and can be run either forwards or in reverse. The telecine machine contains also three spool motors and two solenoid-operated clutches, which are used for driving the sound drums during run-up, run-down and inching operations.

The signal amplitude is controlled by an iris which is positioned in the optical path inside the projector lamphouse. This iris is known as a light valve and consists of a motor-driven metal vane which is controlled by the setting of the *Light* control. The range of control provided is such that the peak illumination in the image plane of the plumbicon lens is about 4·5 foot-candles (48 lux) for all films with a minimum density between 0·1 and 1·1.

All operational controls can be operated either locally or from a remote position. Automatic control of signal amplitude is provided together with a limited amount of automatic flare correction.

The only test equipment permanently built into the machine consists of an 11-inch picture monitor and a small loudspeaker; a P.P.M. is provided on bay 5 and, when the machine has sound recording facilities, an additional P.P.M. is mounted on the CA1/506 (bay 1). These items are adequate for lacing-up and operating the machine but do not provide the facilities required for maintenance or line-up purposes. A mobile line-up trolley which carries an oscilloscope, a vectorscope and various waveform generators is provided for video maintenance and line-up purposes, together with a trolley-mounted colour picture monitor. Similarly, sound jackfields are provided on the CA1/506 cabinet and on bay 5 for sound line-up and for high-quality sound monitoring.

Fig. 1 is a simplified family tree which shows the way in which the major units comprising an EP6/505 are interconnected; a complete list of all units and sub-units comprising (or associated with) an EP6/505 is given at the end of this Instruction. Fig. 2 is a layout diagram which shows the relative positions of the projector, the camera channel and the units contained in bays 1 to 5. Bay 5 is at right angles to the other bays but, for the sale of clarity, all the bays are shown in a row in the diagram. Beyond bay 5 is a power supply cabinet (not shown in Fig. 2).

This Instruction deals with the EP6/505 as a system and the only details given are those which apply to the equipment as a whole. Detailed descriptions of the units contained in the equipment are given in the relevant Instructions.

Mechanical and Optical Coupling

Because the film gate and the images focused on the targets of the plumbicon tubes by the optical system are so small (0·280 × 0·372 inches gate aperture and 12·8 × 17·1 mm scanned image size) accurate and vibrationless mechanical coupling between the projector and the camera is very important. If camera and projector were both

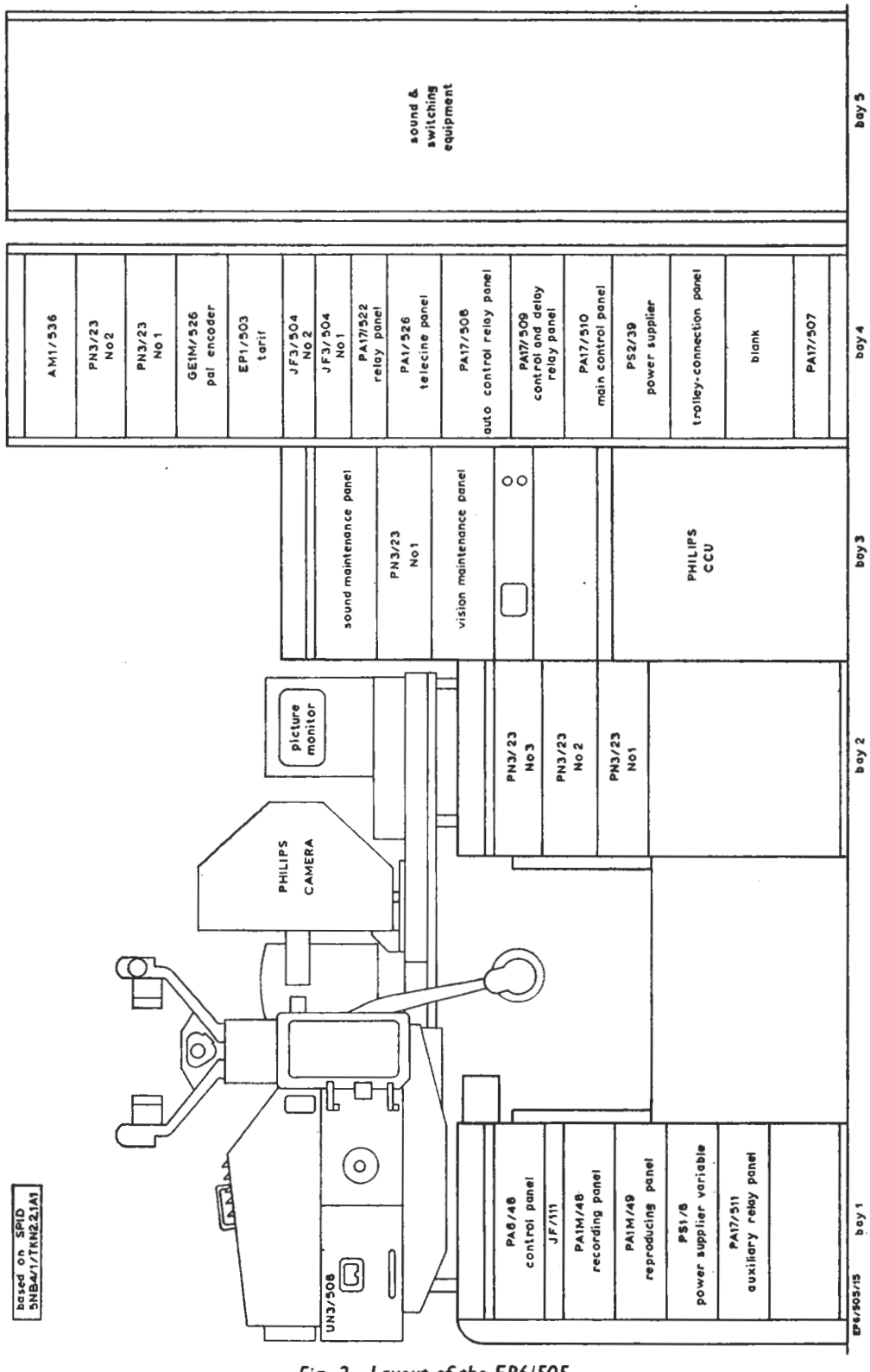

Fig. 2 Layout of the EP6/505

mounted on the same rigid baseplate, accurate alignment would be easily achieved but vibration might be transmitted to the camera tubes at frequencies which could cause microphony. Therefore camera and projector are each mounted on robust steel cabinets which are bolted to the floor. The cabinets are positioned so that the focal planes of the projector and camera lenses are coincident, and the lenses are focused at infinity. The arrangement is known as a *telecentric* system and is immune to vibration in all directions, provided that the axes of the lenses remain parallel to the system axis. The only mechanical strength required of the cabinets is that they resist rotational vibration about any axis.

The magnification of the system is that of the ratio of the focal lengths of the lenses. To achieve the required value the projection lens is a Schnieder Componon 80 mm f/5·6 and the camera lens is a Schnieder TV-Procolor 150 mm f/2·8. This combination gives a basic magnification of 1·875, which can be reduced if the system departs from the *telecentric* condition.

The spacing and focusing of the lenses used on the telecine gives a magnification that is about 2% too great. This results in a corresponding resistance to vibration and movement due to racking which is still in excess of that required for acceptable operation.

Operation

Line-up

The line-up procedure for the EP6/505 telecine channel is given below; the proportion of this line-up which needs to be carried out daily will be determined in the light of operational experience. A.G.C. line-up information is given later under Maintenance and Alignment. Line-up procedures for the Coder and TARIF units associated with the telecine machines are dealt with in separate Instructions.

1. Switch on all supplies at the Power Cabinet. Observe the indicator lamps on bay 4 and check that three-phase mains, single-phase mains and station 50-volt supplies are available. Check that the *System* switch is set to *Beam Cut*.
   Switch *On* the *Mains* switch on the C.C.U.
   Switch the *Local/Remote* switch to *Local* and the *Safe/Unsafe* switch (on the projector) to *Safe*.
2. Switch the sound-selection switch on the maintenance control panel to *Off* (to remove the Commag head from the film) and check that the sound power supplies are switched on. Clean the film lacing path. Generally dusting with a light brush is sufficient, but care must be taken to remove any emulsion dust from around the gate and any emulsion corns from the gate runners. If degreasing agents are used they must be applied sparingly.
   Clean the Commag erase and programme heads with a small amount of Inhibisol on a cotton bud. If a Sepmag film is to be used, clean the Sepmag film lacing path and the Sepmag erase, record and reproduce heads as detailed above.
3. Lace a test card loop (about 4 feet in circumference) into the machine.
   To obtain the correct picture-sound spacing, rotate the *Hand Inch* knob half a turn after pull-down and set the loop after the intermittent sprocket to be about half-an-inch from the main casting when the lacing is complete, with the compliance arm on its backstop and the film just tight.
4. Switch to *Normal* and *A.G.C. Off* (manual).
   Press the *Show* button and adjust the *Light Control* to obtain a picture of the test card on the picture monitor.
   Switch to *Unsafe*. Press the door interlock microswitch and the *Forward* button so that the projector runs (it is not possible to run a loop with the door shut). Adjust *Racking* as required.
   Check that the meter on the lamp control panel reads in the green band; if not adjust the left-hand knob on the panel until it does.
5. Sound output level. To check, set the P.P.M. switch to *Machine Out* and the source-selection switches to *Combined* and *Comopt*. Check that the Comopt indicator lamp is lit and that the P.P.M. reads $5\frac{1}{2}$.
   If reproduction from magnetic stock is required, place a loop of the appropriate magnetic line-up test film on the machine. To check the Commag channel set the source-selection switches to *Combined* and *Commag*; to check the Sepmag channel set the source-selection switches to *Internal Sepmag* and check that the P.P.M. reads 4.
6. Press the *Stop* and *Show* buttons and check that the meter reads in the red band.
   Remove the film and observe the open-gate image to ensure that there is no beam limiting. Check for spots or other optical blemishes. Press *Cancel Show*.

7. Connect a line-up trolley to the channel.
   Check the Waveform Monitor calibration and the Sawtooth Generator output; ensure that the sawtooth is non-composite.
   Set the *TARIF Mode* switch to *Bypass*.
8. On the camera channel set the *Contours Mode* switch to *Operate* and the *Matrix* switch to *Cut*. Set the *System* switch to *Test C.C.U.* and check that a sawtooth waveform appears at the R, G and B outputs.
   Set the *Master Lift* control to its midpoint and adjust the R, G and B *Black Level* controls.
9. On each processing amplifier, turn the *First Limiter* (R15) fully clockwise and the *Second Limiter* fully anticlockwise.
10. Monitor G—G1. Vary the Green *Gamma Corrector* control over its full range and adjust *G PID Gain* (an additional control, added to the camera channel on installation) until no change can be observed in the white point of the sawtooth. Repeat on R-R1 and B-B1.
    Monitor G. Set the *G Black Level* and *G Output Gain* (R61) controls until a sawtooth output of exactly 0·7 V p-p is obtained. (The Colour Calibrator which is mounted on the line-up trolley can be used for this check.)
    Monitor G—G1. Set *G Linear Gain* for white balance.
    Monitor R—G. Set *R Black Level* for black level balance, and *R Output Gain* (R61) for white balance.
    Monitor R—R1. Set *R Linear Gain* (R78) for white point balance.
    Monitor G—B. Set *B Black Level* for black level balance and *B Output Gain* (R61) for white balance.
    Monitor B—B1. Set *B Linear Gain* (R78) for white point balance.
11. Set the *System Switch* to *Beam Cut*. Adjust *Pulse Cancellation* so that the black level does not alter when the individual R, G and B *Gain* controls are varied from end to end of their travel.
12. Set the motor-driven *Master Gain* control to maximum and set the *System* switch to *Test Head Amp*. Check that a sawtooth waveform is present at R, G and B.
    Monitor G. Set *G Gain* for an 0·7V p-p sawtooth waveform. Repeat for R and B.
13. Set *G Gamma* to a point just short of maximum correction.
    Monitor R—G. Adjust *R Gamma* and *R Black Level* for optimum match.
    Monitor G—B. Adjust *B Gamma* and *B Black Level* for optimum match.
14. Insert a Test Card in the projector. Monitor G, press the *Show* button and adjust the *Light Control* to obtain a picture signal of approximately 0·7V p-p.
    Roughly adjust the following Green channel controls:
    Beam
    Beam Focus
    Alignment
    Master Scan Amplitudes
    Centring
    Accurately adjust the projector lens for optimum optical focus.
    Set *Green Focus* in the camera so that the green plumbicon tube is almost at the forward limit of its travel.
    Set *G Target Volts*.
    Set G Beam to discharge a 1·0V p-p output signal.
    Operate *G Focus Rock* and adjust the *G Alignment* controls for zero image movement at the centre of the scanned area. The alignment controls must be adjusted in conjunction with the centring controls.
    Adjust green *Beam Focus*, *Master Scan Amplitude* and *Centring* controls until half the depth of the Test Card castellations have disappeared. In this condition, corner cutting should not appear on the displayed picture.
    Return the controls to their previous setting.
    Check the rotation of the green yoke by comparing the Test Card with the scanned patch.
15. Monitor R. Repeat step 14 for the Red channel, except that optical focus must be carried out by movement of the red yoke assembly.
16. Monitor B. Carry out adjustments as for the Red channel.
17. Remove the Test Card and insert a Registration Grille.
    Set the R, G and B *Aperture Correction* controls to their mid-point.
    Monitor G and check that *G Linearity* is correct.
18. Monitor R—G. Adjust the Red *Linearity*, *Scan Amplitude*, *Centring* and *Skew* controls to produce the best cancellation. If necessary, rotate the red yoke to make the Red and Green horizontals parallel; after carrying out this adjustment recheck Red optical focus.

19. Monitor B—G. Repeat step 18, using Blue controls.
    Reset all *Aperture* controls to zero. Remove the Registration Grille.
20. Monitor G at the field rate. Set the *Light Control* to display an open-gate waveform of 0·7V. Insert opaque spacing into the gate film path until one half of the gate is obscured. Operate the *Show* and *Cancel* Show buttons in turn and adjust the Green *Black Level Autostab* control for minimum change in signal level for the obscured portion of the gate (i.e. for minimum flare).
21. Repeat step 20 for the Red and Blue channels.
22. Reset the R, G and B *Black Levels*. (The flare-correction controls interact with the black-level controls. Therefore, if it is impossible to set all three levels correctly, some compromise is necessary in the flare-correction settings.)
23. Insert a Resolution Card or a Test Card.
    Monitor G. Switch *Contours* to *On* and switch *Monitor Contours* (the red switch on the Green Processing Amplifier) to *On*.
    Adjust *Zero Balance* on the Contour Corrector for minimum low-frequency information on the picture monitor.
    Set *Pregamma Correction* on the Contour Corrector fully anticlockwise.
    Set *Small Amplitudes* on the Contour Corrector fully clockwise.
    Adjust *Contour Correction* for adequate vertical correction without visible overshoot.
24. Switch *Matrix* to *In*. Insert Greyscale Step-wedge (colour stock).
    Monitor G. Adjust Light Control to make white level 0·7V.
    Set C.L.U.E. to *Normal* and select *RG*. Trim the Red *Black Level*, *Gain* and *Gamma* controls to minimise patterning in the C.L.U.E. display on the check monitor.
    Select *BG* on the C.L.U.E. unit and trim the Blue controls in the same manner.
25. Remove the Greyscale and insert an 0·2 standard density.
    Adjust the *Light Control* for a picture signal output of 0·7V p-p.
    Switch to *AGC On* and check that there is no appreciable change in the output. If a change does occur, small adjustments can be made to the *AGC Gain* control on the front panel of the AM3/510 unit.

Loading

1. Check that the machine is switched to *Safe*.
   Lace the picture film, making sure that the correct direction of rotation has been selected for the feed spool. Switch to *Unsafe* and inch the film through to the synchronising mark on the leader. To get correct synchronising with a Sepmag film, rotate the *Hand Inch* knob half a turn after pull-down.
2. Set the three mode-selection keys on the maintenance control panel to the required positions; e.g. *A.G.C. On*, *Combined* and *Comopt*.
3. Before lacing a Sepmag film, switch to *Safe* and press the button on the side of the Sepmag box to set the separation of the compliance arms. Note that the correct head assembly must be fitted and the head screen must be removed to facilitate lacing.
   When lacing the Sepmag film, make sure that the direction of rotation of the feed spool is correct and that the direction of take-up is as indicated by the arrow showing the direction selected for the picture side. The film should fit snugly round all the rollers, it should be tight on the sprocket but it should not pull the compliance arms further apart. (When the machine is running the mechanism which holds the compliance arms apart is tripped and the arms should then be parallel. When running in the forward direction the compliance arms should settle in the mid-position after the mechanism has stabilised. If necessary the position of the arms can be adjusted by means of the knob on the side of the Sepmag box.)
   De-clutch the sprocket, by pressing it inwards, and wind the film round until the synchronising mark on the leader is adjacent to the replay head. Press the button on the side of the Sepmag box and check that the synchronising mark comes in the centre of the replay head.
   Replace the head screen.
4. Shut the door, switch to *Unsafe* and run the machine down to the start mark.
   Check that the *Ready* indicator is lit.
   If *Comopt* is selected, check that the exciter lamp indicator lights up when the machine runs. If Commag is selected, check that the indicator lamp on the projector is lit.
5. The machine is now ready to run. Switch to *Remote Full* if required.

