RESTRICTED

AIR PUBLICATION
2523C
VOLUME I

RADAR PHOTOGRAPHIC DISPLAY SYSTEM 1498

GENERAL AND TECHNICAL INFORMATION

Prepared by direction of
the Minister of Supply

J. R. C. Helmore

Promulgated by Order
of the Air Council

J. H. Barnes

AIR MINISTRY

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AMENDMENT RECORD SHEET

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A.L. No.	AMENDED BY	DATE
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LAYOUT OF A.P. 2523C

RADAR PHOTOGRAPHIC DISPLAY SYSTEM 1498

Heavy type indicates the books being issued under this A.P. number ; when issued they will be listed in A.P. 113

VOLUME 1, Part 1		**Leading particulars and general information**
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The inclusion of references to items of equipment does not constitute authority for demanding the items.

Each leaf, except the original issue of preliminaries, bears the date of issue and the number of the Amendment List with which is was issued. New or amended technical matter on new leaves which are inserted when the publication is amended will be indicated by triangles, positioned in the text thus :—◀— — — — — —▶to show the extent of amended text, and thus :— ▶◀ to show where text has been deleted. When a Part, Section, or Chapter is issued in a completely revised form, the triangles will not appear

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PART 1

LEADING PARTICULARS AND GENERAL INFORMATION

SECTION 1

GENERAL INFORMATION

Chapter 1

OUTLINE OF PERFORMANCE

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LIST OF ILLUSTRATIONS

General

1. Radar photographic display system 1498 is intended for use in CEW stations and certain GCI stations. It provides a fully processed high definition photograph of a cathode ray tube display on 35mm. film and this is projected on to the underside of a horizontal translucent screen. The final picture is approximately 6ft. in diameter and it is viewed from the upper side of the screen normally situated in the track telling room.

2. The equipment consists of a projector console (projector unit 100) and a power supply and control rack (rack assembly (power supply) 340) together with the projection screen and certain ancillary items. The projector console and control rack are located in a room known as the " Udder " which is below the track telling room.

3. Two equipments normally form a complete installation enabling a station to maintain continuous watch with one equipment as a standby for use when the other is undergoing routine servicing. In this case, an interconnecting mirror, which may be turned through 90 deg. about a horizontal axis, is used between the two projectors so that the picture from either may be directed to the screen as required. After reflection from the mirror, the cone of rays which forms the picture passes through a hood suspended from the ceiling of the Udder. The purpose of the hood is to prevent stray light from the Udder from reaching the projection screen and spoiling the contrast of the picture.
A view of a typical installation in the Udder is given in fig. 2.

4. The photography is in synchronism with the radar aerial scan and the equipment will work satisfactorily for a scan duration between 8 and 25 sec. The optimum quality of processing is obtained between the limits of 8 and 16 sec. The rate of picture production thus depends on the speed of rotation of the controlling radar head. The picture of the PPI display generated during one scan period is projected during the next-but-one scan.

5. The film used is a 35mm., safety base, negative panchromatic material having a grey anti-halation backing. The emulsion is specially pre-hardened so that it is able to withstand the vigorous action of the processing solutions. The film is enclosed in a light-tight cassette which will accommodate 2,000ft. of film but is normally loaded with 1,000ft.; this will last for 24 hours at an operating speed of four pictures per minute.

6. The chemicals used for processing the film are contained in glass bottles. These require replenishing at intervals of 8 hours continuous running irrespective of the operating speed. Undesirable fumes and vapours produced by the processing system are exhausted to atmosphere.

7. Used chemicals collect in a waste tank which is automatically emptied to an external drain at intervals of twelve hours continuous running.

8. The projection lamp is a one kilowatt mercury vapour arc lamp containing some xenon gas. It has a guaranteed life of 500 hours.

9. If required, the equipment may be used for the projection of a previously processed film.

10. A fault warning system is included which indicates certain routine faults to the operator by means of a buzzer and a series of warning lights. A remote fault warning panel gives a duplicate fault warning in the radar office.

Projector unit 100

11. The projector console contains units, which amplify the various radar input quantities and generate a CRT display, together with the camera, processing and projection equipment required to produce the final picture. A 7 in. diameter cathode ray tube is used and the final performance of the equipment is such that it will resolve 2,000 lines evenly spaced across the face of the tube at a camera aperture of f/4 starting with a contrast of 10 to 1 at the tube. At full aperture (f/2) the resolution for the same conditions falls to 1,500 lines. In reality, the cathode ray tube display provides only a low contrast and the final resolution is probably about 1,000 lines at full aperture.

12. The required radar information is routed to the console from the radar office via a junction box on the wall of the Udder. It consists of the following :—

(1) Radar video signals.
(2) Radar bright-up.
(3) Range marks.
(4) Video map signals.
(5) Resolved timebase waveforms.
(6) IFF signals.

13. In addition to various power supplies, which are derived from the power supply rack, the projector console requires a supply of compressed air, free from oil and water, at between 40 and 80lb./sq. in. with a flow corresponding to approximately 4 cu. ft. per minute. This is obtained from a compressor in the site installation. The equipment also requires a large volume of low pressure air. This is obtained from the site equipment cooling air supply and is used to remove heat from the electronic chassis and projection lamp.

Rack assembly (power supply) 340

14. The power supply rack contains the following :—

(1) Power packs which provide all the DC power required by the projector console.

(2) Ballast chokes, control gear and recording instruments for the mercury vapour projection lamp.

(3) A selsyn receiver coupled to a magslip transmitter which provides the projector with information relating to the position of the radar aerial. The input to the selsyn receiver is obtained from the controlling radar head via a selsyn patching box on the wall of the Udder.

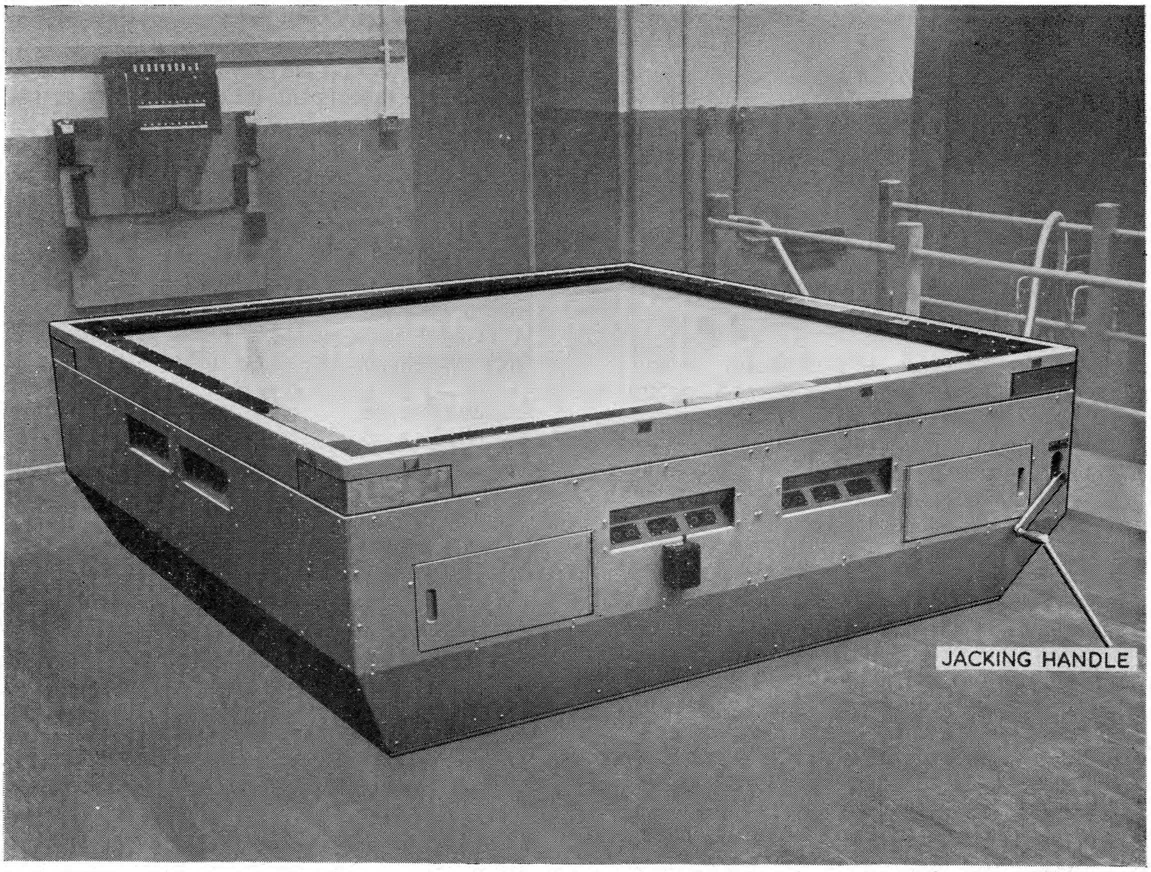

Fig. 1. Projection screen

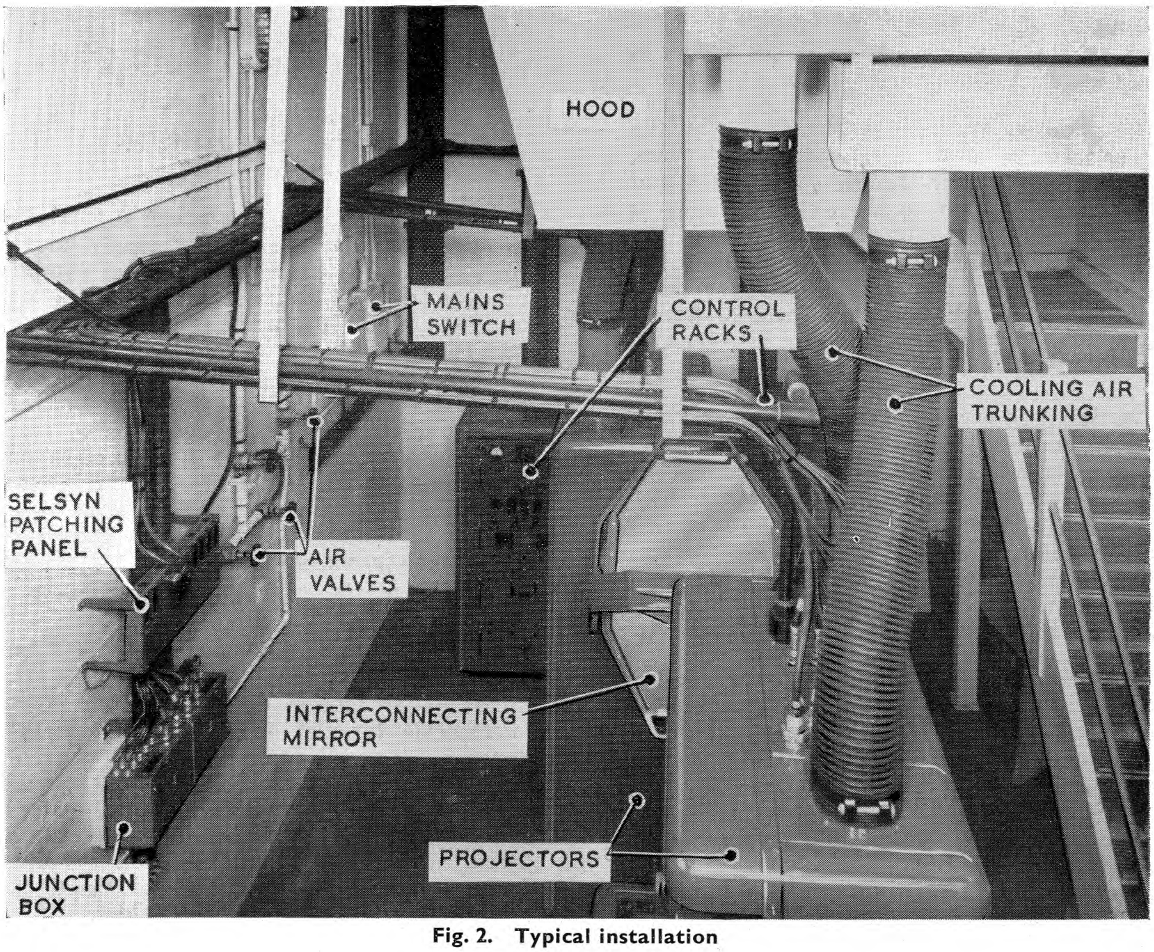

Fig. 2. Typical installation

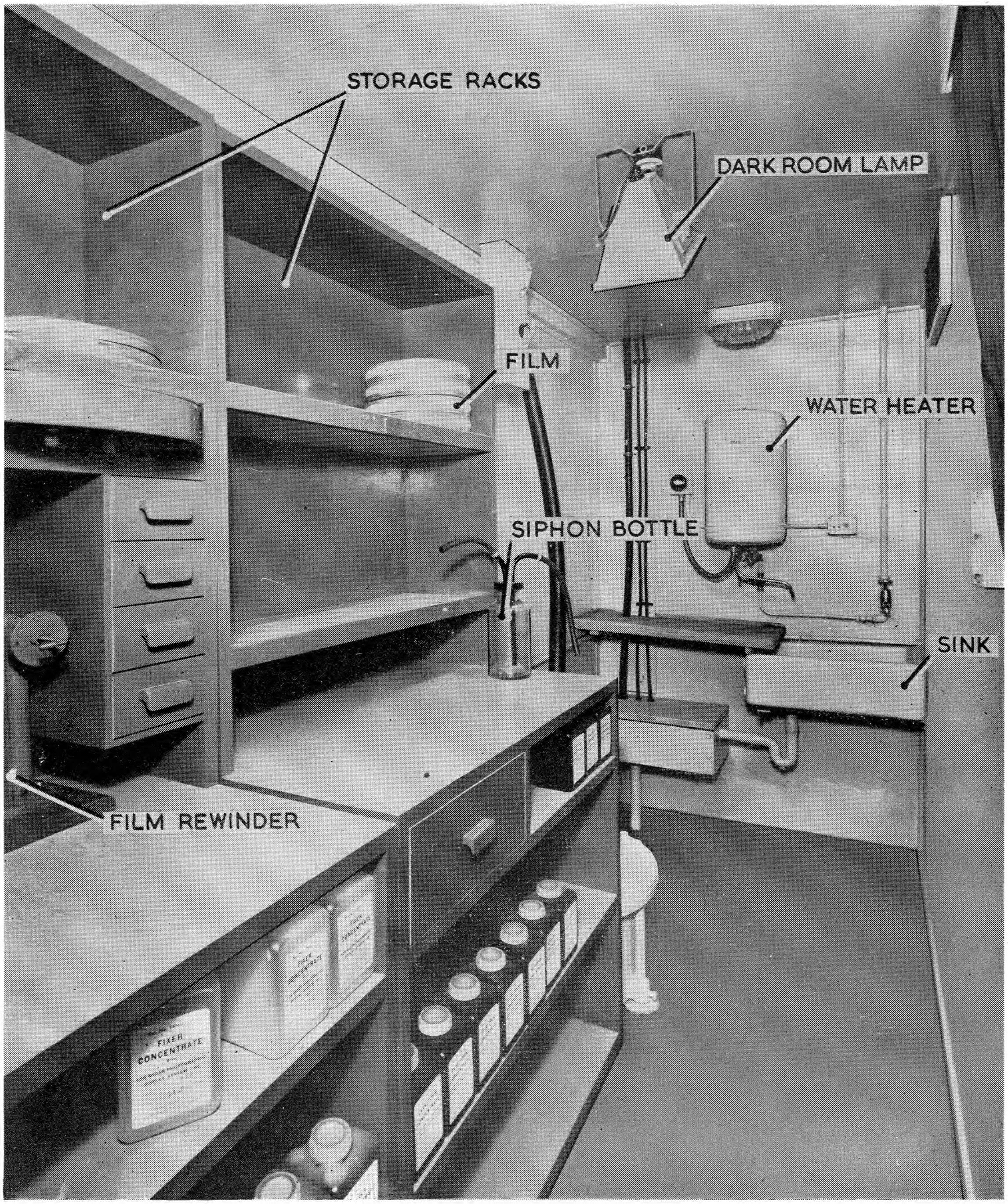

Fig. 3. Typical Darkroom

(4) Switching and control circuits for the equipment.

(5) Switches for head selection and head combining.

15. Two 230V 50c/s mains supplies are required for the power supply rack : one of 15A (regulated) and the other of 30A (unregulated). These supplies are controlled by ironclad switches on the wall of the Udder (*fig.* 2).

Projection screen

16. The projection screen consists of a sheet of special paper supported by two pieces of $\frac{1}{2}$ in. armour plate glass each measuring 7ft. × 3ft. 4 in. carried on a wooden framework. Covering the paper is a 7ft. square of $\frac{1}{4}$ in. plate glass carried in a wooden frame which may be raised by means of a jacking handle. There are two jacking points at diagonally opposite corners of the assembly : either may be used to lift the top sheet of glass. A view of the screen is given in fig. 1.

17. Video map signals are not used operationally since the magnification involved in the system would give a map outline too thick to be tolerated. The video map is therefore used only for routine checking of electronic alignment and for initial setting up when a permanent map is drawn on the paper which forms the screen. The drawing of the map is a job which requires an experienced draughtsman; instructions are given in Volume 5 of this Air Publication.

18. The total length of the optical path from the film to the projection screen is 14ft. 7 in. The vertical distance from the interconnecting mirror to the screen is 12ft. These figures apply to a typical CEW station installation.

Ancillary items

19. As well as the projector console, power supply rack, projection screen, interconnecting mirror and remote fault warning panel already mentioned, a complete installation includes the following :—

(1) a pair of storage racks for film and solutions.

(2) A box of tools which provides the means for routine cleaning and adjustment of the equipment.

(3) Film rewinder.

Darkroom

20. A darkroom, equipped with hot and cold water supply and sink, is required for loading film into cassettes and for mixing chemicals. A view of a typical darkroom, which is built into the Udder, is given in fig. 3.

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Chapter 2

GENERAL DESCRIPTION

LIST OF ILLUSTRATIONS

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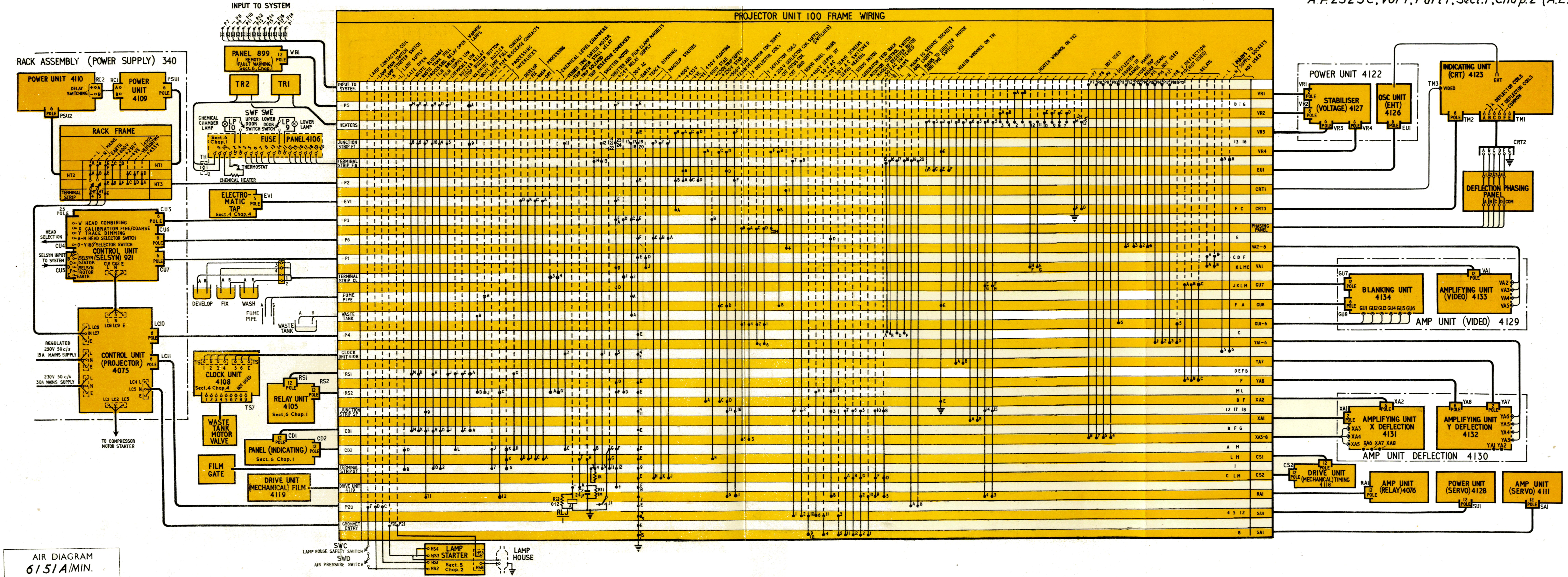

AIR DIAGRAM 6151A/MIN.

ISSUE 4

PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY

Radar photographic display system 1498 : interconnections

Fig. 1

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Chapter 2

GENERAL DESCRIPTION

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LIST OF ILLUSTRATIONS

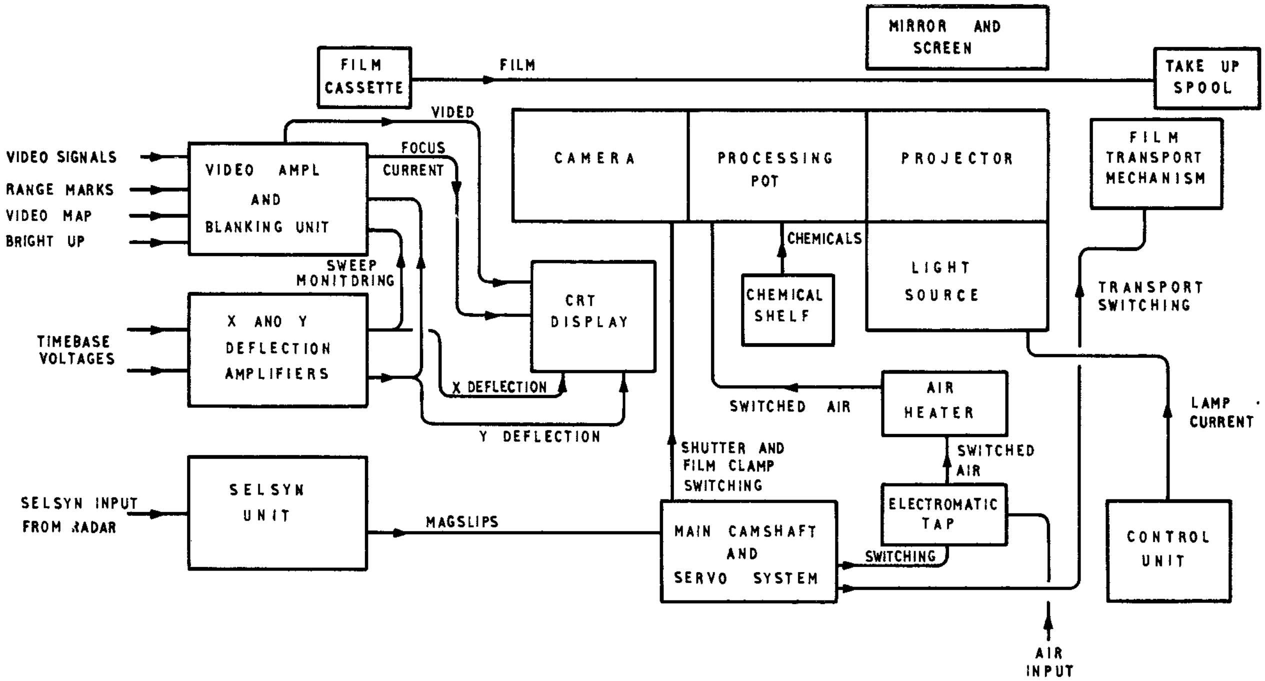

Fig. 2. Simplified block diagram

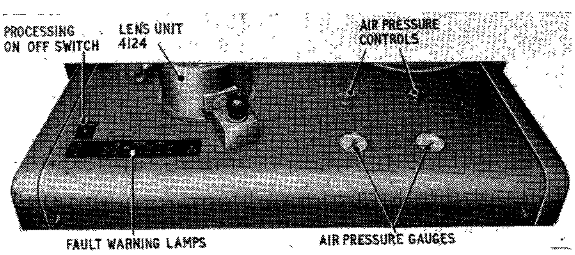

Fig. 3. Indicating panel

Introduction

1. The equipment generates a PPI display on a special flat-faced CRT from information provided by the radar office. The CRT is situated below the lens of a camera system and an image of the display is focused on to the horizontal film.

2. The film is continuously drawn from a storage cassette and is looped so that it can remain stationary over the camera lens for the required time of scan (one complete rotation of the controlling radar head). At the end of this time, the film is snatched horizontally so that the portion of film carrying the photographic image moves rapidly to a new position and a new unexposed portion (or "frame") is moved over the camera lens. The first frame is then processed while the second receives the image of the next PPI scan.

3. At the end of the second scan, the film is again snatched so that the first frame moves to a position under a projection lens. Light is passed through the film and is focused by the projection lens on to a viewing screen. The processed image of the first PPI scan is thus projected during the time that the image of the second scan is processed and a third frame receives its exposure in the camera position.

4. A simplified block diagram of the system is given in fig. 2. Views of the projector console are given in fig. 7, 8, 9 and 10; a front view of the control rack appears in fig. 6.

CRT display

5. The CRT display is produced from resolved timebase waveforms, radar video signals, range

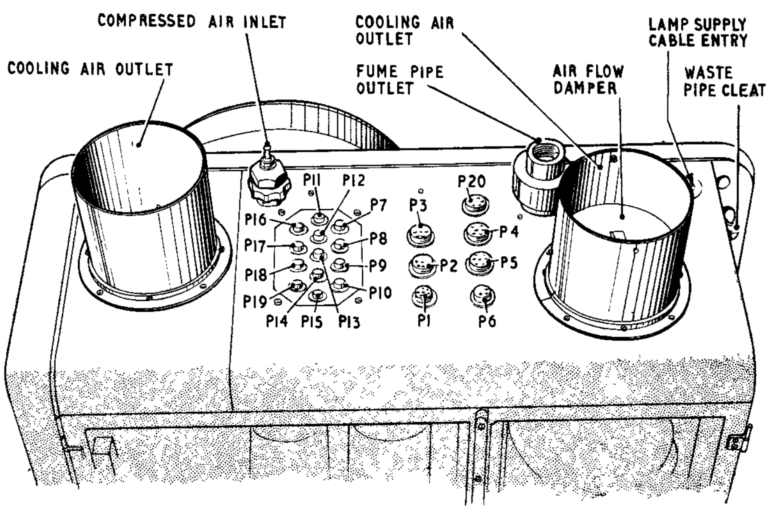

Fig. 4. Projector roof panel

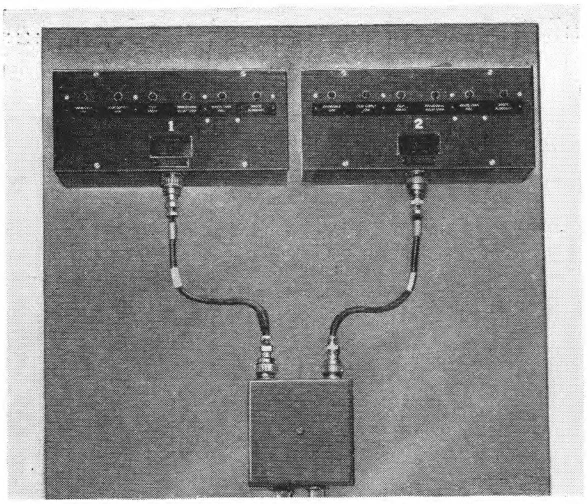

Fig. 5. Panels 899

marks, video map signals and bright-up pulses supplied to the system from the radar office. These are amplified by units in the projector console and are applied to the cathode ray tube.

Film gate

6. The film gate provides the means for supporting the film during the photography of the CRT display, the processing of the photographic image and the projection of the final picture. It contains three apertures enabling the operations to take place.

Camera

7. The film cassette, which provides the store of unexposed film, is mounted on one end of the film gate (*fig.* 7) and the film is drawn from this at constant speed. It is allowed to form into a feed loop from which it is snatched by the action of the transport mechanism. The film is held in tension between the feed loop and the transport sprocket by means of a spring-loaded sprocket.

Processing

8. The processing operation is done by means of a system of chemical jets which apply the various chemicals to the film in the form of a fine spray. The action is timed by means of compressed air which is applied via an electrically operated tap and air heater. The operation of the tap is initiated by switches operated by a camshaft. Other switches operated by the camshaft control the film transport mechanism and a system of clamps which holds the film in position over the camera and processing apertures. The camshaft is made to rotate at the correct speed by a servo system whose input is derived from a system of selsyns and magslips.

9. The various photographic chemicals are contained in storage bottles which feed constant level chambers located on the chemical shelf at the rear of the projector (*fig.* 9). After use, the waste chemicals accumulate in a waste tank (*fig.* 9) which is automatically emptied at 12-hour intervals.

Projection

10. After processing, the film is moved on to the projection aperture where light is passed through it. The light rays, modified by the photographic image on the film, are focused by means of a projection lens on to the viewing screen. The mercury vapour lamp, which forms the light source, receives its power from a control unit which contains ballast chokes for the lamp current and also contains various switches which route the mains supply to various portions of the equipment.

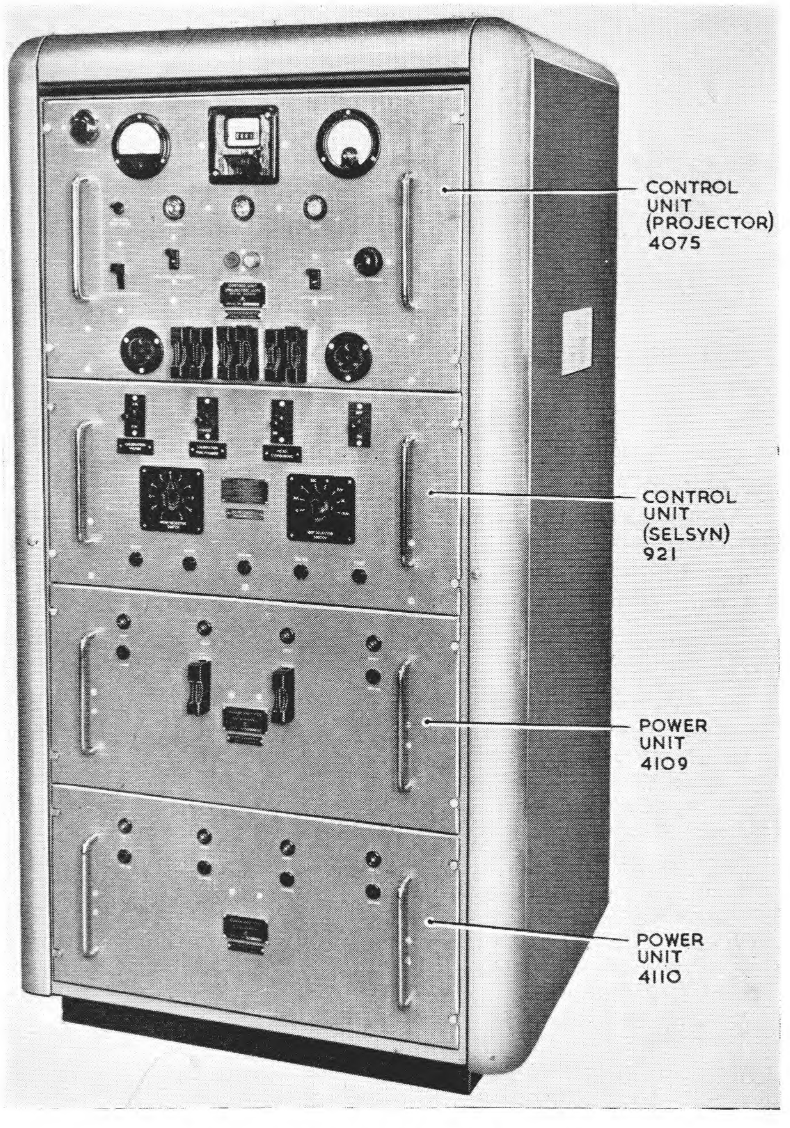

Fig. 6. Rack assembly (power supply) 340

Power supplies

11. The power supply rack (*fig.* 6) contains units which generate all the DC power required by the equipment. It also contains the lamp control unit (control unit (projector) 4075) and the selsyn unit (control unit (selsyn) 921).

PRINCIPAL UNITS

Projector console

12. A brief description of the principle units in the projector console is given in the following list.

Amplifying unit (video) 4133	Part of amplifying unit (video) 4129 (*fig.*7). It contains circuits which amplify radar video signals, video map signals and range marks and superimpose them on the trace compensation and video gate waveforms.
Blanking unit 4134	Part of amplifying unit (video) 4129 (*fig.* 7). This unit is triggered by the radar bright-up pulses to produce the video gate and trace compensation waveforms required by amplifying unit (video) 4133. It also contains circuits which modify the video gate waveform according to the requirements of scan failure and octagonal blanking. The information for this is obtained from amplifying unit (deflection) 4130.
Amplifying unit (X deflection) 4131	Part of amplifying unit (deflection) 4130 (*fig.*7). It amplifies the sine component of the resolved timebase waveforms from the radar office and produces paraphase current waveforms for application to the X coils of the cathode ray tube. It also produces part of the information required by the scan failure and octagonal blanking circuits of blanking unit 4134.
Amplifying unit (Y deflection) 4132	Part of amplifying unit (deflection) 4130 (*fig.* 7). This unit performs a similar function to the X deflection amplifier but its input is the cosine component of the resolved timebases and its outputs feed the Y coils of the cathode ray tube.
Stabilizer (voltage) 4127	Part of power unit 4122 (*fig.* 7). It produces stabilized power supplies for the electronic units in the projector console from the unstabilized supplies delivered by power units 4109 and 4110 in the power supply rack.
Oscillator unit (EHT) 4126	Part of power unit 4122 (*fig.* 7). It generates the EHT voltage for the cathode ray tube.
Indicating unit (CRT) 4123 (*fig.* 7 *and* 10)	This unit consists of the cathode ray tube and its mounting.
Lens unit 4124 (*fig.* 7)	A light tight shroud between the face of the CRT and the camera lens. It incorporates an optical system enabling the operator to examine the PPI display directly.
Film gate (*fig.* 7)	The film gate contains the camera, processing and projection apertures and provides a mounting for the camera lens, processing pot and projection lens. It also provides a mounting for the film cassette, projection prism, camera shutter and drive, and the film clamping and crimping mechanism.
Drive unit (mechanical) film 4119 (*fig.* 7)	This is the film transport mechanism which moves the film from one frame to the next. It is triggered at the required instant by the action of the camshaft unit.
Film cassette (*fig.* 7)	This provides storage for 2,000 ft. of film. It is mounted on the film gate.
Take-up spool (*fig.* 7)	The take-up spool is mounted on the projector mainplate. It is over-driven through a friction drive and provides a store for the processed film after projection.
Jet unit (*fig.* 7)	This unit contains a group of three chemical jets and an air drying jet. It is mounted in the processing pot in the processing aperture of the film gate.
Chemical shelf (*fig.* 9)	A mounting for the chemical storage bottles and constant level chambers.
Four-way electromatic tap (*fig.* 8)	Operated by switches in the camshaft unit to control the supply of compressed air to the jets in the jet unit.
Air heater (*fig.* 8)	This heats the air emerging from the electromatic tap to provide heating of the chemical sprays from the jet unit. This assists rapid and complete processing.