Video

General

A simplified block diagram which shows the video signal paths through an EP6/505 telecine machine, together with the associated line-up and colour-monitor trolleys, is given in Fig. 3. A more detailed diagram which omits the trolleys but includes pulse distribution is given in Fig. 4.

The RGB signals from the Philips camera channel are fed to an EP1/503 Tarif Processing Equipment. This equipment provided variable gain and contrast controls for each of the colour channels to compensate for incorrect colour bias in any of the constituent layers of the film being projected. From the EP1/503 the processed signals are fed via distribution amplifiers to a GE1M/526 PAL Coder, together with RGB signals from a GE4/523 Colour Bar Generator. The coder output comprises either a coded picture signal or coded colour bars and the selected signal is fed via a distribution amplifier to a relay which routes to line either the coder output or the output of a GE4/506B Sawtooth and Lift Generator.

An additional output is provided by a UN9/544 RGBY switch unit. This unit accepts feeds of the three colour signals prior to coding, samples them sequentially, and produces an output signal which is repeated every five lines. (One line in the sequence is blank and one is reserved for a luminance signal which is not used in this application.) The unit also produces a trigger pulse at the start of each sampling sequence, but this is not used in this application. The output can be displayed on an MN6/503 waveform monitor which is mounted on the remote control desk.

Automatic Gain Control

The A.G.C. system compares the video signal with a reference potential which is determined by the setting of the *Light Control*, and uses the resulting error signal to control the light valve in the projector.

Rising and falling signals are treated in different ways by the A.G.C. system. Overloads are considered visually objectionable and are reduced to normal amplitude within one field, but a fall in signal level is restored to normal relatively slowly (about 0·5 seconds) to avoid the visual affect of a sudden increase in level.

An interconnection diagram of the units comprising the A.G.C. system is given in Fig. 5. The telecine machine operates in the A.G.C. mode only when the *A.G.C. On/A.G.C. Off* key on the PA6/521 panel is set to *A.G.C. On*. At all other times the feedback path is interrupted by the contacts of the *Auto* relay on the PA1/526A Telecine Panel.

The video signal is sampled at the first point in the camera channel at which it reaches maximum amplitude (0·7V). It is then applied to a UN1/556 Waveform Suppression Unit which blanks out a border round the edge of the picture to ensure that spurious pulses do not upset the operation of the A.G.C. system. From the Waveform Suppression Unit the signal is fed to an AM3/510 A.G.C. Amplifier Detector in which the peak signal amplitude is compared with the reference signal from the *Light Control* and an appropriate error signal is derived. When the telecine is working in the A.G.C. mode, this error signal is amplified in an AM1/8 Motor Drive Amplifier and is then applied to the motor which drives the light valve (The function of the resistor-diode network connected to the input of the AM1/8 is to limit the excursion of the light valve.)

When the telecine is working in the manual (A.G.C. Off) mode, the potential present at the wiper of the *Light Control* is applied directly to the Motor Drive Amplifier. Thus, for manual operation, the setting of the light valve is varied only when the *Light Control* is varied.

Automatic stabilisation is provided also for the *Black Level* circuit, to compensate for variations in the average scene brightness. This circuit forms part of the camera channel and is described in the Philips handbook.

Local/Remote Operation

When *Remote Full* operation is selected (see Fig. 5) an earth is applied via the *Local/Remote* key to relays RMA and RMC on the PA17/509 Control and Delay relay panel. The AGC *On/Off* control is then transferred, via relay contact RMC-2, to the remote position.

Monitoring

The only video monitor which forms a permanent part of the telecine machine is an 11-inch monochrome picture monitor which is mounted to the right of the camera. This monitor is fed from a C.L.U.E. (Colour Line-up Equipment) unit which, in turn, is fed with feeds of the three colour signals and with the selected output (labelled *Cam. Mon Output* in Fig. 4) of the C.C.U. monitor panel. This output consists of: one of the colour signals,

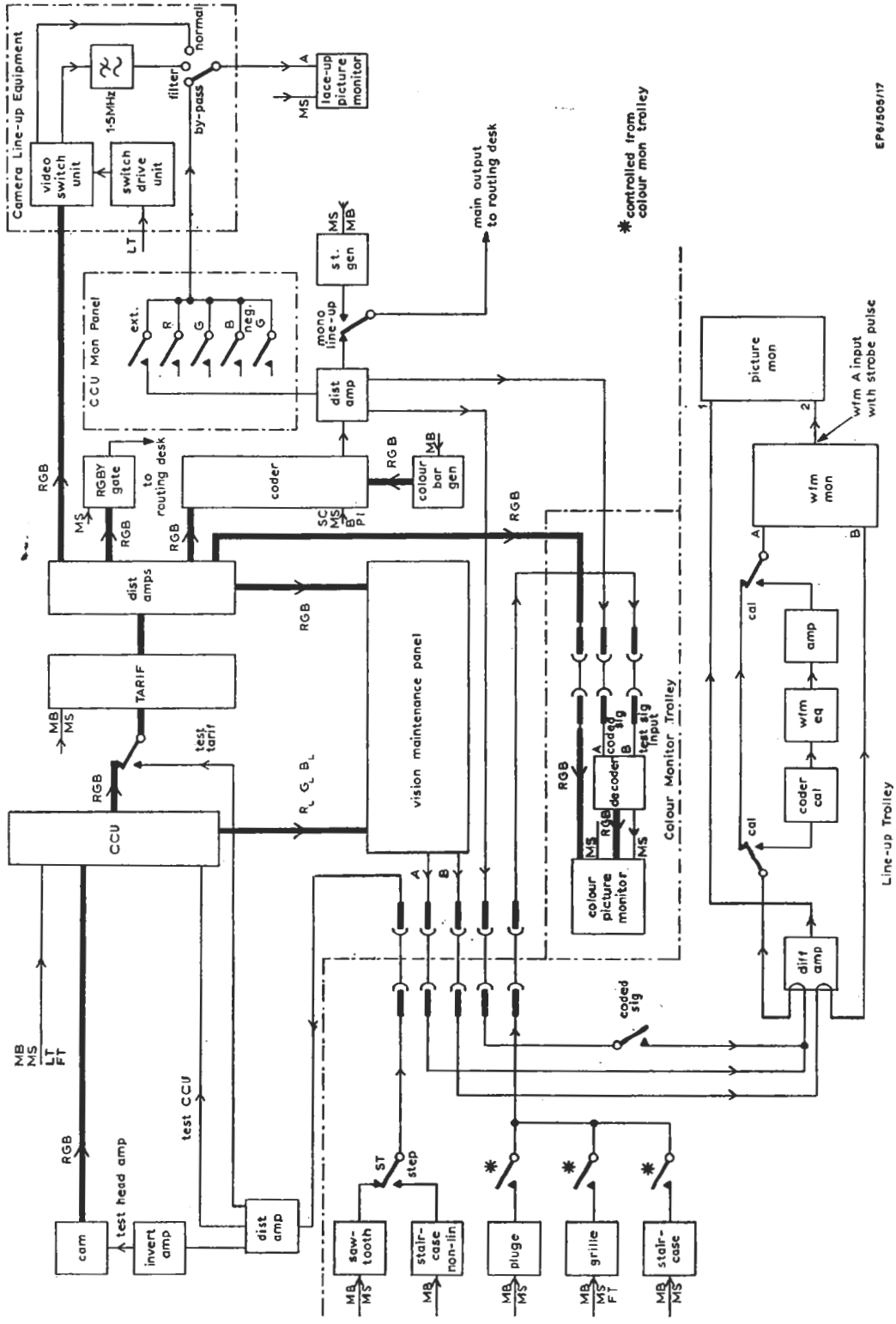

Fig. 3 Simplified Block Diagram of Video Paths

a negative green signal, or the coded output of the telecine channel. When the C.L.U.E. unit is working in its normal mode, as a colour-balancing device, its output consists of alternate bands of green and another colour (red or blue as selected); each band being about four lines wide. However, the C.L.U.E. unit contains a bypass switch which can be used to route the *Cam. Mon Output* signal through to the monitor in place of the colour-balancing signal. Thus the monitor can display:

any one of the colour signals
a negative green signal
green and one other colour signal in alternate four-line bands
the luminance component of the coded signal.

For more sophisticated monitoring, e.g. for maintenance and line-up purposes, trolley-mounted equipment is provided.

A line-up trolley and a colour monitor trolley can be connected to the telecine channel via multi-way sockets on bay 4. The line-up trolley carries a waveform monitor, a vectorscope, a coder calibrator, a selection of test-waveform generators, a monochrome picture monitor and a PA6/520 Tarif Control Panel. The colour monitor trolley carries a 19-inch colour picture monitor and a decoder.

A simplified circuit of the line-up trolley, which shows also the d.c. connections to the colour monitor trolley, is given in Fig. 6. Three switches are provided on the trolley; one to calibrate the waveform monitor, one to select the required input to the waveform monitor and one to select the required test signal (sawtooth or non-linear staircase) for application to the telecine channel. The monochrome picture monitor is fed either with the output of an AM1/535A Difference Amplifier or (via a U-link) with a signal from the waveform monitor consisting of the A-input signal plus a strobe pulse.

The waveform monitor signal-selection circuits external to the line-up trolley are given in Figs. 4 and 7; the signal circuits in Fig. 4 and the d.c. circuit in Fig. 7. The selection pushbuttons are mounted on the Vision Maintenance Panel above the C.C.U. and the associated relays form part of a PA17/522 relay panel which is located on Bay 4. A detailed circuit of the relay panel is given in Fig. 8.

Test Signals

Test signals can be derived either from the built-in GE4/506B Sawtooth and Lift Generator (see Fig. 4) or from the test-signal generators mounted on the line-up trolley. Normally, the GE4/506B is used to test the line external to the telecine machine and a test signal from the line-up trolley is used to test the video path through the telecine machine and its associated units. However, both signals appear at U-links on the bay and so they can be cross-coupled if required.

Test signals can be applied to the video chain at three points: at the inputs to the head amplifiers (called first pre-amplifiers in the Philips handbook); at the inputs to the processing amplifiers in the C.C.U. and at the input to the EP1/503 TARIF equipment. The signal circuits are shown in Fig. 4 and the d.c. circuits are shown in Fig. 7.

The Philips head amplifiers have been modified to accept a standard-level test signal; this is fed to the camera via the viewfinder feed in the camera cable. The modification is shown in Fig. 9.

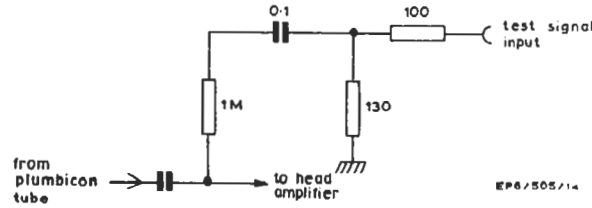

Fig. 9 Modification to Apply Standard-level Test Signals to the Head Amplifiers

When the *Test Signal* switch is in the *Test Head Amp* position, an 0·7 volt test signal is applied to the input of each head amplifier via a potential divider, an isolating capacitor and a 1-megohm resistor. The potential divider reduces the signal amplitude to 0·3 volts and so a signal current of 0·3 μA flows through the 1-megohm resistor to the head amplifier.

When the *Test Signal* switch is in the *Test C.C.U.* position, a test signal with an amplitude of 1·4 volts p-p is applied to the processing amplifiers in the C.C.U. Note that although the individual *Test* switches on the processing amplifiers are no longer used, *they must not be operated because they are still present in the signal path.*

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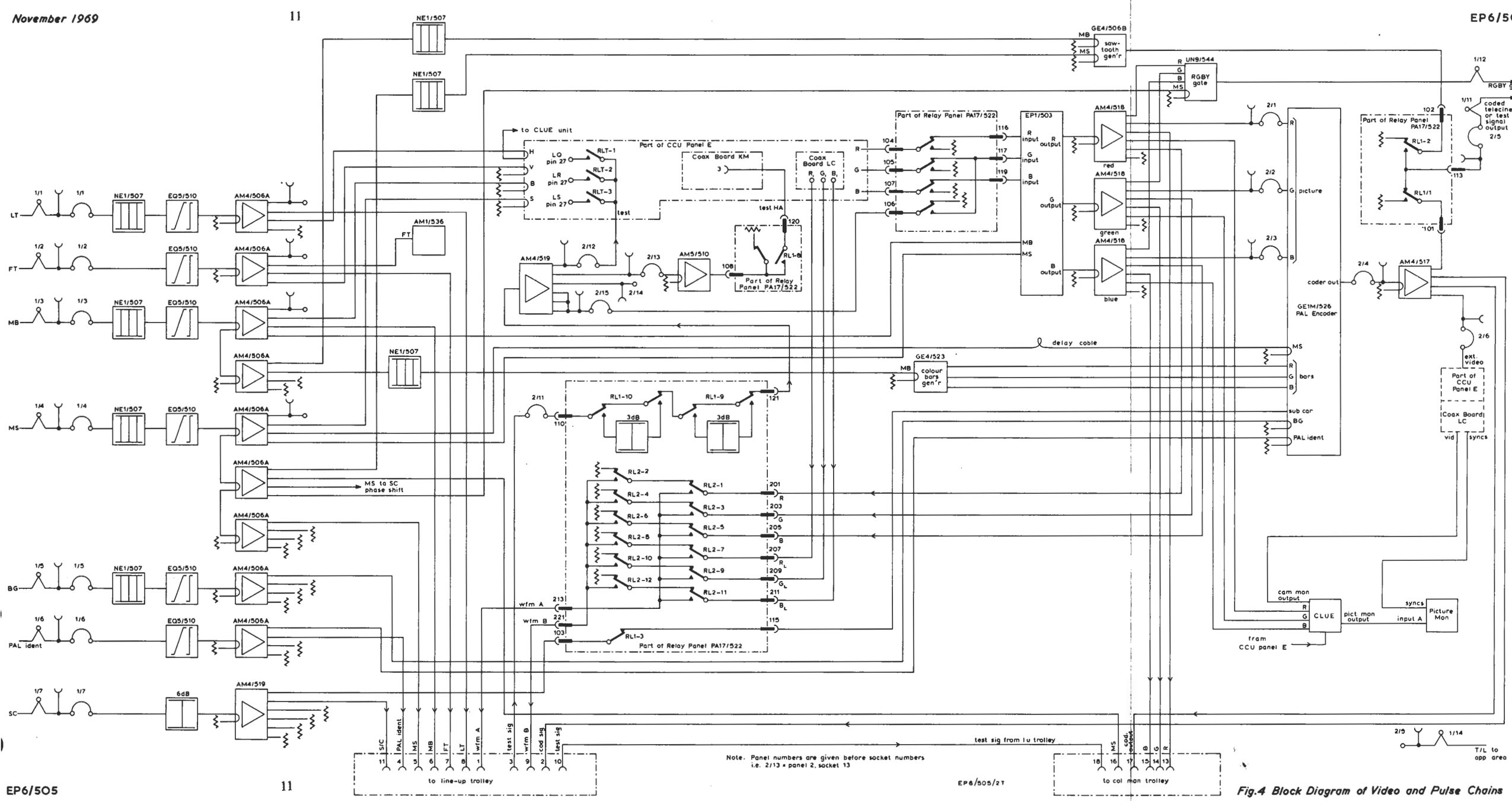


Note. Panel numbers are given before socket numbers i.e. 2/13 = panel 2, socket 13

EP6/505/2T

Fig.4 Block Diagram of Video and Pulse Chains

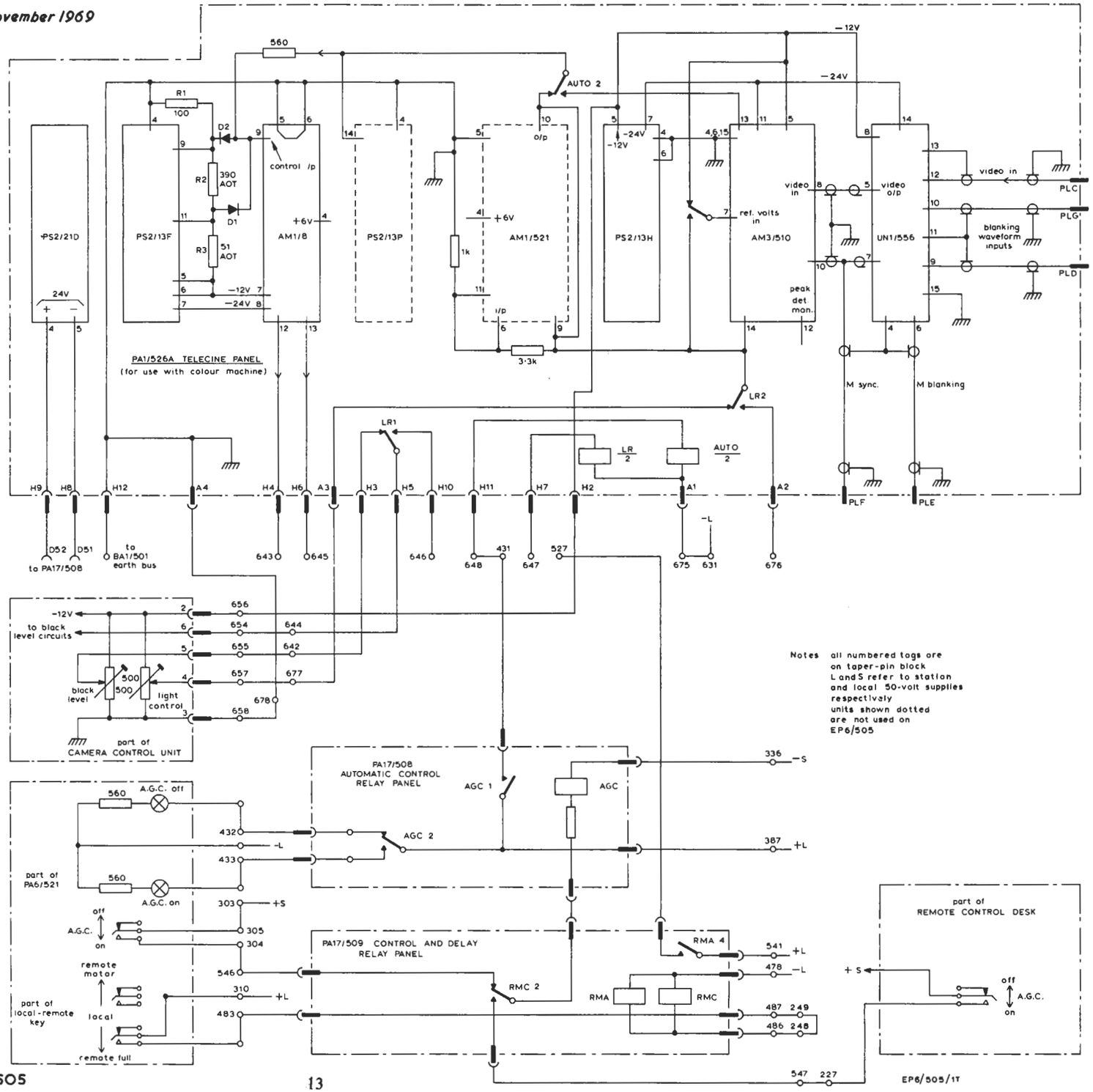
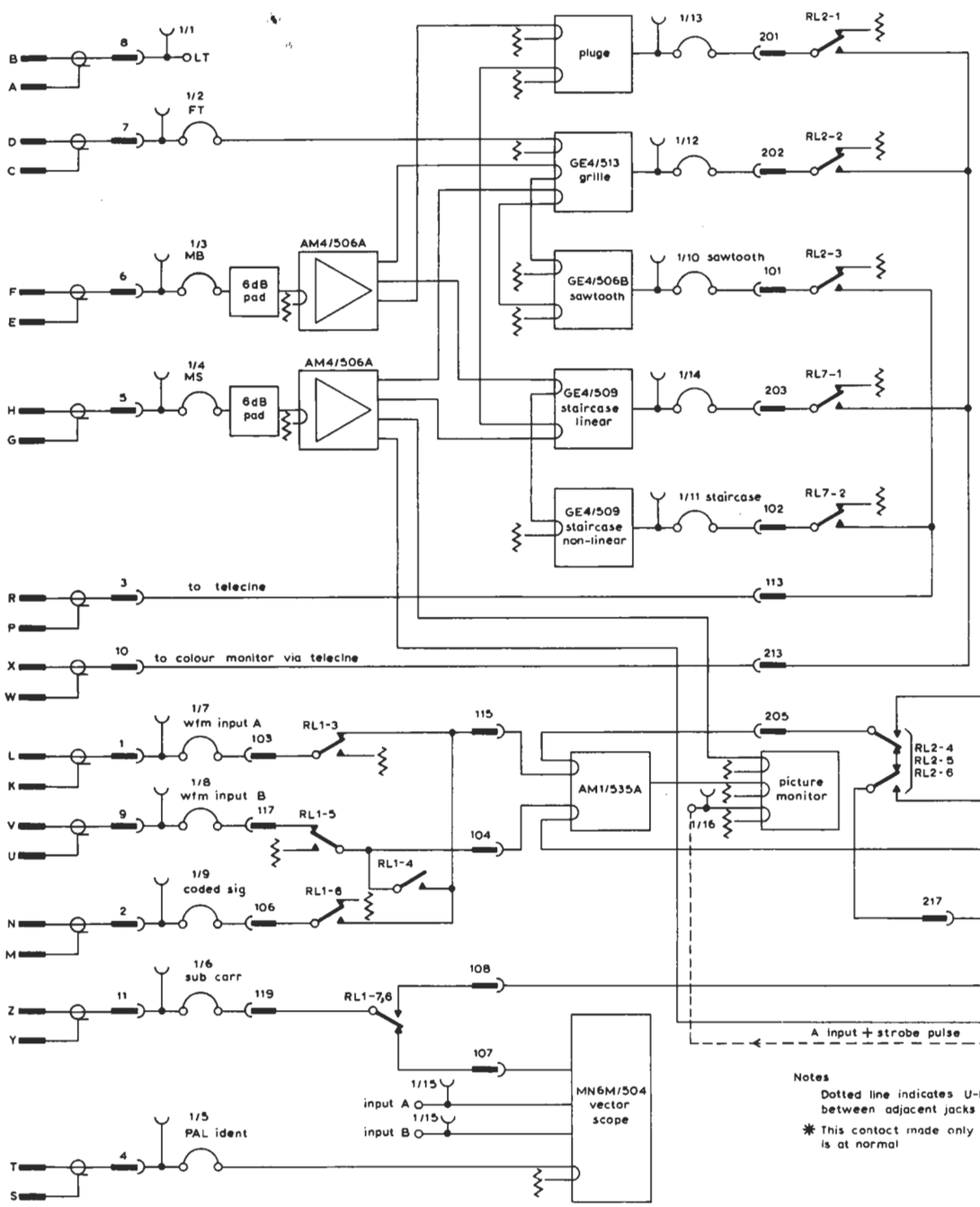


Fig 5 Interconnections of the A.G.C. System in EP6/505



Notes

Dotted line indicates U-link connection between adjacent jacks

* This contact made only when switch is at normal

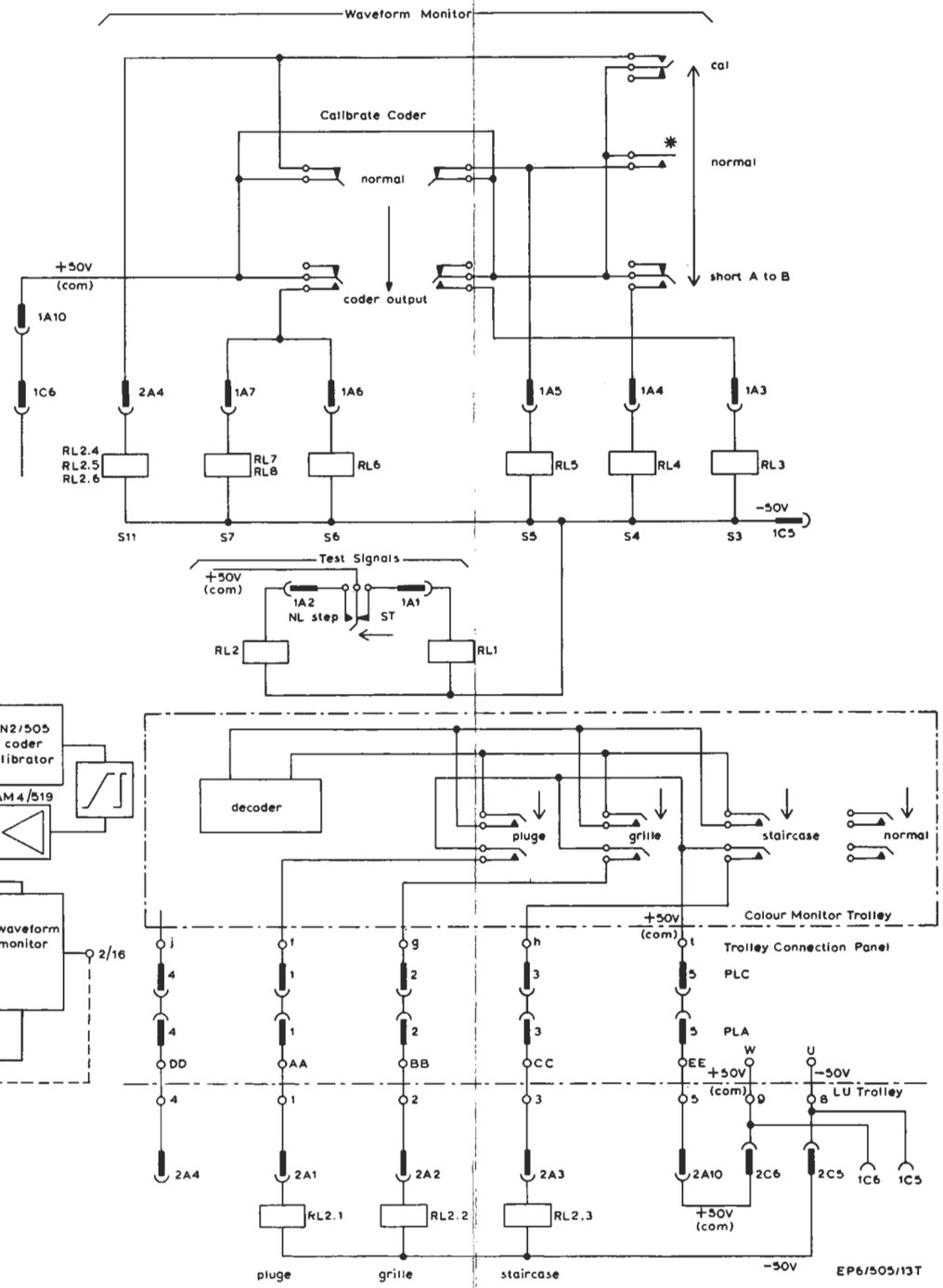


Fig.6 Simplified Circuit of Line-up Trolley

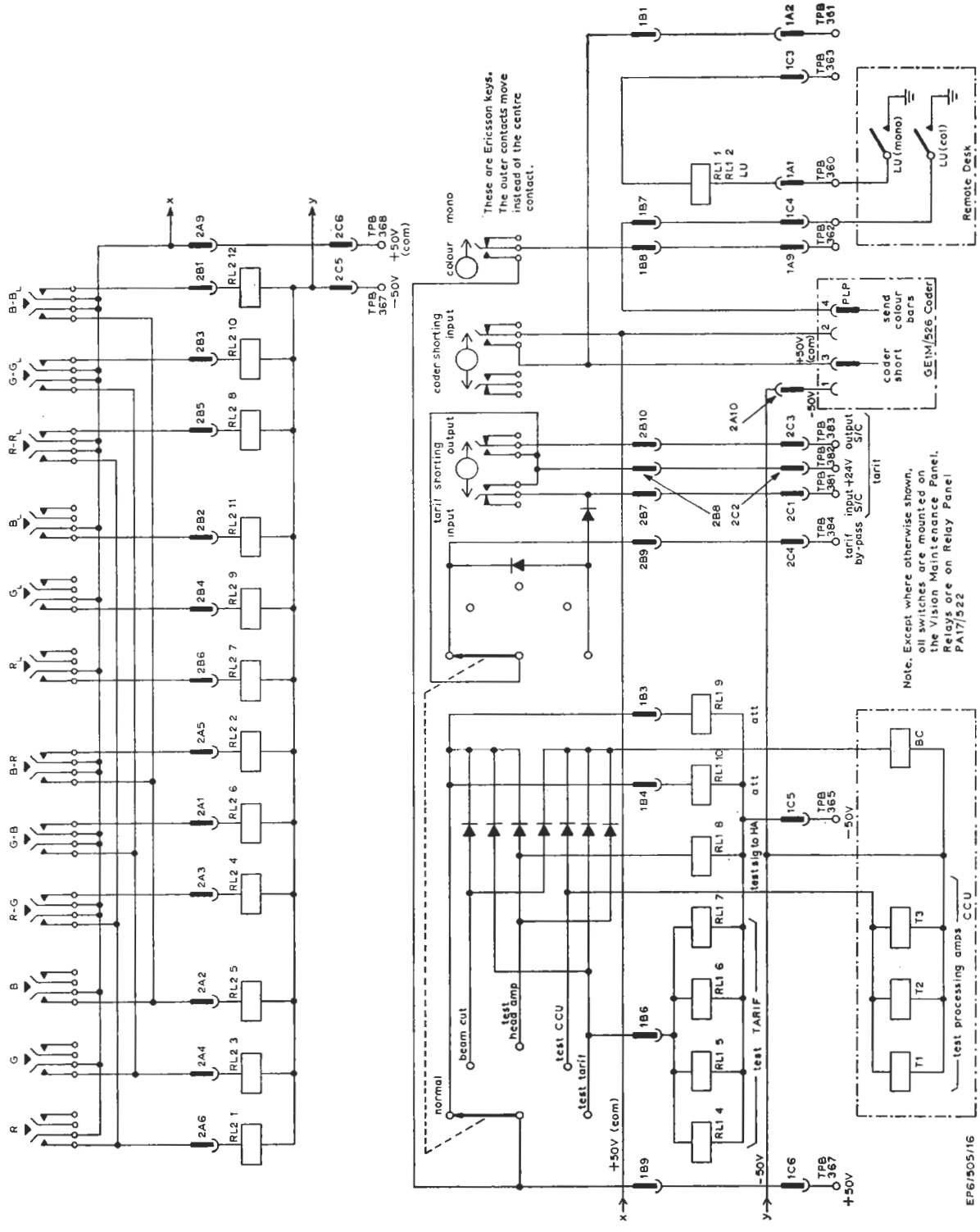
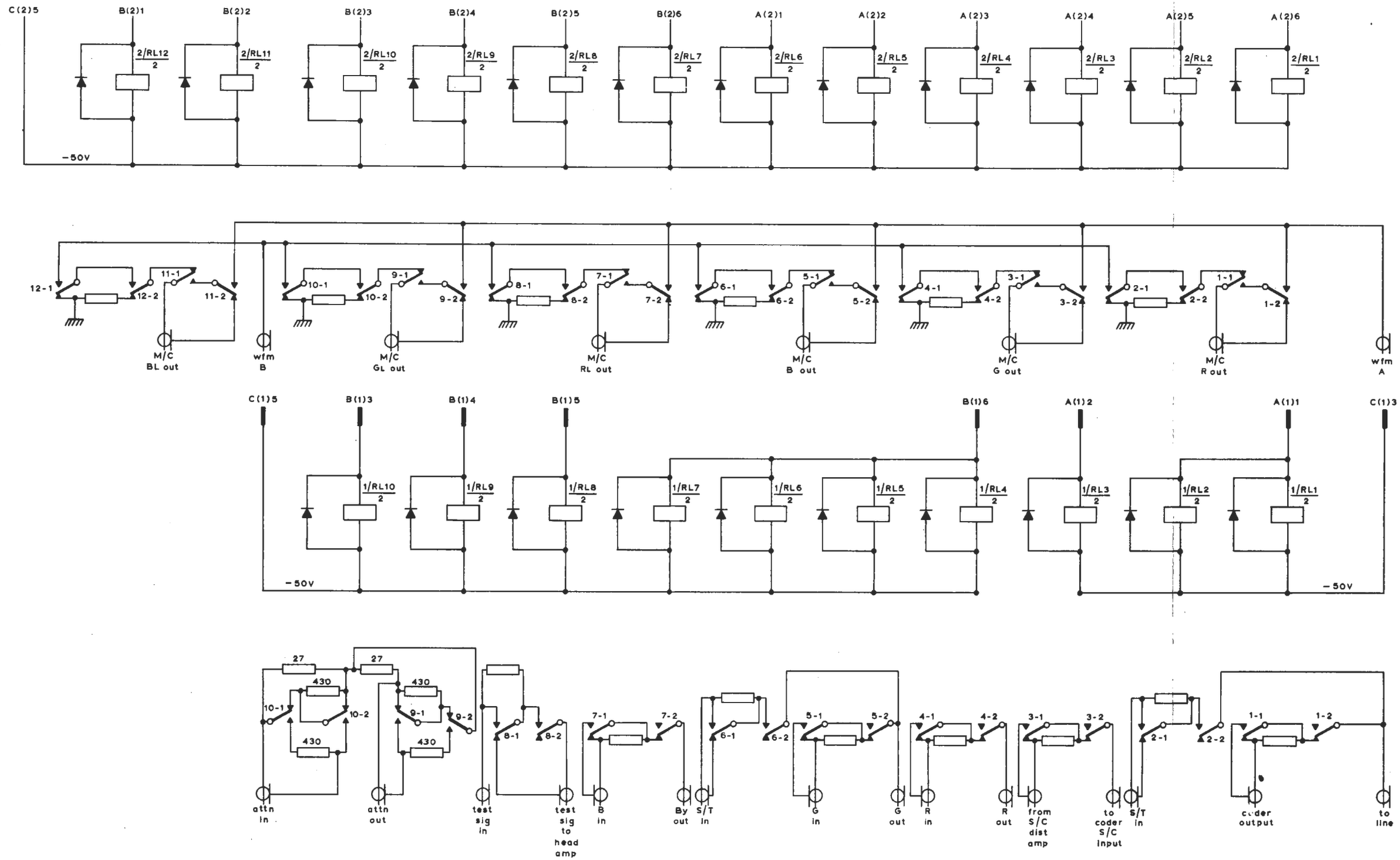


Fig. 7 Waveform Monitor Signal-selection Circuit



notes all relays are type
all diodes are type
all unmarked resistors are 75Ω.