Waste tank (*fig.* 9)	The reservoir for waste liquids. It is emptied automatically at the end of each twelve-hour running period by the action of clock unit 4108 and a motor-operated air valve.
Clock unit 4108 (*fig.* 10)	A time switch containing contacts which close, at the end of each twelve hours of running, for a period long enough to allow complete emptying of the waste tank. The clock only operates while processing is in progress.
Drive unit (mechanical) timing 4118 (*fig.* 9)	This is the camshaft unit. It contains the camshaft and cam-operated switches, together with the servo motor-generator and the magslip receiver.
Amplifying unit (servo) 4111 (*fig.* 9)	The servo amplifier. Its input consists of a voltage proportional to the misalignment between the magslip receiver in the camshaft unit and the magslip transmitter in the power supply rack. Its output drives the camshaft motor-generator.
Lamphouse (*fig.* 9)	The lamphouse contains the projection lamp and the main part of the optical condenser system.
Fuse panel (*fig.* 8)	This carries all the mains fuses in the projector console.
Indicating panel (*fig.* 3)	This forms the front desk of the projector console. It carries the PROCESSING ON-OFF switch, setting controls and pressure gauges for the high-pressure air systems and a system of fault warning lights and buzzer. The JET INSPECTION SWITCH is mounted below the panel.
Relay unit 4105 (*fig.* 9)	This carries the majority of the relays associated with the projector mechanism. The relays associated with the electronic units are mounted in the units themselves.
Amplifying unit (relay) 4076 (*fig.* 9)	This unit monitors the rotation of the camshaft and operates a relay which cuts off processing if rotation stops for any reason.

Rack assembly (power supply) 340

13. The units which compose the power supply rack are as follows:—

Control unit (projector) 4075 (*fig.* 6)	The function of this unit is principally to supply current to the projection lamp in the projector console. In addition, it carries switches which control the 230V 50c/s mains supply to the equipment.
Control unit (selsyn) 921 (*fig.* 6)	This control unit contains the selsyn receiver and magslip transmitter which are included in the camshaft servo system. It provides the 24V DC supply required for operating various relays in the projector console and for the film transport motor and the shutter and film clamp mechanism. It provides the 30V AC required for the chemicals and waste warning systems. It carries the HEAD SELECTOR, HEAD COMBINING and 180 DEG. SELECTOR switches.
Power units 4109 and 4110 (*fig.* 6)	These units provide all the HT supplies for the projector console.

Panel 899

14. A view of a pair of these units (one for each projector in a typical installation) is given in fig. 5. The units duplicate the fault warnings given on the projector indicating panels.

INTERCONNECTIONS

15. A complete interconnection diagram showing all the connections associated with a single projector and its power supply rack, is given in fig. 1. When using this diagram, it should be noted that the connections in a single column, in the block showing the projector frame wiring, are not necessarily denoted in the sequence in which they occur. Detailed connections, relating to all the columns containing more than two connections, are given in fig. 12. Reference should be made to this where there is any ambiguity evident in fig. 1.

16. The block diagram given in fig. 11 shows the cabling for a complete installation involving two equipments. The services carried by the various cables are given in the following list:—

P1 to CU7	Relay switching, video map/range marks.
P2 to HT3	435V, 600V, 490V floating, 250V deflector coil supply.
P3 to CU3	Trip supply, 30V AC, 24V DC.

P4 to LC10	Heater transformers mains supply, service sockets and lights.
P5 to WB1 via 2A or 2B	Remote fault warnings to panel 899.
P6 to CU6	Magslip (servo system).
P10 to wall junction box via 16A or 16B	X deflection input.
P11 to wall junction box via 12A or 12B	Bright-up.
P12 to wall junction box via 14A or 14B	Range marks.
P13 to wall junction box via 11A or 11B	Video map.
P14 to wall junction box via 13A or 13B	Radar signal.
P18 to wall junction box via 15A or 15B	Y deflection input.
P20 to LC11	Projection lamp starter, mains and switching.
P21 to LC4	Lamp supply line.
P22 to LC5	Lamp supply neutral.
E to E	Earth.
Iron-clad switch	Mains 250V 50c/s a.c. 15A regulated supply.
Iron-clad switch	Mains 250V 50c/s a.c. 30A supply.

Location of plugs, sockets and terminal strips

17. The following list gives the location of various plugs, sockets and terminal strips in the projector console.

P1 to P20	Projector roof panel (*fig.* 4).
P21, P22, E	Top, left-hand side of console (*fig.* 10).
VR1 to VR4 EU1 VA1 to VA6 GU1 to GU8 YA1 to YA8 XA1 to XA8	Electronics distribution panel (*fig.* 9).
Deflection phasing panel	Console floor below electronics distribution panel.
Terminal strip SP RS1, RS2, CS1, CS2, RA1, SU1, SA1	Servo panel (i.e., the panel carrying the servo units at the rear of the console (*fig.* 9)).
Valve heater transformers	Console floor (*fig.* 9).
Junction strip FT	Console frame, rear, above waste tank (*fig.* 10).
CRT1, CRT2, CRT3	Waste tank compartment (*fig.* 9).
Terminal strip FB	Fuse panel—right-hand side of console (*fig.* 8).
EV1	Four-way electromatic tap (*fig.* 8).
Terminal strip CL	Console framework above fuse panel (*fig.* 8).
Terminal strip GT	Projector mainplate, front, immediately behind film cassette.
CD1, CD2	Top, left of c.r.t. compartment.

GENERAL DATA

18. This paragraph gives some useful performance data relating to the projector console.

Camera

Aperture at film gate	0·810 in. dia.
Diameter of c.r.t. face	7 in.
Diameter of c.r.t. face covered by camera	6·25 in.
Lens	Taylor, Taylor and Hobson, speed panchro. Maximum relative aperture f/2, focal length 50mm. Limited focusing adjustment.
◀Shutter	Drum type. 24V d.c. trip. Shutter closes for 1/50 revolution of the camshaft (7·2°). ▶
Distance from c.r.t. face to film.	19 in.
Shutter motor	Shaded pole, 200/250V 50c/s. Type T.P.I., B.S.R. Ltd. 10–15 watts.

Processing

Aperture at film gate	0·85 in.
Jets. Distance from film	2·312 in.
Liquid level	Nominally 0·936 in. below liquid orifice with a minimum of 0·316 in. and a maximum of 1·191 in.
Orifice sizes	Liquid 0·02 in., Air 0·024 in. Nozzle 0·037 in. nom. calibrated to give consumption of 670 cm³ of solution per hour.

Air distribution	Dunlop 4-way electromatic tap. Orifice 0·062 in. 24V d.c.
Air heating	Electric heater. 346 volt amps. Thermostatically controlled around 200° C.
Camshaft cycle	Variable between 8 and 15s. by aerial or internal control.
Cam dwell	Develop 82°, fix 82°, wash 82°, dry 114°.

Projection

Arc lamp	1kw Siemens, 2 electrode, mercury vapour. Contains xenon gas at a pressure of 2 atmospheres.
Arc voltage	65–75 volts.
Arc running current	14–19 amps.
Arc length	7–8mm.
Projection lens	Taylor, Taylor and Hobson, speed panchro. Relative aperture f/2. Focal length 50mm.
Projection lens focusing mount	Cooke and Perkins. Leica thread.
Light trap	Film crimped. Force required at crimper blade—20 lb.
Lamphouse cooling	Forced draught from site equipment cooling air supply. Automatically controlled.
Film cooling	By compressed air jet in projection aperture. Pressure 25 lb/in^2. Flow 1·7 ft^3/min.
Film protection	Pressure switch in lamp contactor circuit makes on rising air pressure of 20 lb/in^2.
Light condenser system	Kelvin and Hughes Ltd. Efficiency approximately 10%.

Film transport and registration

Transport motor	Kelvin and Hughes Ltd. Type M21 Mk. 37. 24V, 2,800 rev/min. Torque 300 g.cm. Current 2 amps.
Trip solenoid	Operated by discharge of 24μF capacitor.
Film clamping and crimping	Solenoid :— 24V d.c. operating ; 9V d.c. holding. Loading :— Processing clamp 3 lb ; Camera clamp 1 lb; Crimper 20 lb.
Transport time	1/25s.
Registration	±0·0015 in. longitudinally and transversely measured at the film gate. Longitudinal registration determined by transport sprocket corrector mechanism. Transverse registration by side pressure rollers.

Waste tank

Motor valve	Saunders Valve Co. Normal voltage 24V. Operating range 18–29V. Maximum current 0·62A. Operating time 3s.
Air consumption	0·48 ft^3/min. with a tank orifice of 0·062 in., 25 ft. waste head and 40 ft. of ¼ in. bore pipe.

CONNECTORS

19. The following list gives brief details of all the connectors required for a typical installation, including two projectors and two power supply racks.

Cable			End "A"				End "B"			
Cores	Working voltage	Length Ft. in.	Termination	Moulding position	Angle between key and angle outlet (deg.)	Marker sleeve	Termination	Moulding position	Angle between key and angle outlet (deg.)	Marker sleeve
Internal connectors for projector console										
6	2kV	2 9	Plug straight	0		XA2	Socket straight	0		XA2
6	2kV	2 9	Plug angled	0	45	CRT2	Socket angled	0	135	TM1
6	2kV	2 9	Plug angled	1	45	CRT3	Socket angled	1	135	TM2
6	2kV	2 9	Plug straight	0		GU8	Socket straight	0		GU8
6	2kV	2 9	Plug straight	0		VR3	Socket straight	0		VR3
6	2kV	2 9	Plug straight	0		VR2	Socket straight	0		VR2
6	2kV	2 9	Plug straight	0		VR4	Socket straight	0		VR4
6	2kV	2 9	Plug straight	0		EU1	Socket straight	0		EU1
6	250V	2 9	Plug straight	0		YA8	Socket straight	0		YA8
12	250V	2 8	Plug straight	0		GU7	Socket straight	0		GU7
12	250V	2 8	Plug straight	0		VA1	Socket straight	0		VA1
2	250V	2 8	Plug straight	0		YA7	Socket straight	0		YA7
2	250V	2 8	Plug straight	0		XA1	Socket straight	0		XA1
2	250V	2 8	Plug straight	0		VR1	Socket straight	0		VR1
Coaxial		2 10	Plug			YA3	Plug			YA3
Coaxial		3 3	Plug			TM3	Plug			CRT1
Coaxial		2 10	Plug			YA4	Plug			YA4
Coaxial		2 10	Plug			YA5	Plug			YA5
Coaxial		2 10	Plug			YA6	Plug			YA6
Coaxial		2 10	Plug			XA3	Plug			XA3
Coaxial		2 10	Plug			XA4	Plug			XA4
Coaxial		2 10	Plug			XA5	Plug			XA5
Coaxial		2 10	Plug			GU1	Plug			GU1
Coaxial		2 10	Plug			GU2	Plug			GU2
Coaxial		2 10	Plug			GU3	Plug			GU3
Coaxial		2 10	Plug			GU4	Plug			GU4
Coaxial		2 10	Plug			GU5	Plug			GU5
Coaxial		2 10	Plug			GU6	Plug			GU6
Coaxial		2 10	Plug			VA2	Plug			VA2
Coaxial		2 10	Plug			VA3	Plug			VA3
Coaxial		2 10	Plug			VA4	Plug			VA4
Coaxial		2 10	Plug			VA5	Plug			VA5

Cable			End "A"				End "B"			
Cores	Working voltage	Length Ft. in.	Termination	Moulding position	Angle between key and angle outlet (deg.)	Marker sleeve	Termination	Moulding position	Angle between key and angle outlet (deg.)	Marker sleeve
Internal connectors for power supply rack										
6	2kV	4 2	Plug angled	1	135	HT2	Socket straight	1		PSU2
6	2kV	3 1	Plug angled	0	135	HT1	Socket straight	0		PSU1
2	250V	3 2	Plug angled	0	180	RC2	Socket angled	0	225	RC1
3-core T.R.S.40/36		3 3	Free ends			LC8, 9, E	Free ends			CU1, 2, E
3-core T.R.S.40/36		1 11	Free ends			LC6, 7, E	Free ends			HT4, 5, E
Connectors between power supply rack 1 and projector console 1										
6	2kV	31 0	Plug straight	0		LC10	Socket straight	0		P4
6	2kV	31 0	Plug straight	1		LC11	Socket straight	1		P20
6	2kV	32 0	Plug angled	2	0	CU3	Socket straight	2		P3
6	2kV	30 0	Plug angled	3	225	HT3	Socket straight	3		P2
6	250V	32 0	Socket angled	0	315	CU6	Plug straight	0		P6
6	250V	32 0	Socket angled	1	45	CU7	Plug straight	1		P1
3-core T.R.S.110/36		33 0	Free ends			LC4, 5, E	Free ends			P21, 22, E
Connectors between power supply rack 2 and projector console 2										
6	2kV	27 0	Plug straight	0		LC10	Socket straight	0		P4
6	2kV	27 0	Plug straight	1		LC11	Socket straight	1		P20
6	2kV	28 0	Plug angled	2	0	CU3	Socket straight	2		P3
6	2kV	26 0	Plug angled	3	225	HT3	Socket straight	3		P2
6	250V	28 0	Socket angled	0	315	CU6	Plug straight	0		P6
6	250V	28 0	Socket angled	1	45	CU7	Plug straight	1		P1
3-core T.R.S.110/36		30 0	Free ends			LC4, 5, E	Free ends			P21, 22, E
Connectors between projector console 1 and wall junction box										
12	250V	17 0	Plug straight	0		P5	Socket straight	0		2A
Coaxial		17 0	Plug			P10	Plug			15A
Coaxial		17 0	Plug			P11	Plug			12A
Coaxial		17 0	Plug			P12	Plug			14A
Coaxial		17 0	Plug			P13	Plug			11A
Coaxial		17 0	Plug			P14	Plug			13A
Coaxial		17 0	Plug			P18	Plug			16A

Cable			End "A"				End "B"			
Cores	Working voltage	Length Ft. in.	Termination	Moulding position	Angle between key and angle outlet (deg.)	Marker sleeve	Termination	Moulding position	Angle between key and angle outlet (deg.)	Marker sleeve
Connectors between projector console 2 and wall junction box										
12	250V	15 0	Plug straight	0		P5	Socket straight	0		2B
Coaxial		15 0	Plug			P10	Plug			15B
Coaxial		15 0	Plug			P11	Plug			12B
Coaxial		15 0	Plug			P12	Plug			14B
Coaxial		15 0	Plug			P13	Plug			11B
Coaxial		15 0	Plug			P14	Plug			13B
Coaxial		15 0	Plug			P18	Plug			16B
Connector between power supply rack 1 and selsyn patching panel										
6-core miniature No. 6J	14/36	25 0	Socket angled 6-pole Mk. 4	0	0	CU5	Plug angled 12-pole Jones			2
Connector between power supply rack 2 and selsyn patching panel										
6-core miniature No. 6J	14/36	29 0	Socket angled 6-pole Mk. 4	0	0	CU5	Plug angled 12-pole Jones			4
Connector between power supply rack 1 and wall junction box										
25	250V	27 0	Socket angled	0	0	CU4	Plug straight	0		3A
Connector between power supply rack 2 and wall junction box										
25	250V	25 0	Socket angled	0	0	CU4	Plug straight	0		3B

Lengths of earth connectors

Projector 1	18 ft.
Projector 2	17 ft.
Power supply rack 1	24 ft.
Power supply rack 2	28 ft.

Lengths of mains cables from power supply racks to wall ironclad switches

15A mains supplies. Total length 90 ft. of 250V V.I.R., insulated cores, T.R.S. 3-core cable 40/0·0076 in.

30A mains supplies. Total length 55 ft. of 250V, V.I.R., insulated cores, T.R.S. 3-core cable 110/0·0076 in.

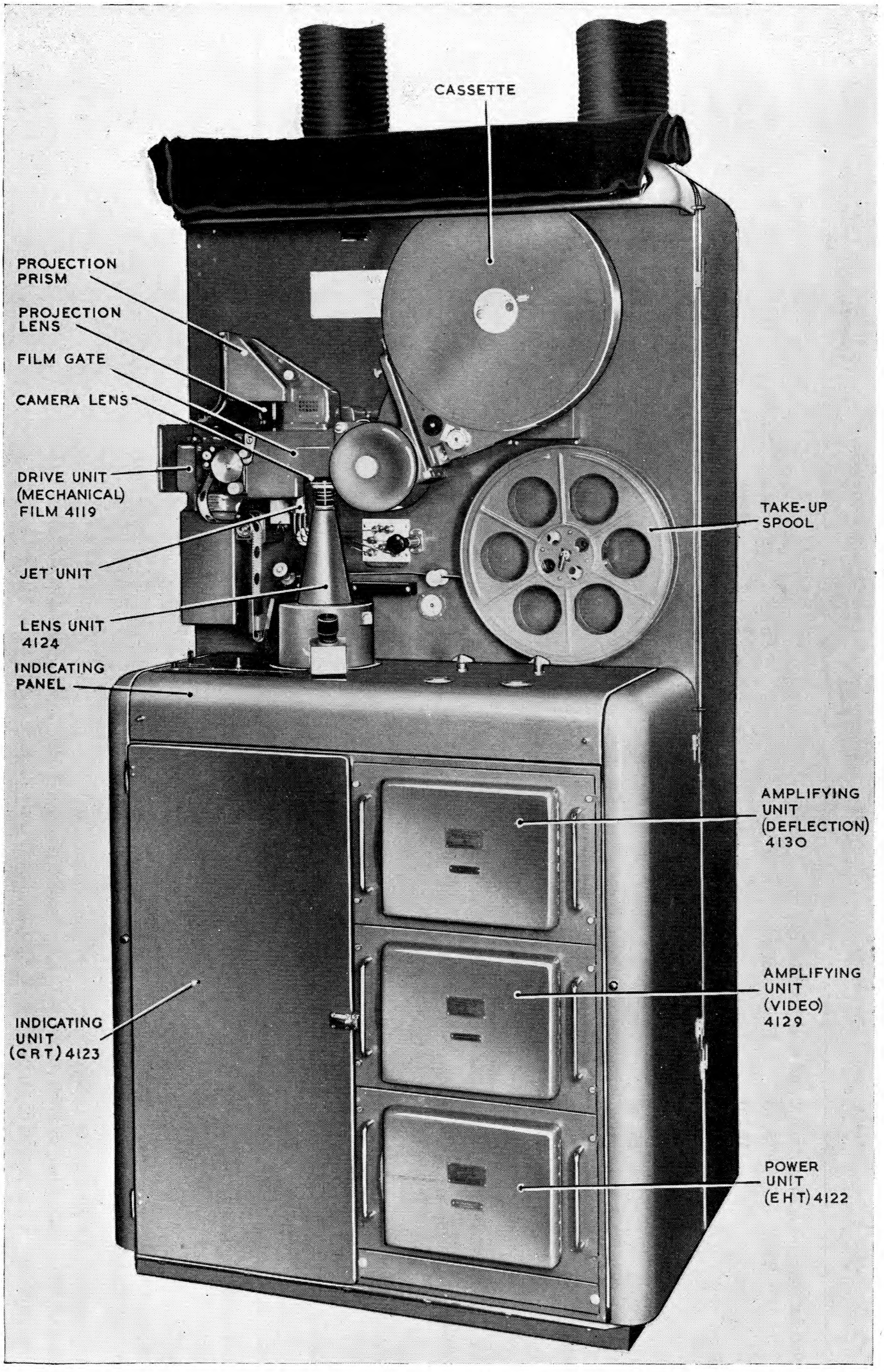

Fig. 7. Projector unit 100: front view

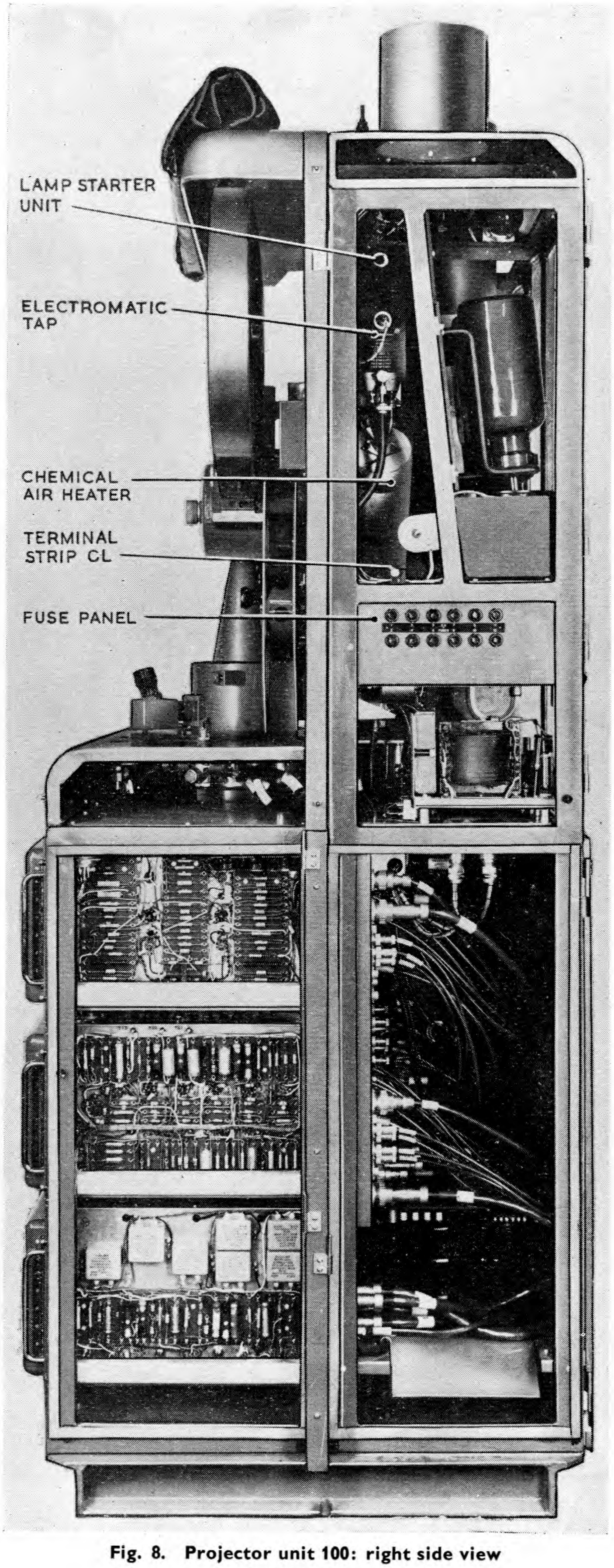

Fig. 8. Projector unit 100: right side view

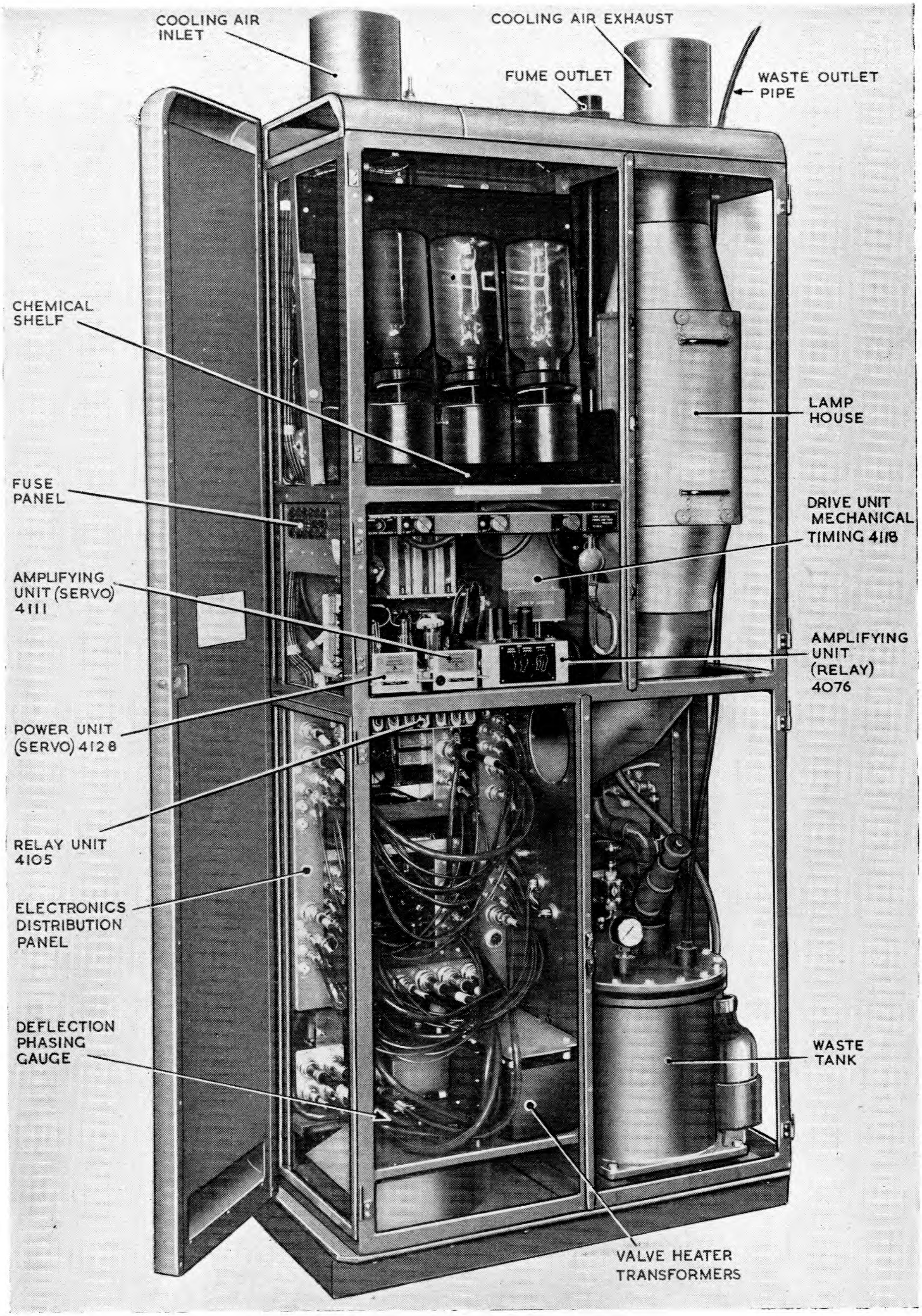

Fig. 9. Projector unit 100: rear view

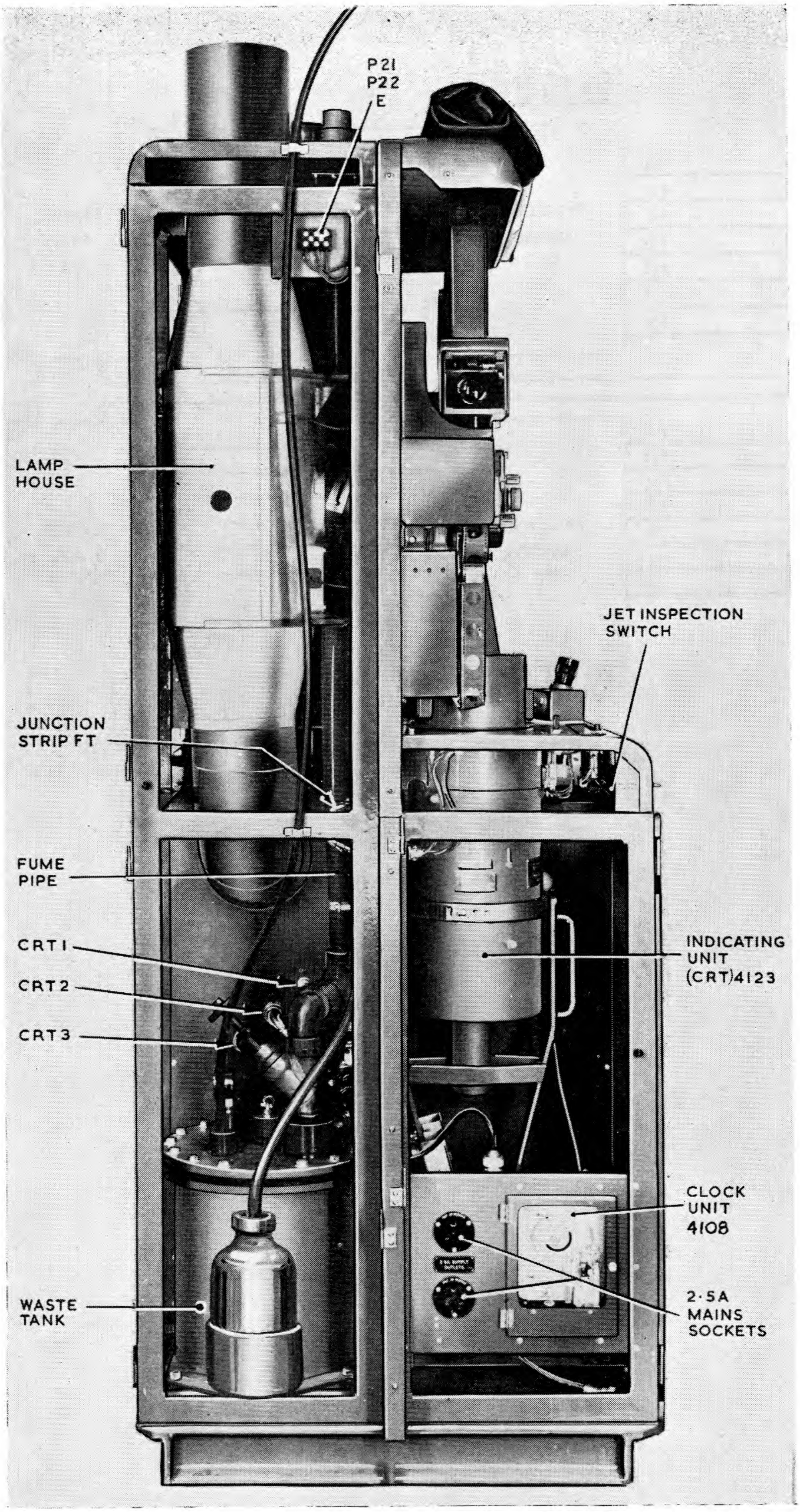

Fig. 10. Projector unit 100: left side view

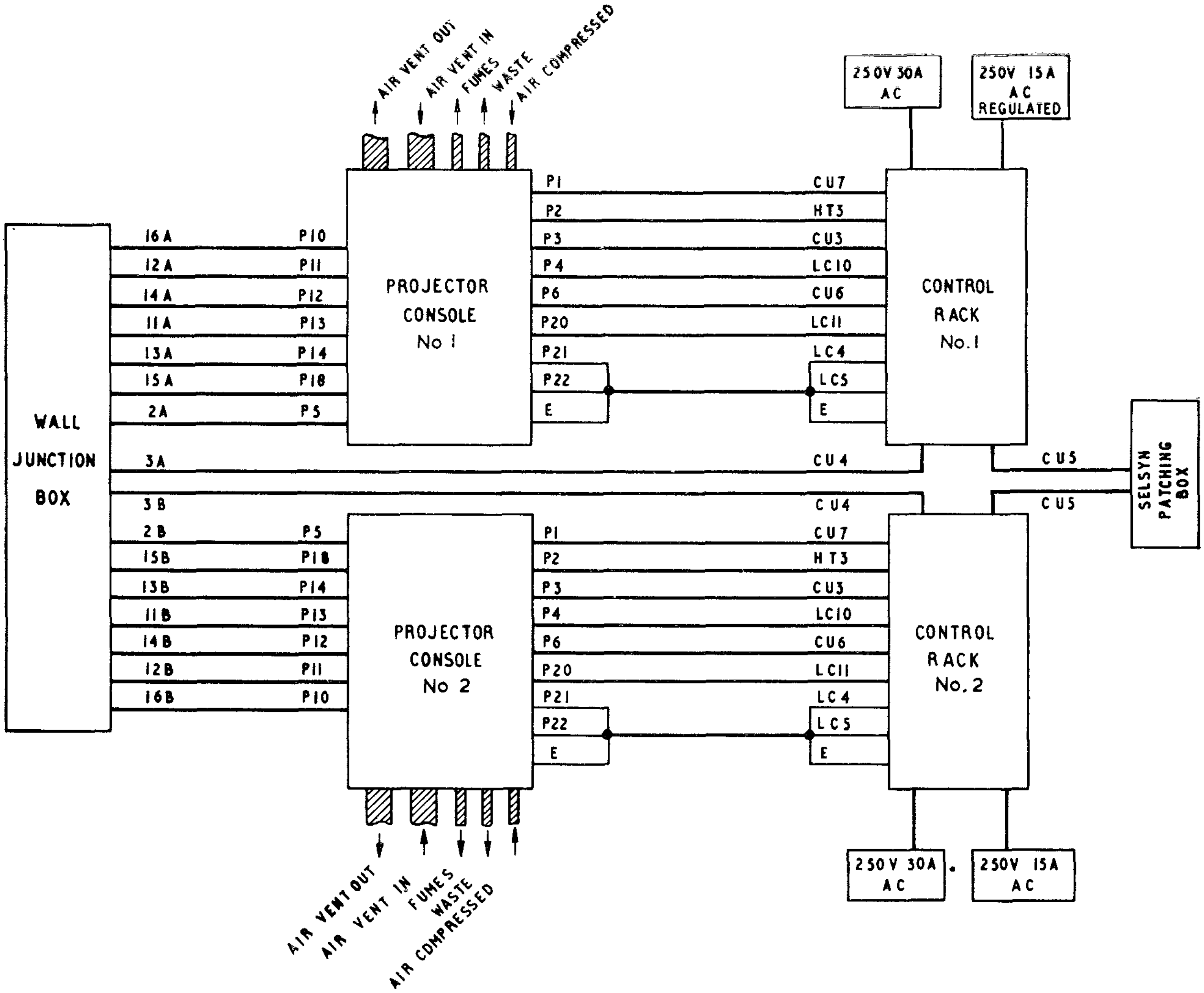

Fig. 11. Typical installation: schematic diagram

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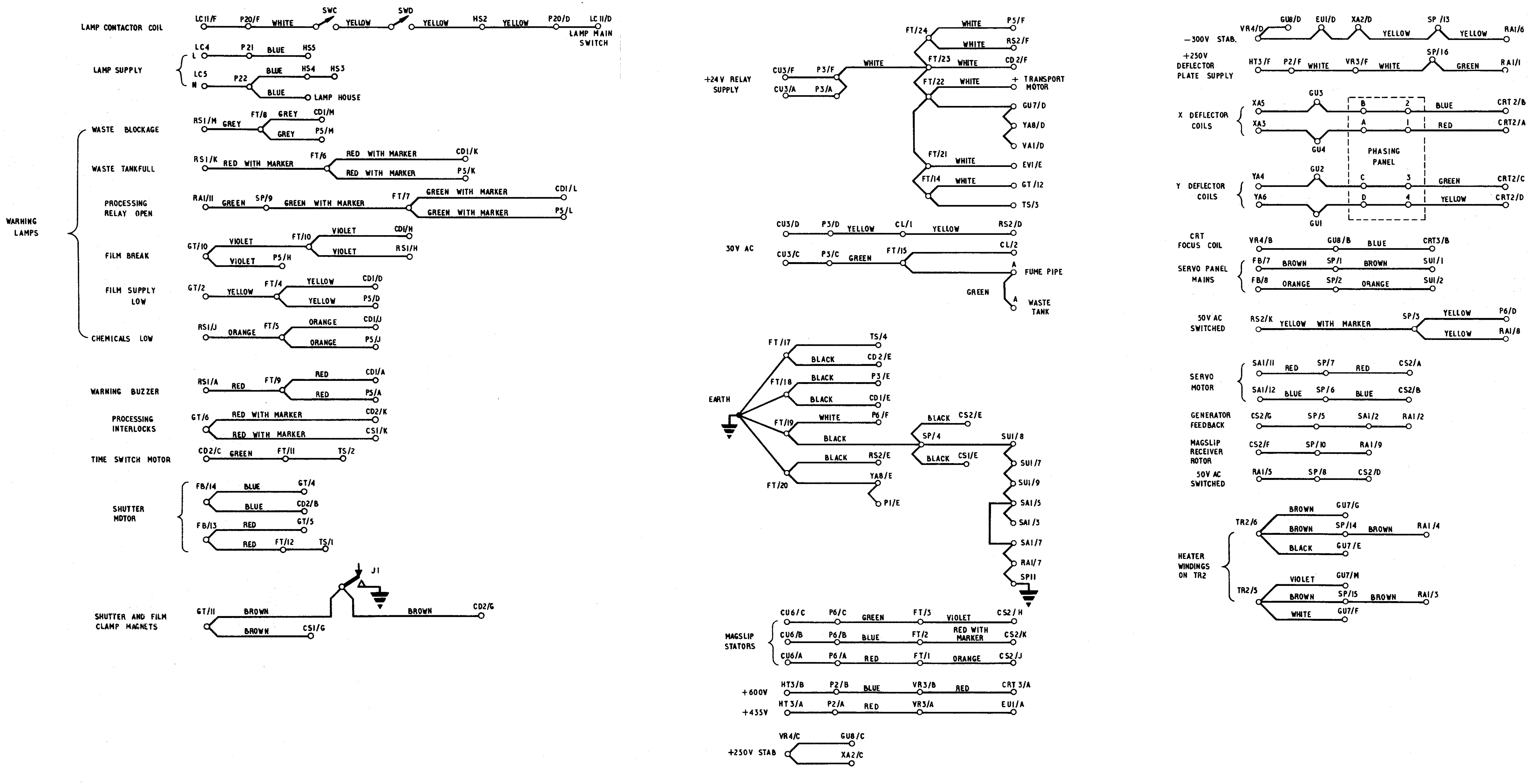

AIR DIAGRAM
6151K/MIN.