EP6/505/10T

Fig.8 Relay Panel

The *Test TARIF* position of the *Test Signal* switch is used in conjunction with the *Input* position of the *TARIF Shorting* switch to apply test signals to the TARIF equipment. When both switches are set to the appropriate position, the R, G and B outputs of the C.C.U. are disconnected from the TARIF equipment and the R, G and B inputs of the TARIF equipment are connected together. The test signal is then applied via the G input connection to all three TARIF inputs (see Fig. 4).

Also shown in Fig. 7 are the *Coder Shorting* and *Colour/Mono* switches. The *Coder Shorting* switch is used to connect together the colour inputs to the coder for alignment purposes. The *Colour/Mono* switch is a locking version of the *Coder Shorting* switch.

Sound

A block diagram of sound reproducing facilities is shown in Fig. 10 and a block diagram of the sound recording facilities, which are provided on one channel, is shown in Fig. 11. The reproducing controls are located on the PA6/521 Maintenance Control Panel and the recording controls are located on the PA6/48 Sepmag and Commag Recording Control Panel.

Reproducing

(a) Comopt

The light from an exciter lamp is focussed onto the optical sound track of the film and the light emerging from the sound track is applied, via a silicon photovoltaic cell and a transformer, to an AM16/3 Reproducing Amplifier. This provides

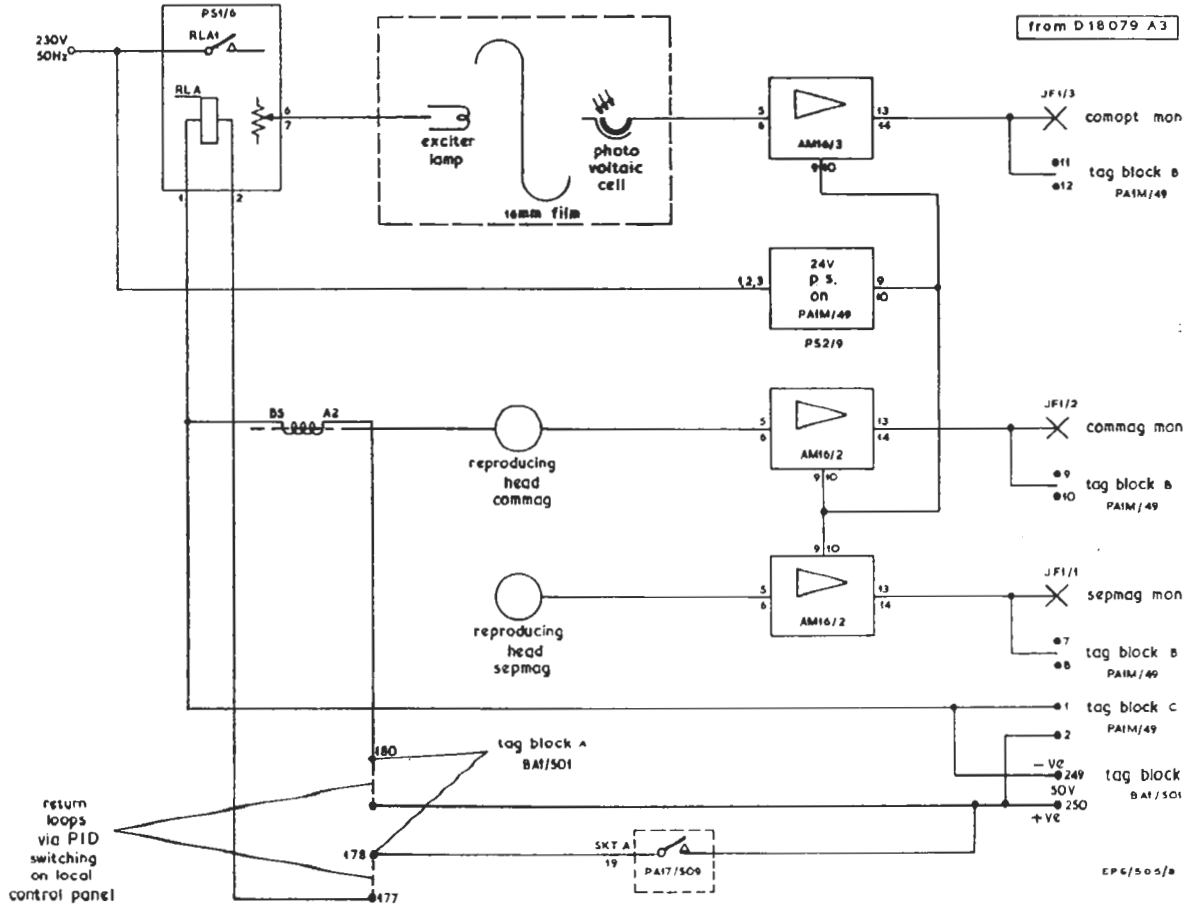


Fig. 10 Block Diagram of Sound Reproducing System

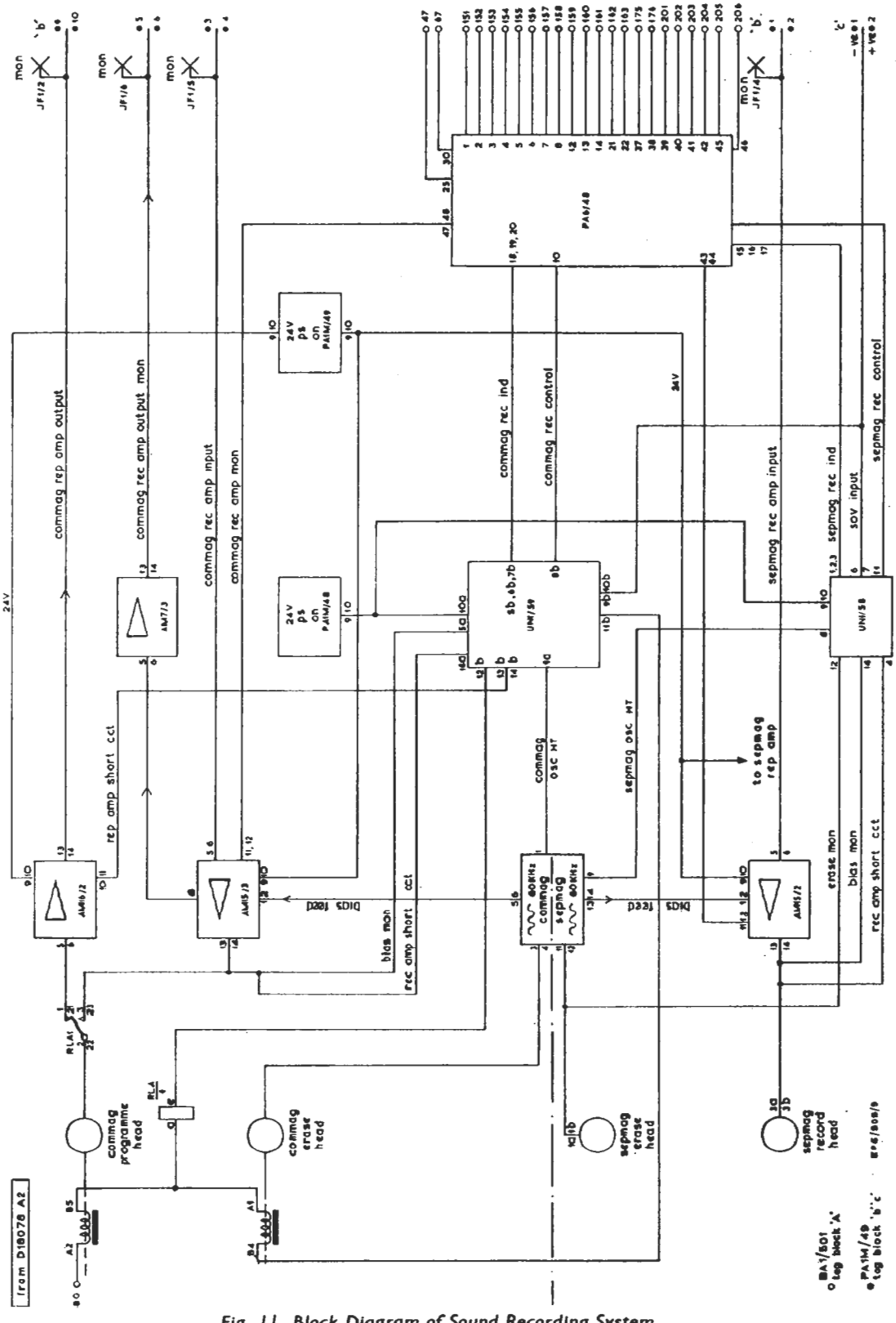


Fig. 11 Block Diagram of Sound Recording System

compensation for the high-frequency loss caused by the finite width of the scanning slit. The output from the amplifier feeds the main sound programme tag-block (mounted on the rear of the PA1M/49 reproducing panel) and a monitor point on the local jackfield.

(*b*) *Commag*

The commag programme head is brought into contact with the magnetic stripe on the film by the action of a solenoid unit which is energised from the local 50-volt supply via the source-selection key on the maintenance control panel and a relay in the bay 5. When the solenoid operates it also actuates a microswitch which lights an indicator lamp. The output from the head is fed via an AM16/2 Reproducing Amplifier to the main sound programme tag-block and also to a monitor point on the local jackfield.

(*c*) *Sepmag*

The Sepmag reproducing head is in contact with the magnetic film stock at all times. The output from the head is applied via an AM16/2 Reproducing Amplifier to the main sound programme tag block and also to a monitor point on the local jackfield. The Sepmag and Commag chains both use AM16/2 amplifiers but, because of the different reproducing heads used, these amplifiers are not directly interchangeable.

Recording

(*a*) *Commag*

In the Commag system the same head (the programme head) is used both for recording and for reproducing. Therefore, when recording, it is necessary to switch the head from the input of the reproducing amplifier to the output of the recording amplifier. It is necessary also to bring the erase head into contact with the magnetic stripe on the film.

When the Commag *Record Available* key and the Commag *Record* pushbutton are both operated the following operations take place:

1. The erase head is brought into contact with the magnetic stripe on the film by means of a solenoid; an indicator lamp is lit when this operation is completed.
2. The programme head is changed over from the input of the AM16/2 Reproducing Amplifier to the output of the AM15/3 Recording Amplifier.
3. A short-circuit is inserted at a convenient point in the reproducing amplifier circuit to prevent cross-talk from the recording amplifier being fed to line via the contacts of the change-over relay and the reproducing amplifier.
4. A short-circuit previously connected across the output of the recording amplifier is removed. This short-circuit is applied to the recording amplifier when the equipment is working in the reproducing mode.
5. Power is applied to the bias and erase oscillators. Additionally, the lamp in the Commag *Record* button is lit to indicate that the sequence of switching operations is complete.

To stop recording, press the Commag *Stop Record* button and the above sequence of operations is carried out in the reverse order. The unit which carries out these operations is the UN1/59 Telecine Commag Relay and Metering Unit.

Because a common head is used for both recording and reproduction, monitoring of the programme recorded on the magnetic stripe is not possible. Therefore the recording is monitored by feeding the programme head current, via a de-emphasis network and an AM7/3 line amplifier, to a P.P.M. and to a monitor point on the local jackfield.

(*b*) *Sepmag*

In the Sepmag system the recording head is permanently connected to an AM15/2 Recording Amplifier. When the Sepmag *Record Available* key and the Sepmag *Record* pushbutton are both operated the following operations take place:

1. A short-circuit is removed from the recording amplifier output.
2. Power is applied to the bias-and-erase oscillator and the lamp in the Sepmag *Record* button is lit.

To stop recording, press the Sepmag *Stop Record* button and the above sequence of events is carried out in the reverse order. The unit which carries out these operations is the UN1/58 Telecine Sepmag Relay and Metering Unit.

A monitoring unit, located in the Sepmag recording amplifier, provides a monitoring feed of the incoming audio signal and this is fed via selection switches to a P.P.M. and an external loudspeaker.

Optics

General

The optical system has to meet the following requirements:

(a) The channel must produce a fully modulated picture for all films which have a minimum

density of between 0·1 and 1·1 (a range of 10 : 1 in light transmission).
(b) The light path must not be obscured by a shutter blade when the projector mechanism comes to rest.
(c) Lamp failure must not cause a complete signal failure.
(d) The signal must not be over-modulated when the machine is stopping and starting.

These requirements are met by:
(a) Inserting a motor-driven iris (or light valve) in the light path.
(b) Using a shutter with two folding petals which open at about half speed.
(c) Using two projector lamps and combining their light outputs via a half-silvered mirror
(d) Automatically reducing the projector brightness (by switching one lamp off) when the machine is stopped, stopping or being inched. Delaying the full brightness of the lamps if the machine is started from a *Show* condition as distinct from an *Off* condition.

Lamphouse and Light Valve

In a conventional projector-lamphouse layout, the filament of the lamp is imaged directly onto the projector lens and any object placed between the lamp and the gate shows up as a shadow or as shading on the final picture image. (A sharp shadow is formed by the shutter but, because its frequency of operation is relatively high, the eye integrates the light and sees only an evenly illuminated field.) Therefore, if a light valve is placed in the light path, it must be positioned at a point at which it is effectively out of focus if it is not to cause shading; i.e. it must be placed at the focal point of the projector lamp filament. This is done by means of a relay lens system as shown in Fig. 12.

There are four lenses in this relay system; two primary lenses which collect light from the two projector lamps, a final lens which forms an image of the light valve on the projection lens and a relay lens (ideally situated at the light valve) which images the primary lens on to the final lens. Unfortunately the relay lens in conjunction with the final lens forms an image on the gate aperture of a point somewhere between itself and the primary lenses. Therefore a restriction is imposed on the position of the combining mirror; this must not be in focus because particles of dust may settle on it.

The light valve consists of a slotted metal vane which is driven by a low-hysteresis torque motor. Because the light valve is imaged into the main projector lens, operation of the valve controls the aperture of the lens and the depth of focus of the system. A mirror is used in conjunction with the light valve to restore the symmetry of the system and prevent shading at low light levels.

The layout of all the lamphouse components is shown in Fig. 13.

Lamps

The projector lamps are fed from a UN3/508 Lamp Supply Panel. Each lamp is fed separately but the adjusting resistors in the supply circuits are ganged so that the lamps give the same outputs. The open-circuit supply voltage is 30 volts and this is applied to the lamps via 1-ohm surge-limiting resistors. Adjustment of full brightness is by means of 1-ohm variable resistors in the lamp feeds and half brightness is achieved by switching only one lamp on. When running at the correct colour temperature the output from the lamps is in excess of that required for plumbicon operation. The required degree of attenuation is provided by Perspex diffusers which are positioned between the lamps and the primary lenses. The diffusers also help to provide the evenly-illuminated field which is required for colour working.

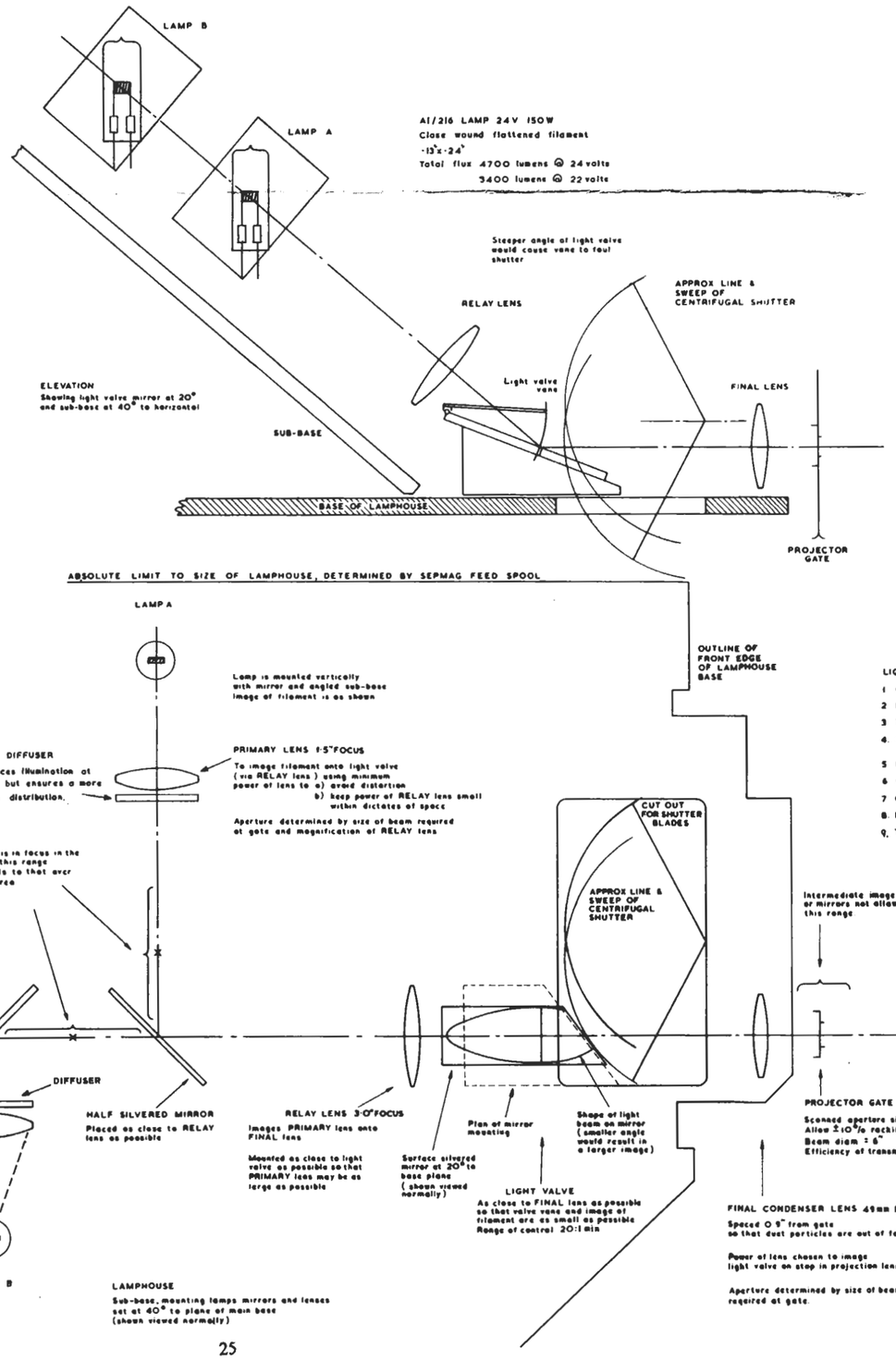
To adjust the lamps or clean the lenses it is necessary to open the lamphouse. So that the light under these conditions is not too bright for close investigation, the lamps are individually provided with a special low-power setting. At this setting the lamps have too low a colour temperature to provide a blue output.