ISSUE 1

PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY ADMIRALTY

Radar photographic display system 1498 : detailed interconnections

Fig. 12

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Chapter 3

ANCILLARY ITEMS

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

General

1. The following ancillary items are described in this chapter:—

(1) Tool kit
(2) Film rewinder
(3) Siphon bottle
(4) Storage racks
(5) Setting board

Tool kit

2. The tool kit, which contains all the tools required for day-to-day servicing of the photographic display system, is illustrated in fig. 1.

3. The kit is contained in a wooden box having loose trays with separate stowage positions for each of the various tools. The box is fitted with a lock.

4. Some of the tools are peculiar to this equipment. The uses for which they are intended are given in the following list.

Selvyt cloth and squirrel hair brushes	For cleaning optical glass surfaces.
Chamois leather	For routine cleaning of ordinary glass surfaces and paintwork.
1 in. flat brush	Routine dusting.
Jet spanner	A "C" type spanner for tightening the ring locking the jet unit into the processing pot.
Spanner (key) 125	This fits the locking ring securing lenses 6 and 7 into their cell in the film gate casting. It also fits the clamp ring securing the bloomed glass disc to the projection lens mount in the gate cover casting.
Extractor tools for lamps and caps	For P.O. No. 2 lamps and caps (e.g., fault warning lamps).
Window (inspection) 314	Jet inspection window.
Plug (servicing) film gate	A S.R.B.P. plug for insertion in the camera aperture when cleaning the film gate. The plug prevents foreign matter from falling on to the camera lens.
Gauge, pot, processing	A non-corrodible steel plug having a 0·002 in. deep recess in its face. It enables the processing pot to be set so that its rim extends for 0·002 in. above the surface of the lower table in the film gate: this is the optimum position.

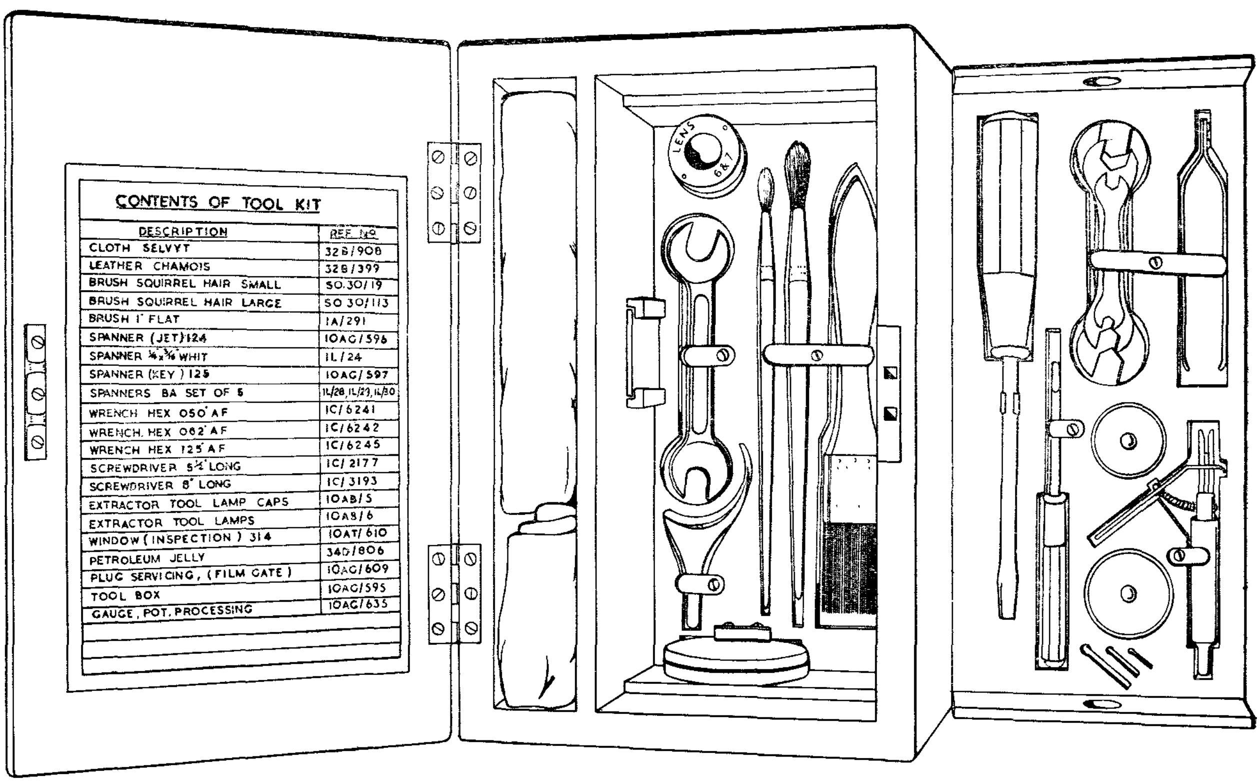

Fig. 1. Tool kit

Film rewinder

5. The film, used in the photographic display system, is supplied in 1,000 ft. lengths, wound on Bakelite centres and stored in flat circular tins. When loading the projector with new film, a length, complete with its centre, is loaded into the film cassette as described in Section 7, Chapter 2. The charged film cassette is then substituted for the exhausted cassette on the projector and the full take-up spool on the projector is replaced with an empty take-up spool.

6. The purpose of the film rewinder is to enable the film on the full take-up spool to be wound back on to the Bakelite centre from which it came; this centre will be in the empty cassette.

7. The machine is illustrated in fig. 2. It consists of an oak baseboard carrying two cast metal columns. One of the columns carries a free horizontal spindle for mounting the take-up spool. The other column has a spindle which is driven by a handle through 3:1 gearing. Mounted on the spindle is a flat disc which rotates with it to provide a locating plane for successive turns of film. During the rewinding process, the growing spool of film is retained against the disc by a spring loaded diametral metal strip. This is pivoted at one end on a spindle which is retained in the base of the cast column. The strip can be pulled out against the pressure of the spring until it is clear of the centre spindle and then turned to one side. This allows access to the spindle for mounting the Bakelite centre or for removing the rewound spool of film.

8. The procedure for rewinding film is given in Section 7, Chapter 2.

Siphon bottle

9. The purpose of the siphon bottle is to facilitate the removal of liquids from the chemical level chambers in the projector console. It consists of a standard 50 oz. bottle (similar to those used in the projector for the fix and wash solutions) fitted with a special cap assembly. The cap is made of black polythene and it screws on to the neck of the bottle; a synthetic rubber sealing washer ensures an airtight joint.

10. Two polythene tubes, one long and one short, are welded into the cap. The short tube has a mouthpiece at one end and projects through the cap for about an inch. The long tube carries a moulded entry nozzle at one end and the other end passes through the cap right to the bottom of the bottle.

11. When using the siphon bottle to withdraw liquid from a level chamber, the operator places the

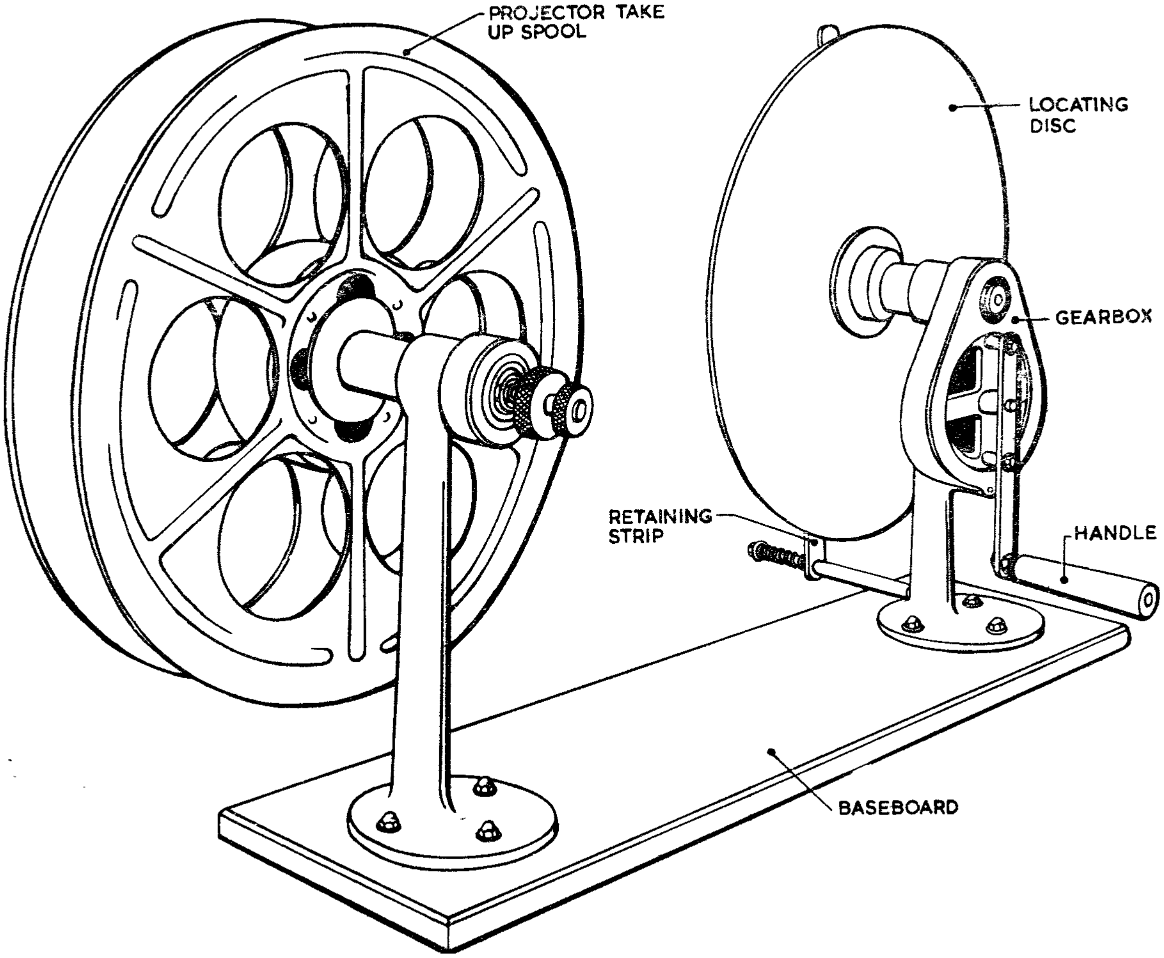

Fig. 2. Film rewinder

entry nozzle into the liquid and holds the bottle at a lower level. He sucks through the mouthpiece until liquid starts to run through the long tube into bottle. He then releases the mouthpiece and liquid continues to run into the bottle by siphon action until the entry nozzle becomes uncovered or until the level in the bottle reaches that in the chamber.

Storage racks

12. Each installation includes a rack 178 and a rack 179 for the storage of film and chemicals. These racks are normally situated in the darkroom. They can be seen in the view of a typical darkroom given in Chapter 1.

Setting board

13. This board is fixed to the floor between the two projectors of a normal installation. The board carries various markings to facilitate the setting up of the standby projector. The method of marking out the board is given in Section 7, Chapter 1. Its use for setting up the equipment is given in Volume 5 of this Air Publication.

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SECTION 2

CRT DISPLAY

Chapter I

GENERAL DESCRIPTION

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

General

1. The CRT display is generated from information supplied from the radar office by the action of four main units in the projector console. These are:—

(1) Amplifying unit (video) 4129

(2) Amplifying unit (deflection) 4130

(3) Power unit 4122

(4) Indicating unit (CRT) 4123

2. The electronic units are situated in the lower front section of the projector console. A view of this section is given in fig. 1. A schematic diagram, including all the units concerned with the production of the CRT display, is given in fig. 2.

3. Interconnections between units in the electronics section of the projector console and connections to other parts of the equipment are made via a distribution board at the rear of the main electronics compartment. A view of this panel is given in fig. 3. Details of the connections made via the board will be found in Section 1, Chapter 2.

Indicating unit (CRT) 4123

4. The indicating unit occupies the lower, front, left-hand compartment of the projector console (*fig.* 1). It consists of a sprung framework carrying a mounting tube which contains the CRT and its focus and deflection coils.

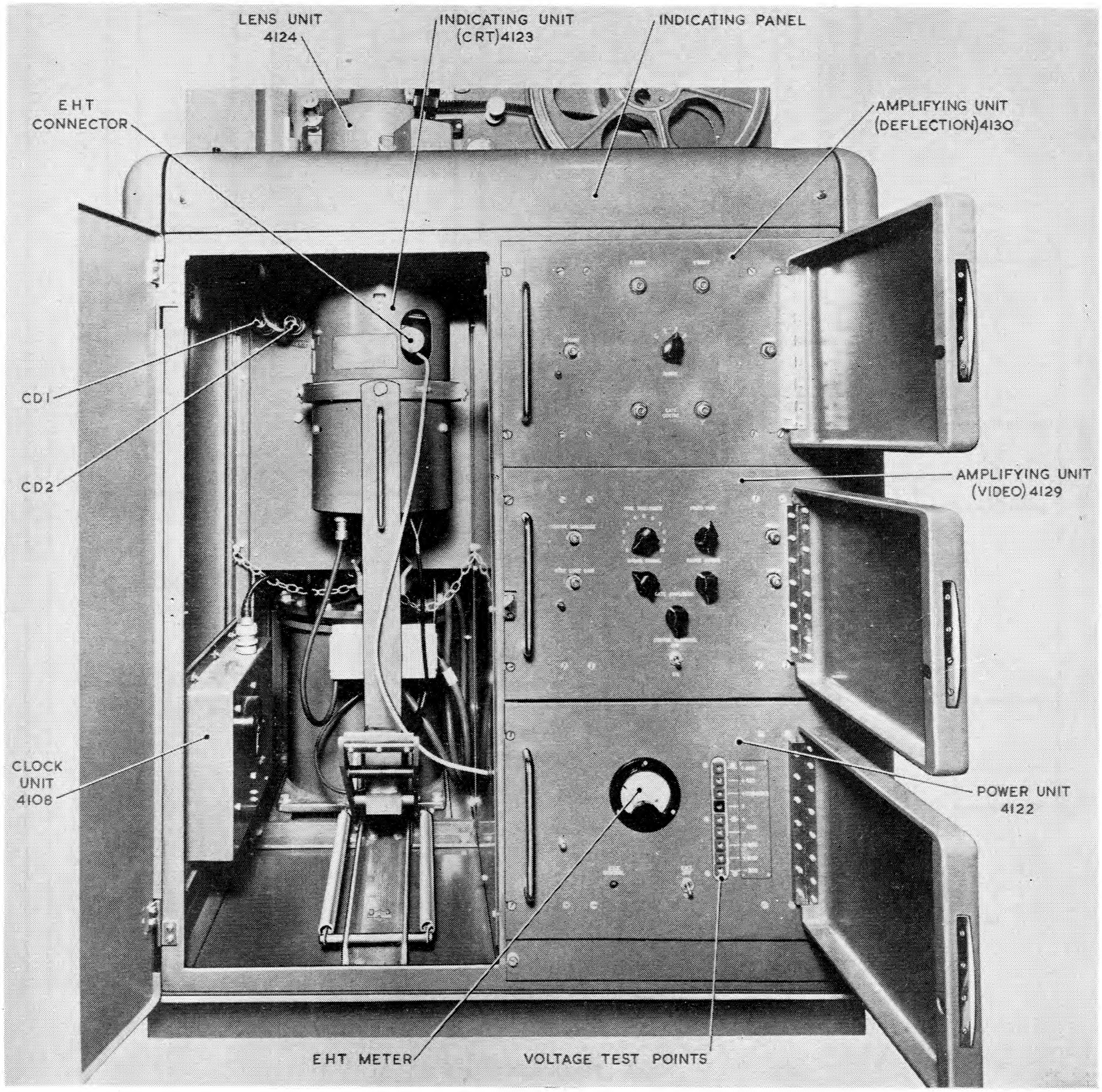

Fig. 1. Electronic units: general view

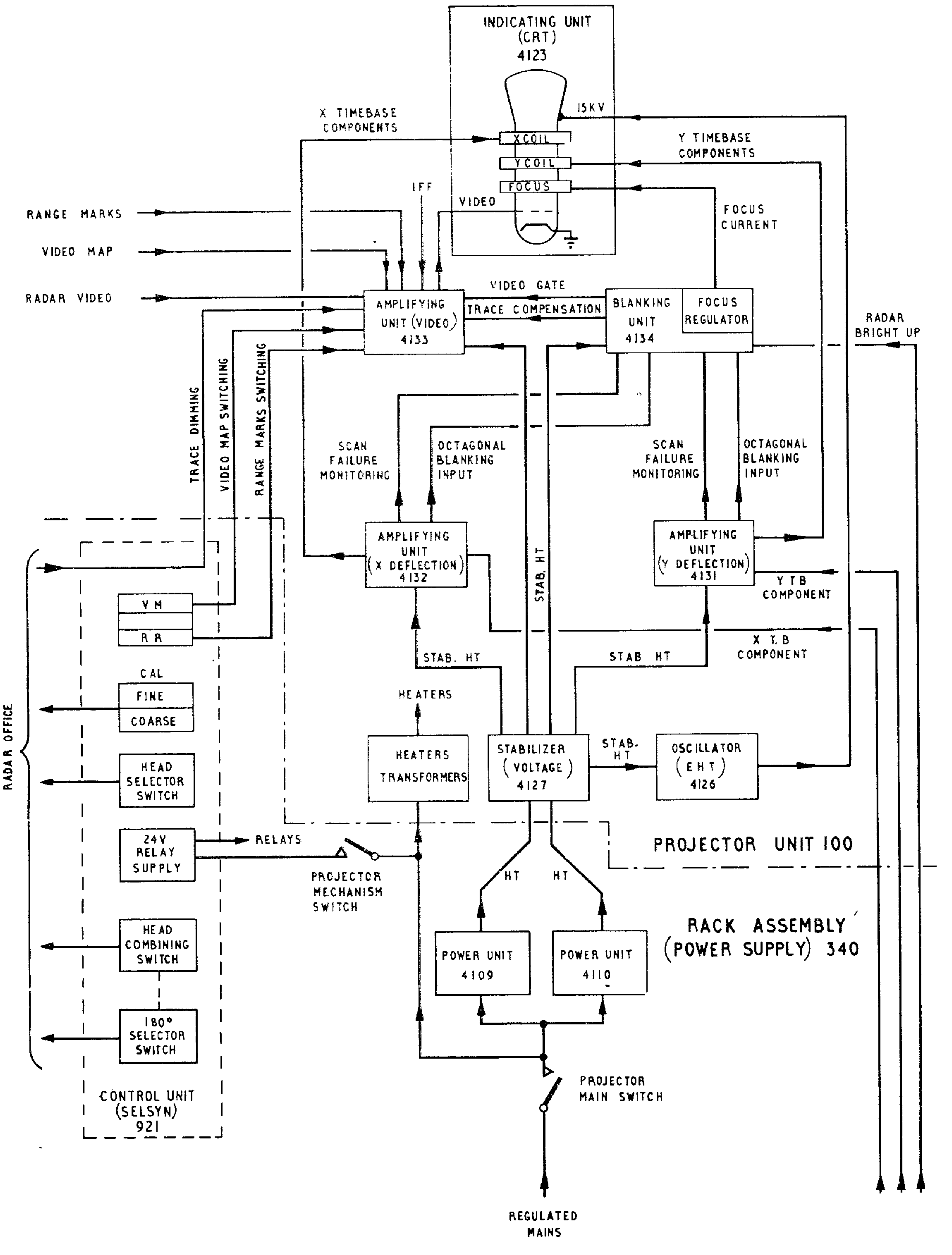

Fig. 2. Schematic diagram

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EHT supply

5. The EHT supply for the cathode ray tube is obtained from oscillator unit (EHT) 4126, which is part of power unit 4122 in the lower shelf of the electronics compartment. The EHT circuit consists of a RF oscillator whose output is applied to the primary of a RF transformer. The output from the secondary of this transformer is applied to a voltage trebler rectifier circuit to provide the + 15kV supply required for the CRT. The circuit employs negative DC feedback in order to obtain the high degree of stability required. A meter, mounted on the front of power unit 4122, monitors the value of the EHT supply to the CRT.

Focus current

6. The CRT focus coil is supplied with current via a circuit in blanking unit 4134 (*para.* 11).

Amplifying unit (video) 4129

7. This unit contains amplifying unit (video) 4133 and blanking unit 4134 which are mounted side by side and share a common front panel. It occupies the centre shelf of the electronics compartment.

Amplifying unit (video) 4133

8. The video amplifier is mounted at the left-hand side of amplifying unit (video) 4129. Its purpose is to accept all the video quantities which are to be displayed as brightness modulation on the CRT. These quantities are mixed at appropriate levels, limited and amplified, and are then gated by the video gate waveform from the blanking unit and are superimposed on the trace compensation waveform also from the blanking unit. The video output waveform from the unit is connected to the grid of the cathode ray tube.

9. Radar video signals, range marks and video map signals are connected to the video amplifier from the radar office. The radar video signal is permanently connected to the input of the first stage, but the other signals are connected via relay contacts. The relays are operated as required by setting the CALIBRATION VM/RR switch on control unit (selsyn) 921 in the power supply rack to the appropriate position. Control unit (selsyn) 921 also carries the following switches associated with the inputs to the system from the radar office.

(1) The CALIBRATION FINE/COARSE switch

(2) The HEAD SELECTOR switch

(3) The HEAD COMBINING switch

(4) The 180 deg. SELECTOR switch

The operation of these switches and their effect on the display is described in Section 4, Chapter 7.

10. If the magslip resolver in the radar office ceases to rotate, resulting in a stationary trace on the indicating unit CRT, a relay in the video amplifier releases. This reduces the gain of the amplifier, so reducing the brightness of the stationary trace to a safe level.

Blanking unit 4134

11. The blanking unit forms the right-hand section of amplifying unit (video) 4129. It performs the following functions.

(1) From the radar bright-up waveform supplied by the radar office it generates the basic video gate waveform which ensures that the CRT spot is only brightened during those periods when it is moving from the centre to the edge of the CRT face.

(2) It modifies the basic video gate waveform according to the requirements of scan failure and octagonal blanking. The input quantities required for this purpose are obtained from amplifying unit (deflection) 4130. The scan failure blanking circuit ensures that the CRT trace is blanked if no outputs are obtained from the deflection amplifiers. If an output is obtained from one amplifier but not from the other, the CRT display is blanked when the amplitude of the trace, resulting from one amplifier operating alone, falls below a certain preset level. The octagonal blanking circuit ensures that the display is blanked outside the useful area of the CRT face, so preventing degeneration of the picture contrast or possible damage to the structure of the tube.

(3) From the video gate waveform it generates a trace compensation (or "taper") waveform which ensures that the CRT spot brightens progressively during its excursion from the centre to the edge of the tube face. This effect compensates for the divergence of adjacent traces and ensures that all signal echoes cause the same intensity of illumination on the CRT screen irrespective of where they appear.

(4) It provides regulated current for the CRT focus coil so obviating the need for focus adjustment during operation.

Amplifying unit (deflection) 4130

12. This unit occupies the top shelf of the electronics compartment. It consists of two similar amplifiers mounted side by side and sharing a common front panel.

Amplifying unit (X deflection) 4132

13. The X deflection amplifier is supplied with the X component of the resolved timebase waveforms from the radar office. Its main outputs consist of paraphase current waveforms which are applied to the X deflecting coils in the indicating unit. In addition, it supplies waveforms to blanking unit 4134 to provide information for the scan failure and octagonal blanking circuits.

Amplifying unit (Y deflection) 4131

14. This amplifier is driven by the Y timebase component from the radar office and delivers paraphase currents to the Y deflection coils. It also supplies octagonal blanking and scan failure information to blanking unit 4134.

Timebase ranges

15. Four different timebase ranges are available as determined by the setting of a switch on the front panel of amplifying unit (deflection) 4130. The switch position selected determines the condition of various relays in the deflection amplifiers and in blanking unit 4134. By this means, the gain of the amplifiers is made appropriate to the required

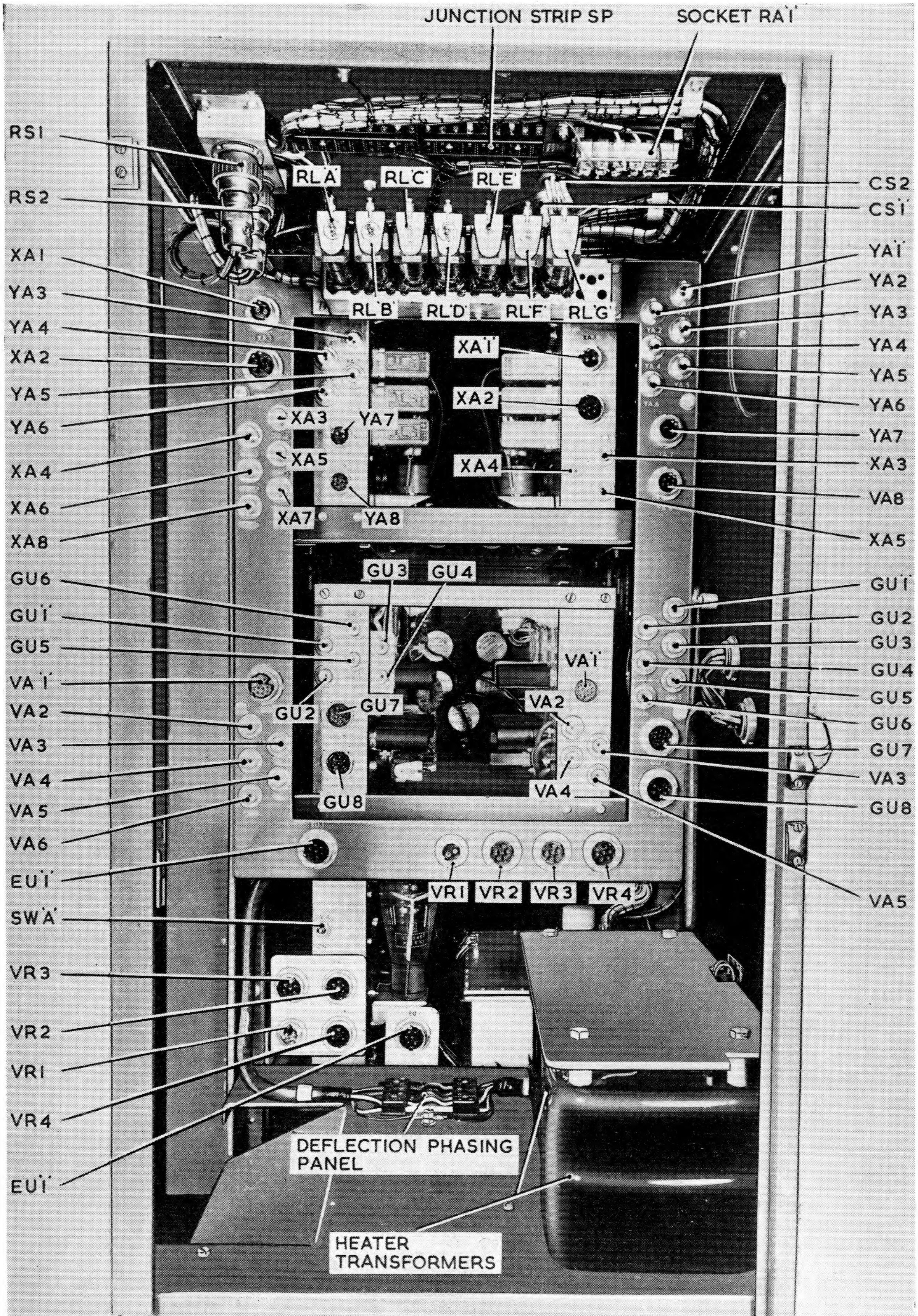

Fig. 3. Distribution board

range and the video trace compensation waveform is modified to suit the range.

Deflection phasing panel

16. The connections between the deflection amplifiers and the CRT deflector coils pass via the deflection phasing panel which is mounted on the floor plate of the projector console below the distribution board (*fig.* 3). The panel carries five input and five output terminals connected by wire links. The panel provides a means of varying the connections between the amplifiers and the CRT coils in order to alter the orientation of the CRT display (and hence of the final picture displayed on the projection screen) to suit local site requirements.

Power supplies

17. All the HT supplies for the electronic units originate in power units 4109 and 4110 in the power supply rack. The regulated mains supply to these power units is switched by the PROJECTOR MAIN SWITCH. Certain outputs from the power units are applied to stabilizer (voltage) 4127 (part of power unit 4122) where stabilized supplies are derive from them.

Valve heater supplies

18. Heater supplies for the various valves in th electronic units are derived from two heater tran formers in the base of the projector console (*fig.* 3 The mains supply to these transformers is switche by the PROJECTOR MAIN SWITCH on the pow supply rack.

Relay supplies

19. The 24V DC supply, required for operatin the various relays in the electronic units and els where in the projector console, is generated by co trol unit (selsyn) 921 in the power supply rac The 230V AC input to the control unit is switche by the PROJECTOR MECHANISM switch as well as b the PROJECTOR MAIN SWITCH.

Note . . .

The trace dimming relay in the video amplifi (para. 10) is energized by a 50V DC supply fro the radar office and not by the 24V relay suppl from the power supply rack.

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Chapter 2

AMPLIFYING UNIT (VIDEO) 4129

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION

1. Amplifying unit (video) 4129 consists of a front panel and framework carrying blanking unit 4134 and amplifying unit (video) 4133. They are mounted with their chassis vertical, the blanking unit being to the right and the video amplifier to the left as viewed from their common front panel. The whole unit is mounted in the middle shelf of the electronics compartment at the lower right-hand side of the projector console (*Chapter* 1).

2. The front panel of the unit, carrying the various operating controls and switches, can be seen in the general view of the electronic units given in Chapter 1.

Blanking unit 4134

3. This unit amplifies the standard radar bright-up pulse from the radar office and produces from it a gating waveform for the video amplifier. The gating waveform includes provision for blanking the picture on the indicating unit CRT when the timebase scan proceeds beyond the limits of the screen area (octagonal blanking) and when failure of either timebase component occurs. The commencement of the gating wave may also be modified to give blanking at the centre of the display to remove the undesirable bright patch resulting from short range permanent echoes.

4. The blanking unit also contains a circuit for regulation of the CRT focus coil current and a circuit which produces a trace compensation (or taper) waveform for the video amplifier.

Amplifying unit (video) 4133

5. The purpose of this unit is to amplify the radar video signal from the radar office together with video map or range markers if required. The signals are gated in the amplifier, by the video gate waveform produced in the blanking unit, so that the CRT trace is brightened only inside the screen area, and only then when the scan circuits are operating satisfactorily. An arrangement is included which reduces the gain of the amplifier, and hence the brightness of signals on the CRT, if the magslip resolver in the radar office should cease rotation. The trace compensation waveform from the blanking unit is also applied to the amplifier in such a manner that the output signals are superimposed on a sawtooth pedestal; the result of this is that the CRT spot is gradually brightened as it proceeds from the origin of the scan towards the edge of the picture, thus compensating for the divergence of adjacent traces.

BLANKING UNIT 4134

General

6. A block diagram of the blanking unit is given in fig. 1.

7. The radar bright-up waveform from the radar office consists of a square wave approximately 2V in amplitude; this is positive-going for the duration of the timebase trace. It is amplified in the bright-up amplifier and is then applied to the video gate generator. Also applied to the video gate generator is a blanking waveform from a blanking circuit.

8. The scan failure blanking circuit is driven by the voltage pulses which are produced at the anodes of the four output valves of amplifying unit (deflection) 4130. Provided that all these pulses are present, no output is obtained for application to the common blanking valve. If, however, one or more of the deflection output valves fails to deliver a pulse, an output is obtained from the common blanking valve during the period when the defective deflection circuit should be providing the largest negative-going pulse to the blanking unit.

9. The octagonal blanking circuit is fed from the cathodes of the four deflection amplifier output valves. Whatever the bearing of the radar head, the voltages at two of these cathodes will be negative-going and these operate the octagonal blanking circuit in a manner such that the common blanking valve is driven when the CRT spot reaches the edge of the screen. The output from

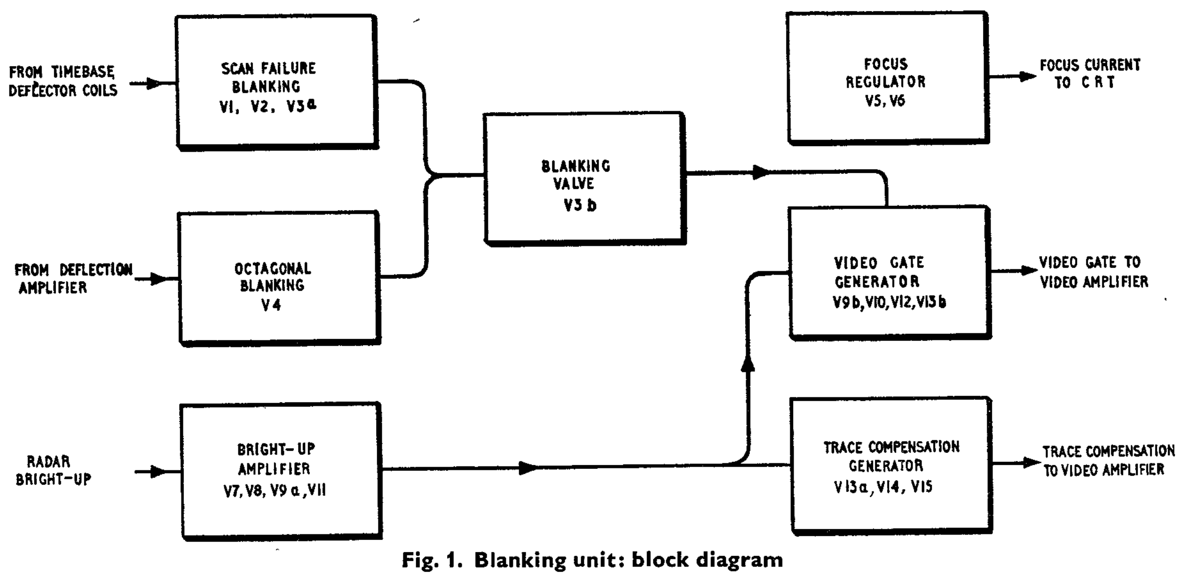

Fig. 1. Blanking unit: block diagram

the common blanking valve consists of a waveform which is negative-going during the periods when either scan failure occurs or when the spot on the CRT is deflected beyond the edge of the CRT screen.

10. The output from the video gate generator consists of a positive-going square wave which commences at the onset of the trace period, due to the action of the radar bright-up waveform, and ends at the onset of the negative-going blanking wave from the common blanking valve or at the end of the radar bright-up—whichever occurs first. If required, the gate waveform may be modified to give a sloping leading edge to the positive-going portion; this introduces a delay between the start of the timebase trace and the appearance of video signals on the display. This is known as centre blanking.

11. The trace compensation generator produces its sawtooth output by the charging of a condenser through a resistor during the trace period. The charging process is initiated by the bright-up amplifier.

12. The focus regulator has no connection with the other circuits in the blanking unit, and is located in this unit purely for convenience. Its purpose is to stabilize the current through the CRT focus coil to obviate the need for frequent adjustments during operation.

13. A complete circuit diagram of the blanking unit is given in fig. 11. Component layout diagrams are given in fig. 8 and 9.

Bright-up amplifier

14. The radar bright-up voltage, from rack assembly 184 in the radar office, is in the form of a positive-going square wave approximately 2V in amplitude (*waveform* 1, *fig.* 2) and occurring at the repetition frequency of the selected radar. The duration of the square wave is the same as that of the timebase waveforms applied to the deflection amplifiers. It enters the blanking unit at socket GU6 being fed via the junction box on the wall and PL11 on the roof panel of the projector. It is developed across R28 (*fig.* 11), which provides a suitable termination for the connecting cable, and is applied via C7 to the grid circuit of V7b.

15. Since valve V7b has no cathode bias, DC restoration takes place at the grid fixing the positive excursion of the input at earth potential. The output from the anode circuit of the valve consists of a square wave approximately 65V in amplitude which is negative-going during the trace period.

16. The output from the anode of V7b is applied via C8 to the grid circuit of V7a (*waveform* 2, *fig.* 2). Here, the positive-going excursion of the waveform is clamped at +20V by the action of a DC restoring diode V8a whose cathode is connected to the junction R32, R33. The cathode of V7a is connected to earth via the series circuit consisting of R38 and the two diodes V11b and V11a. It is also connected to the −300V line via R37. The diodes are associated with the video trace compensation wave generator (*para.* 28).

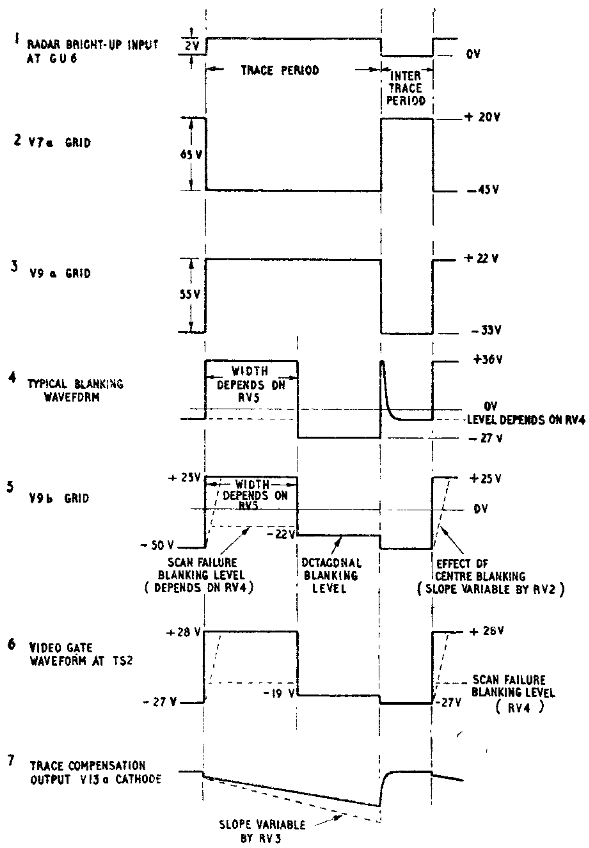

Fig. 2. Bright-up circuit waveforms

17. Due to the DC restoration of the waveform from V7b anode, the grid of V7a falls to about −45V during the trace period. The cathode potential of the valve will also fall to approximately −45V due to the large cathode load R37 and the diodes V11a and V11b will be cut off. Since the current through the valve will only be about 0·25mA, the anode potential will be close to that of the HT line and the gain of the stage will be very small because of the current feedback through R37. At the end of the trace period, the grid moves positive to +20V where it is clamped by V8a. The cathode potential follows this movement and, as it passes through earth potential, the diodes V11a and V11b conduct, reducing the cathode load to the value of R38 and increasing the stage gain to approximately $2\frac{1}{2}$. Thus, during the initial part of the positive excursion of the grid, there is a negligible effect in the anode circuit, but the excursion above earth potential is amplified some $2\frac{1}{2}$ times and a square wave of amplitude approximately 55V is obtained at the anode. This square wave is positive-going during the trace period.

18. The waveform at the anode of V7a is applied via C9 to the grid circuit of a cathode follower V9a, where its negative-going excursion is clamped at −33V by the action of the DC restorer V8b, whose anode is returned to the junction R40, R41 (*waveform* 3, *fig.* 2). This waveform is reproduced at the cathode of the valve with its DC levels slightly altered to approximately +25V during the trace period and −30V during the intertrace period.

Video gate generator

19. Valve V9b is a cathode follower whose input consists of the amplified radar bright-up waveform from the cathode of V9a (modified for centre blanking if required) together with the blanking waveform from the cathode of the common blanking valve V3b (*para.* 51).

20. A circuit consisting of the diode V10a and R46 is connected between the cathode of V9a and the slider of RV2 which is part of a potentiometer network across the HT supply. When switch SWA is set to OFF the diode always conducts, since the voltage at V9a cathode never rises above that of RV2 slider; the voltage at V10a anode therefore follows that at V9a cathode. This voltage is connected to the cathode of V10b, whose anode is also connected to RV2 slider via R47.

21. The blanking waveform from the cathode of V3b is connected to the cathode of the diode-connected triode V13b. The anode of this valve is connected to the anode of V10b; the potential at this point depends on that of the cathode of V13b or V10b, whichever is the more negative. A typical blanking waveform is given in fig. 2 (*waveform* 4). Assuming that there is no scan failure blanking at the start of the trace period, the voltage applied to V9b grid from the junction of V10b and V13b anodes rises from the intertrace level of −30V to +25V, where it remains for a period determined by the setting of the GATE AMPLITUDE control RV5 (*para.* 49). It then falls to the octagonal blanking level of about −22V (rather more positive than V13b cathode due to valve impedance) until the end of the trace period, when it reassumes the intertrace level of −30V. The positive peak shown at the start of the intertrace period in waveform 4 (*fig.* 2) has no effect since V9b grid is held at −30V by the action of V10.

Note . . .
The parts of waveforms 4 and 5 (fig. 2) and waveform 5 (fig. 3) which depend on the setting of RV5 will also vary in duration as a result of aerial position and X or Y shift as appropriate.

22. When scan failure blanking occurs, the level of the positive excursion at the start of the trace period is limited by V13b to a value determined by the setting of RV4 (*para.* 39).

Centre blanking

23. When the CENTRE BLANKING ON–OFF switch SWA is set to ON, a circuit consisting of C11, R45 and the crystal diode V12 is connected between the anode of V10a and earth. During the intertrace period, V10a conducts holding the junction of V10a anode and C11 at −30V. At the onset of the trace period, V10a cathode rises rapidly and cuts off the valve since its anode potential is held down by C11. C11 now charges via the circuit consisting of R46, V10b and R47 towards the slider potential of RV2. The potential at V10a anode thus rises exponentially until it reaches +25V, when V10a conducts again and the condenser stops charging. Since charging ceases long before the potential at RV2 slider is reached, the voltage rise at V10a anode is approximately linear since it is only the first part of an exponential voltage excursion.

24. At the end of the trace period, the potential at the cathode and anode of V10a drops sharply to −30V, carrying the junction C11, R45 down to −55V and cutting off V12. The potential at this junction then rises exponentially to earth as C11 discharges via R45.

25. As a result of centre blanking, the voltage at V10b cathode does not reach its steady positive level until a short time after the onset of the trace period. The amount of the delay depends on the setting of RV2, which determines the voltage applied to the charging circuit of C11 and hence the rate of change of voltage across the condenser.

26. The output from the cathode of V9b follows the voltage at the grid of the valve (*waveform* 6, *fig.* 2). It is connected to the video amplifier (*para.* 77).

Blanking NORMAL-TEST switch

27. This switch is used when setting up the video amplifier. When it is set to TEST, R44 is connected between V9b cathode and the HT line, so lifting the cathode potential to +50V and cutting off the valve. The video gating waveform is then suppressed.

Video trace compensation waveform

28. The diodes V11a and V11b in the cathode circuit of V7a conduct during the intertrace period as described in para. 17, so that the anode of V11a (and hence the grid of V13a) is held at earth potential and condenser C13 is discharged. At the onset of the trace period V11a is cut off, allowing C13 to charge via V15 and R57 towards the potential at the slider of RV3. The voltage at V13a grid thus falls exponentially. At the end of the trace period V11a conducts, again returning V13a grid to earth potential; the condenser then discharges via R58 and V14. Since the time constant of C13 and R57 is very much longer than the trace period, only the initial linear portion of the exponential charging waveform appears at V13a grid.

29. Condenser C13 is used alone in the circuit only on the shortest timebase range. When the range is altered by means of the switch on amplifying unit (deflection) 4130, additional capacitance is added in parallel with C13 by the action of relays RLB/1, RLC/1 or RLD/1. The time constant of the charging circuit, and hence the slope of the negative-going voltage at V13a grid, is thus adjusted to be appropriate to the timebase range. A fine control of the slope, for setting up the circuit, is provided by the TAPER control RV3, whose setting determines the voltage applied across the CR circuit when V11a cuts off.

30. Valve V13a is a cathode follower. The waveform at the cathode of the valve is therefore a replica of that at the grid and consists of a negative-going voltage which increases linearly during the trace period (*waveform* 7, *fig.* 2). The voltage at any instant during the trace period is therefore proportional to the distance between the spot on the CRT and the origin of the timebase.

TEST-NORMAL switch

31. This switch, SWC, is used when setting up the video amplifier. When it is set to TEST, the grid of V13a is connected to earth, so suppressing the trace compensation waveform.

Blanking circuit

Scan failure blanking

32. The voltage pulses which are generated across the CRT deflector coils as a result of the sawtooth current waveforms passing through them are used to cut off valve V3a during the timebase sweep.

33. A typical current waveform is given in waveform 1, fig. 3. In this the current starts from some mean level and increases linearly to the point where limiting takes place in the relevant deflection amplifier. It remains at this level until the end of the trace period and then falls rapidly to the mean level.

34. The voltage across the deflector coil, due to the current waveform just described, is given in waveform 2, fig. 3. The initial negative step is due to the changing current through the inductance of the deflector coil and the following linear voltage change is due to the linear current change through the resistance of the coil. When limiting occurs, the current becomes steady and the voltage moves to a value determined only by coil resistance. At the end of the trace period, an extremely rapid change of current takes place corresponding to the trailing edge of the sawtooth input waveform to the deflection amplifier. This gives rise to a large voltage pulse; following this, the voltage returns to the normal intertrace level.

35. The voltage waveform across each deflector coil varies sinusoidally in amplitude in step with the rotation of the radar aerial. Since the waveform across the X1 coil is in antiphase with that across the X2 and the waveforms across the Y coils are in antiphase and vary in quadrature with those across the X coils, it follows that the waveform from at least one of the coils must always be negative-going during the trace period, and the amplitude of this will be sufficient to cut off the scan failure blanking circuit.

36. The waveform for the Y2 coil is applied via socket GU1 and condenser C1 to the cathode of V1a, where it is developed across R1. The Y1, X1 and X2 waveforms are similarly applied to the cathodes of V1b, V2a and V2b respectively via GU2, C2 GU3, C3 and GU4, C4.

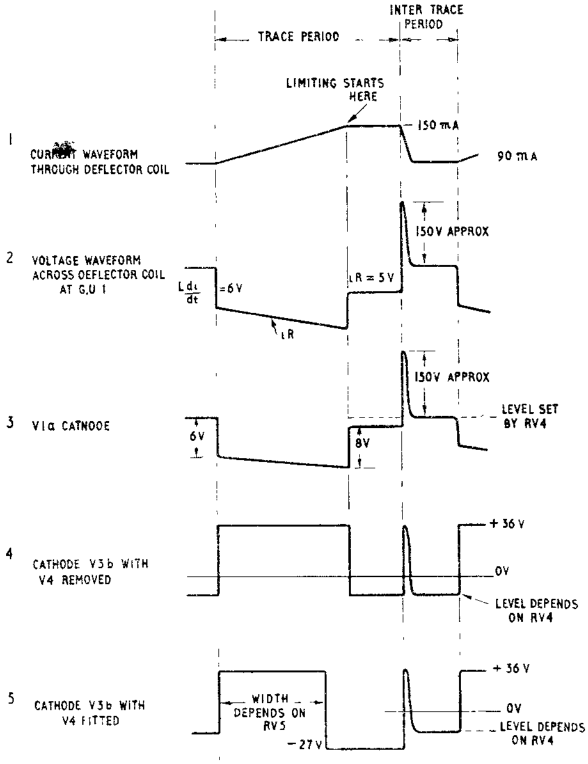

Fig. 3. Blanking circuit waveforms

37. The time constants C1, R1 C2, R2 etc. are comparable with the duration of the trace period. The resulting pulses at the cathodes of the diodes are therefore approximately square-topped (*waveform* 3, *fig.* 3).

38. When the radar aerial is bearing north, the pulses entering sockets GU3 and GU4 from the X coils will have zero amplitude, but those at socket GU1, from the Y2 coil, will be at their negative maximum amplitude. Thus, from the onset of the trace period to the point where limiting occurs, valve V1a conducts and its anode potential falls, cutting off V3a and the other three diodes. Due to the rotation of the radar aerial, the pulses at GU1 decrease in amplitude and those at GU4 increase negatively until bearing 45 deg. is passed, when the pulses at GU4 are the more negative and V3a is held cut off by the action of V2b. A similar action takes place as the aerial bearing passes through 135 deg., 225 deg., and 315 deg. when V3a is operated by V1b, V2a and V1a respectively.

39. The anode potential of V3a when the valve is cut off is approximately +200V, and the voltage which results at the grid of V3b is then some +32V, due to the potentiometer network R8, R9, R14 down to the −300V line. The resulting potential at the cathode of V3b is approximately +36V; this is the normal level in the absence of blanking. If either the X or the Y amplifier should fail to deliver an output, the relevant diode will fail to conduct while the radar aerial passes through the sector during which the inoperative amplifier should have been producing negative pulses to hold off the blanking. During this period the anode potential of V3a will fall to a level depending on the setting of RV4, which sets the bias on V3a in the absence of current through any diode.

40. It should be noted that V3a will be operated at the onset of limiting in each trace period. Since this normally occurs after the onset of octagonal blanking (*para.* 42), its effect will not be evident at the cathode of V3b.

41. The large voltage pulse seen in waveform 3 (*fig.* 3) at the end of the trace period will always be negative-going on the cathode of one of the diodes, and its effect will also be present at V3a anode. Since octagonal blanking will have ceased with the end of the trace period, the effect of this pulse will also be present at V3b cathode, giving a brief positive excursion followed by a return to the level determined by the setting of RV4.

Octagonal blanking

42. The purpose of the octagonal blanking circuit is to modify the video gate waveform so that the CRT spot is extinguished whenever it is deflected beyond the normal screen area. This is desirable because overflow electrons hitting the sides of the cathode ray tube may damage the tube itself or cause diffused light to be reflected back over the working screen area, so spoiling the contrast of the picture. The effect is particularly likely if the trace is affected by areas of cloud or other strong signals just beyond the visible screen area.

43. The cathode of each output valve in each deflection amplifier (*Chap.* 3, *fig.* 4 *and* 5) is connected via a series circuit consisting of a crystal diode (V4 or V7), a 10K ohms resistor (R47 or R48) and part of the GATE CENTRE potentiometer (2·5K ohms assuming the controls to be set to their mid positions) to the cathode of the octagonal blanking valve V4 in the blanking unit. The relevant parts of the circuit are given in simplified form in fig. 4.

44. The cathode of V4 is connected to a point on the resistor chain R61, R62, R63 across the +250V supply. The grid of the valve is connected to the slider of RV5, which is part of another network across the HT supply, where the voltage can be adjusted between the limits of +18V and +25 5V. The low screen potential (46V) and the low anode potential (about 100V) shorten the grid base of the valve so that a cathode voltage excursion of less than 1V is enough to drive the valve from cut off to saturation.

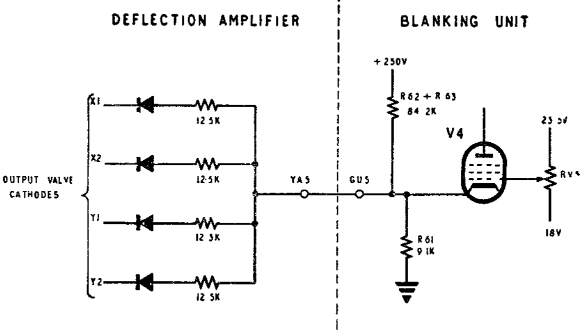

Fig. 4. Octagonal blanking: simplified circuit

45. When the CRT spot is at the electrical centre of the tube face, the cathode potentials of all four deflection amplifier output valves are at +30V and the crystal diodes do not conduct since this is above V4 cathode potential. As the spot moves horizontally across the tube face, the voltage at one X amplifier output valve cathode will rise and that at the other will fall. Similarly, for vertical displacement of the spot, one Y amplifier cathode must rise in potential and the other fall. Thus, whatever the position of the spot on the screen, the voltages applied to two of the crystal diode circuits will be below the spot centre value of +30V and those applied to the other two will be above +30V. (Clearly, if the spot is on the X or Y axis, the voltages at the appropriate amplifier cathodes will both be the spot centre value.)

46. Suppose the setting of RV5 in the blanking unit to be such that V4 conducts when its cathode falls to +20V. At this value the current through R61 is 20V/9100 ohms = 2·2mA and that through R62, R63 is 230V/84200 ohms = 2·73mA. The difference between these two currents (i.e. 0·53mA) must enter the circuit via socket GU5. Thus, whenever the current passing via GU5 rises to 0·53mA, valve V4 will conduct and its anode potential will fall, operating the common blanking valve V3b (*para.* 53).

47. If the current enters via a single crystal diode, the voltage drop across the associated resistor (12·5K ohms assuming the GATE CENTRE control to be at the centre of its travel) will be 0·53 × 12500 = 6·6V, and is therefore the result of one deflection amplifier output valve cathode potential falling to 20 − 6·6 = 13·4V. The output valve cathode potential is proportional to the deflector coil current and therefore is a measure of the position of the spot on the CRT screen. Thus, X amplifier cathode voltages of 13·4V define vertical picture boundaries at the right- and left-hand edges of the CRT screen. Similarly, Y amplifier cathode voltages of 13·4V define horizontal picture boundaries at the top and bottom of the screen. In the absence of any other effect, the result of this would be a picture which was blanked beyond the confines of a square.

48. The current of 0·53mA could, however, be made up partly by current from one X amplifier and partly by current from one Y amplifier. For this to happen, one X amplifier output valve cathode and one Y must fall below 20V, and a simple calculation will show that if the amount by which one falls below 20V added to the amount by which the other falls below 20V totals 6·6V, the current entering GU5 will be 0·53mA and the blanking circuit will operate. The effect of this is to blank the picture along boundaries which make angles of 45 deg. with the horizontal and vertical diameters of the tube face, thus completing the blanking octagon.

49. In the foregoing explanation it was assumed that RV5 had been set so that V4 operated when its cathode voltage fell to 20V. Clearly, if the setting of RV5 is altered, then the X and Y amplifier cathode voltages at which the circuit operates will alter also, thus varying the dimensions of the octagonal picture area. The control is labelled GATE AMPLITUDE, and it is normally set so that the octagon just circumscribes the useful CRT screen area as shown in fig. 5.

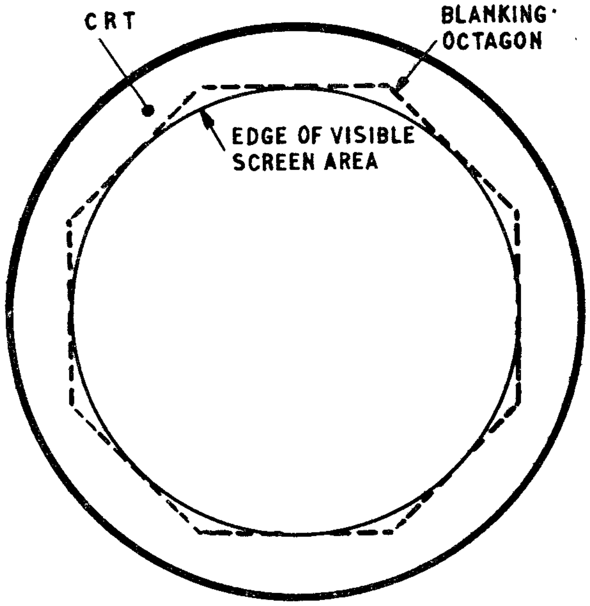

Fig. 5. Setting of the blanking octagon

50. It may happen, on some equipments, that equal currents through the deflector coils will not give a centred spot on the CRT screen. Thus, if the blanking octagon is to be centred, blanking must occur at differing values of deflector coil current. Alteration of the setting of the GATE CENTRE control RV6 in the X deflection amplifier alters the X1 output valve cathode voltage at which the blanking circuit operates with respect to the X2 voltage, and thus enables the octagon to be centred horizontally. The similar control in the Y deflection amplifier enables vertical centring to be achieved.

Common blanking valve

51. Valve V3b is a cathode follower which is driven by the scan failure blanking waveform from V3a and the output of the octagonal blanking valve V4. In the absence of either type of blanking, V3a and V4 will both be cut off and the potential of V3b grid will be approximately +32V as determined by the network R66, R7, R8, R9, R14 between the +250V and −300V lines; the corresponding cathode potential will be about 36V.

52. In the event of scan failure, valve V3a conducts and its anode voltage drops to a level determined by the setting of RV4 (*para.* 39). About two-thirds of this voltage change appears at the grid of V3b so that the cathode potential of the valve drops also to a level determined by the setting of RV4. The condensers C5 and C6 are included to balance out stray capacitances and ensure a rapid response. Waveform 4, fig. 3 illustrates the output obtained at the cathods of V3b with V4 removed. This consists of a positive-going portion followed by a sharp drop at the onset of limiting in the deflection amplifier to a negative level determined by the setting of RV4. At the end of the trace period, V3a is again cut off by the large voltage pulse resulting from the rapid rate of change of current in the deflector coils at the end of the timebase waveform giving a positive pulse to the +36V level at V3b cathode, followed by a return to the level determined by RV4 until the start of the next trace period.

53. Towards the end of each trace period, the octagonal blanking valve V4 will be driven into conduction as described in para. 46, causing the voltage at the junction R8, R9 to fall and cut off V3b; the cathode potential of the valve then falls to −27V as determined by R16, R17. The effect of the octagonal blanking circuit is then to modify waveform 4, fig. 3 as shown in waveform 5.

54. Since octagonal blanking normally occurs before the onset of limiting in the deflection amplifier, the positive-going portion of the waveform at the beginning of the trace period lasts only for a time determined by the setting of the GATE AMPLITUDE control RV5, and after this the voltage falls to −27V. At the end of the trace period, the positive voltage pulse up to +36V occurs, followed by a fall to the level depending on the setting of RV4 since the octagonal blanking valve V4 will be again cut off at the end of the trace period.

55. The blanking waveform from V3b cathode is connected via the diode-connected triode V13b to the grid of the video gate generator V9b (*para.* 21).

Focus regulator

56. The CRT focus coil is supplied with current from the 600V unstabilized supply derived from power unit 4109 in the power supply rack. The current is stabilized by the action of valves V5 and V6 in the blanking unit, thus obviating the need for constant adjustments during operation and ensuring the CRT picture remains correctly focused despite variations in the 600V supply, and temperature effects on the focus coil resistance.

57. The focus coil forms the anode load of valve V5; the cathode load of the valve is a high stability resistor R19. Since the screen grid of the valve is connected to the +250V stabilized HT line, any variations in cathode voltage must be the result of variations in the focus coil current. The operation of the circuit is as follows.

58. Part of any voltage change at the cathode of V5 is applied from the slider of the FOCUS potentiometer RV1, which is part of a resistor chain between V5 cathode and the −300V line, to the grid of the control valve V6 which is a high gain DC amplifier. The resulting variation at V6 anode is an amplified antiphase version of that at V5 cathode, and it is applied from the junction R22, R23 to V5 grid, thus varying the bias on the valve and restoring the focus current to its correct value.

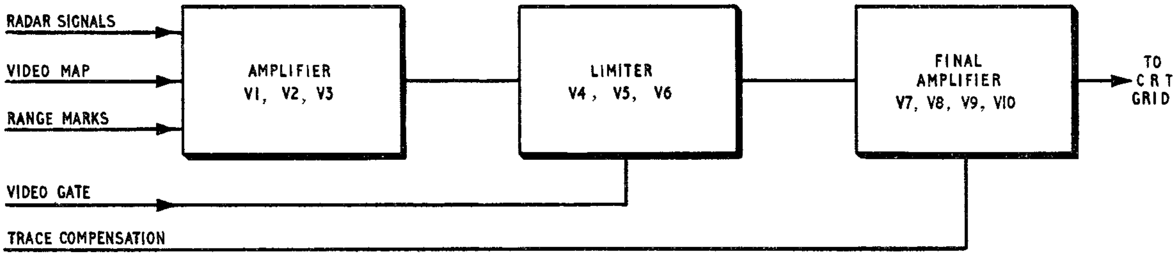

Fig. 6. Video amplifier: block diagram

59. The actual stabilized value of the focus coil current clearly depends on the setting of RV1 since this determines the operating point of V6 and therefore of V5. The control is preset and is mounted on the front panel of the complete unit.

60. The grid circuit of V6 is completed via contacts A1. Current for operating relay RLA1 is derived from the 6·3V heater supply via the bridge rectifier MR1 and the relay operates immediately the PROJECTOR MAIN SWITCH on the power supply rack is closed, routing the 230V AC supply to the main heater transformers. Thus, immediately the equipment is switched off or if a mains failure occurs, contacts RLA1 open, causing the potential at the slider of RV1 to rise sharply, with a consequent fall in voltage at V6 anode, which cuts off V5. This ensures that the CRT spot is immediately defocused, thus preventing damage to the CRT screen during the short period when HT and EHT voltages are collapsing.

AMPLIFYING UNIT (VIDEO) 4133

General

61. A block diagram of amplifying unit (video) 4133 is given in fig. 6. A component layout diagram and a complete circuit are given in fig. 10 and 12.

62. The unit consists of three DC coupled amplifiers employing negative feedback. In the first of these, the radar signals, range marks and video map signals are amplified and mixed as required. In the second, the mixed video signals are limited and gated so that this amplifier only produces an output from the start of the trace period to the onset of octagonal blanking or scan failure blanking. The third amplifier combines the limited and gated signals with the trace compensation waveform from the blanking unit. The output of this is fed to the grid of the CRT in the indicating unit, giving brightness modulation of the rotating time-base trace.

63. An analysis of amplifiers employing negative voltage feedback will be found in A.P.1093E (2), Chap. 7, Sect. 16. The circuits used in this unit bear some resemblance to the X and Y deflection amplifiers, and a brief description of the principles will be found in Chapter 3.

Initial mixing amplifier

64. The radar signal, video map and range marks inputs are obtained from rack assembly 184 in the radar office and enter and projector via the wall junction box and plugs P14, P13 and P12 on the projector roof panel. From here they are connected to sockets VA2, VA3 and VA5 on the video amplifier via the distribution panel at the rear of the electronics compartment.

65. Positive-going radar signals at VA2 are developed across potentiometer RV1, which provides a suitable termination for the connecting cable and a means of varying the amplitude of signals applied via C1 and R3 to the grid circuit of V1. RV1 is the RADAR SIGNAL control on the front panel of the unit.

66. The negative-going output from the anode of V1 is applied from the junction R11, R12 to the input grid of the cathode coupled amplifier formed by V2 and V3. Part of the output from V3 is fed back via R5 + R6 to the grid of V1. Since a "virtual earth" may be said to exist at V1 grid, the overall gain of the amplifier for radar signals is approximately $(R5+R6)/R3=13$ times.

67. In order to preserve pulse shape, the gain of the amplifier for AC components must be the same as it is for DC. The total capacitance across the feed resistor (C5 + strays) must therefore be approximately 13 times that across the feedback path (C3 + C4 + strays). The small trimmer C3 enables this to be adjusted.

68. Potentiometers RV4 and RV5 enable the DC operating conditions of the three valves to be set. A small adjustment to RV4 will make little difference to the current through V1 but a large difference to that through V2 and V3, since the voltage movement resulting from alteration of RV4 will be amplified by V1. RV4 is therefore used to set the operating conditions of V2 and V3. Similarly, a voltage movement at RV5 slider is amplified by V3, and this control is used to set the conditions of V1.

69. Video map signals or range marks can be applied to the grid of V1 if required. The selection is done by means of the CALIBRATION VM/RM switch on control unit (selsyn) 921 in the power supply rack. The video map signals are developed across RV2. Since the range marks are considerably greater in amplitude than the video map signals, they are attenuated by the network R65, RV3. Movement of the CALIBRATION VM/RM switch from its OFF position energizes either relay RLA/1 or RLB/1 connecting the appropriate

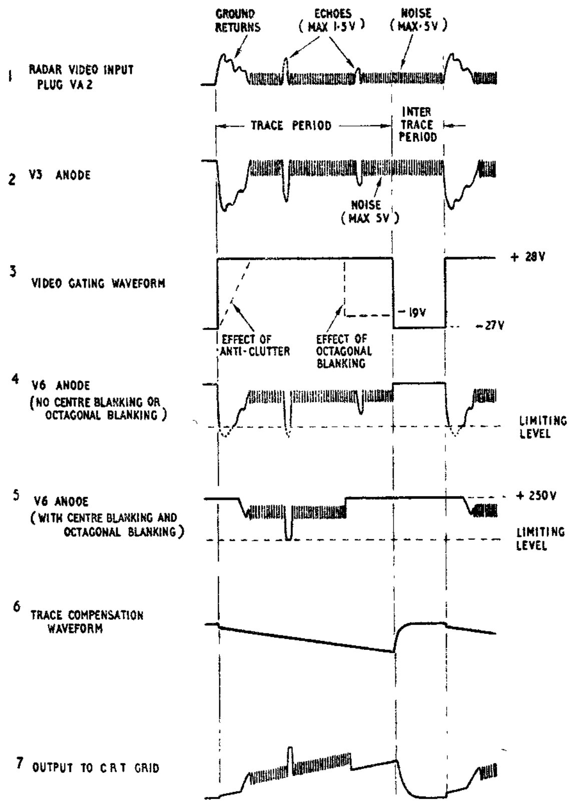

Fig. 7. Video amplifier waveforms

signals via R4 to the grid circuit of V1. The gain on this channel is approximately (R5 + R6) / R4 = 4 times.

70. The variable capacitance (C6 + C7) across the feed resistor R4 can be adjusted by means of C7 to balance the effect of C3 + C4 (already adjusted for radar signals) across the feedback circuit.

Limiting and gating amplifier

71. The negative-going signals (radar video perhaps with range marks or video map signals) at V3 anode (*waveform* 2, *fig.* 7) are passed via C10 and are DC restored by the action of V4a. The negative going excursions of the signals at V4a anode therefore start at some negative voltage preset by RV10.

72. Valves V5 and V6 form a DC coupled amplifier with negative voltage feedback via R22. The voltage gain of this amplifier to the cathode of V6 is something less than the ratio R22/R18 since the voltage gain of the amplifier without feedback would be small and no "virtual earth" exists at V5 grid. The condensers C9, C12 and C13 have the usual effect of making the AC gain approximate to the DC gain, thus preserving pulse shape.