When the projector is running, the relay control system (see Controls) over-rides both the low-power and the *Show* (half-power) conditions. When the projector stops the lamps turn off after a tun-down period at half power. If the projector is switched from *Off* to *Run* the lamps lighr immediately, but their rate of heating matches the acceleration of the projector and over-modulation of the picture signal does not occur.

Controls and Motors

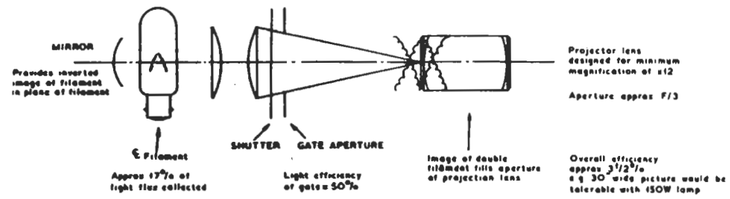
Controls

The functions of the controls for the various conditions of operation of the telecine machine are given in Table 1. In the table, a reference to Automatic under the heading Location of Controls,

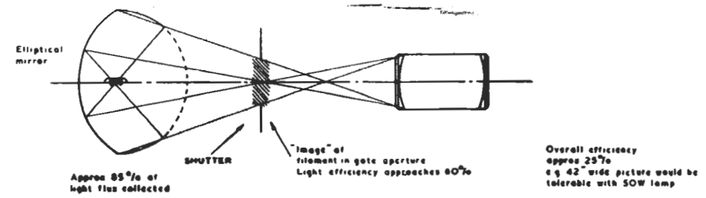


LIGHT FLUX REQUIRED (APPROX) IN LUMENS

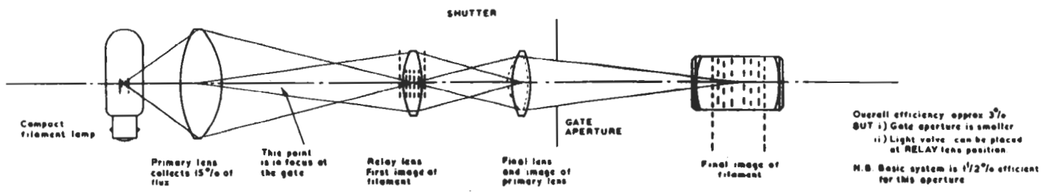
1	On target of plumbicon	·01
2	Into projection lens	·015
3	Through film	·02
4	Onto back of gate (open gate)	·06
5	From light valve	1·4
6	Onto light valve	2·9
7	Onto Diffuser	5·1
8	Into primary lens	60
9	Total filament output	3000



BASIC LANTERN PROJECTION SYSTEM



ELLIPTICAL MIRROR PROJECTION SYSTEM



RELAY LENS PROJECTION SYSTEM

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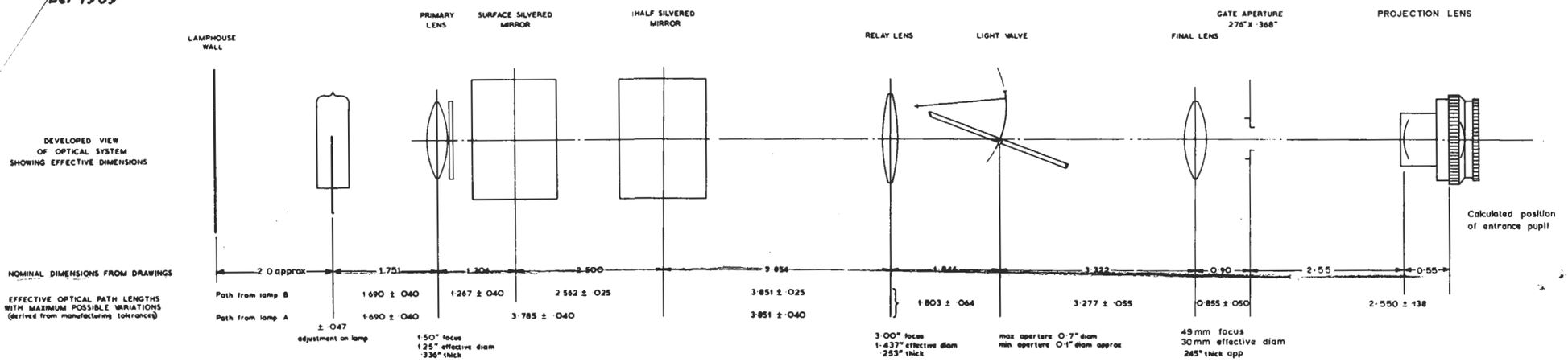
EP6/505

Fig.12 Optical System: Lamphouse Design



EP6/505

FORMATION OF 'IN FOCUS' POINTS ON GATE APERTURE

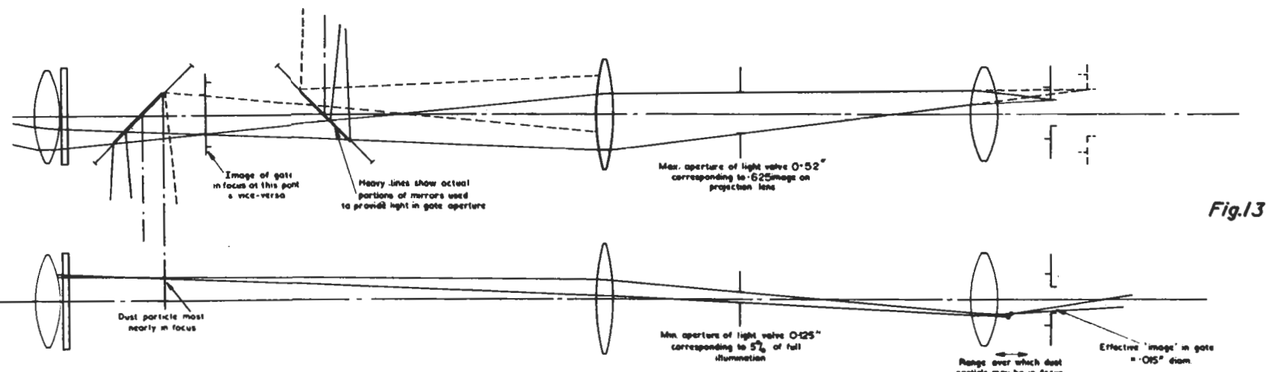


Fig.13 Optical System : Lamphouse Layout

indicates that the function referred to is controlled by logic circuits. These circuits are shown in Figs. 14 to 18.

The machine will perform the functions shown in the table subject to the conditions as described being correct. All the functions can be selected either locally or from a remote control panel unless specifically described otherwise. The lamp indicators on the remote panel are illuminated only when *Remote* operation has been selected; when the machine is operated from a remote position all local lamp indicators are illuminated in the appropriate manner. All controls and indications which can be switched to a remote control panel are operated by the station 50-volt supply; all derived controls and components which take a heavy current are operated by a locally-generated 50-volt supply. In Figs. 14 to 18, the letters +S and −S refer to the station supply and the letters +L and −L refer to the locally-generated supply.

Some functions of the machine can be initiated from the machine itself or from a remote control panel and several of the control circuits are associated with two or more relay panels. In these circumstances one comprehensive circuit diagram of the entire control system would be too unwieldy for use. Therefore several circuits have been provided, each one dealing with certain specific functions of the control system.

Fig. 14 shows the basic *Run* conditions for the motor.

Fig. 15 deals with the *Inch* and *Stop* conditions; this drawing also shows the brake and clutch circuits.

Fig. 16 shows the *Sepmag Lock* and *Unlock* arrangements, the feeds to the spool motors and sound drums, and the hour-meter circuit.

Fig. 17 shows the indicator lamps.

Fig. 18 shows the mains switching and d.c. distribution circuits together with the film-racking and lamp-control circuits.

The *Forward*, *Reverse*, *Inch* and *Stop* buttons can be operated in any order. If more than one of these buttons is pressed at a time, *Stop* always takes precedence over all the other buttons and *Inch* takes precedence over the remainder. If the *Forward* and *Reverse* buttons are pressed simultaneously, no operation takes place. If buttons are pressed sequentially, the last button to be pressed in the sequence causes the mechanism to select that mode.

TABLE 1

Item	*Condition or Mode*	*Form of Operation*	*Location of Control*
MOTOR	BASIC RUN	Safety Switches closed. Indicators showing '*Unsafe*.' Projector safety door closed. (May be opened temporarily when running.)	Local Local Local
	BASIC RUN-UP	Motor accelerates under reduced power and reaches full speed in 2 seconds. At this time it is running in synchronism with field pulses and is switched to full power.	Automatic
	FORWARD from Stop	Press '*Forward*' button momentarily. Buttons illuminate green. Motor runs up to full speed.	
	REVERSE from Stop	Press '*Reverse*' button momentarily. Buttons illuminate dark blue. Motor runs up to full speed in reverse mode.	

TABLE 1 (continued)

Item	*Condition or Mode*	*Form of Operation*	*Location of Control*
MOTOR (contd.)	REVERSE from Forward run-up	Press '*Reverse*' button momentarily when machine is accelerating in forward direction. Buttons will illuminate dark blue. Motor runs down and stops. After a pause motor runs up in reverse. The time to reach full speed will be the same as for 'Reverse from stop.'	
	REVERSE from Forward full speed	Press '*Reverse*' button momentarily when machine is running at full speed. Buttons will illuminate dark blue. Motor runs down and stops at normal deceleration—about two seconds. After a pause motor runs up in reverse.	
	FORWARD from Reverse	Action similar to 'Reverse from Forward,' either condition.	
	INCH	Inching may take place with the safety door open.	Local
	INCH from Stop	Press '*Inch*' button and hold down. Buttons illuminate white. Motor runs at slow speed forwards. Speed may slowly increase. Motor stops when button is released. If brakes are in use motor stops on brakes.	Local and Remote Motor
	INCH from Forward	Initiate as for '*Inch*.' Motor runs down until it reaches inch speed. When button is released motor stops. Brakes are not applied.	
	INCH from Reverse	Initiate as for 'Inch.' Motor runs down, stops, pauses and starts at slow speed in forward direction. Stop sequence as for 'Inch from forward.'	

TABLE 1 (continued)

Item	*Condition or Mode*	*Form of Operation*	*Location of Control*
MOTOR (contd.)	FORWARD from Inch	Press '*Forward*' button. Release '*Inch*' button before releasing '*Forward*' Button (safety door must be closed). Buttons illuminate green. Motor transfers directly to normal run-up mode.	
	REVERSE from Inch	Initiate in a similar manner to previous item. Buttons illuminate dark blue. Motor runs down, stops, pauses and runs up in reverse. The pause will be shorter than that for 'Reverse from forward.'	
	STOP	Press '*Stop*' button momentarily. Buttons illuminate red. Motor runs down and stops in about 25 frames, or two seconds. Open either safety switch. Indicators show '*Safe*.' Motor runs down in normal manner.	All locations Local
	STOP with brakes	If brakes are in use press '*Stop*' button and hold down. Brakes are applied and machine stops in about one second.	All locations
	SEPMAG LOCK	Safety switches closed. Indicators showing '*Unsafe*.' Machine not running. Press '*Lock*' button. Sepmag selsyn may inch up to half a rev., selsyns lock, '*Lock*' buttons illuminate, Indicators show '*Locked*.' Safety switches may be opened and system will remain locked, indicating '*Safe*' and '*Locked*.' During locking sequence all the motor mode controls are isolated.	Local Local Local and Sepmag Automatic Local Automatic
	SEPMAG UNLOCK	Press '*Unlock*' button. Selsyns unlock and '*Lock*' button-lamps extinguish.	All locations

TABLE 1 (continued)

Item	*Condition or Mode*	*Form of Operation*	*Location of Control*
MOTOR (contd.)	RUNAWAY	Press ' *Unlock* ' button immediately. N.B. Runaway is a fault condition in which the machine attempts to run at twice normal speed. The only method of removing power is to break the lock between the selsyns. If brakes are in use, the machine should be held stationary. See also the section on the Clutch.	All locations
SPOOL MOTORS	BASIC RUN	Spool motors start running as soon as main motor starts under any conditions except runaway.	Automatic
	STOP	Spool motors stop about 3 seconds after main motor begins its run down sequence.	Automatic
	REVERSE	All spools always run in the same direction whichever way the main motor runs.	
	FORWARD	Internal Sepmag (Double Band) feed spool will not run unless magnetic film is present.	Automatic
	A and B WIND Picture	Operate R.H. switch so that arrow shows direction of pay-off of film from feed spool. Spool motor drive acts as hold-back for the film or take-up during reverse running.	Local
	A and B WIND Sound	Operational is identical to previous item. Direction of take up has been determined by previous operation—one spool motor drives picture feed and sound take-up—arrow shows rotatation of spool.	Local

Item	*Condition or Mode*	*Form of Operation*	*Location of Control*
BRAKES	SELECTION	(a) no brakes (b) brakes if locked to a Sepmag machine (c) brakes if not locked to a Sepmag machine (d) brakes in either condition	Local
	RUN DOWN	Hold '*Stop*' button down. Brakes are applied until button is released.	All locations
	STOP	Brakes are applied when machine is at rest, at the instant that the spool motors stop.	Automatic
	STOP from Inch	Brakes are NOT operative during normal run down. Brakes operate during run down from local inch if inch was initiated from '*Stop*.'	Local and Remote Motor
CLUTCH	HAND INCH	Clutch, which connects hand-inch knob to motor shaft, is powered as spool motors stop. Clutch operates in an identical manner to brakes for 'Stop from Inch.' Clutch slipping torque does not allow impulsive hand inching to break lock with Sepmag. If during a runaway from a running condition, the '*Stop*' button is pressed and the brakes do not hold the machine, the hand inch knob will rotate at the motor speed after a 3 seconds delay.	Automatic Local and Remote Motor Local
FLYWHEEL DRIVE	RUN-UP	Flywheels of Combined or Separate sound systems are connected to the projector mechanism during the 2 second run-up cycle.	Automatic
	RUN DOWN	Flywheels are also connected during the run down cycle and remains so until the spool motors stop.	Automatic

TABLE 1 (continued)

Item	*Condition or Mode*	*Form of Operation*	*Location of Control*
FLYWHEEL DRIVE (contd.)	INCH	Flywheels are driven during powered inching. The flywheels are friction driven with allowance for wear in the device. Extended inching may cause some loss of loop and film slip on the sound drum.	Automatic
	HAND INCH	Flywheels are not driven during hand inch except for 3 seconds immediately following powered inch—see '*Run Down.*'	Local
	SEPMAG	Sepmag flywheel is not driven if there is no magnetic film.	Automatic
PROJECTION LAMPS	LOW POWER	Ensure that the lamps are off, by operating '*Cancel Show.*' Ensure that the mechanism is stationary. Press 'Low Power' button momentarily. Button illuminates red. One lamp lights and the corresponding lamp button illuminates. Press appropriate lamp button to light other lamp. There will be a delay as the lamps change over due to the low rate of heating of the lamps.	Local Local
	COOLING FAN	Fan operates whenever any lamp is alight and for a suitable period after all lamps are extinguished.	Automatic
	HALF POWER Show	Press '*Show*' button momentarily. One lamp lights and meter reads in the red band. The appropriate lamp button and the *Show* button will illuminate white whenever a projection lamp is on.	Local
	OFF	Press '*Show*' button momentarily.	Local
	HALF POWER Test	When the machine is being operated remotely the local '*Show*' button must be held down for the lamp to remain alight, i.e. it provides a test facility.	Local

TABLE 1 (continued)

Item	*Condition or Mode*	*Form of Operation*	*Location of Control*
PROJECTION LAMPS (continued)	INCH	During inching only one lamp is on (half power condition) the lamp goes out when the spool motors stop.	Automatic
	RUN	The lamps light at full power only when the motor is running at full speed. Light meter reads in the green band.	Local
		Full power mode cancels any other selected mode.	Automatic
	RUN from Stop	Lamps receive full power as soon as machine is started. Lamps attain full brightness after about 1 second.	Automatic
	RUN from Show	One lamp is already on, the second lamp reaches full brightness after about one second.	Automatic
	STOP from Run	Lamps are switched to half-power mode as soon as the stop sequence begins.	Automatic
		Lamps extinguish when spool motors stop.	Automatic
INDICATORS	REMOTE	Select either *Remote Motor* or *Remote Full.*	Local
		Remote Motor gives *Ready to Run* indication (a combination of the projector *Stop* and *Ready* indicators) and *Forward* or *Reverse* as appropriate.	Remote
		Remote Full gives the above indicators plus *Locked, Show, No Opt Film* and *No Mag Film.* (The *No Mag Film* indicator lights only if there was magnetic film in the projector when *Remote Full* was selected and the film subsequently breaks or runs out.)	Remote
		Local indicators which give the position of remote controls are: *A.G.C. On/Off, Off/Comopt/Commag, Ext Sepmag/Combined/Int Sepmag.*	Local

TABLE 1 (continued)

Item	*Condition or Mode*	*Form of Operation*	*Location of Control*
CONTROLS	REMOTE	Other controls available on the Remote Panel are: *Manual/AGC*, *Unlock*, *Racking* and *TARIF* controls.	Remote
MAINS SWITCHING (Interlocks)		Primary ON/OFF switch feeds station 50 V to Main Relay Panel PA17/510.	Local
		Primary relays feed single phase mains to Bay 4.	Automatic
		Local 50 V supply on bay 4 feeds the Main Relay Panel.	Automatic
		Secondary relays feed three phase mains to Auxiliary Relay Panel PA17/511 and to the:	Automatic
		Tertiary relay. This feeds single phase mains to the Sound Cabinet CA1/506 and the C.C.U. Also station and local 50 V supplies to the main distribution blocks.	Automatic
(Unit Feeds)		No video or control unit has a switch in the supply feed. The primary ON/OFF switch controls the whole telecine as an integral piece of apparatus.	Local

Motor and Motor Drive

The motor used on the telecine machine consists of two separate motors mounted on a common shaft; each motor has a continuous rating of $\frac{1}{16}$ h.p. The basic *Run* conditions for the motor are shown in Fig. 14 and the *Inch* and *Stop* modes of operation are shown in Fig. 15.