73. The anode of V5 is DC coupled to the grid of V6 via the network R26, R28; the condensers C25 and C14 are included to balance the effect of stray capacitance and the input capacitance of V6. The DC operating conditions of V6 are set by means of RV6 and RV10. During the setting up procedure, the push button switch SWA is opened, applying a large enough negative voltage to V5 grid to cut the valve off, and the current through V6 is adjusted to 12mA (with the video gating waveform suppressed, contacts RLC closed and RV7 adjusted to zero resistance) by means of RV6. SWA is then released and V6 current is set to 1·5mA using RV10. These two conditions simulate:—

(1) The effect of a large enough signal into V5 grid to cut the valve off.

(2) The no signal condition.

Clearly, the greatest voltage change which can take place at V6 anode is the result of a current change through R29 of 10·5mA (i.e. from 12mA to 1·5mA) so that the output from the valve is limited to a signal amplitude of approximately 30V.

74. The negative-going signal amplitude at V3 anode required to cut off V5 when RV10 is correctly set is approximately 7V, giving an excursion at V5 grid from about −4V to cut off. Thus any signals in excess of 7V amplitude at V3 anode will be limited to 30V at the anode of V6.

75. Potentiometer RV7, in the cathode circuit of V6, is the POST LIMIT GAIN control on the front panel of amplifying unit 4129; it was assumed in the preceding paragraph that this was set to zero resistance. If the control is now turned in a counter-clockwise direction, the voltage at V6 cathode will remain approximately constant due to the effect of the negative voltage feedback via R22, but the current turned on in the valve when V5 is cut off will be reduced. Alteration of the setting of RV7 therefore does nothing to the signal amplitude required from V3 to cause limiting, but alters the amplitude of the limited signals at V6 anode.

76. Relay RLC/1 is normally operated by 50V DC supplied via rack assembly 184 in the radar office. This is connected to control unit (selsyn) 921 in the power supply rack and thence via P1 on the projector roof to the video amplifier. If the magslip resolver in the radar office ceases to rotate, resulting in a stationary trace on the indicating unit CRT, the 50V DC is removed, opening contacts RLC1. R32 is then included in the cathode circuit of V6, immediately reducing the amplitude of the limited signals at V6 anode to a safe level and preventing damage to the CRT screen.

Gating

77. The video gate waveform (*waveform* 3, *fig.* 7) from the blanking unit is connected to the grid of V6 via the diode V4b. During the intertrace period the cathode potential of V4b is at −27V so that current passes through the diode holding the grid of V6 below cut off; V6 anode voltage is therefore that of the HT line. At the start of the trace period, V4B cuts off, since its cathode rises to +28V. V6 is now allowed to conduct until the onset of octagonal or scan failure blanking, when V4b cathode returns to a negative level. The current turned on in V6 (at maximum gain) by the gating waveform is 1·5mA (*para.* 73), so that a negative-going pedestal some 4V in amplitude appears at V6 anode. The video signals from V3 anode are superimposed on this pedestal (*waveform* 4, *fig.* 7). Alteration of the POST LIMIT GAIN control alters the amplitude of the pedestal as well as the amplitude of limited signals.

Final mixing amplifier

78. The final amplifier in the unit consists of valves V8 and V9. The composite waveform, consisting of negative-going video signals superimposed on a pedestal, is applied to V8 grid via a feed resistor R34. Also applied to this grid is the trace compensation waveform generated by the blanking unit; here the feed resistance is R37 + R38. Condenser C19 across the feedback resistor R41 is adjusted to balance the effect of C16.

79. Valves V8 and V9 are both high-slope pentodes and the gain of the amplifier without feedback is about 30. The "virtual earth" conception may therefore be applied and the gain of the amplifier for the video waveform approximates to 2·5; the gain for the trace compensation waveform is approximately unity.

80. The output from the anode of V6 (*waveform* 5, *fig.* 7) is passed via C15 and is DC restored by the action of V7b so that the negative-going pedestal starts at the voltage determined by the setting of RV8. The trace compensation waveform (*waveform* 6, *fig.* 7) is similarly DC restored by the action of V7a having passed through a coupling condenser (C12 *in fig.* 11) in the blanking unit. The output of the amplifier is developed across the cathode load of V9 and consists of a positive-going pedestal carrying video signals, superimposed on the sawtooth trace compensation (or taper) waveform.

81. The effect of octagonal blanking is to terminate the pedestal and signals, but the trace compensation waveform continues to the end of the trace period. Scan failure blanking has a similar effect. If the CENTRE BLANKING switch on the blanking unit is set to ON, then some delay occurs before the cathode of V4b reaches a sufficiently high potential to cut off the valve and allow V6 to operate. The start of the pedestal and signals at V9 cathode is therefore similarly delayed, thus preventing local permanent echoes from affecting the CRT display.

Output circuit

82. The composite waveform at the cathode of V9 (*waveform* 7, *fig.* 7) is passed via C21 and is developed across R57 where its negative level is clamped at a voltage determined by the setting of the COARSE BRILLIANCE control RV9 by the action of the double diode V10. Fine control of this voltage is provided by the FINE BRILLIANCE control RV11, which varies the voltage applied across RV9. The DC restored waveform is connected via socket VA4 to the grid of the cathode ray tube in indicating unit (CRT) 4123.

POWER SUPPLIES

83. The +250V stabilized supply and the −300V bias supply are derived from power unit 4122. These enter the blanking unit at plug GU8, via the distribution panel at the rear of the electronics compartment, and are conveyed to the video amplifier by soldered connections.

84. Heater supplies for the various valves are derived from the main heater transformers in the projector console (*Sect.* 1, *Chap.* 2, *fig.* 1) and are connected to the blanking unit via GU7 and to the video amplifier via VA1.

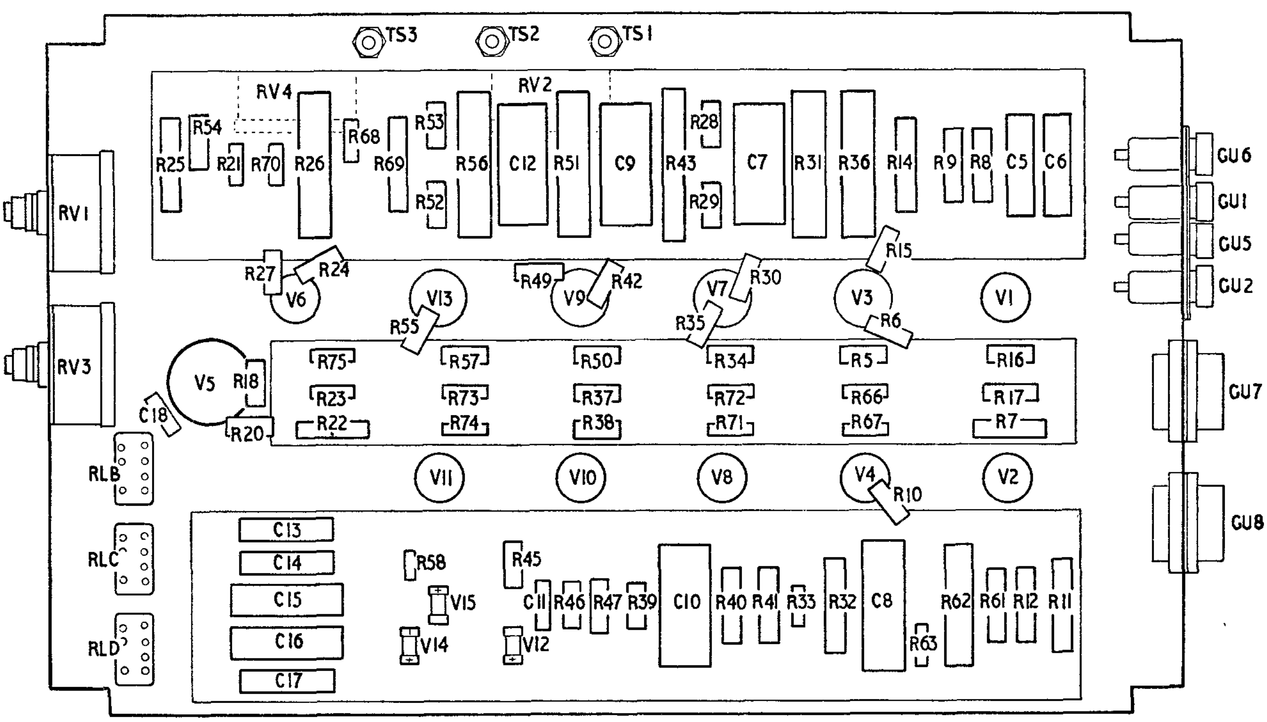

Fig 8. Blanking unit 4134: under view

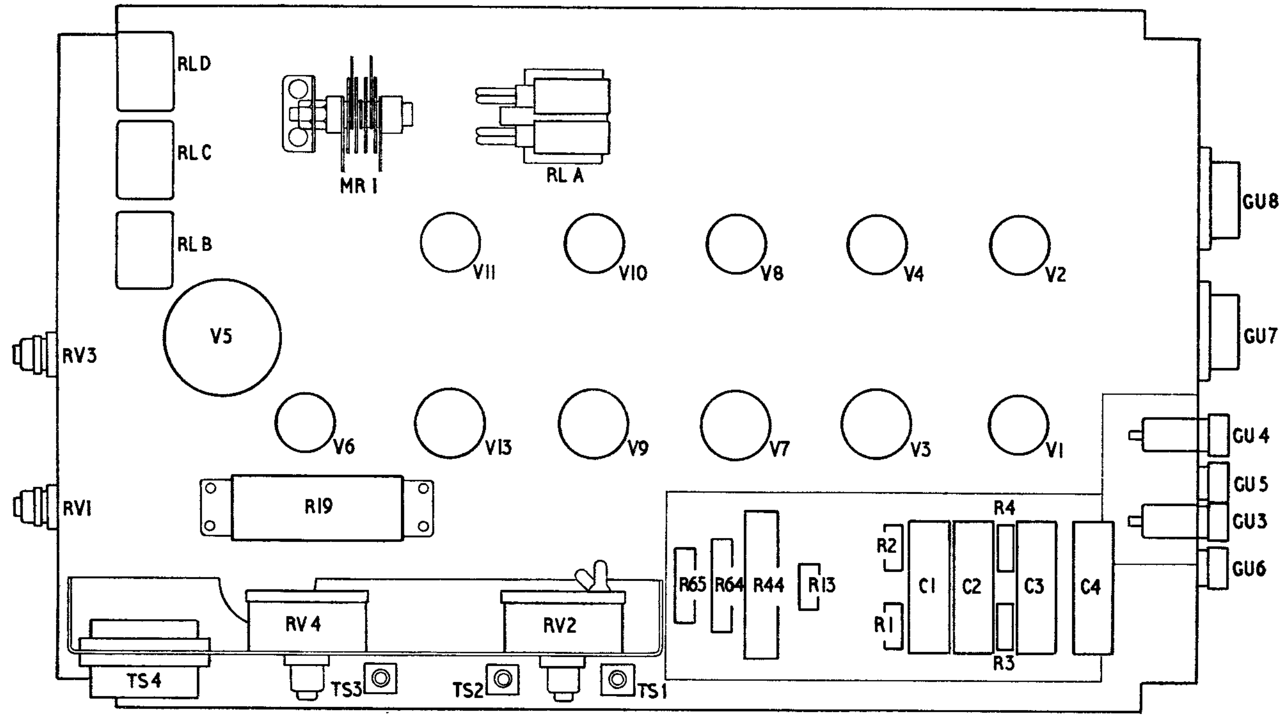

Fig. 9. Blanking unit 4134: top view

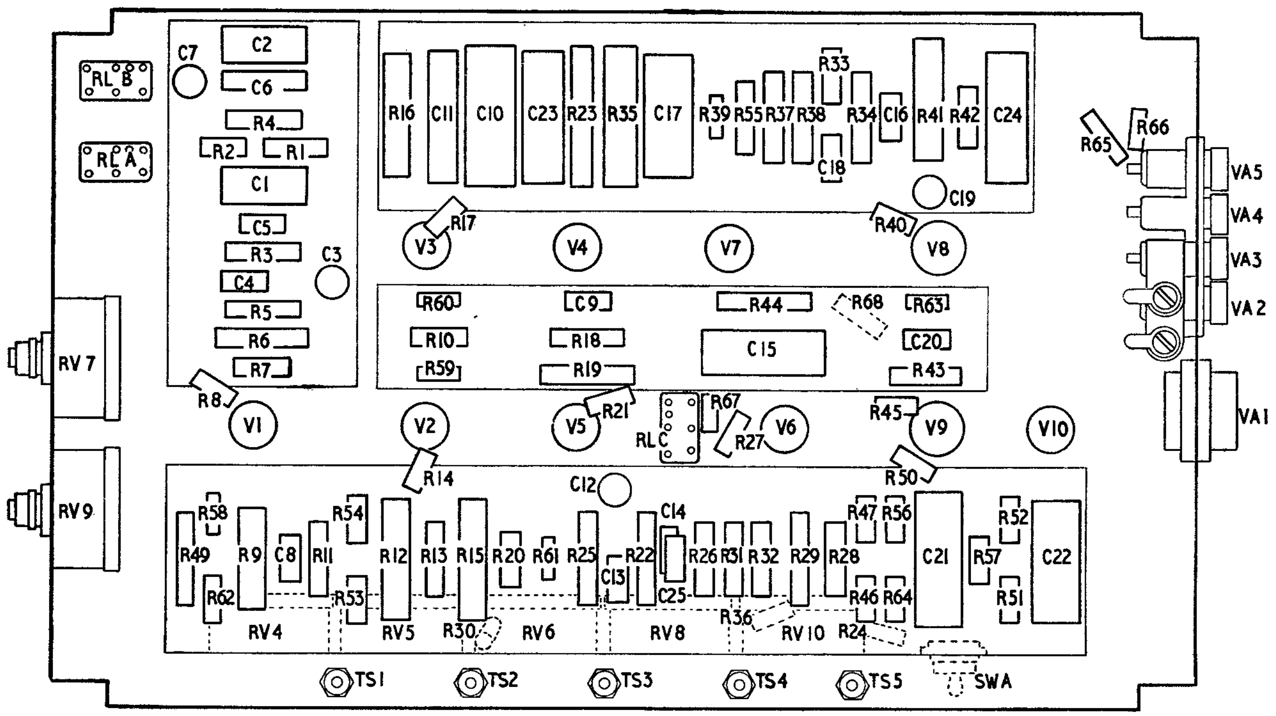

Fig. 10. Amplifying unit (video) 4133: under view

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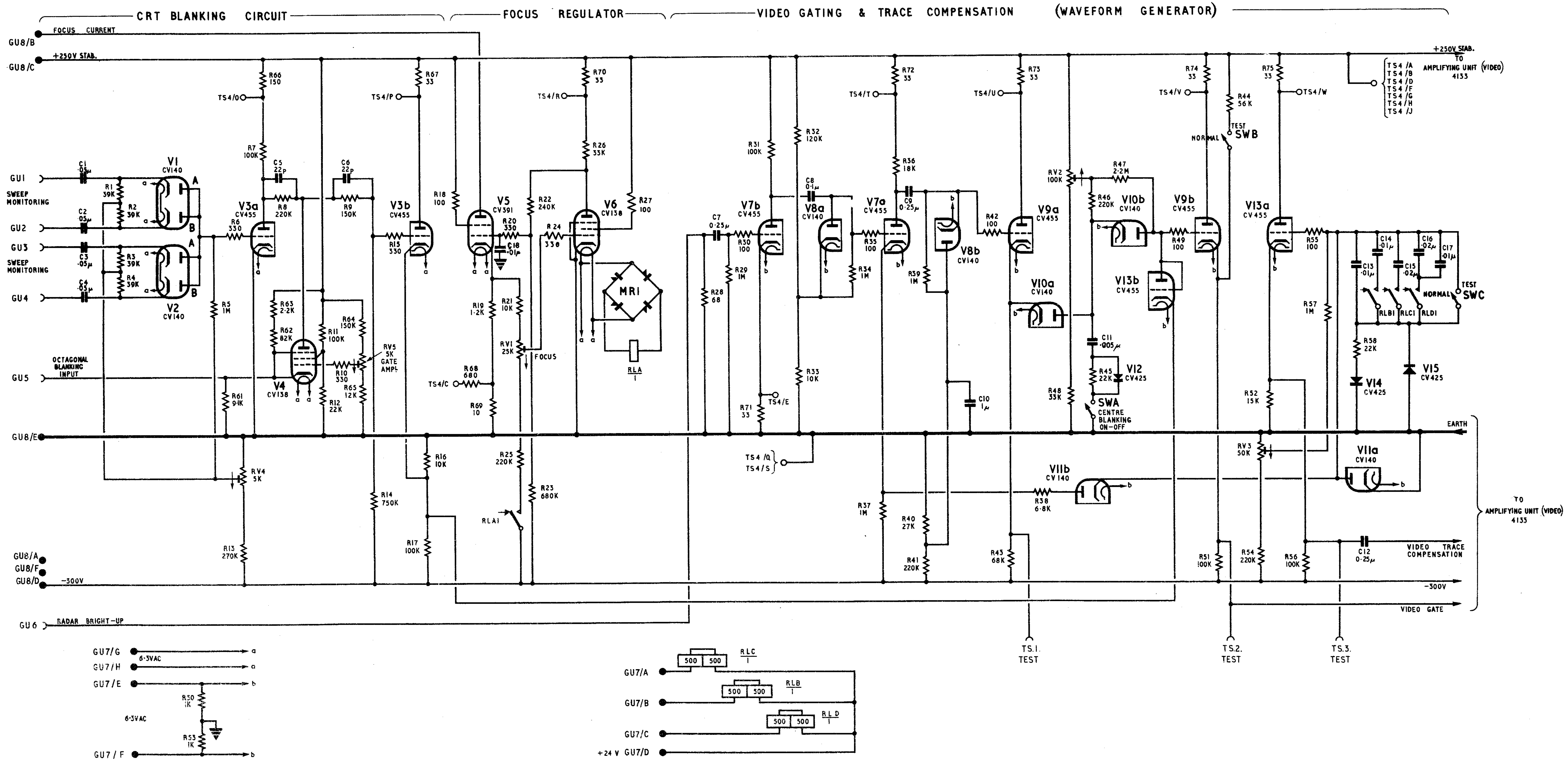

AIR DIAGRAM 6151G/MIN.

ISSUE 1

PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY ADMIRALTY

RADAR PHOTOGRAPHIC DISPLAY SYSTEM 1498

Blanking unit 4134: circuit

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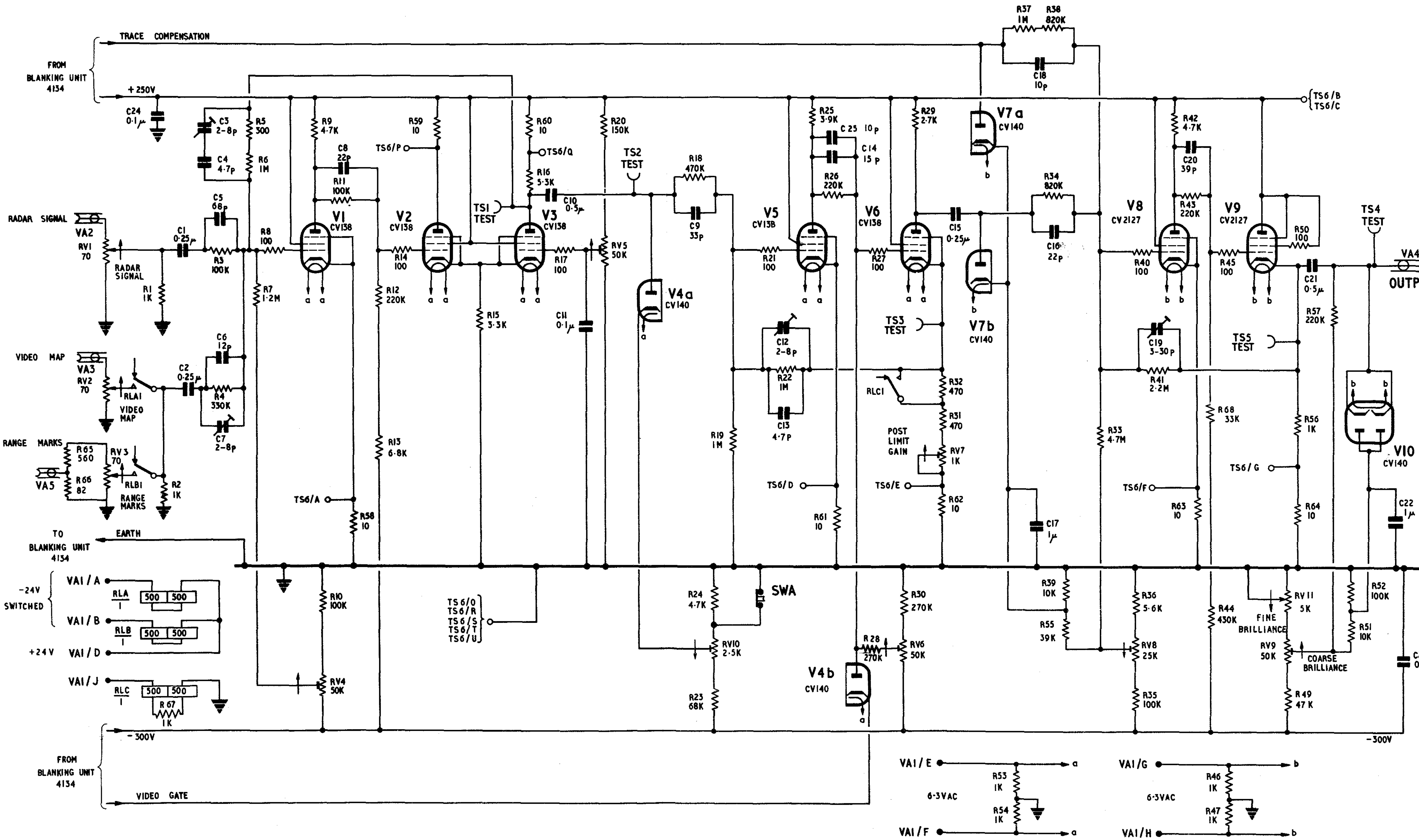

AIR DIAGRAM 6151H/MIN.
ISSUE 1 — PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY ADMIRALTY

RADAR PHOTOGRAPHIC DISPLAY SYSTEM 1498

Amplifying unit video 4133 : circuit

Fig 12

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552966 43289 4091 9/55 1000 CWSLtd1470 Gp979-2

Chapter 3

AMPLIFYING UNIT (DEFLECTION) 4130

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LIST OF ILLUSTRATIONS

INTRODUCTION

1. Amplifying unit (deflection) 4130 consists of a front panel and framework carrying the X- and Y-deflection amplifiers; these are known as amplifying unit (X-deflection) 4131 and amplifying unit (Y-deflection) 4132. They are mounted with their chassis vertical with the X amplifier to the left and the Y amplifier to the right as viewed from their common front panel. The whole unit is mounted in the top of the electronics compartment at the lower right-hand side of the projector (*Chapter* 1).

2. The unit is a power amplifier which is driven by the X- and Y-timebase waveforms supplied from the radar office and develops current waveforms for the generation of the timebase on the CRT screen of indicating unit (CRT) 4123. Controls are included for shift of the display.

3. The timebase waveforms from the radar office enter the projector console at plugs P10 and P18 on the roof panel from the junction box on the wall (*Sect.* 1, *Chap.* 2). The amplifying unit includes facilities for attenuating these waveforms in order to alter the scale of the picture. Voltages are developed from the output current waveforms for the operation of the scan failure and octagonal blanking circuits in amplifying unit (video) 4129 (*Chapter* 2).

AMPLIFYING UNIT (X-DEFLECTION) 4131

General

4. A block diagram of the X-amplifier is given in fig. 1. It consists of two negative feedback amplifiers; one of these feeds the X1 deflector coil in the indicating unit and the other the X2 coil in antiphase to the X1 coil. The input to the X1 amplifier consists of the X component of the resolved timebase waveform from rack assembly 184 in the radar office (*A.P.*2527E). The input to the X2 amplifier is derived from the output stage of the X1 amplifier.

5. The input waveform is applied to the X-amplifier via a range switching network. This consists of a resistor chain which is modified by the action of relay contacts controlled by a four-position range switch. This switch also controls the action of similar relays in the Y-deflection amplifier and relays in the blanking unit (*Chapter* 2) which modify the trace compensation waveform in the video amplifier in a manner appropriate to the timebase range.

6. Also applied to the X1 amplifier is a DC voltage from the X SHIFT control. This modifies the operating conditions of the amplifier and determines the east-west position of the picture on the indicating unit CRT.

7. A limiting circuit prevents the combined deflection and shift voltage from becoming sufficient to overdrive the amplifier.

8. A complete circuit diagram of amplifying unit (X deflection) 4131 is given in fig. 4. Component layout diagrams are given in fig. 2 and 3.

X1 amplifier

9. The resolved sawtooth timebase waveform enters the unit at plug XA4 and is applied via switch SWB to RV4 and R49. Switch SWB is the TEST–NORMAL switch at the front end of the chassis; when it is set to test, the deflection input is removed and the input to the amplifier is earthed, thus facilitating the adjustment of the various preset controls. RV4 is the X-GAIN control on the front panel: adjustment of this control determines the amount of the input sawtooth which is applied via all or part of the resistor chain R1, R2, R3, R6, R8 to the grid of V2a.

10. Valves V2, V3 and V5 form a high-gain amplifier to which negative feedback is applied via R13. A detailed analysis of amplifiers employing negative voltage feedback is given in A.P.1093E (2), Chap. 7, Sect. 15. A brief explanation is as follows.

11. Since the gain of the amplifier is large, the voltage variation at V2a grid is negligible in comparison with the output voltage. A "virtual earth" is

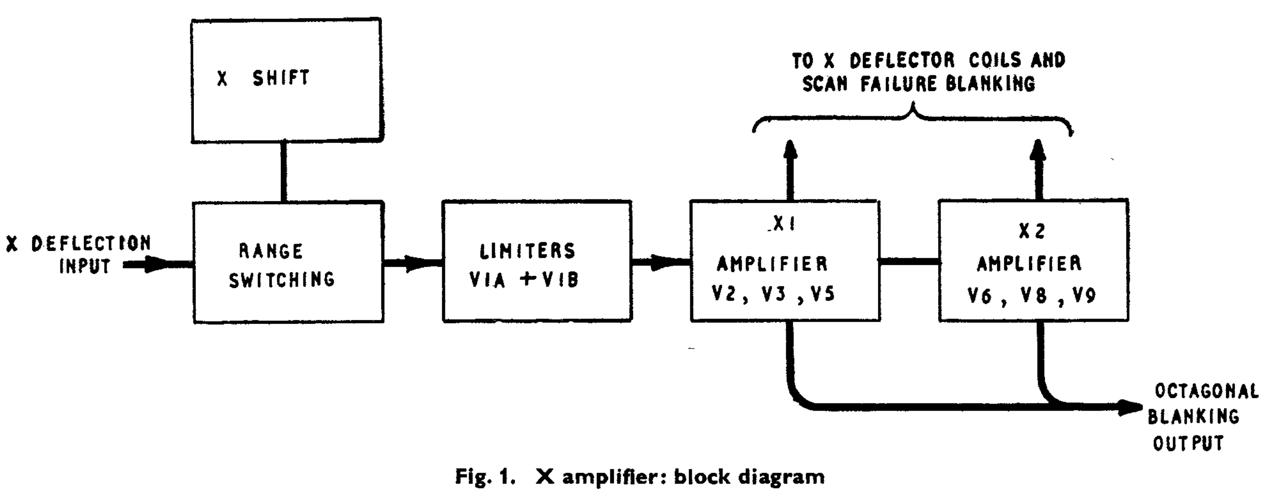

Fig. 1. X amplifier: block diagram

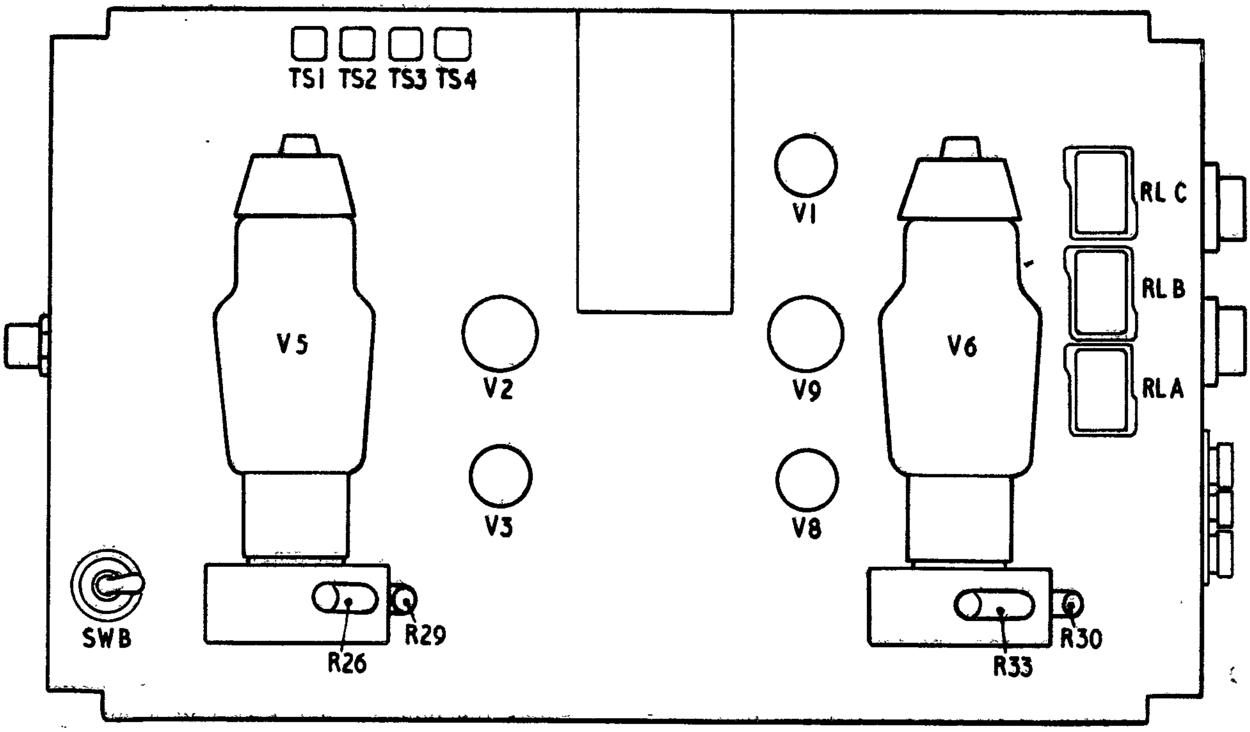

Fig. 2. X amplifier: top view

said to exist at V2a grid, since any infinitesimal voltage movement there will cause a large opposing voltage to be fed back from the output. Assuming all the relays to be released, a voltage change at RV4 slider may be considered as being across the whole of the input resistor chain and will cause a current to flow through it. If no grid current is to flow in V2a, the input current must flow also through R13. The input voltage change to the amplifier is thus equal to the voltage change across the input resistor chain and the output voltage is the voltage change across the feedback resistor R13. Since the same current flows through each resistance, the ratio of output voltage/input voltage must equal the ratio R13/input resistor chain; i.e., approximately 0·5 in this instance.

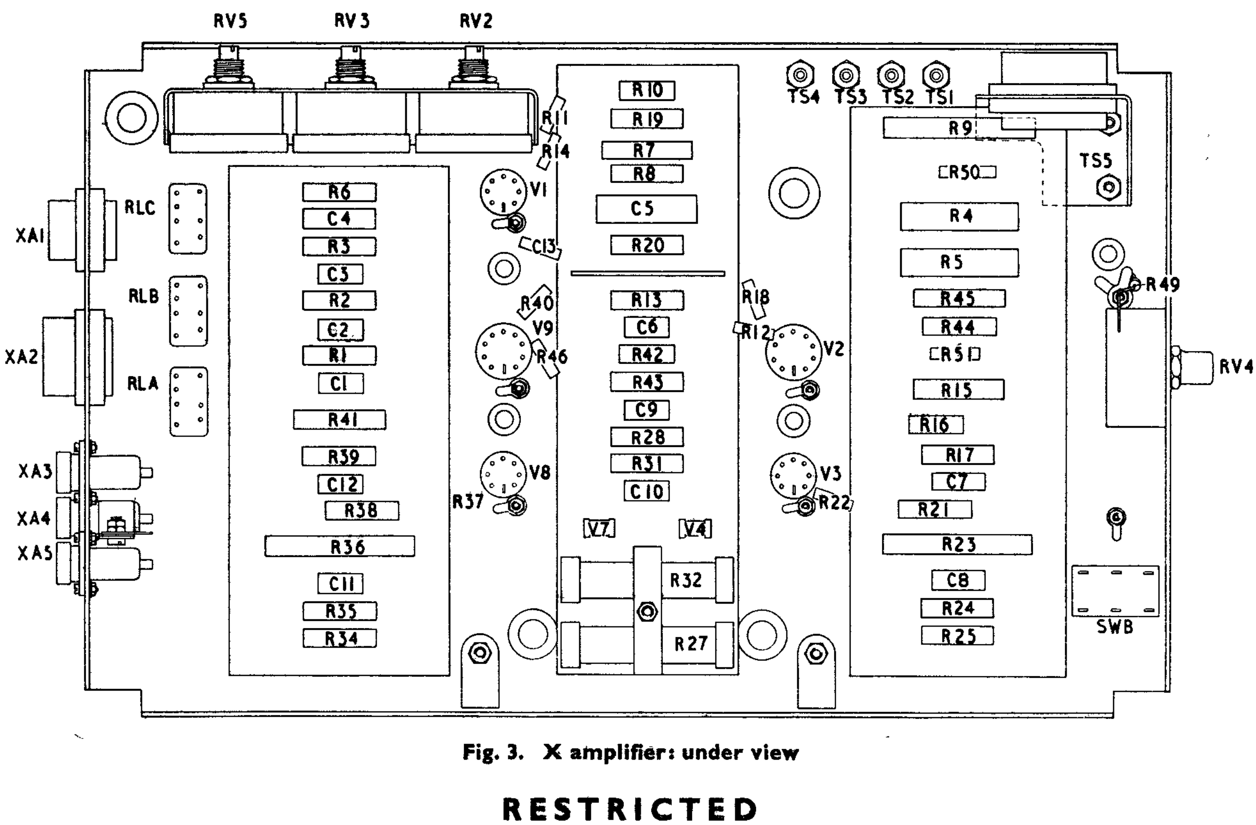

Fig. 3. X amplifier: under view

12. Clearly, if the feed resistance is changed, the gain will change in proportion. Thus, the closing of contacts RLA1, RLB1 or RLC1 will increase the gain to 2/3, 1 or 2 respectively. The relays are switched by the range switch in the centre of the front panel. The 24V DC supply for the relays is connected via pin YA8/D in the Y-deflection amplifier, and is routed via the range switch to the relays in both deflection amplifiers, and also to relays in the blanking unit for modification of the video trace compensation waveform.