The primary motor is a three-phase wound-rotor synchronous motor which requires a 230-volt supply on the stator and about 20 volts on the rotor. Both stator and rotor have four-pole windings giving a synchronous speed of 1500 r.p.m. and a one-to-one correlation between change of motor speed and the frequency of the rotor supply expressed as a fraction of the mains supply frequency. (For synchronism the rotor supply is d.c.) Anti-hunt bars are fitted to the rotor and these, in addition to their primary function, enable the motor to run as an induction motor when the rotor is open-circuited.

The secondary motor also is a three-phase wound-rotor synchronous motor; it has two-pole windings and a high-impedance rotor. Anti-hunt bars are not fitted as it is essential that the motor remains stationary when power is applied to the stator but not to the rotor. This motor provides a slow-speed *Inching* facility for the telecine machine and acts also as a Selsyn drive to an external machine, usually a Sepmag recorder or reproducer.

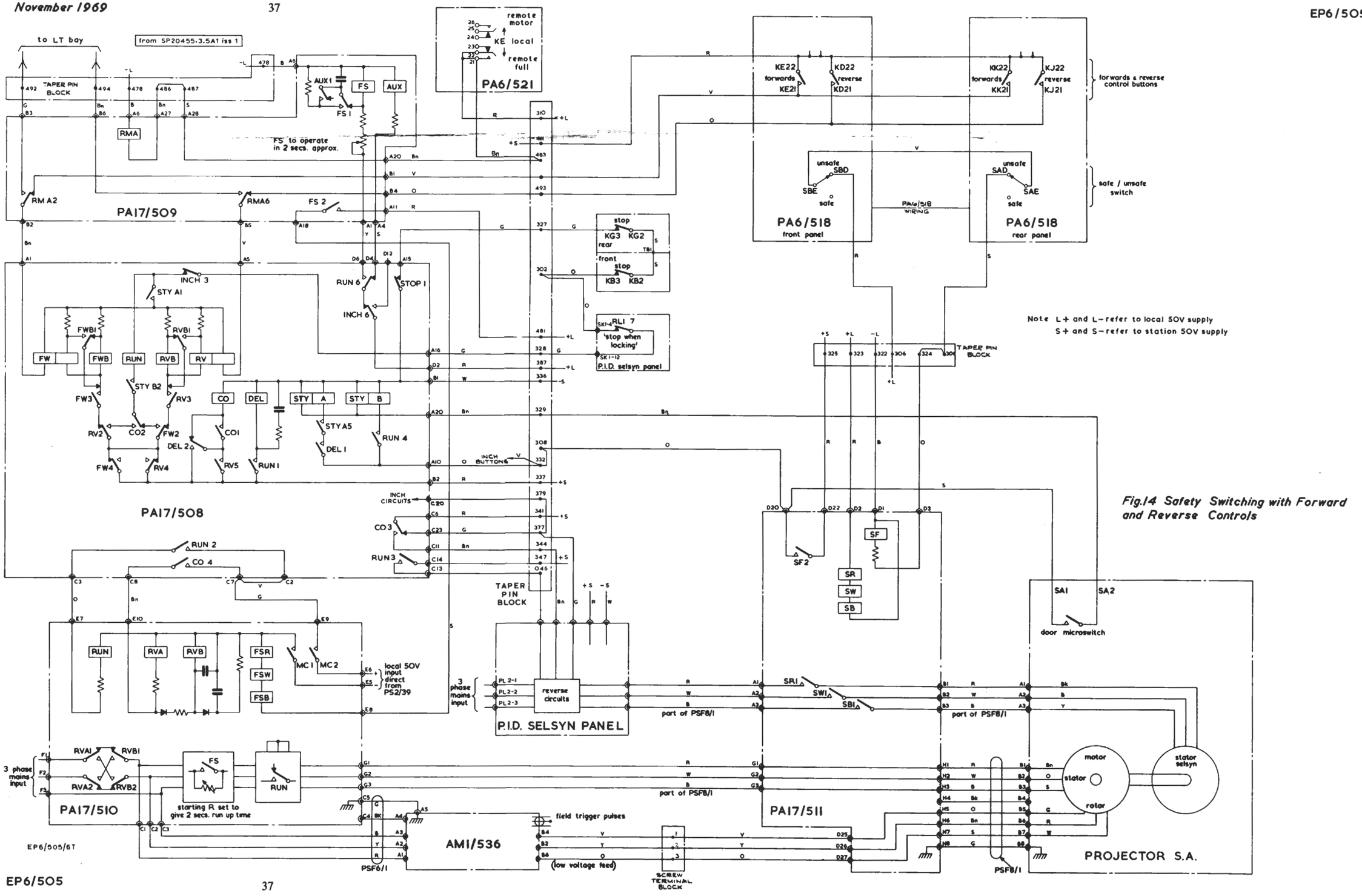


Fig.14 Safety Switching with Forward and Reverse Controls

EP6/505/6T

Note L+ and L− refer to local 50V supply
S+ and S− refer to station 50V supply

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EP6/505

PA6/513

PA6/518

PA17/509

PA17/508

PA17/511

EP6/505/4T

Fig. 15 Inch and Stop Controls with Brake and Clutch (Hand Inch) Operation

The telecine is driven in synchronism with field pulses by applying mains to the stator of the primary motor and applying to the rotor a signal whose frequency is the difference between the mains and field pulse frequencies; this signal is derived from an AM4/536 Motor Drive Amplifier. The main power produced by the motor comes from the mains supply but additional power is required, especially when the motor is driven faster than its mains synchronous speed, and the Motor Drive Amplifier provides this extra power. For a given power available there is, therefore, a limit to the change in speed that can be achieved; this change will depend also on the mechanical loading of the motor.

The telecine drive system will accommodate a difference between the mains and field frequencies of ± 2 Hz under no-load conditions and about $\pm 1{\cdot}7$ Hz under full-load conditions; i.e. when running up into synchronism and coupled to a Sepmag machine with both machines laced with film.

If the rotor of the secondary motor is short-circuited, it will run as an induction motor and because it is a two-pole machine it will approach its natural speed of 3000 r.p.m. If, however, the rotor resistance is increased to a relatively high value (about 500 ohms) by connecting external resistors to it, the peak of the motor torque-speed curve comes at the low-speed end of the range and the torque at higher speeds is very low. Thus the motor will drive the projector comfortably at relatively slow inch speeds.

The Selsyn drive system used in the EP6/505 is similar to the system described in Technical Instruction TVX 7 (Crossfire Telecine and Regional Dubbing Equipment). The supplies to the selsyn motor are taken through a PA17/511 Auxiliary Contactor Panel to enable them to be isolated when the control power to this panel is removed.

Sepmag lock and unlock arrangements are shown in Fig. 16. The selsyn system can only be locked when the machine is not running and is switched to *Unsafe*. However, after locking has been completed the safety switch can be moved to *Safe* and the system will remain in lock. Although the indication is now *Safe*, a reminder of the locked condition is provided on the indicator panel which is located between the spool arms of the projector and, unless a *runaway* takes place, the machine is considered to be intrinsically safe for non-technical operators.

The phenomenon known as *runaway* occurs when two selsyns are coupled together electrically and their rotors are out of phase so that the rotor of one selsyn effectively short-circuits the rotor of the other. Thus, when power is applied to their stators, the two selsyns will run at their own speed as induction motors instead of forming links in a driving chain.

Power Supply Failure

Failure of any power supply (see Fig. 18) will stop the machine. When power is restored the apparatus will switch on again and reset to its selected function but the motors will not run until its mode of operation has been reselected. If the relay panel did not fail safe in this way the motor might be driven at full speed on the restoration of power, without power assistance to the sound drums, and this would result in damage to the film.

Remote Control

The functions which can be transferred to a remote control panel have been listed in Table 1. These functions can be subdivided as follows:

(a) Circuit switched by the remote relays in the Control and Delay Relay Panel PA17/509

(b) Circuits switched by the Telecine Panel PA1/526A

(c) Circuits switched by the S.P.I.D. Relay Panels on Bay 5.

The Telecine Panel receives its remote signals from the Control and Delay Relay Panel and switches only the *Black Level* and *Light Control* circuits. The S.P.I.D. panels receive direct feeds from the *Local/Remote* key; these panels deal with sound selection and select also command and indication lines to reduce routing requirements.

The switching to a remote position of the indicator lamp circuits is shown in Fig. 17 and the remote switching of the film-racking and *Show/Cancel Show* control circuits is shown in Fig. 18. The remainder of the controls have been covered in Table 1.

A circuit diagram of the remote control system provided in the News area at Television Centre is given in Figs. 19 and 20. Note that this diagram gives also the connections for the EP6/501 (monochrome) machines and the Pye telecine machines.

Maintenance and Alignment

The electrical performance of the equipment should need checking only at infrequent intervals (to be determined in the light of operational

experience). The lubrication instructions for the projector should be strictly adhered to.

Optical Alignment

1. Switch on the equipment and check that the projector and the camera are both working.
   Set the camera lens for full aperture and as far back as possible.
   Position the camera about ½ in. from the Sepmag box.
   Set the projector lens for full aperture and adjust it to give a focussed image of the gate aperture. Inch a Test Card C film strip through the gate and set the projector racking to the correct position.
   Monitor the output of the green channel and adjust the camera scans so that the boundaries of the Plumbicon target can be seen.
2. Remove the Test Card C strip.
   Remove the diffusers and the *Final* lens from the lamphouse.
   Swing the *Projector* lens clear of the optical path.
   Check that the light valve vane travels freely in its slot, if not it must be adjusted.
   Place a Tufnol alignment aid (a Tufnol jig which has a 1-mm hole drilled in the position which corresponds to the centre of the frame, ±0·5 mm) in the gate aperture and close the *Light Valve* to give an almost circular image—slightly elongated in the vertical direction. The lamphouse may be set to *Low Power* if required.
3. Adjust the camera so that the image appears in the centre of the target. The adjustments are carried out as follows:
   (a) Vertically, by adjusting the three large screws provided. (Make sure that transversely the camera remains as level as the lamphouse baseplate.)
   (b) Horizontally, by adjusting the four smaller screws underneath the camera.

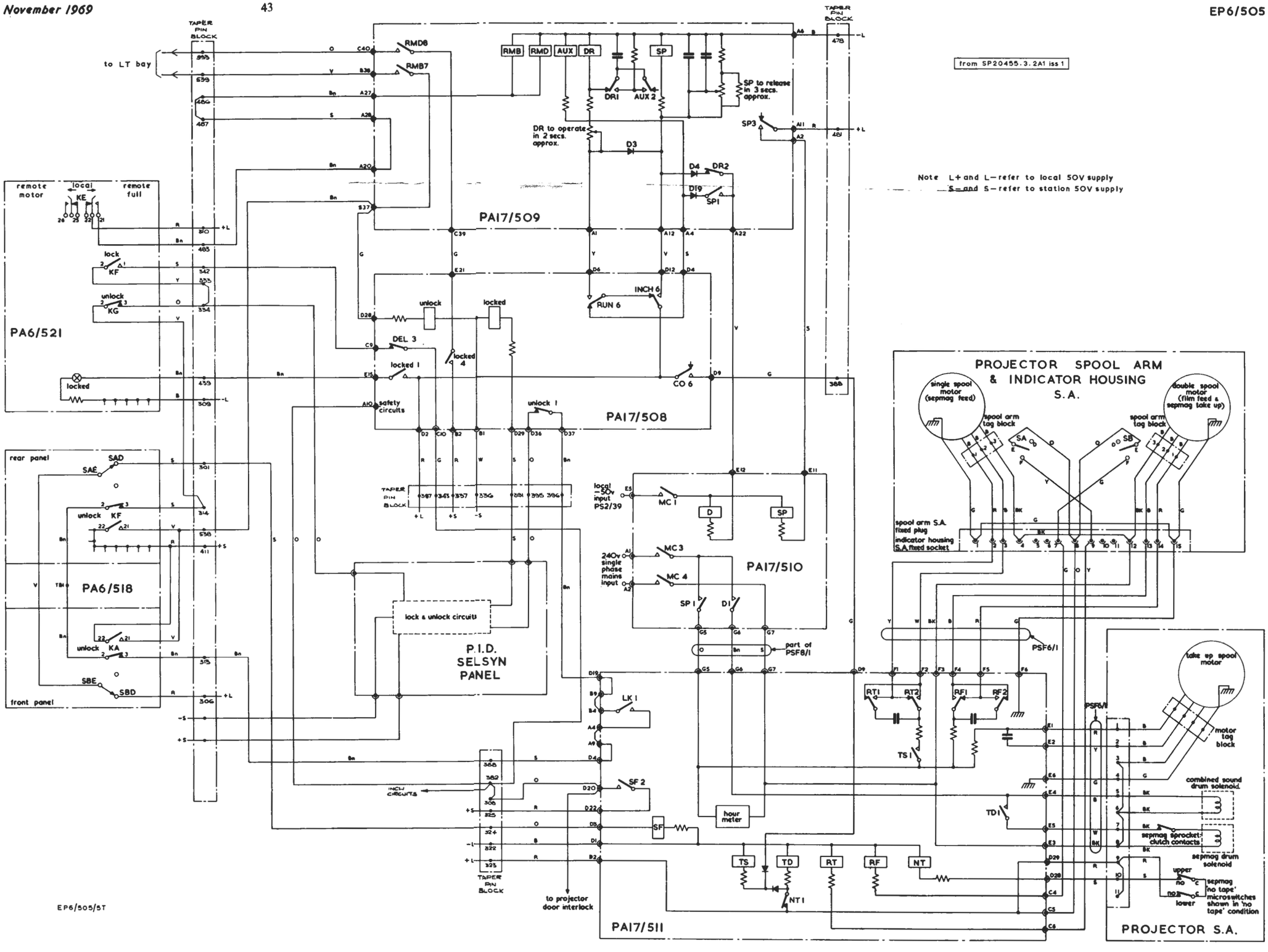
   Remove the camera lens hood and cap up the camera with the special lens cap provided; this cap has concentric rings engraved on its outer surface with a dot at the centre of the optical axis.
   Reduce any ambient lighting in the area and switch to full lamp power so that the output of the pinhole jig can be seen on the lens cap. If the spot does not appear in the centre of the cap, skew the camera until it does.
   Repeat these operations until the spot is central at both the target and the lens cap.
4. Remove the lens cap and swing the *Projector* lens into position.
   Adjust the *Projector* lens mounting-plate to position the pinhole spot in the centre of the target. (Shims are provided to square the lens with the projector.)
5. Remove the pinhole jig from the projector and replace the Test Card C film strip.
   Check that the image of the test card is symmetrically disposed within the target area. If not repeat items 3 and 4 to tighter tolerances. (Remember that this now makes the Green channel the reference channel as far as physical alignment is concerned.)
6. Cap up the camera. Remove all the lamphouse lenses and fully open the *Light Valve*. Remove the Test Card C Film Strip.
   Adjust the components inside the lamphouse as follows:
   (a) Cover the near-side lamp and adjust the half-silvered mirror so that image seen on the camera lens cap is central. Uncover the lamp.
   (b) Cover the far-side lamp and adjust the fully-silvered mirror so that the image seen on the lens cap is central. Uncover the lamp.
   (c) Replace the *Relay* lens and adjust this for a symmetrical image.
   (d) Replace each *Primary* lens in turn and adjust for a symmetrical image.
   (e) Fit the diffusers; these are placed on the far side of the primary lens with respect to the projection lamp.

   Note. The diffuser on the far lamp acts as the lens retainer in conjunction with a spacing ring; on the near lamp a circlip is used to retain the lens.
7. Close the *Light Valve*. Swing the *Projector* lens clear of the light path. Replace the *Final* lens and adjust for a symmetrical image on the lens cap.
8. Lace-up a Test Card C film strip in the gate and replace the *Projector* lens. Set the following controls for the *Green* channel of the camera:
   scan amplitudes and rotation
   beam current
   alignment
   electrical focus
   optical focus

Text continued on page 53

from SP20455.3.2A1 iss 1

Note L+ and L− refer to local 50V supply
S+ and S− refer to station 50V supply

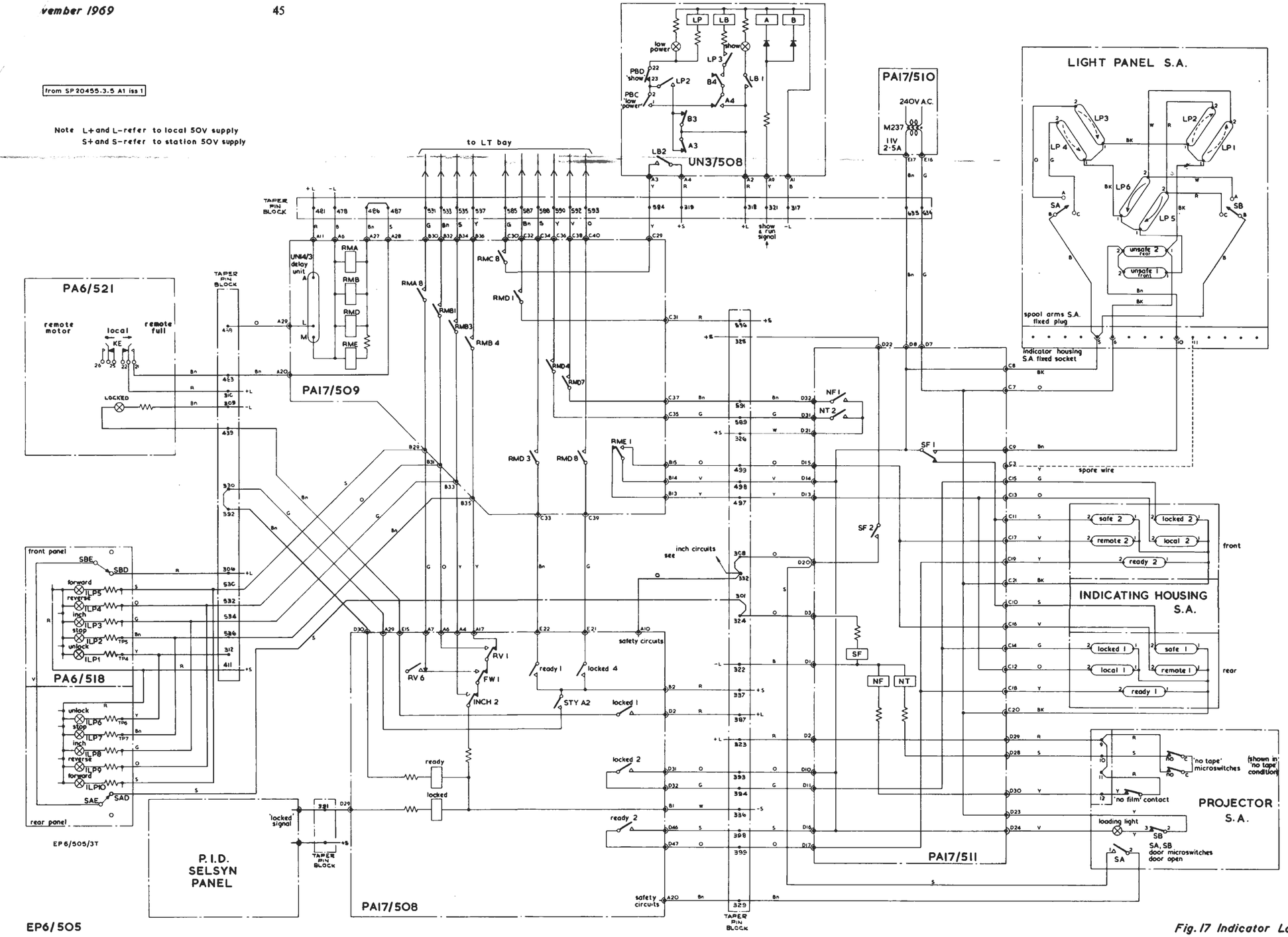


EP6/505/5T

Fig.16 Sepmag Lock and Unlock Circuits, Sound Drum and Spool motor Feeds

from SP 20455.3.5 A1 iss 1

Note L+ and L− refer to local 50V supply
S+ and S− refer to station 50V supply



EP6/505

EP6/505

Fig. 17 Indicator Lamps

from SP20455.3.4A1 iss 1

Note L+ and L− refer to local 50V supply
S+ and S− refer to station 50V supply

EP6/505

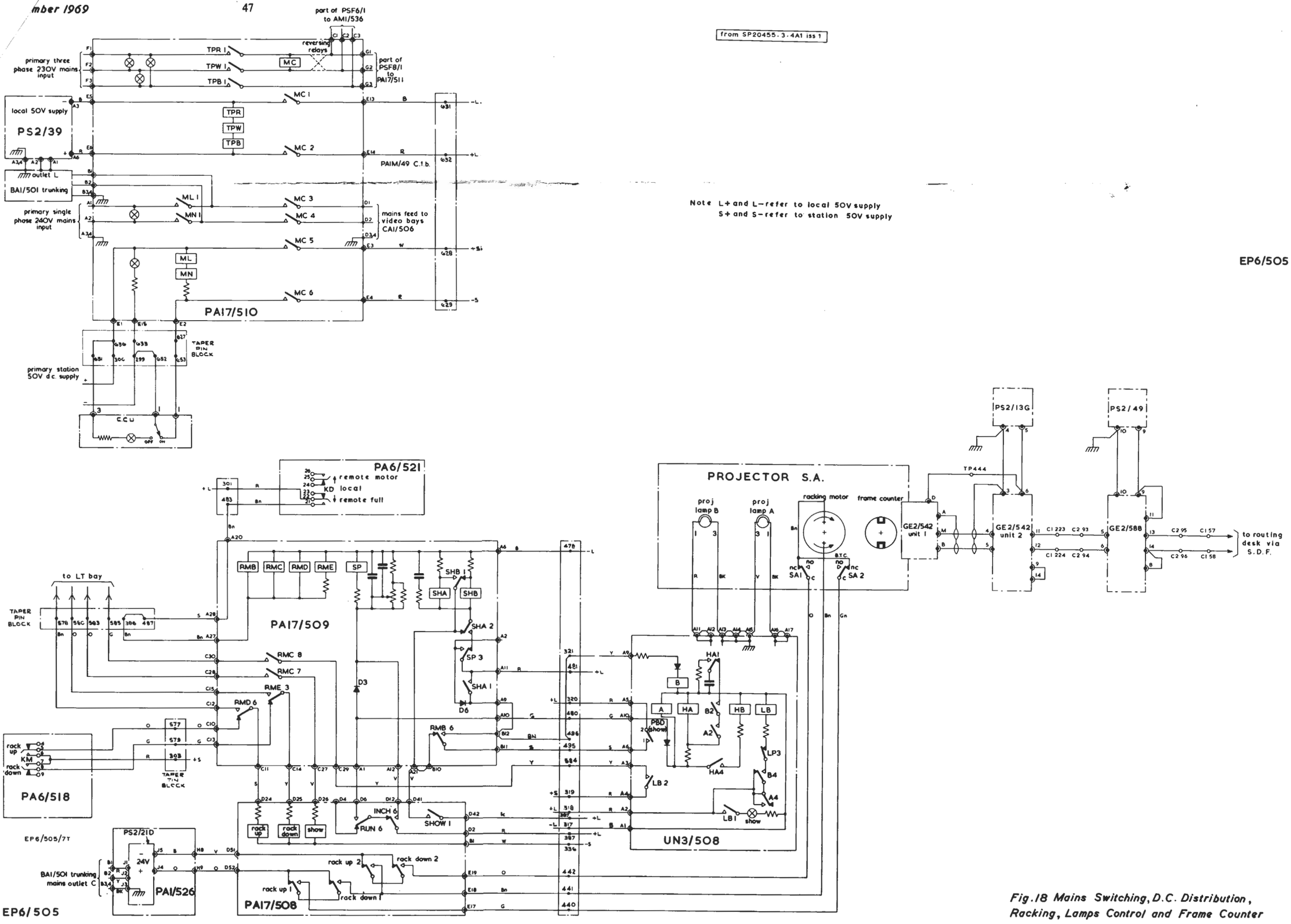


Fig.18 Mains Switching, D.C. Distribution, Racking, Lamps Control and Frame Counter

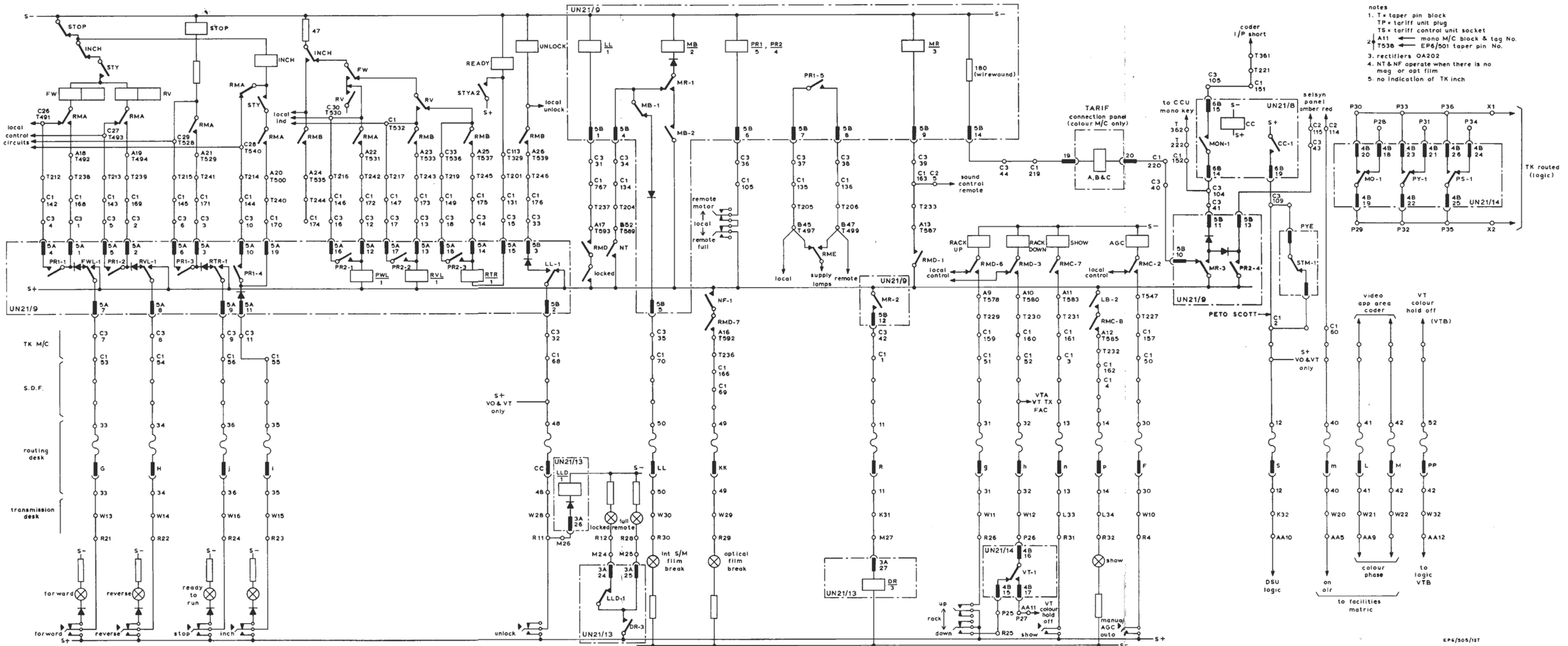
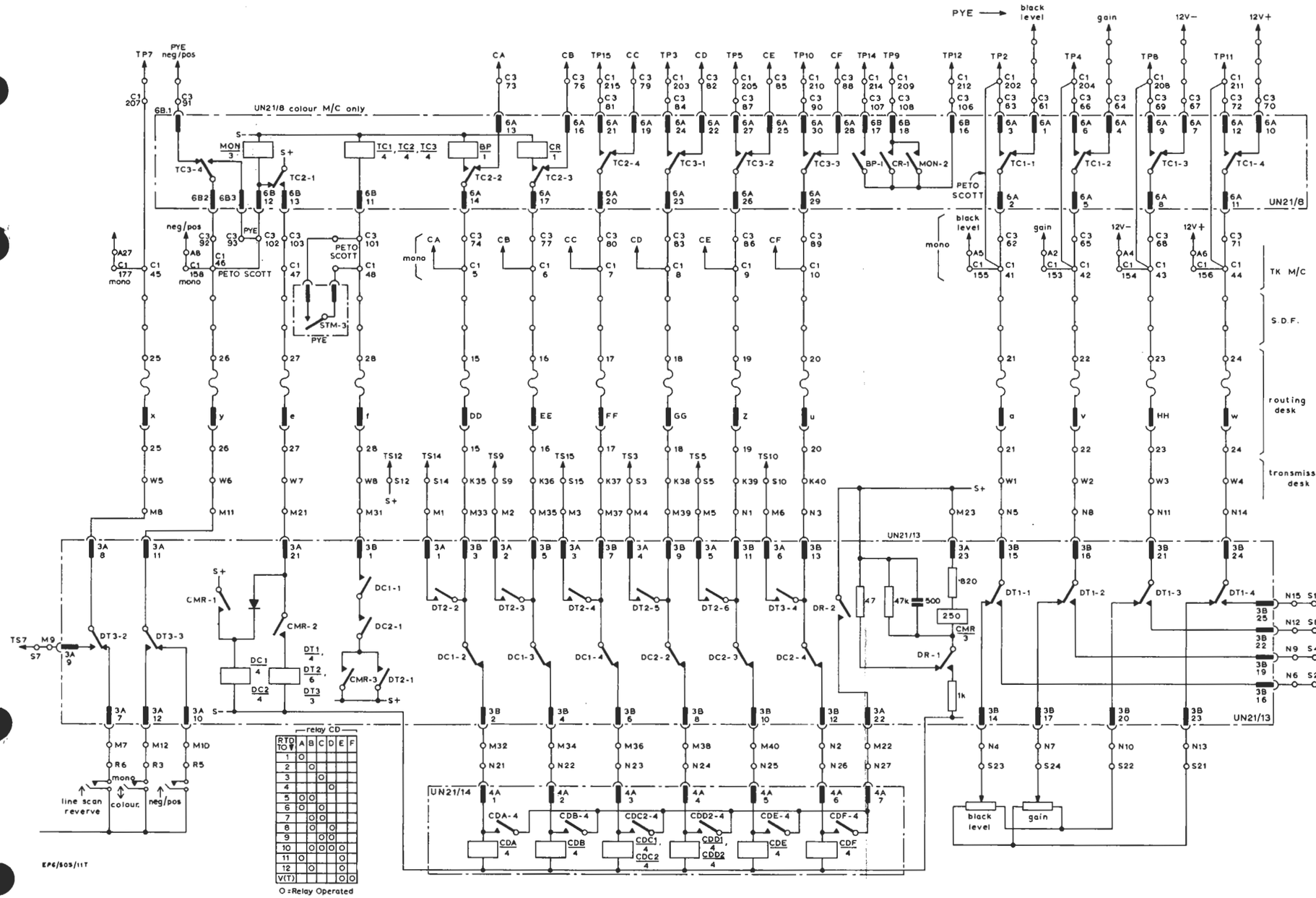


Fig 19 Remote Control System (sheet 1 of 2 sheets)



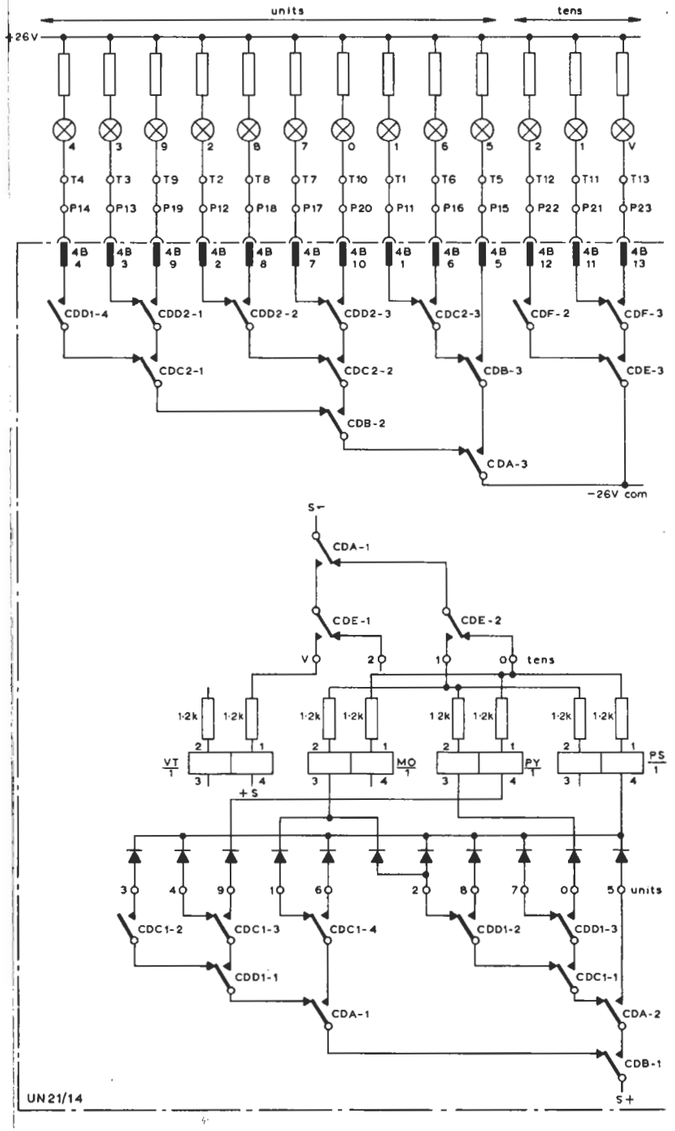


Fig 20 Remote Control System (sheet 2 of 2 sheets)

For optical focus set the green yoke to mid position, switch to low power and open the light valve fully. Move the projector lens if necessary.