13. An independent control of overall gain is provided by RV4. This is used for balancing the gains of the X- and Y-amplifiers (in order to produce range rings which are truly circular) and for matching the scales of the pictures obtained from two projectors working together as a pair.

14. The condensers C1 to C6 are included to ensure that the AC gain of the amplifier approximates to the DC gain. Actually, the AC gain is slightly greater than the DC gain in order to add a small increased rate of change to the start of the output waveform. A linear waveform at the ouput would result in a tendency for there to be a slow start to the current sawtooth in the deflector coils, which would give non-linearity near the trace origin on the CRT.

15. Direct connections are used throughout the amplifier and, in consequence, care has been taken in the design to minimize DC drift which would cause inaccuracy in the CRT display. Such drift may be caused either by a variation of the valve heater voltage, which would change the emission of the valves and hence the mean level of their anodes, or by the changing dissipation of the valves due to the changing amplitude of the resolved sawtooth input waveform.

16. Consider the action of the amplifier in response to a drift in the output level of V5 cathode when the feed and feedback resistors are equal (range 3) and there is zero input (SWB set to TEST). Any change in the output level as a result of drift is counteracted by the effect of feedback. Suppose that without feedback (R13 disconnected) the output changed by Y volts and that with feedback (R13 reconnected) this became Z volts. The voltage Z may then be regarded as the static error resulting from the correction of a drift of Y. The input voltage to V2a grid under these conditions is Z/2, since feed and feedback resistors are equal, giving rise to an output correction of Z/2 multiplied by the gain of the amplifier. Therefore, Z + gain times Z/2 is equal to Y, making Z equal to 2Y/(gain +2). The resultant error Z is thus inversely proportional to the gain of the amplifier and directly proportional to the amount of drift which is allowed to take place.

17. The amplifier consists effectively of two stages, since the voltage gain of V5 is less than unity. Any drift occurring in V3 thus has negligible effect, but any drift in V2 is amplified in V3, and it is therefore the characteristics of V2 which determine the heating drift in the output.

18. Valve V2 is connected as a cathode-coupled amplifier. In this circuit the effect of heater voltage variation is to vary the common cathode current, which in turn varies the grid-cathode voltage of both sections of the valve in such a manner that the variation in emission is offset. The stage is thus self-compensating. The heating drift due to the variation in dissipation with aerial rotation is minimized by the limiting circuit described in para. 21.

19. An analysis of the cathode-coupled amplifier is given in AP.1093E (2), Chap. 7, Sect. 23. In the circuit used in this amplifier paraphase outputs are not required, and the output, taken from the anode of V2b, is in phase with the input at V2a grid. However, since V2a anode is connected to the +250V line and V2b anode to +400V, the currents through the two sections of the valve are of the same order of magnitude. The grid of V2b is connected to a positive potential at the junction of R19 and R20, such that both sections of the valve operate in class A. The DC connection from the anode circuit of V2b to the grid of V3 is made from the junction of R17 and R21, which are connected between V2b anode and the -300V line, thus satisfying bias requirements for V3. Condenser C7 and the input capacitance of V3 form a potential divider for AC components which is equivalent to the ratio R24/R25. The output from V3 anode is coupled to V5 grid by a similar arrangement; here condenser C8 compensates for the input capacitance of V5.

X-shift

20. The X-SHIFT control RV1 is part of a potentiometer network between the +250V and -300V lines. The voltage at the slider of the control is connected via R7 to the junction of R6 and R8, so that a steady voltage, whose magnitude and polarity depend on the setting of the control, is superimposed on the waveform at V2a grid. Movement of the X-SHIFT control thus alters the point on the input sawtooth at which the current in the deflector coil reaches the value corresponding to zero deflection of the CRT spot, with the result that the whole picture moves relative to the centre of the screen. The amount of X-shift possible corresponds to about 200 miles on range 1. It will be less than this on other ranges, since the amount of current drawn through R7 will vary with the amplifier feed resistance.

Limiting

21. The input to valve V2a is limited by the action of a circuit consisting of the double diode V1 and the potentiometer network R9, RV2, RV3. As described in para. 17, the operation of valve V2 will have the greatest effect on the problem of DC drift in the amplifier. Drift, due to varying heat dissipation in V2, is minimized by preventing the grid voltage from reaching a level which would result in saturation or cut off of the amplifier. This is most likely to happen on the short ranges when only a portion of the input sawtooth is being used to produce a visible timebase on the CRT. Clearly, if the output valve V5 is either driven to saturation or cut off, feedback ceases and the whole remaining input voltage excursion is applied to V2, resulting in extreme overdriving of that stage.

22. The anode of V1a and the cathode of V1b are connected to the junction of R6 and R8. The positive-going excursion of the voltage at this junction is thus limited to the voltage at the slider of RV2 and the negative-going excursion to the voltage at the slider of RV3. These controls are set up to give limiting just before overdriving of the output valve occurs. Whatever the timebase range selected, the current flowing through the feedback resistor R13 flows also through R8; therefore, the voltage excursion at the junction R6, R8 is always the same fraction (about 1/5) of the voltage at V5 cathode, and always bears the same relation (about 1/5 times the gain of the amplifier) to the voltage at V2a grid. Limiting of the voltage at the junction R6, R8 thus limits the voltage at V2a grid.

23. It should be noted that the limiting action takes place at specific voltages irrespective of how these are derived. The circuit thus takes any voltage supplied from the X-SHIFT control into account.

X2 amplifier

24. The X2 amplifier consists of valves V9, V8 and V6, which operate in a similar manner to valves V2, V3 and V5. The input to the amplifier is from the cathode of the X1 amplifier output valve V5 and is fed via R28 to the grid of V9a. The feedback circuit is from the cathode circuit of V6, also to the grid of V9a via R31. Since R28 and R31 have the same value the amplifier has a gain of unity, the voltage at V6 cathode being in antiphase to that at V5 cathode. Condensers C9 and C10 ensure that the gain is unity for AC components also.

25. The mean DC levels throughout the X2 amplifier are set to be the same as those of the X1 amplifier by means of RV5, which is part of a potentiometer network across the –300V supply. The voltage at the slider of this control is connected via R43 to the grid of V9a. The current passing through R43 via R28 and R31 generates a voltage variable by means of RV5 which provides the correct bias for V9a. RV5 is normally set to make the cathode current of V6 equal to that of V5 when the input terminal of the whole X-amplifier is earthed by means of the TEST-NORMAL switch SWB.

Output stage

26. The anodes of the output valves V5 and V6 are connected via XA3 and XA5, the deflection phasing panel and deflector coils in the indicating unit to the 250V stabilized deflector coil supply generated by power unit 4109 in the control rack. The supply is routed via power unit 4122, where it is controlled by switch SWA located at the rear of the power unit chassis and accessible from the rear of the projector. The switch is thus conveniently near the deflection phasing panel which is mounted on the floor plate at the rear of the electronics compartment.

27. The output circuits of the Y-deflection amplifier also pass via the deflection phasing panel. The purpose of the panel is to provide a convenient point for altering the connections between the deflection amplifiers and the deflector coils in the indicating unit in order to orient the picture on the projection screen according to local requirements.

Octagonal blanking output

28. The circuit consisting of the crystal diodes V4, V7 and resistors R47, RV6, R48 between the cathodes V5 and V6 forms part of the octagonal blanking circuit and is associated with the action of valve V4 in blanking unit 4134. A description of this is given in chapter 2.

Scan failure blanking

29. The linear change of current through one output valve causes a square wave of voltage across the deflector coil; the amplitude of this is equal to the inductance of the coil multiplied by the rate of change of current through it. Superimposed on this voltage square wave is a sawtooth of voltage due to the linear change of current through the resistance of the coil. The composite voltage so formed across each deflector coil is connected to blanking unit 4134 via the distribution board at the rear of the electronics compartment and actuates the scan failure blanking circuit as described in chapter 2.

Test points

30. Test points are provided at various places in the circuit for the examination of waveforms and voltages to assist in setting up and servicing the unit. Four of these (viz., TS1 to TS4) are located near the top edge of the chassis as it is mounted in the projector. The other test points are grouped together in socket TS5 immediately behind the front panel, providing a means of connecting a multimeter Type 100.

AMPLIFYING UNIT (Y-DEFLECTION) 4132

31. A circuit diagram of this amplifier is given in fig. 5. No component layout diagrams are given, since these would only be mirror images of those given for the X-amplifier in fig. 2 and 3, with a few differences concerned with the routing of power supplies and relay switching. These differences should be evident from the description of para. 33.

32. The electrical description of the X-amplifier applies equally well to the Y-amplifier, since component values and references are the same throughout with the exception that the input grid of the Y2 amplifier is that of V9b, whereas it is that of V9a in the X2 amplifier. Plugs and sockets on the Y-amplifier are prefixed YA. The Y-component of the resolved timebase waveform enters the unit at YA3 via P18 on the roof panel of the projector. The outputs to the Y-deflector coils pass via sockets YA4 and YA6.

POWER SUPPLIES AND INTERCONNECTIONS

33. Anode, screen and bias voltages for the various valves in the unit, with the exception of the four output valves (*para.* 26) are derived from the +400V, +250V and –300V stabilized supplies from power unit 4122. These are connected to the X-amplifier at plug XA2, and thence by soldered connections to the Y-amplifier.

34. Valve heater voltages for both amplifiers are derived from the main heater transformers in the projector console. The X-amplifier is supplied from tags 4A and 4B on transformer TR1 (*Sect.* 1, *Chap.* 2, *fig.* 1) which are connected to plug XA1; the Y-amplifier is supplied from tags 3A and 3B on TR1 connected via plug YA7.

35. The relay switching voltages are carried by plug YA8 and are connected to the X-amplifier by soldered leads. The interconnections between the deflection amplifiers and the blanking unit are made on the distribution panel at the rear of the electronics compartment.

36. The sliders of RV6 in both amplifiers are connected together and to socket YA5 on the Y-amplifier. This is the octagonal blanking output which is fed to amplifying unit (video) 4129.

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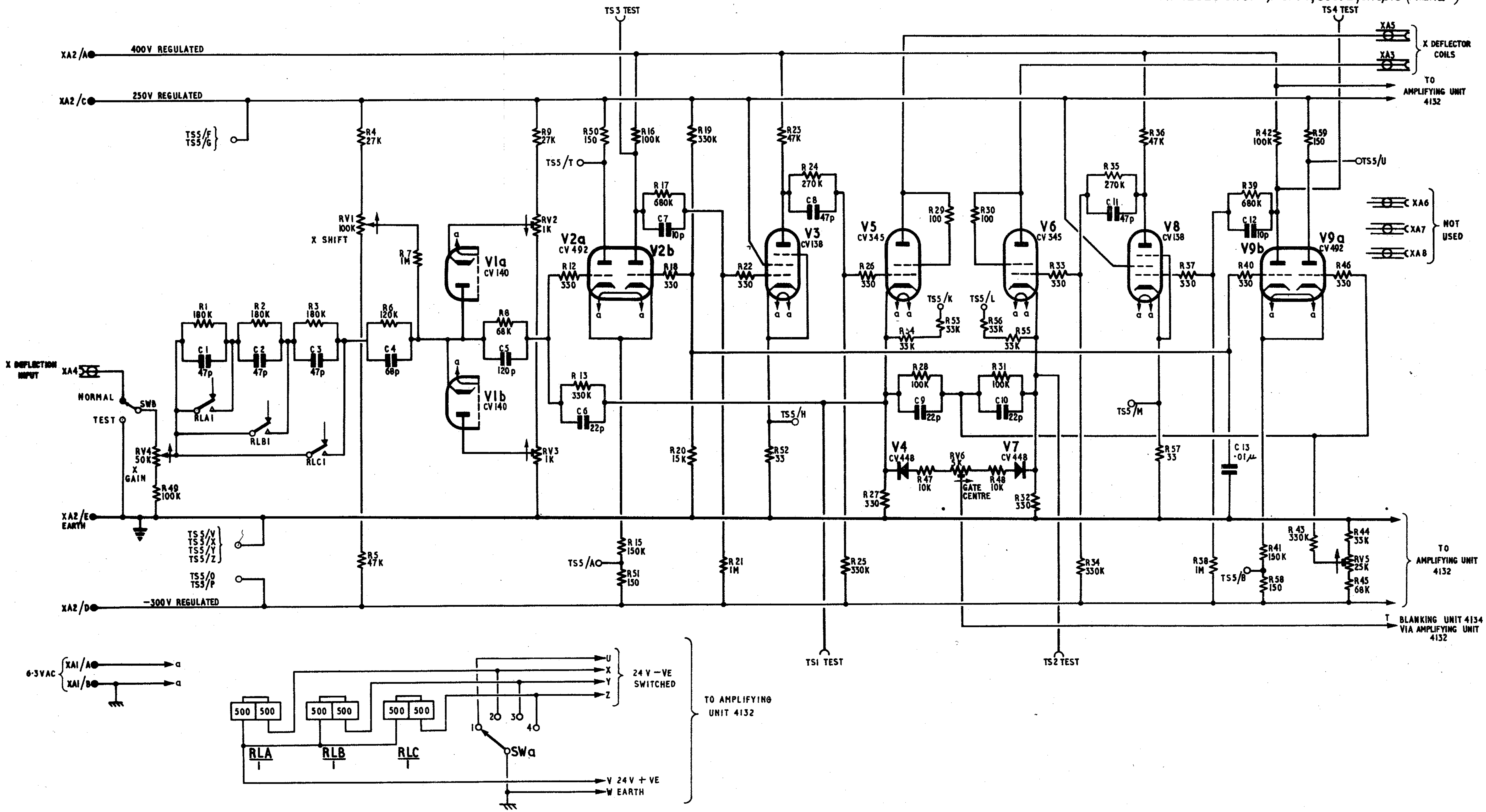

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RADAR PHOTOGRAPHIC DISPLAY SYSTEM

Amplifying unit (X deflection) 4131: Circuit

Fig. 4

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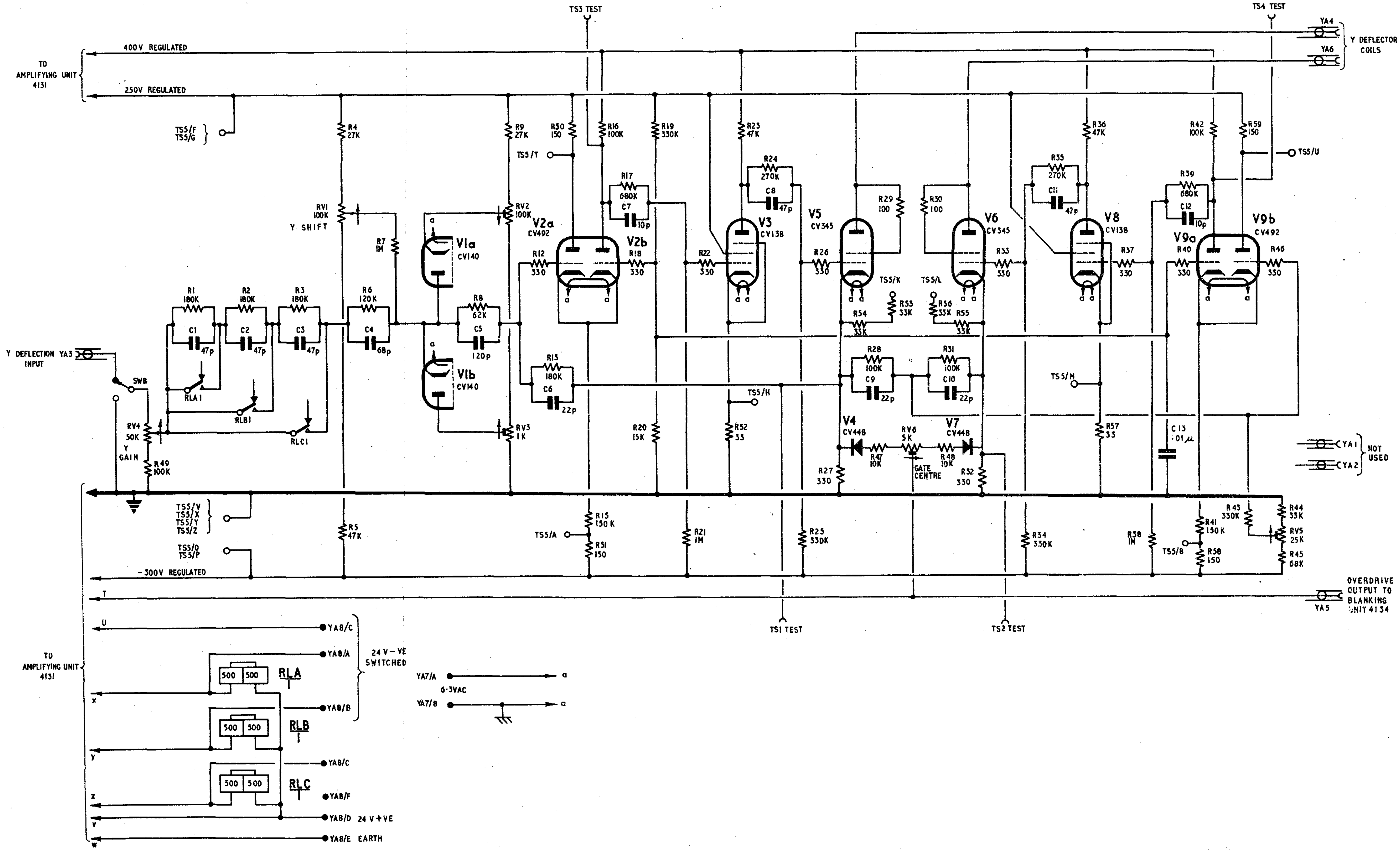

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Amplifying unit (Y deflection) 4132: Circuit

Fig. 5

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Chapter 4

POWER UNIT 4109

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LIST OF ILLUSTRATIONS

INTRODUCTION

1. Power unit 4109 is part of rack assembly (power supply) 340. It generates a 250V positive stabilized voltage and a 600V positive voltage. The +250V stabilized line provides the HT voltage for the X and Y deflection amplifiers in amplifying unit (deflection) 4130. The 600V line provides current for the CRT focus coil; it is also connected to power unit 4122 (*Chapter* 6) where it forms the basis for the +400V stabilized supply.

2. The unit is supplied with 230V AC at 50 c/s from the 15A regulated mains supply fed via pins A and B of the 6-pole Plessey Mk. 4 plug PSU1 at the rear of the chassis.

3. A front panel view of power unit 4109 is given in fig. 1; the layout of principal components is shown in fig. 2.

CIRCUIT DESCRIPTION

General

4. The 15A regulated mains supply is connected to rack assembly (power supply) 340 at a three-pole terminal strip in control unit (projector) 4075; it is then switched by the PROJECTOR MAIN SWITCH and emerges from the control unit on terminals LC6 and LC7 (*Section* 6, *Chapter* 2). From here, it is connected via terminals HT4 and HT5, the HT ON–OFF switch and pins HT1/A and HT1/B on the rack distribution panel to plug PSU1 on power unit 4109.

5. A complete circuit diagram of the power unit is given in fig. 3.

6. The mains supply at pins PSU1/A and PSU1/B is connected via fuses F1 and F2 to the primary of transformer T1. When the mains circuit through the fuses is complete, an indication is provided by the glowing of the neon indicator lamps LP1 and LP2 which are mounted above the fuses on the front panel.

600V positive stabilized supply

7. One secondary winding of T1 supplies a bridge rectifier circuit consisting of MR1, MR2, MR3 and MR4. The winding is tapped to enable the voltage applied to the rectifier to be varied for different load requirements.

8. The DC output from the rectifier is switched by contacts RLA1 (*para.* 18) and is then applied to a condenser input filter consisting of C1, L1 and C2. Resistor R3, in parallel with C2, forms a bleed ensuring the rapid discharge of the condensers when the circuit is switched off.

9. The output of the filter is fused by F3 and is connected via pin PSU1/C to HT1/C on the rack distribution panel. The presence of the output is indicated by the neon indicator lamp LP3 which is mounted above F3 on the front panel.

250V positive stabilized supply

10. A second secondary winding of T1 supplies a bridge rectifier consisting of MR5, MR6, MR7 and MR8. Tappings on the secondary winding enable the voltage applied to the rectifier to be varied for different load requirements.

11. The DC output from the rectifier is applied to a two-stage choke input filter consisting of L3, C4, L2 and C5, and is then stabilized by the action of valves V1 to V5 and the circuits associated with them. The heaters of these valves are supplied from windings on T1.

12. Valves V1, V2 and V3 are connected in parallel and behave as a resistance in series with the HT line. The valve circuits include control and screen grid stoppers, R14 to R19, to prevent any tendency to parasitic oscillation. The effective

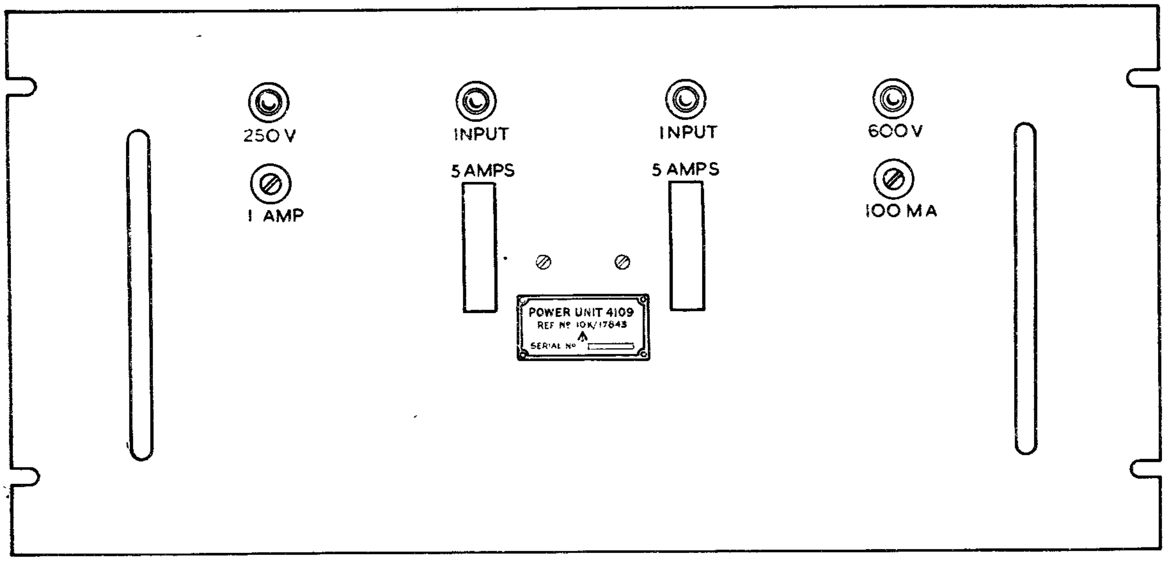

Fig. 1. Front view

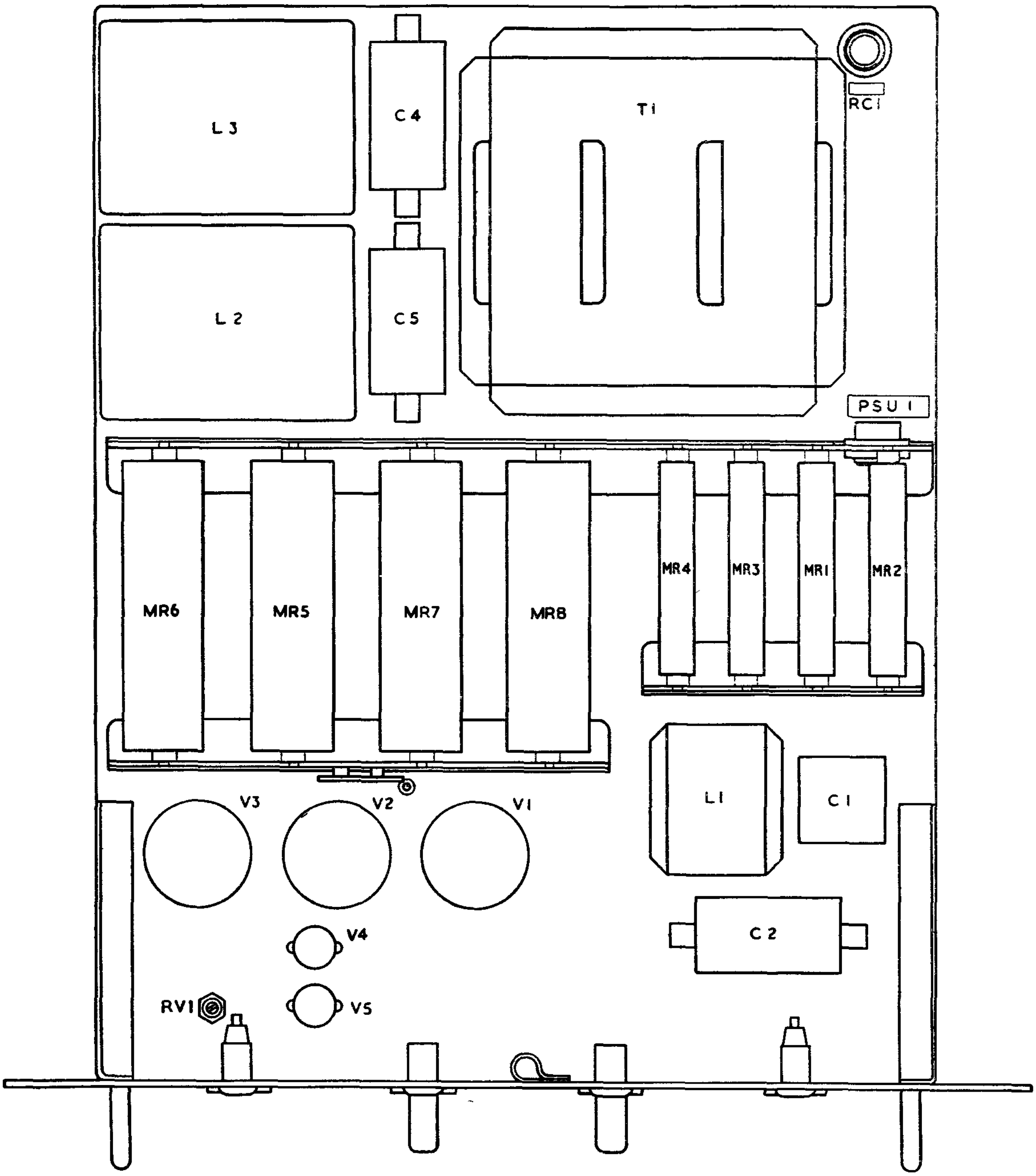

Fig. 2. Interior view

resistance of the valves depends on the potential of their control grids which are connected to the anode of V4.

13. The cathode of V4 is connected to the junction of resistors R7 and R9 which form a potential divider across the supply. The potential at this junction is stabilized at about +80V by the action of the gas-filled reference tube V5. The screen grid voltage for V4 is derived from another potential divider consisting of R8 and R10.

14. The action of the stabilizing circuit is as follows: —

A network, consisting of R21, RV1 and R22, is connected between earth and the output point at the cathodes of V1, V2 and V3. A reduced version of any output voltage variation appears at the slider of RV1 and is connected via R13 to V4 control grid. The consequent variation in V4 anode potential is applied to the grids of V1, V2 and V3, thus varying the resistance in series with the HT line in such a manner that the output voltage is kept stable. The precise voltage about which stabilization takes place is adjusted by means of RV1 (*fig.* 2).

15. The degree of output stability depends on the gain of the control valve V4. The gain is reduced for DC and very low frequencies because of the attenuating effect of the resistor chain R22, RV1 and R21 which is made necessary by the biasing requirements for V4. The inclusion of condenser C7, in the grid circuit of V4, increases the gain at the mains frequency, thus reducing mains hum on the output line to a very low figure.

16. The +250V stabilized output, which appears at the cathodes of V1, V2 and V3, is switched by contacts RLB1 (*para.* 18) and is then connected via fuse F4 and pin PSU1/D to HT1/D on the rack distribution panel. The presence of the supply is indicated by the neon indicator lamp LP4 which is mounted above F4 on the front panel.

Delay switching

17. Assuming the HT ON–OFF switch on the rack distribution panel to be made, the mains supply is connected to the input terminals of transformer T1 when the PROJECTOR MAIN SWITCH on control unit (projector) 4075 is closed. The heaters of valves V1 to V4 then start to warm up, but no output is obtained from the power unit since contacts RLA1 and RLB1 will be open.

18. A voltage, generated by the delay switching circuit in power unit 4110 (*Chapter* 5, *para.* 7), appears at pins RC1/A and RC1/B approximately one minute after the PROJECTOR MAIN SWITCH is closed and is applied to the operating coils of relays RLA/1 and RLB/1. The relays operate with the following results:—

(1) Contacts RLA1 close and complete the +600V line. The neon indicator LP3 lights indicating the presence of the output.

(2) Contacts RLB1 close and complete the output circuit of the +250V stabilized supply. The neon indicator LP4 lights indicating the presence of the +250V output.

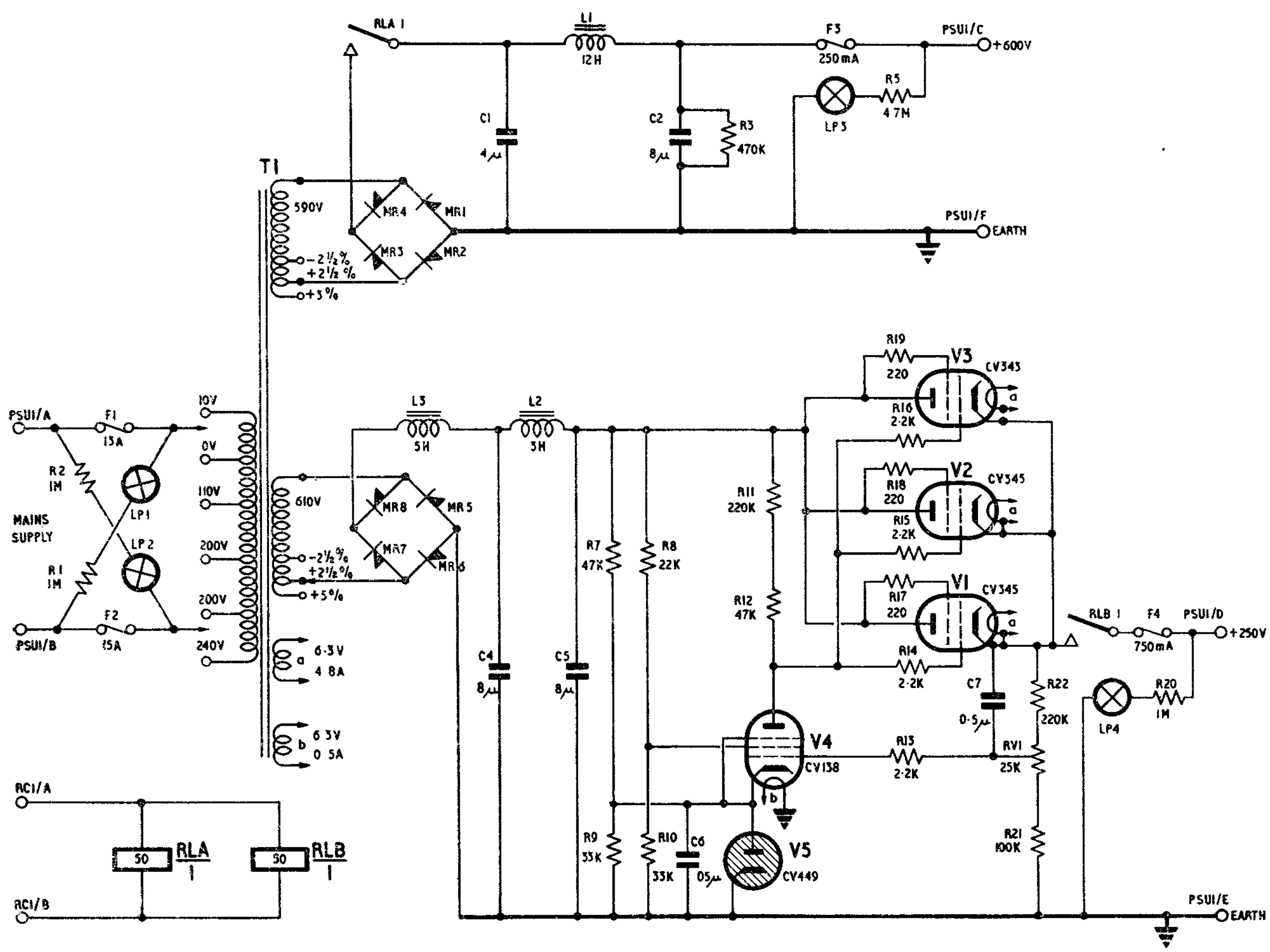

Fig. 3. Power unit 4109: circuit

Chapter 5

POWER UNIT 4110

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LIST OF ILLUSTRATIONS

INTRODUCTION

1. Power unit 4110 is part of rack assembly (power supply) 340. It generates 490V floating and 435V positive voltages which are applied to power unit 4122 in the projector console to form the basis for the 300V negative and 250V positive stabilized supplies. The unstabilized 435V positive output from the unit is also used in power unit 4122 as the HT voltage for the RF oscillator EHT unit (*Chapter* 6).

2. The unit is supplied with 230V AC at 50 c/s from the 15A regulated mains supply fed via pins A and B of the 6-pole Plessey Mk. 4 plug PSU2 at the rear of the chassis. The application of this mains voltage to the HT transformer is automatically delayed for about a minute; this prevents the HT output voltages from being applied to valves in the electronic chassis before their heaters have reached operating temperature. The switching circuit which does this also delays the outputs from power unit 4109 (*Chapter* 4) for the same reason.

3. A front panel view of power unit 4110 is given in fig. 1; the layout of principal components is shown in fig. 2.

CIRCUIT DESCRIPTION

General

4. The 15A regulated mains supply is connected to rack assembly (power supply) 340 at a three-pole terminal strip in control unit (projector) 4075 (*Section* 6, *Chapter* 2); it is then switched by the PROJECTOR MAIN SWITCH and emerges from the control unit on terminals LC6 and LC7. From here, it is connected via terminals HT4 and HT5, the HT ON–OFF switch and pins HT2/A and HT2/B on the rack distribution panel to plug PSU2 on power unit 4110.

5. A complete circuit diagram of the power unit is given in fig. 3.

Delay switching circuit

6. The mains supply at pins PSU2/A and PSU2/B is applied via fuses F1 and F2 to the primary of transformer T2. When the mains circuit through the fuses is complete, an indication is provided by the glowing of the neon lamps LP1 and LP2 which are mounted above the fuses on the front panel.

7. The 6·3V AC output from the secondary of T2 is connected to the heater of a thermal delay valve V1 via contacts RLA1; it is also applied to a bridge rectifier MR9. After a delay of approximately a minute, the delay valve contacts close and complete the DC output circuit of the rectifier to the operating coil of relay RLA/3 and via RC2/A and RC2/B to similar relays in power unit 4109 (*Chapter* 4, *para.* 18).

8. Relay RLA/3 operates with the following results:—

(1) Contacts RLA2 close providing a hold-on path for the relay.

(2) Contacts RLA1 open breaking the circuit of V1 heater so that the valve cools down ensuring the correct operation of the delay circuit if the mains circuit is subsequently broken and made again.

(3) Contacts RLA3 close and connect the mains voltage to the primary of transformer T1.

435V positive supply

9. One secondary winding of transformer T1 supplies a bridge rectifier circuit consisting of MR1, MR2, MR3 and MR4. The winding is tapped to enable the voltage applied to the rectifier circuit to be varied for different load requirements.

10. The DC output from the rectifier is smoothed by a two-section condenser input filter consisting

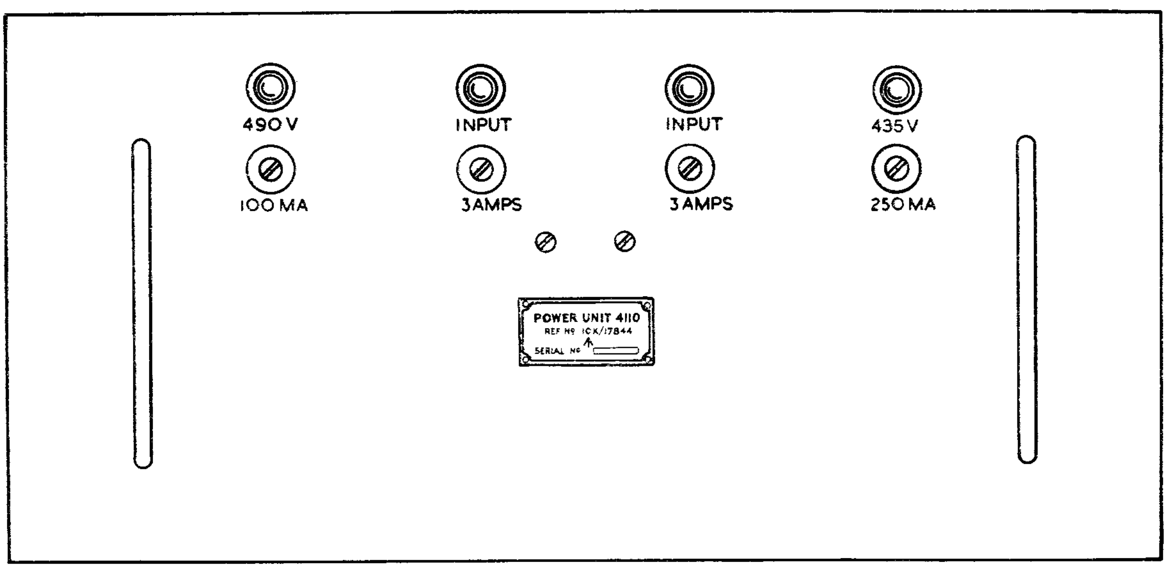

Fig. 1. Front view

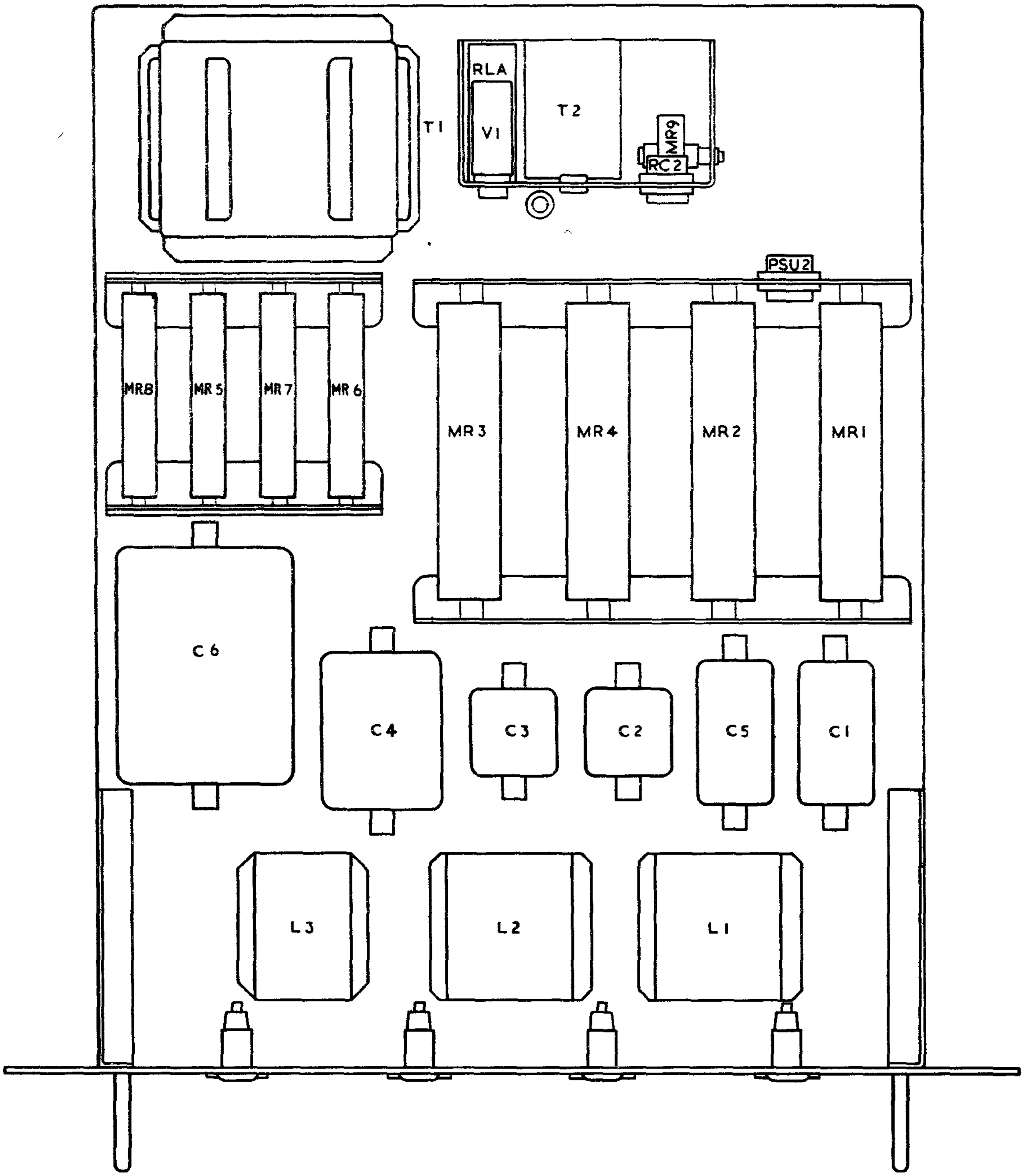

Fig. 2. Interior view

of C1, C5, L1, C2, L2 and C3; resistor R3, in parallel with C1 and C5, forms a bleed ensuring the rapid discharge of the condensers when the circuit is switched off.

11. The output of the filter is fused by F3 and is connected via pin PSU2/D to HT2/D on the rack distribution panel. The presence of the output is indicated by the neon indicator lamp LP3 which is mounted above F3 on the front panel.

490V floating supply

12. A second winding on transformer T1 supplies the bridge rectifier consisting of MR5, MR6, MR7 and MR8. Tappings on the secondary winding enable the input to the rectifier to be varied for different load requirements.

13. The DC output from the rectifier is smoothed by a condenser input filter consisting of C4, L3 and C6; resistor R5, in parallel with C4, forms a bleed ensuring the rapid discharge of the condensers when the circuit is switched off.

14. The output from the filter is fused by F4 and is connected via pins PSU2/C and PSU2/F to HT2/C and HT2/F on the rack distribution panel. The presence of the 490V floating supply is indicated by the neon indicator lamp LP4 which is mounted above F4 on the front panel.

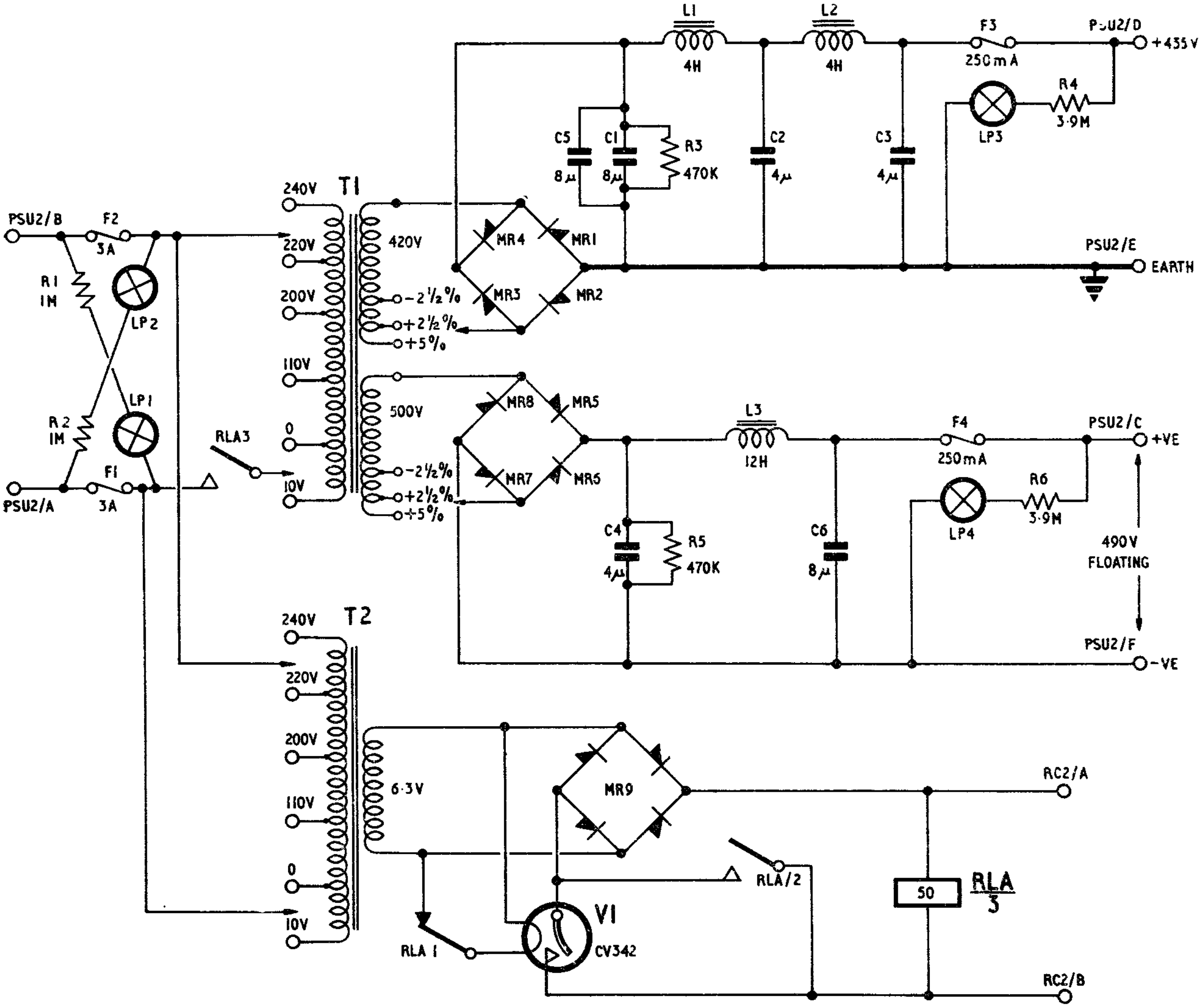

Fig. 3. Power unit 4110: circuit

Chapter 6

POWER UNIT 4122

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LIST OF ILLUSTRATIONS

Introduction

1. Power unit 4122 consists of a front panel and framework carrying voltage stabilizers for the +400V, +250V and −300V stabilized supplies together with a power unit which provides the EHT for the cathode ray tube in indicating unit (CRT) 4123. The unit is mounted in the bottom shelf of the electronics compartment at the lower right-hand side of the projector console.

2. The voltage stabilizers are carried on a sub-chassis which is mounted on edge at the right-hand side of the framework: this is known as stabilizer (voltage) 4127. Another sub-chassis carries a RF oscillator, oscillator unit (EHT) 4126, which operates in conjunction with a RF transformer and EHT rectifier circuit (transformer unit 184) contained in an oil-filled hermetically sealed tank.

STABILIZER (VOLTAGE) 4127

General

3. The +400V, −300V and +250V stabilized outputs from this unit are derived from the +600V, 490V floating and +435V supplies respectively from power units 4109 and 4110 in the power supply rack (*Chap. 4 and 5*). Heater voltages for the various valves come from the main heater transformers in the projector console and become present immediately the PROJECTOR MAIN SWITCH on the power supply rack is closed (*Sect. 6, Chap. 1*). Provided that the HT ON–OFF switch on the power supply rack frame is closed, the input voltages to the stablizer circuits appear after a delay of approximately one minute: the switching circuit which causes the delay is located in power unit 4110.

Circuit description

4. A circuit diagram of the voltage stabilizer chassis is given in fig. 1. A diagram showing the layout of components on the underside of the chassis is given in fig. 6. The layout of remaining components can be seen in fig. 3, 4 and 5.

5. The various input and output connections are made via the distribution board at the rear of the electronics compartment. Unstabilized voltages enter via plug VR3 and the stabilized outputs leave via VR4. Heater voltages for the unit enter on plugs VR1 and VR2. The various DC voltages may be monitored at test sockets (TS. 1 to 9) on the front panel of the power unit. A test socket is included for monitoring the 250V stabilized deflector coil supply which is generated in power unit 4109 and routed for convenience through this unit (*Chap. 3.*) A 25-pole test socket (TS. 10) mounted inside the power unit enables measurements to be made on the stabilized outputs only, using a multimeter Type 100.

Positive 400V stabilizer

6. This supplies the HT voltage for the initial stages of the X and Y deflection amplifiers, and high stability is therefore required if the accuracy of the CRT display is to be maintained, since any variations or ripple will be amplified in the output stages.

7. Valve V1 behaves as a resistance in series with the +600V line; the effective resistance of the valve depends on the potential of its control grid which is connected to the anode of V3. A resistor network, consisting of R15, R16, R17, RV1, R19, is connected between the cathode of V1 and the −300V stabilized line. A reduced version of any output voltage variation appears at the slider of RV1 and is connected via R13 to V3 control grid. The consequent amplified, antiphase variation at V3 anode is applied to the grid of V1, thus altering the resistance in series with the HT line in such a manner that the output voltage at V1 cathode is corrected.

8. Valve V3 is a high-gain amplifier having a large anode load. In order that the valve may pass sufficient current to maintain the gain, its HT is derived from the +600V line and is stabilized by the action of R2 and the gas-filled reference tube V6. A change in the level of the 600V line would, without the presence of V6, cause the same change to take place at the anode of V3 and consequently at the grid of V1. This would change the output voltage, which in turn would vary the grid potential of V3, so altering V1 grid potential and offsetting the 600V line variation. Thus, supposing the gain of V3 to be 100, a change of 100mV will be required at V3 grid in order to cancel a change of 10V on the 600V line; owing to the potential dividing effect of the resistor chain, this would demand a change of 200mV at the output. The provision of a stable HT for V3 prevents a change on the 600V line from affecting the anode potential of V3 directly. The change will, however, alter the output of the circuit unless the impedance of V1 is altered to offset it. The alteration needed (again supposing a 10V excursion on the 600V line) will only be about 1V at V1 grid requiring a movement of 10mV at V3 grid.

9. The cathode of V6 is connected to the junction R16, R17 and not to the stabilized output line. The purpose of this is to allow the effect of variations on the 600V line to be corrected without affecting the stabilized output. A 10V movement at V1 anode alters the current flowing through R2 and V6 by 0·5mA, and this current, flowing through R16 and R15, gives a voltage change of 20mV relative to V1 cathode at the junction R16, R17. The voltage change which appears at V3 grid is therefore the 10mV required to correct the input variation of 10V without demanding any voltage movement at V1 cathode; complete cancellation of input voltage variation is thereby achieved.

10. The resistor network between the stabilized 400V output line and the −300V stabilized line is essential in order to provide suitable DC bias conditions for V3. It has the effect of reducing the gain for steady conditions by approximately one-half. The capacitor C3 is included in the circuit to enable it to operate against ripple and pulse voltage variations which, in the absence of C3, would be much attenuated at V3 grid, due to the input capacitance of the valve and stray capacitance in the grid circuit. Since the impedance of C3, at the mains frequency, is negligible compared with that of the resistive network, the stabilization for AC on the output line is approximately twice as good as it is for DC. The capacitor is connected to the junction R15, R16 and not to the output line

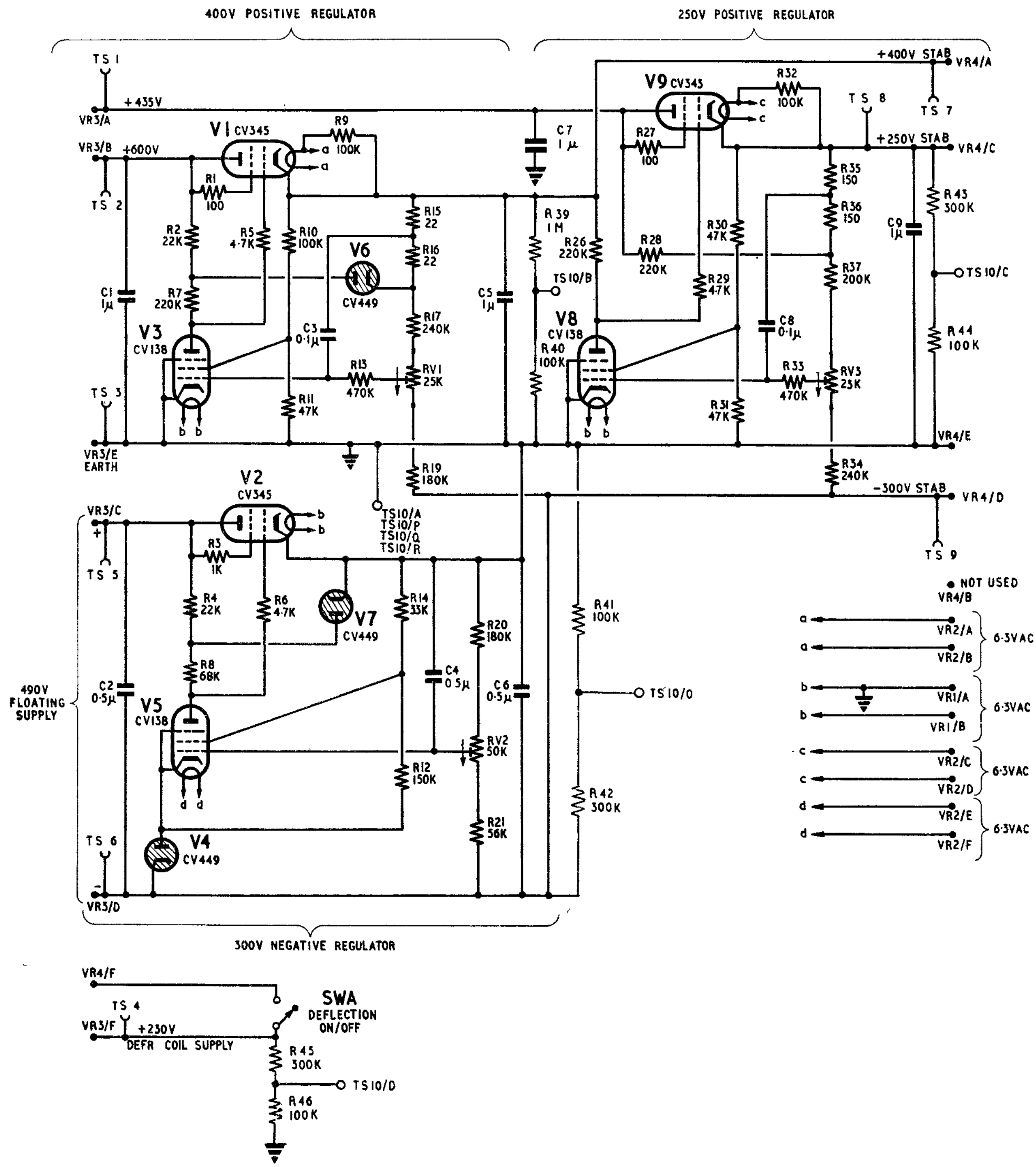

Fig. 1. Stabilizer (voltage) 4127: circuit

in order to cancel completely the effect of ripple on the 600V line. For example:—10V of ripple at V1 anode will require approximately 1V of ripple in antiphase at V1 grid. The ripple voltage at the junction R16, R17 will be 20mV, due to the current through R2 and V6, but only 10mV is required at V3 grid; this is provided via C3 from the junction R15, R16. Any ripple which may be present on the −300V line will not affect the circuit, due to the filtering action of R19, R13 and C3.

11. The precise value of the stabilized output voltage is adjusted by means of RV1, which determines the mean operating conditions of V1 and V3.

Negative 300V stabilizer

12. The −300V output is obtained from the 490V floating supply and the circuit operates in a manner similar to that just described for the +400V stabilizer. The positive line of the output is earthed and the stabilized output line is therefore negative. The cathode of the gas-filled reference tube V7 is connected directly to the cathode of the series valve V2, and variations of input voltage will therefore have some slight effect on the stabilized output. Since no stabilized supply more negative than −300V is available, correct bias conditions for the shunt valve V5 are obtained by connecting its

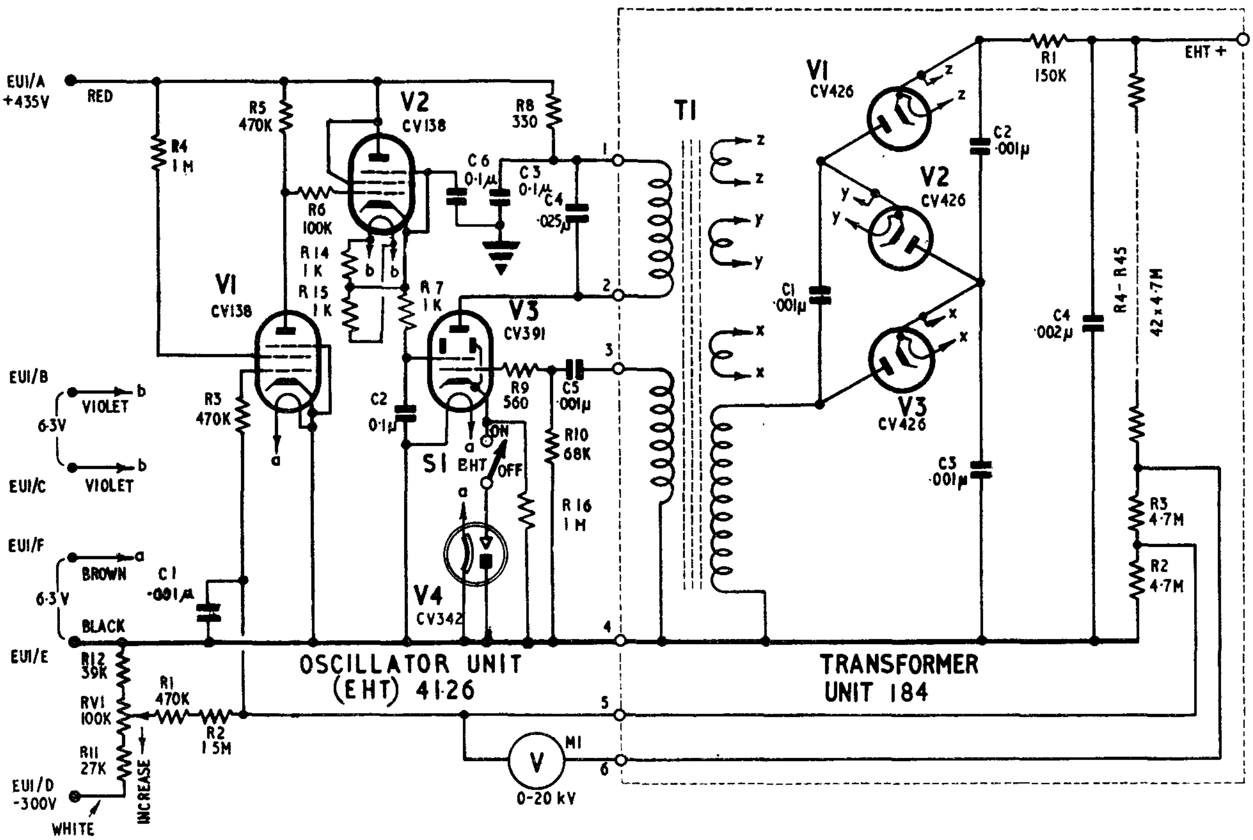

Fig. 2. EHT power unit: circuit

cathode to a potential which is stabilized at approximately 80V above the −300V output line by the action of V4, R12 and R14. The precise value of the output is set by means of RV2.

Positive 250V stabilizer

13. The +250V output is derived from the +435V supply from power unit 4110 by the action of V8 and V9. The stabilizing circuit operates in a similar manner to the +400V circuit. The stabilized 400V line provides the HT for the shunt valve V8, obviating the need for separate stabilizing of the HT for this valve. Exact stabilization of the output for changes in the +435V line is provided by the network R28, R35, R36. The precise value of the stabilized output is adjusted by means of RV3.

EHT POWER UNIT

14. A circuit diagram of the EHT power unit, which incorporates oscillator unit (EHT) 4126 and transformer unit 184, is given in fig. 2. Details of component layout can be seen in fig. 3 and 7.

Oscillator

15. Valve V3 is connected as a conventional RF oscillator having its anode and grid coils mutually coupled to a load coil. The three coils are wound in slots on a PTFE former which includes a dust iron core. The circuit operates in Class C at a frequency of about 18 kc/s.

16. The amplitude of the oscillatory voltage developed across V3 anode coil is regulated, by control of V3 screen grid potential, to allow for variations in EHT load current and variations on the 435V unregulated supply which provides the HT voltage for the circuit. The heater circuit of V3 includes the heater of a thermal delay valve V4 whose contacts complete the cathode circuit of V3 some 90 seconds after the heater voltage is applied (by closing the PROJECTOR MAIN SWITCH on the power supply rack), provided that the EHT ON–OFF switch on the front panel of power unit 4122 is closed. The purpose of this is to prevent EHT from being applied to the cathode ray tube before the deflection and video circuits are fully operative.

Rectifier circuit

17. The RF voltage across V3 anode coil is stepped up in transformer T1 and appears across the secondary winding at about 5kV peak amplitude; it is then applied to a voltage trebler rectifier circuit which includes valves V1, V2 and V3 in transformer unit 184. The heaters of these valves are supplied from windings on T1.

18. During positive half-cycles of the voltage from T1, V3 conducts and C3 charges to +5kV. During negative half-cycles the voltage at V3 anode falls to −5kV and V2 conducts, since its anode is held at +5kV by the charge on C3, charging C1 to 10kV. Also, during positive half-cycles, the voltage at V1 anode rises to +15kV (5kV across the transformer winding +10kV across C1) so that the valve conducts charging C2 to 10kV. The total DC voltage developed across C2 and C3 is thus

+15kV, and this is smoothed by the action of R1 and C4. The +15kV EHT output is connected to a high-voltage terminal on top of the transformer tank and from there to the anode cap of the CRT in indicating unit (CRT) 4123.

19. A 200-megohm bleed chain consisting of forty-four 4·7-megohm resistors is connected across the EHT output. This allows the reservoir condenser C4 to discharge when the circuit is switched off. The voltage across R2, at the earthy end of this chain, is used to provide the input for the stabilizing circuit formed by V1 and V2 in the oscillator unit. The voltage across R3 is connected to the terminals of the EHT voltmeter on the front panel of power unit 4122. The meter is calibrated in kilovolts and registers the actual value of the EHT output.

Stabilizing circuit

20. Valve V2 (oscillator unit) is a cathode follower whose cathode load consists of the triode formed by the cathode, control grid and screen grid of V3. The potential of V3 screen, and therefore the amplitude of the RF voltage generated by the valve, is close to that of V2 grid, whose potential is determined by the operation of V1.

21. The whole RF power unit may be regarded as a DC amplifier employing negative feedback. In this, the input voltage is derived from the slider of RV1, which is part of a potentiometer network across the −300V stabilized supply, and this is applied to the grid circuit of V1 via a 2-megohm feed resistance consisting of R1 and R2. The output from the amplifier is the EHT voltage, and this is also applied to the grid circuit of V1 via a feedback resistance consisting of the 200-megohm EHT bleed R2 to R45. As discussed in Chapter 3, a virtual earth exists at the input grid of such an amplifier and the gain is equal to the ratio between feedback and feed resistors: in this case 100.

22. The voltage at RV1 slider, for a given setting of the control, must be stable, since it is derived from the −300V stabilized supply. The output voltage corresponding to this setting must therefore also be stable for reasonable variations of load and of the 435V unregulated HT supply to valves V1, V2 and V3. The available range of voltage at RV1 slider is from −70V to −250V. Therefore, by means of the control, the EHT output may theoretically be varied from +7kV to +25kV. In the photographic projector, it is normally set to +15kV.