It is best to focus by observing the waveform. Under full aperture conditions it is possible for the plane of best focus to be slightly different from that at smaller apertures.

Repeat these operations for the red and blue channels but using yoke adjustment for optical focus.

Note : the final setting up of registration will be carried out at a later stage.

9. Switch to *Test Camera*; switch *Matrix* and *Contour Injector* to *Off*.
   Using the linear channel outputs, adjust individual black-level and gain on each channel to give 0·7 volts p-p outputs.
   Switch to *Normal*. Remove film and run the machine locked to pulses.
   Set the *Run Brightness* control to 1/4 from minimum. Adjust the *Light Control* to give 0·7 volt on the *Green* output. Adjust the signal current meter to read 300 nA.
   Repeat this operation for the *Red* and *Blue* channels readjusting the *Light Control* as necessary.
10. Observe the *Blue* channel output and insert a 1·1 neutral density filter into the light path. Check that enough adjustment is available on the light control to give an 0·7 volt p-p output. If not, reset the *Run Brightness* control on the lamphouse until this condition is satisfied.
    Remove the density filter and check that the minimum condition of the *Light Control* gives an output of between 0·35 and 0·5 volts.
    Reset this control to give 0·7 volts output.
11. Observe the *Green* channel output and insert a suitable filter (to the nearest 0·1 density) into the prism block assembly to give an 0·7 volt output.
    Repeat this for the red channel.
12. Place a neutral density of 0·3 in the gate and check the evenness of illumination. If necessary make small adjustments to the positions of the *Final* and *Primary* lenses.

Video Alignment

Day-to-day alignment procedure is given under *Operation*. For more detailed information on the Philips Plumbicon Camera Channel see the manufacturer's handbook.

To align the BBC-designed automatic gain control system proceed as follows:

(*a*) *Calibration of AM3/510*

1. Put the unit on a chassis extender and set R70 fully anticlockwise.
2. Switch the projector to *A.G.C. On* and *Show*. Set the *Light Control* so that pin 7 on the AM3/510 is at −6 volts with respect to earth. Check that this setting corresponds to the marked position of the control.
3. Monitor the output of the camera channel and adjust R42 (on the front panel) for an 0·7-volt p-p signal.
4. Apply an overload to the channel and check that the a.g.c. system shows no sign of instability. If instability is present, alter the value of R32 (nominally 68 kilohms) accordingly. Do not reduce the value of this resistor more than is necessary or the recovery time of the A.G.C. system will be too slow.
5. Check the response of the A.G.C. system with a loop of dense film containing 3 or 4 clear frames.
6. Replace the AM3/510 unit in the PA1/526A panel.

(*b*) *Limitation of Input to AM1/8*

1. Switch the projector to *A.G.C. Off* and *Show*.
2. Turn the *Light Control* from maximum to minimum and check that the potential across the light valve for both conditions is 10 volts ± 0·5 volts. If the voltage is incorrect alter the values of the adjust-on-test resistors R3 and R4 which are mounted on the back of the PS2/13F connector (see Fig. 5).
   Note. With the component values shown in Fig. 5 the current from the Light Control Wiper for the maximum, −6V and minimum settings will be +5·05 mA, −1·63 mA and −4·45 mA respectively.

(*c*) *Final Adjustments*

1. Switch the projector to *A.G.C. On* and *Show*.
2. Set the *Light Control* to the marked (−6V) position.
3. Monitor the output of the channel.
   Put the UN1/556 unit on a chassis extender and adjust RV1 for an 0·7-volt p-p signal.
4. Replace the UN1/556 in the PA1/526A panel.

Optical Maintenance

The only optical surfaces which are nearly in focus are the final condenser lens behind the gate and the surface-silvered mirrors. The lens is mounted in such a way that it is easily removed for cleaning. The mirrors can be cleaned in position but great care must be taken because they are surface-silvered.

The only effect of dust on the other optical elements is to reduce the amount of light transmitted. For this reason they should be kept reasonably clean by light dusting.

The projector light level is adjusted by means of a *Running* control on the UN3/508 Lamp Control Unit. With the machine running, set the *Running* control so that the meter on the unit reads in the green band. The *Stationary* control on the UN3/508 is no longer used.

To check the maximum light level, turn the *Light Control* to maximum and place a slide with a density of 1·1 in the gate.

When the projector lamps are replaced, it may be necessary to realign the lenses and mirrors as detailed in the Optical Line-up.

Periodically, clean the lamp-house air filter.

Video Maintenance

See the manufacturer's handbook.

Sound Maintenance

(*a*) *Comopt*

The exciter lamp will deteriorate slowly because of filament evaporation. Excessive deterioration will be apparent when the static signal-to-noise ratio of the Comopt chain is measured. When replacing the lamp, take care not to over-tighten the clamp as this will crack the glass envelope of the lamp.

(*b*) *Commag*

The erase and programme heads are subject to wear. Wear on the programme head affects the frequency response and the amount of bias required for optimum recording conditions. Wear on the erase head affects the degree of erasure of any given magnetic stock. The heads should be examined for wear if any of the above effects become apparent.

(*c*) *Sepmag*

The remarks relating to wear in the Commag heads apply also to the Sepmag heads.

Motor and Control System Maintenance

Inspect the brushes on the drive and selsyn motors annually. Periodically repack the spool motor gearboxes and the bearings of the belt-driven projector input shaft with grease.

The control circuits do not require routine maintenance. However, periodic checks should be made to see that all controls function correctly (as described under Controls and Motors).

Projector Maintenance

(*a*) *Lubrication and Cleaning*

Change the oil in the projector body after the first fifty hours of operation, after a further 100 hours of operation and thereafter at intervals of 500 hours. It is advisable to drain the mechanism while it is warm. A special tool is provided which enables the oil to drain clear of the machine the instant that the oil-retaining screw is removed. The capacity of the oil bath is about 100 cc and the oil used is Castrolite with added Rocal.

Examine the lay-on and idler rollers frequently to see that they rotate freely. To lubricate these rollers, apply a drop of Esso Handy Oil to the end surface of the roller and wipe off the excess. Do not remove the rollers from their shafts unless it is absolutely necessary because the act of removing the retaining circlip is likely to form a burr on the end of the shaft and this will score the inside of the roller when it is removed and replaced.

The guide shaft for the racking mechanism also should be lubricated with Handy Oil.

Inspect all film bearing and guiding surfaces regularly for wear and for hard deposits of emulsion. Remove the emulsion by carefully using the soft aluminium tool provided. Wear may take place on the pressure-pad and aperture-plate runners, and on the guiding edge of the aperture plate.

(*b*) *Mechanical Adjustments*

1. Gate Pressure Pad Adjustment.
   The correct setting for the springs which apply pressure to the gate pressure pads at the top and bottom of the gate is 60 grammes*. Adjust the pressure if necessary; after adjustment re-seal the adjustment nuts with Loctite.
2. Gate Aperture Plate Removal and Replacement.

*This is the optimum pressure for a nitrided gate. For other gate materials the optimum pressure may be different.

If the gate aperture plate is removed from the gate casting, take care when it is replaced to ensure that the plate is free to slide over the full range of its travel before the racking arm is refitted.

3. To Replace and Adjust the Gate Casting.
   If, for any reason, it is necessary to remove the gate casting from the projector, it should be replaced in such a position that:
   (a) in the lowest position the gate aperture plate does not foul the pull-down sprocket;
   (b) the gate aperture plate, the pull-down sprocket and the hold-back sprocket are all in line.

   Note that the third fixing of the gate casting is the pillar which carries the cradle under the pull-down sprockets. Adjustment shims can be fitted: (1) behind the hexagon of this pillar; (2) between this hexagon and the arm carrying the cradle; (3) outside the cradle between the cradle and the shoulder of the pin which carries the cradle.

   The adjustments made by the shims are inter-dependent and are as follows·
   (a) Shims in positions (1) and (3) have exactly the same effect on the efficiency of the latching system to hold the cradle in the open position.
   (b) The range of adjustment of the cradle in the closed position is determined by the number of shims in position (1).
   (c) Shims in position (2) affect only the axial movement of the cradle arm on the pillar.

   Adjust the shims in the following order, but *do not allow* the cradle to spring up to the sprocket until the alignment is exact, because the clearance between the side cheeks of the cradle and the outside of the pull-down sprocket is only a few thousandths of an inch.
   (i) Adjustment of shims in position (2). The clearance is to be as small as possible consistent with free movement when the spring assembly (fitted inside the arm) is locked tight.
   (ii) Adjustment of shims in position (1). Fit a nominal value of shim, say 0·25 mm, in position (3) to determine the size of shim required for position (1). Fit the required shim and tighten the gate assembly fixing pillar.
   (iii) Determine the size of shim required for position (3) and fit it.

   The cradle can now be lowered on to the sprocket. Adjust the back stop so that the clearance between the rollers and the pull-down sprocket is one film thickness on the left-hand roller and two film thicknesses on the right-hand roller. Tighten and lock the cradle return-spring to give a pull-off force of 300 $\pm$30 grammes. Check that the return force is not less than 100 grammes. Hand-inch a piece of spliced film round the pull-down sprocket. The cradle should rock, but the cradle arm should not move.

4. To Replace the P.T.F.E. Washer and the Felt Pad.
   The retarding force on the hold-back sprocketed roller is supplied by a felt pad and the pad is held in compression by a spring which presses the roller against a P.T.F.E. washer. Both pad and washer may require replacement from time to time. To remove the roller, hold the inner knurled ring stationary and unscrew the knurled nut on the end of the shaft. If necessary, metal shims can be fitted behind the P.T.F.E. washer to bring the roller into line with the rest of the film path, but the roller must always bear on the P.T.F.E. washer *not* on a metal shim. Care must be taken when fitting a new washer to ensure that the centre hole is opened out sufficiently to fit the shaft. Badly fitted washers tend to buckle and have adverse effects on flutter and wow. When fitting a replacement felt pad, ensure that its thickness is such that it contacts the side of the roller and not just the protruding oilite bush. However, the felt must not be so thick that it prevents the inner knurled ring engaging with the pin on the shaft.
   The felt pad should be kept clean and dry. If necessary it can be cleaned with Inhibisol.

5. To Adjust the Spring Pressure on the Felt Pad.
   Set the back stop of the compliance arm so that the distance between the centre of the roller carried by this arm and the next lower roller is exactly 3·5 film frames. Lace a length of film, which is long enough to run for a few minutes and on which two points 26 frames apart have been marked, into the machine. One mark must be in the gate aperture and the other level with the Comopt head; the mechanism must be in the middle of a picture dwell period.
   Slacken off the back-stop by half a turn and run the machine forwards at full speed.

Adjust the pressure on the felt pad so that under steady-state conditions the compliance arm is just clear of the back-stop. The pressure is adjusted by loosening the grub screws in the knurled outer knob and applying direct pressure to the knob. When the adjustment has been made, retighten the grub screws and slacken off the compliance arm back-stop by a further whole turn.

6. Sound Drums
Periodically, check that the sound drums are being driven satisfactorily on run-up and run-down. Lace up a film and run the machine forwards and backwards, checking that the stabilisation of the compliance arm is satisfactory. Adjustment of the drive engagement to the picture film sound drum is by means of an Allen screw in the casting near the input drive. Adjustment for the Sepmag drum is via a hole in the bottom of the Sepmag box.
7. Spool Spindles
Periodically, check that the friction drives to the spool spindles are satisfactory.

List of Units

Bay 1 (CA1/506)

PA1M/48 Telecine Recording Panel (only fitted to machines with sound recording facilities)
- AM7/3 Internal Sending Amplifier
- AM15/2 Magnetic Recording Amplifier (Sepmag)
- AM15/3 Magnetic Recording Amplifier (Commag)
- OS2/21 Oscillator
- PS2/9 Stabilised Power Supplier
- UN1/58 Telecine Sepmag Relay and Metering Unit
- UN1/59 Telecine Commag Relay and Metering Unit

PA1M/49 Telecine Reproducing Panel
- AM16/2 Magnetic Reproducing Amplifier
- AM16/3 Optical Reproducing Amplifier
- PS2/9 Stabilised Power Supply

PA6/48 Telecine Commag and Sepmag Control Panel

PA17/511 Auxiliary Relay Panel

PS1/6 Power Supplier

Projector

Bauer Selecton II O Double-band 16 mm Projector

GE2/542 Counter Drive Pulse Generator (Unit 1)

PA6/518 Telecine Control Panel

UN3/508 Lamp Supply Control Unit

Bay 2

NE1/507 Pulse Delay Networks (7 of)

EQ5/510 Equalisers (6 of)

AM4/506A Pulse Distribution Amplifiers (9 of)

AM4/519 General Purpose Distribution Amplifier

Bay 3

Philips Camera Control Unit

PA6/521 Maintenance Control Panel (Sound)

Video Control Panel

C.L.U.E. (Coder Line-up Equipment)

Above Bay 2

Philips Colour Camera

11 in. Prowest Picture Monitor

Bay 4

AM1/536 Motor Drive Amplifier

AM4/519 General Purpose Distribution Amplifier (6dB)

EP1/503 TARIF Processing Equipment
- UN3/512 TARIF Control Panel
- AM1/542 Processing Amplifier (3 of)
- PS2/43 Stabilised Power Supplier

AM4/518 R.G.B. Distribution Amplifier (4 of)

GE2/542 Counter Drive Pulse Generator Unit 2

GE4/506B Sawtooth and Lift Generator

GE4/523 Colour Bar Generator

GE1M/526 PAL Colour Coder
- NE4/505 Colour Coder Delay Network
- UN1/549 Subcarrier Processing Unit and Power Supplier
- UN18/503 Chrominance Unit
- UN19/502 Luminance Unit

PA1/526A Telecine Panel
- AM1/8 Motor Drive Amplifier
- AM3/510 A.G.C. Amplifier Detector
- PS2/13F Power Supplier
- PS2/13H Power Supplier
- PS2/21D Power Supplier

UN1/556 Waveform Suppression Unit
- UN9/526 Switch Unit
- MX1/504 Blanking Mixer
- GE2/530 Pre-field Pulse Generator
- GE2/531 Post-field Pulse Generator
- GE2/532 Line Blanking Generator

PS2/39 50 Volt Power Supplier
PA17/508 Automatic Control Relay Panel
PA17/509 Control and Delay Relay Panel
PA17/510 Main Contactor Relay Panel
PA17/504 Relay Panel
UN9/544 R.G.B.Y. Switch Unit

Bay 5
Sound and Switching Equipment

Line-up Trolley
AM1/535A Difference Amplifier
AM4/506A Pulse Distribution Amplifier (2 of)
AM4/519 General Purpose Distribution Amplifier (6 dB)
GE4/506A Sawtooth and Lift Generator
GE4/509 Pre-set Law Test Step Generator (2 of)
GE4/513 Grille Generator
MN6/504 Vector Waveform Monitor
- DM1/502 PAL Vector Demodulator
- UN1/540 Sync Separator and Power Supplier
- UN9/542 PAL Vector Switch Unit

UN2/505 Coder Calibrator
- AM1/549 Synchronous Dector and Amplifier
- UN2/503A Colour Calibrator

PA6/520 TARIF Control Panel
14-inch Picture Monitor (Monochrome)
High-grade Oscilloscope (Tektronix RM529)

Colour Monitor Trolley
19-inch Colour Picture Monitor
GE1L/528 PAL Decoder
- UN1/540 Sync Separator and Power Supplier
- UN1/572 PAL Filter and Delay Unit
- UN18/504 PAL Chrominance Unit
- UN19/503 Luminance Unit