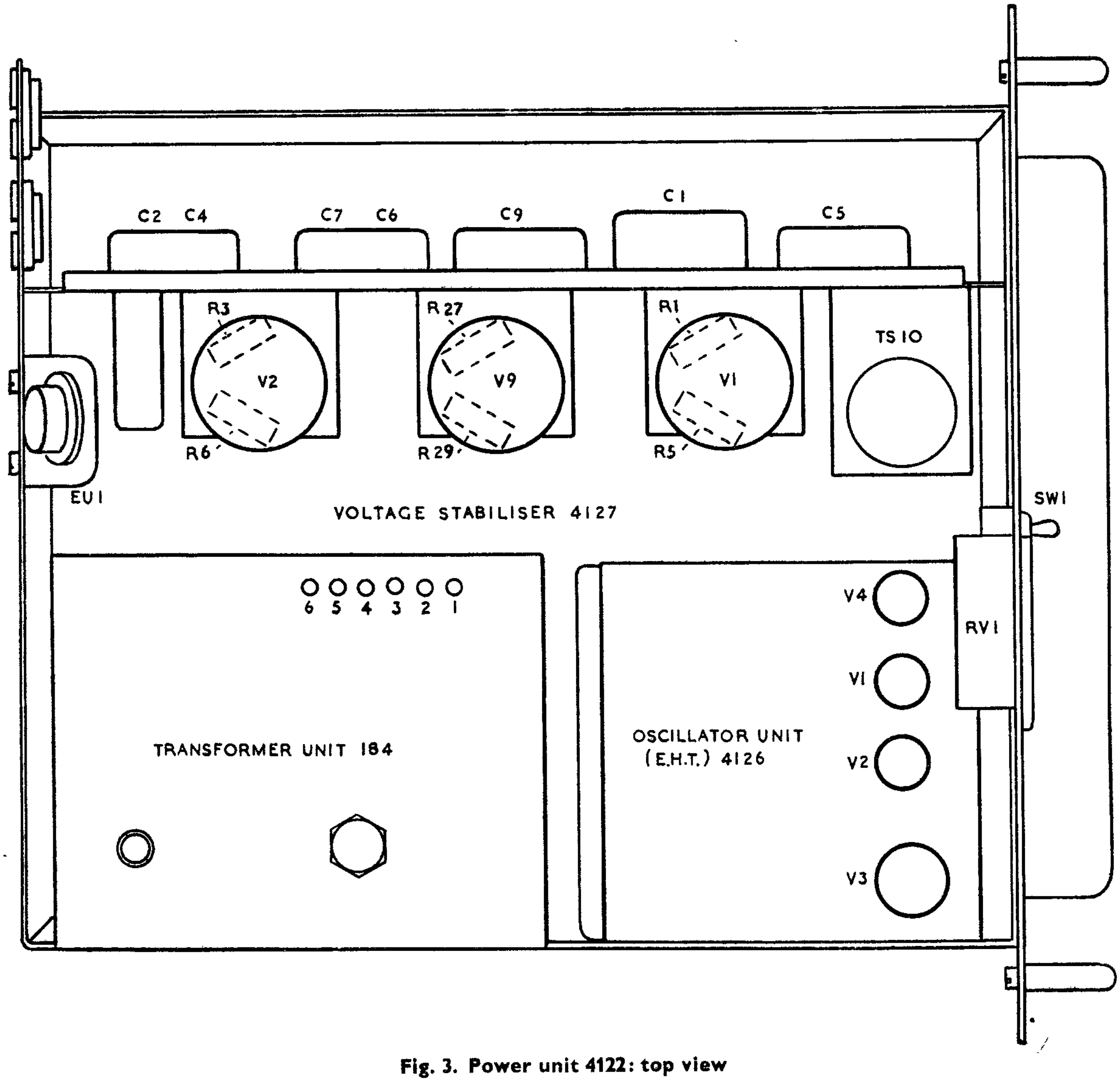

Fig. 3. Power unit 4122: top view

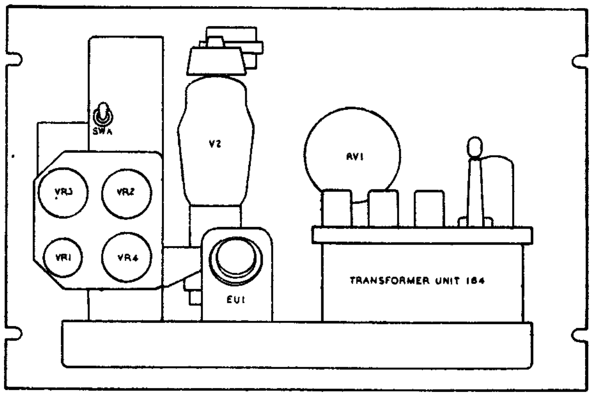

Fig. 4. Power unit 4122: rear view

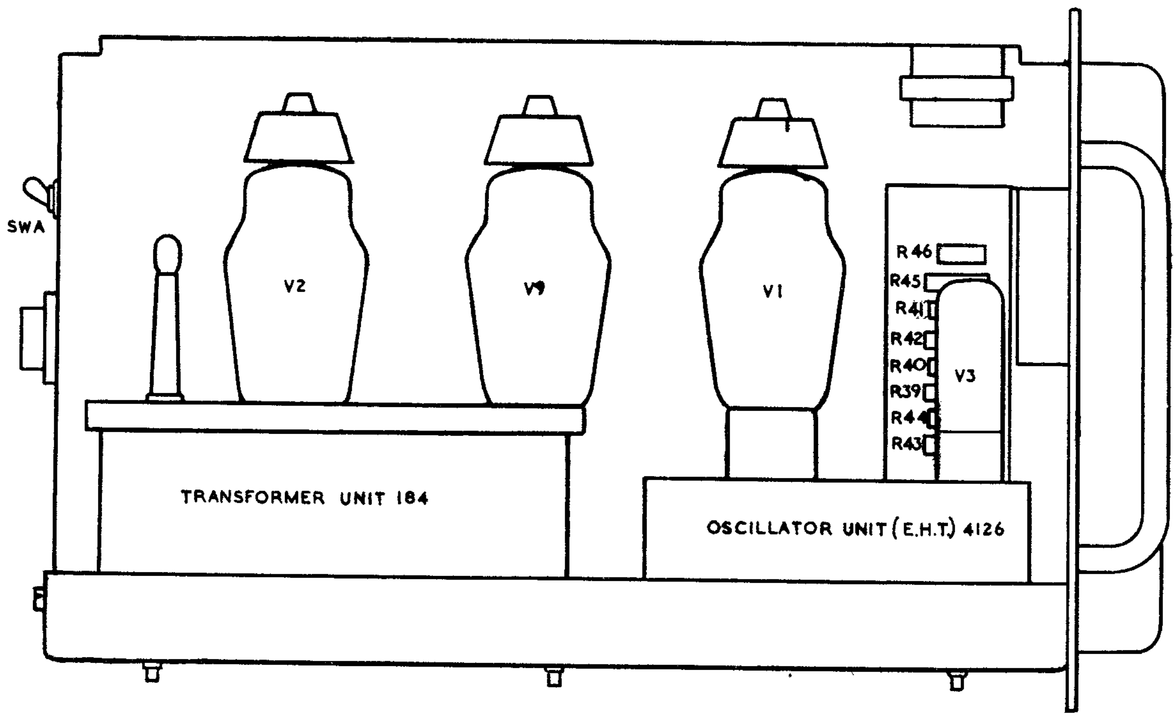

Fig. 5. Power unit 4122: side view

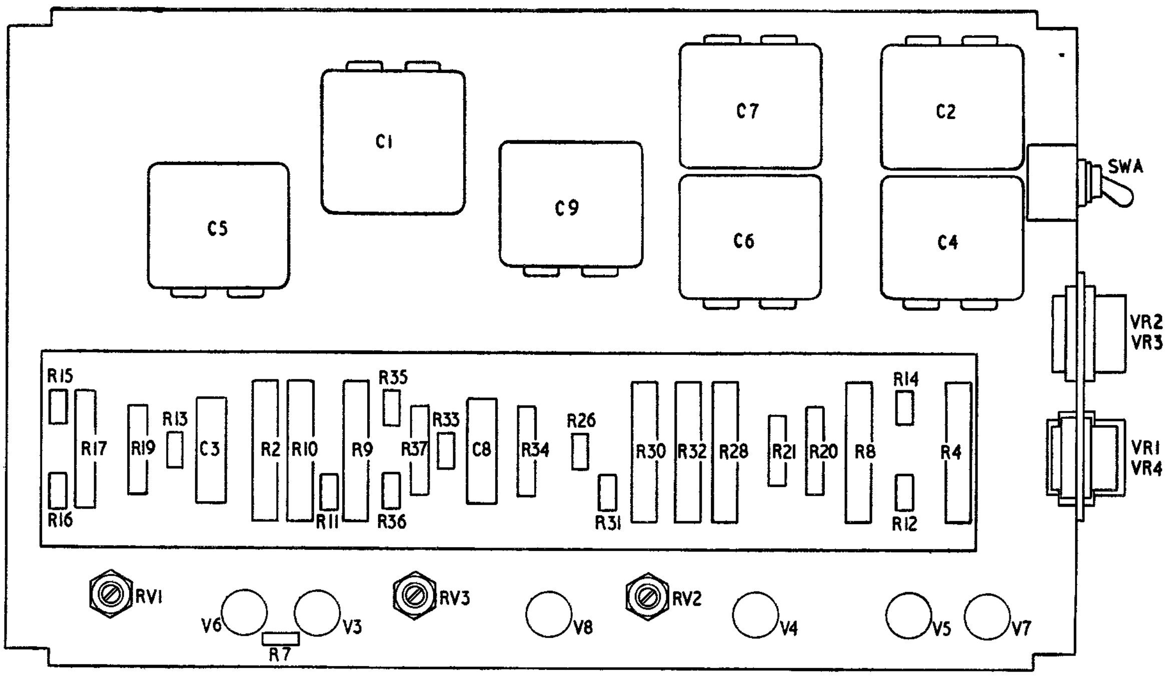

Fig. 6. Stabilizer (voltage) 4127: under view

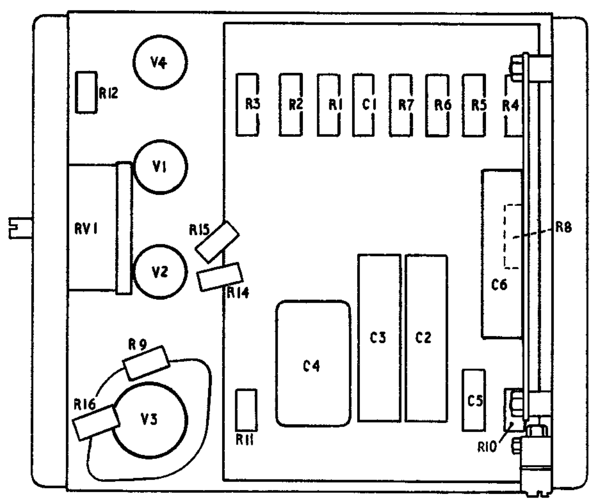

Fig. 7. Oscillator unit (EHT) 4126: under view

46889 555280 4387 10/55 625 CWSLtd1479 Gp539-2

Chapter 7

INDICATING UNIT (CRT) 4123

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LIST OF ILLUSTRATIONS

Introduction

1. Indicating unit (CRT) 4123 carries the cathode-ray tube which provides the radar display. The unit consists of a CRT mounting tube containing the focus and deflector coil assembly. It is held in a mounting frame which is carried on a universal joint on a spring-loaded foot pedal. The whole assembly is located in the lower front left-hand compartment of the projector console (*fig.* 1).

2. When in its correct operating position, the face of the CRT is pressed by the action of the pedal springs against the lower rim of a cylindrical casting under the console desk immediately below lens unit 4124 (*Sect.* 3, *Chap.* 2). The bore of this casting is lined with black velvet to prevent the reflection of light; the velvet extends over the lower rim of the casting to provide a soft seating for the tube face.

3. The foot pedal provides a means of lowering the tube from its operating position, when it may be swung forward towards the operator; the weight of the tube and its mounting is then taken by retaining chains. The equipment may be run with the tube in this position for convenience in setting-up the display. A view of the indicating unit is given in fig. 1.

MECHANICAL DESCRIPTION

4. A schematic drawing, showing the construction of the indicating unit and its mounting frame, is given in fig. 2.

CRT mounting tube

5. The CRT mounting tube is made of Mumetal and consists of two cylindrical sections welded together. The upper section encloses the flare of the CRT and the focus and deflector coils assembly; the lower section encloses the neck of the CRT. The use of Mumetal provides efficient electrostatic and magnetic screening and prevents the display from being affected by external fields.

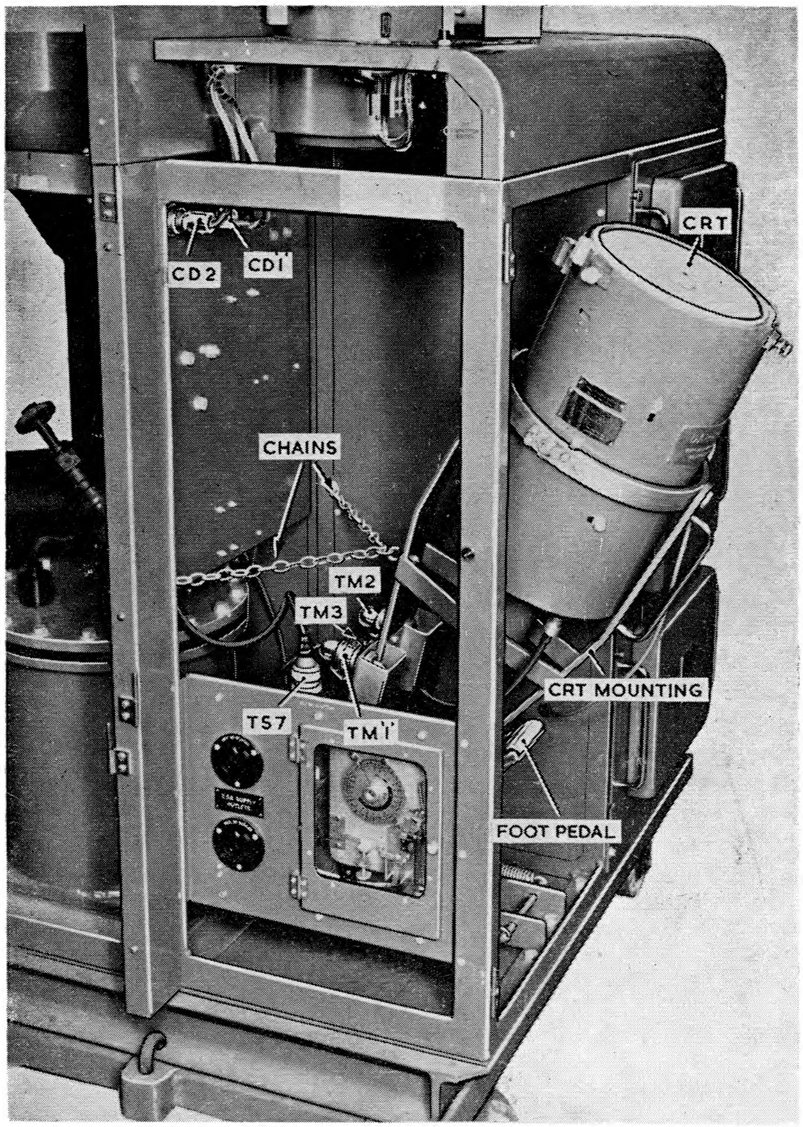

Fig. 1. Indicating unit (CRT) 4123: general view

6. The bulb of the CRT is held in a clamp (34) composed of two pieces of mild steel strip, each bent into a semi-circle and secured together by nuts and bolts; the clamp is lined with sponge rubber. The clamp is held to the mounting tube by two steel strips, one riveted to each semi-circle, and containing hank bushes which carry screws (8) passing through slotted holes in the mounting tube. Three adjusting screws (33) fitted with lock-nuts are used to locate the clamp (34) securely at the top of the mounting tube. One of these screws bears on the strip riveted to one of the clamps; the other two rest on leaf springs (32) riveted to the mounting tube in order to provide strengthened points for the screw pressure. When in position in the mounting tube, the lower surface of the CRT bulb rests on the deflector coil assembly (*para.* 7).

Focus and deflector coils

7. A view of this assembly is given in fig. 3. The coils are mounted on an aluminium alloy casting which has three fixing feet for attachment to the CRT mounting tube. The fixing screws (10) pass through slotted holes in the mounting tube, enabling the assembly to be rotated slightly relative to the CRT for fine orientation of the final projected picture. Connecting cables pass through clearance holes in the mounting tube.

KEY TO FIG. 2

1 PROJECTOR MAINPLATE
2 TUBE SHROUD
3 SPRING-LOADED PLUNGERS
4 TUBE CASTING
5 SPIGOT
6 C.R.T. MOUNTING TUBE
7 LUG
8 C.R.T. CLAMP FIXING SCREWS
9 GIMBAL RING
10 COIL ASSEMBLY FIXING SCREWS
11 RETAINING CHAINS
12 LOCKING KNOB
13 RETAINING SPRING
14 PIVOT
15 LOCKING PLATE
16 BRACKET
17 PEDAL PIVOT
18 SPRING ANCHOR PIN
19 CHANNEL SUPPORT
20 COUPLING BLOCK
21 SPRING ANCHOR PIN
22 TENSION SPRINGS
23 FOOT PEDAL
24 PEDAL STOP PIN
25 C.R.T. BASE SOCKET
26 YOKE
27 SPECIAL NUT
28 PIVOT SCREW
29 HANDLE
30 FOCUS AND DEFLECTOR COIL ASSEMBLY
31 C.R.T. ANODE CAP
32 LEAF SPRING
33 ADJUSTING SCREW
34 C.R.T. CLAMP

Mounting framework

8. The mounting frame consists of a mild steel yoke carrying a gimbal ring at the top and mounted at its lower end on a coupling block held in a spring-loaded foot pedal.

Gimbal ring

9. The gimbal ring (9) is mounted in the yoke (26) by means of pivot screws (28) and special nuts (27). The screws are retained in tapped holes in the ring and the bearing surfaces are provided by the nuts (27), which pass through bearing holes in the yoke and lock the pivot screws in position. The gimbal ring is thus free to turn about a diameter relative to the yoke. The ring also contains two diametrically opposite slots on a line at right angles to its axis in the yoke. These provide a bearing for the pivots (14) which are fixed to the c.r.t mounting tube. Locking plates (15) prevent the pivots (14) from leaving the slots in the ring when the yoke is lowered by means of the foot pedal. Each locking plate is engaged by a locking knob (12) the shaft of which has flats. When the knob is turned so that the flat surfaces are vertical, clearance is offered to a "keyhole" slot in the locking plate (15) which can then be hinged down, so retaining the pivot (14). The locking knob is then turned to bring the flat surfaces horizontal, so preventing the locking plate from lifting. A spring (13) bears against another flat on the head of the locking knob to prevent it from turning accidentally.

Coupling block

10. The coupling block (20) is a brass casting having pivot pins on two axes at right angles. The block pivots in holes in the foot pedal (23) about one of these axes, and the yoke (26) pivots about the other axis. The arrangement forms a universal joint enabling the yoke, complete with the indicating unit, to be moved a limited amount in any direction.

Channel support and foot pedal

11. A short length of mild steel channel is bolted to the base of the projector framework. Two vertical lugs, welded to the channel sides at the rear end, contain bearing slots for the foot pedal

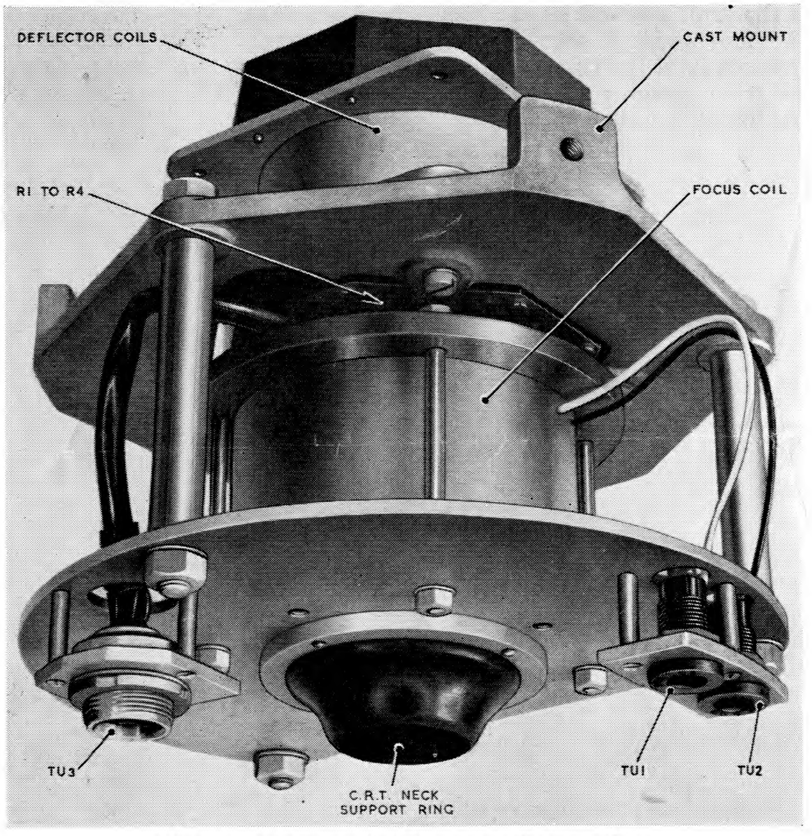

Fig. 3. Focus and deflector coil assembly

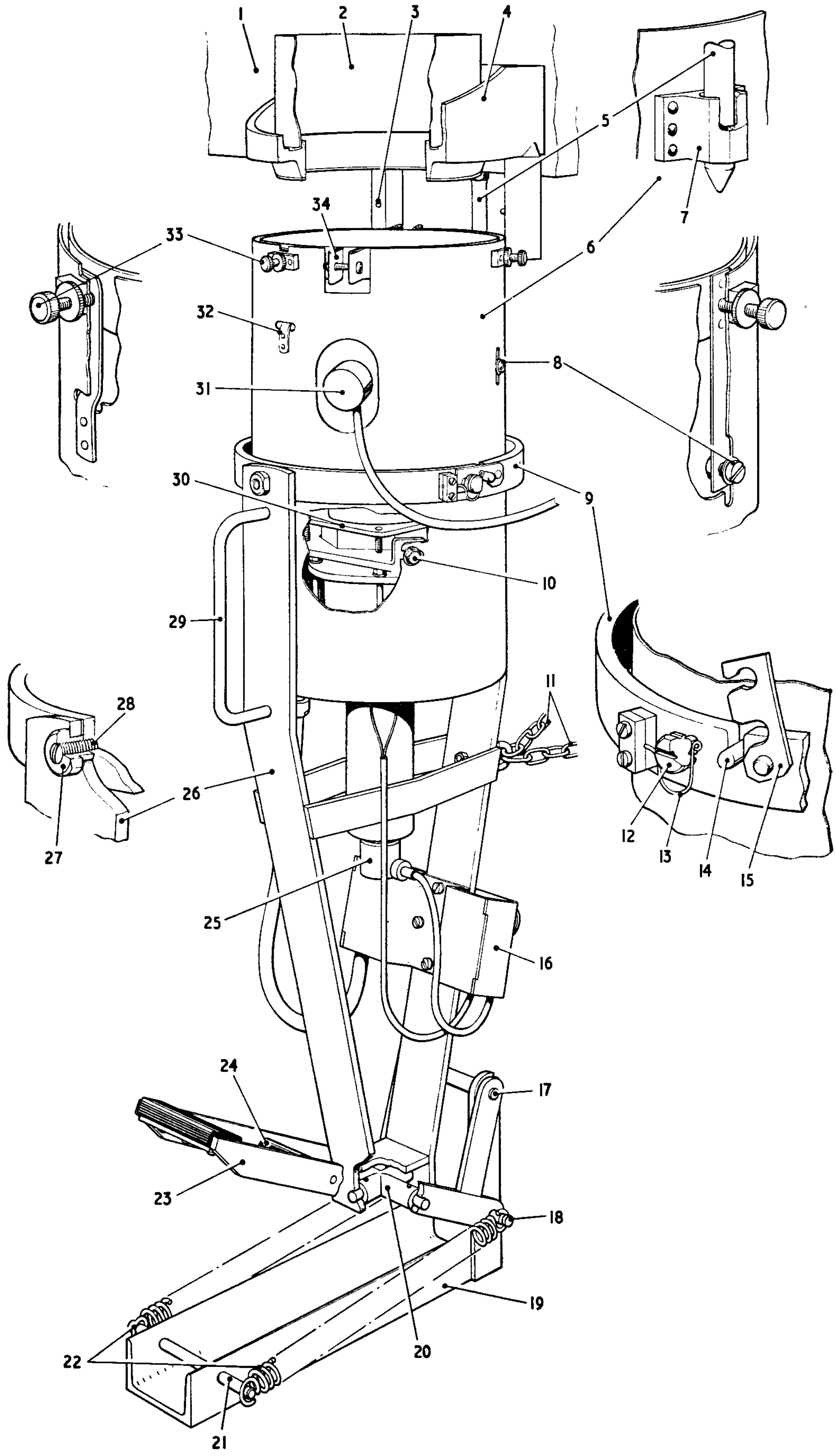

Fig. 2. Indicating unit (CRT) 4123 and mounting

pivot (17) which passes through holes in similar lugs on the foot pedal. Tension springs (22) load the assembly so that the face of the c.r.t. is pressed upwards against the tube casting (4).

General

12. When the indicating unit is in its normal operating position, the c.r.t. mounting tube is located by a spigot (5) which is fixed to the tube casting (4) and enters a hole in a locating lug (7) riveted to the mounting tube. Further location is proved by cast lugs on the tube casting (4) which contain spring-loaded plungers (3).

13. When it is required to swing the unit out from the projector console, the operator places a foot on the foot pedal, at the same time steadying the assembly by means of the handle (29) fixed to the yoke. Downward movement of the pedal causes the coupling block (20) to move to the rear as well as downwards owing to the position of the pedal pivot (17). This causes the gimbal ring to move about the pivots (14) and allows the mounting tube to move vertically downwards. When the lug (7) is clear of the spigot (5) the tube may be swung forward towards the operator to the limit allowed by the retaining chains (11). The foot pedal is then allowed to move gently upwards until the rubber-covered pin (24) reaches the front member of the yoke. Both the pedal and handle are then released.

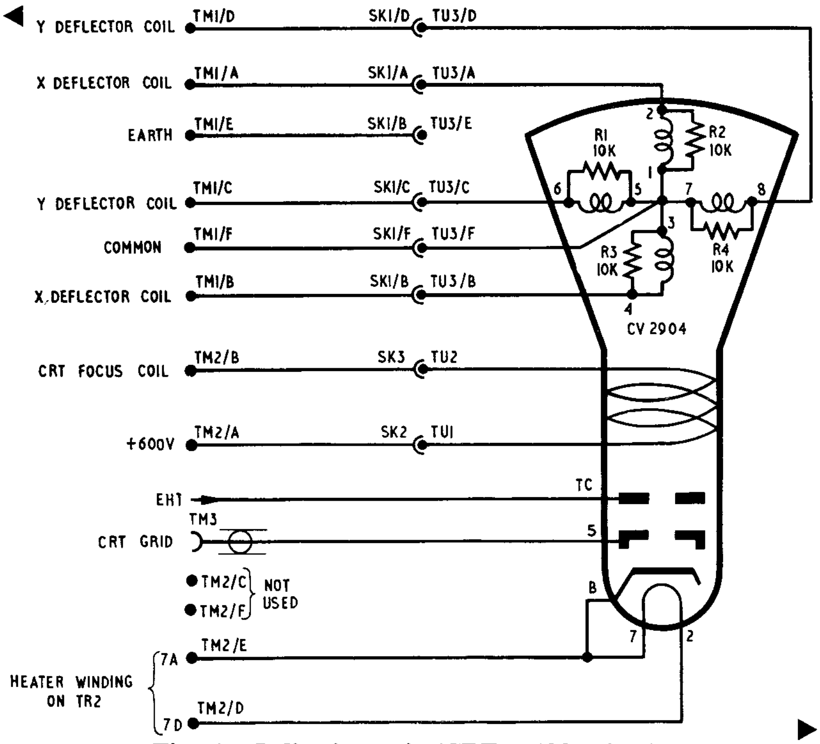

Fig. 4. Indicating unit (CRT) 4123: circuit

CIRCUIT DESCRIPTION

14. The e.h.t. connection to the c.r.t. anode is made direct from the high voltage output terminal of power unit 4122 (*Chap.* 6) to the anode cap of the c.r.t. The c.r.t. mounting tube contains a large clearance hole for the purpose. Other connections are made via the 6-pole plugs TM1 and TM2 and the coaxial socket TM3 mounted on a folded metal bracket fixed to the mounting framework. Details of these connections will be found in the interconnection diagram given in Sect. 1, Chap. 2.

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SECTION 3

CAMERA

Chapter I

GENERAL DESCRIPTION

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APPENDIX

LIST OF ILLUSTRATIONS

General

1. A front view of the upper portion of the projector console showing the main assemblies concerned with the camera system is given in fig. 1.

2. Light, from the c.r.t. display, passes through the camera lens which focuses it to a sharp image on the film held flat in the film gate by a clamping device. The film remains still in the gate for the

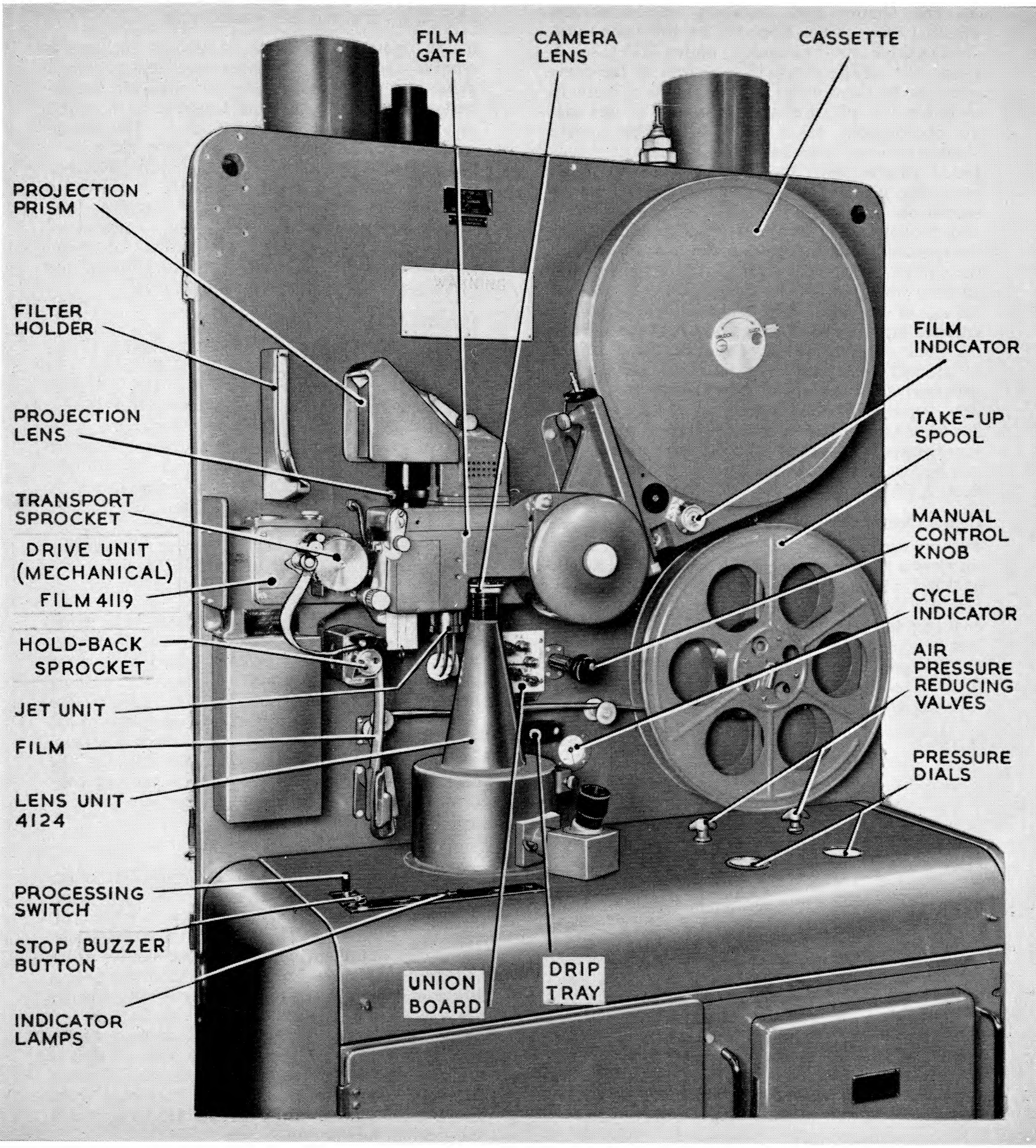

Fig. 1. Projector unit 100: upper front view

time required for the radar aerial to make one complete rotation and is then moved rapidly through a distance corresponding to ten film perforations to bring a new piece of unexposed film in position in the field of the lens. The transport of the film takes place at a time when a shutter, between the lens and the film, is closed so that no blurring of the image occurs.

3. The shutter and transport operations are initiated by switches operated by the main camshaft in drive unit (mechanical) timing 4118 (*Sect.* 4, *Chap.* 5). ◀The camshaft is driven at the same speed as the radar aerial and the shutter is made to close for 7·2° of camshaft rotation. The fact that no photography takes place while the camera shutter is closed makes little difference to the projected picture since the after-glow, from echoes occurring during the " blind " sector, starts to record on the film immediately the shutter opens and, though fading, continues to affect the film for the remaining 352·8 degrees of aerial rotation until the shutter closes again. It should be noted that an echo which occurs just before film transport, at the end of one rotation of the aerial, will be photographed later than one which occurs at the start of the same rotation. Because of this, the positions of aircraft represented on the final picture are progressively more out-of-date reading in a direction opposite to the rotation of the c.r.t. trace. Accurate interpretation of the picture is assisted if film transport occurs at a known bearing and this can be arranged by the setting up method given in Sect. 7, Chap. 1.▶

Camera lens

4. The camera lens used in this equipment has a maximum relative aperture of f/2 and a focal length of 2 in. The surfaces of the various glasses in the lens are bloomed. An iris diaphragm is fitted, enabling the relative aperture to be varied. The lens is screwed into a mount which forms part of the film gate and includes an arrangement for fine focusing of the image. A diagram showing the focusing and iris control rings is given in fig. 2.

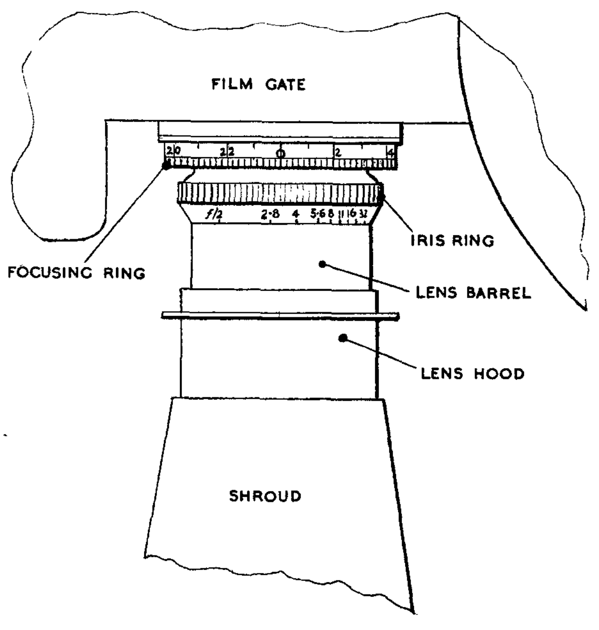

Fig. 2. Camera lens

5. The iris control ring is calibrated in " f/numbers " or " stops " (Appendix). When focusing the camera section the iris ring should be set to f/2, giving maximum " sensitivity " to the focus adjustment. At maximum relative aperture, the image on the film will be sharply defined only over the central area and will tend to become blurred at the edges. As the lens is stopped down (increasing f/number) the area of sharp definition spreads out until at f/4 it covers the whole frame.

6. In operation, the lens is used at the largest relative aperture which gives satisfactory overall definition. If a smaller stop were used, the brightness of the c.r.t. display would have to be increased to give a correctly exposed frame. This would result in an increase of the c.r.t. spot size with a consequent degradation of the definition obtained in the display. The iris ring is therefore set to f/4 and the c.r.t. brightness is adjusted until a satisfactory projected picture is obtained. If the aerial speed is decreased, giving a longer duration to the camera exposure, it is usual to turn down the brilliance rather than stop down the lens.

Lens unit 4124

7. The camera lens is situated at about 17 in. above the c.r.t. screen and some 2 in. below the plane of the film which is held flat in the film gate. The space between the lens and the screen is surrounded by a metal shroud whose purpose is to prevent the entry of extraneous light and ensure that the only light passing through the camera lens originates from the c.r.t. display. The shroud is fitted with an optical system for examination of the c.r.t. display in order to facilitate electrical setting up. The shroud, complete with the optical viewing system, is known as lens unit 4124 (*Chap.* 2).

Film gate

8. The film gate consists of two main castings which hinge together in book form. The film enters the gate through the hinge and passes over three circular apertures arranged in line; the spacing between adjacent apertures is equal to ten film perforations. The aperture at the entry end of the gate is immediately above the camera lens and allows the film to be exposed to the image of the c.r.t. display. The other two apertures are concerned with processing and projection (*Sect.* 4 *and* 5).

Camera shutter

9. The camera shutter is in the form of a hollow drum having a diametrical hole. When the drum is arranged so that the axis of this hole is vertical, the rays of light passing through the camera lens have a free path to the film. If the shutter drum is turned through 90° so that the axis of the hole is horizontal, light from the lens is cut off. Energy for the shutter operation is derived from a coil spring which is wound by a small induction motor. The supply to the motor is continuous so that it stalls when the spring is fully wound. During exposure periods, the spring is prevented from moving the shutter drum by a solenoid-operated escapement mechanism.

10. At an instant determined by the position of the main camshaft, the shutter solenoid is energized and the escapement allows the shutter to close.

The solenoid remains energized for 7·2° of camshaft rotation, after which the escapement mechanism allows the shutter to open.

Film clamping

11. The hinged cover of the gate contains two pressure pads which clamp the film over the camera and processing apertures. Between the pads is a V-shaped bar which crimps the film by forcing it into a V slot in the gate. Between the processing aperture and the projection aperture is another V slot which accepts the crimp put in by the crimping bar during the preceding exposure period. The crimps prevent light which spills from the projection aperture from travelling through the film while the pressure pads are lifted during film transport, and causing fogging at the processing and camera apertures.

Drive unit (mechanical) film 4119

12. This unit carries a 40-tooth film sprocket which is driven by a continuously running 24V d.c. motor via a clutch and gearbox. The clutch is engaged for a brief period, while the camera shutter is closed and the film clamps and crimper are lifted, by the action of a solenoid whose circuit is controlled by the main camshaft. When this

(*continued on next leaf*)

happens, the 40-tooth film sprocket on the gearbox output shaft turns through 90 degrees and the film is transported rapidly through a distance corresponding to ten film perforations; the transport operation takes approximately 1/25 sec.

Film cassette

13. The film cassette is mounted on the film gate and contains a spool of unexposed film. The cassette has capacity for 2,000 ft. of film, but is normally loaded with 1,000 ft. only; this is sufficient for 24 hours of continuous operation at a rate of four exposures per minute. The cassette is loaded with film in the darkroom and is fitted with a light-tight lid. The film emerges from the cassette via a light trap containing a system of rollers; this prevents it from fogging when the cassette is not in place on the equipment.

Film drive system

14. The film drive system includes the following:—

(1) The film feed sprocket which draws the film at constant speed from the cassette into a light-tight chamber at the end of the film gate.

(2) The tension sprocket (also in the chamber at the end of the film gate) which maintains the film in the gate at a suitable tension while allowing a free feed loop to build up between it and the feed sprocket during the exposure periods.

(3) The transport sprocket of drive unit (mechanical) film 4119 which moves the film rapidly through a distance corresponding to ten perforations during a closed period of the shutter.

(4) The take-up spool which provides a store for exposed film.

(5) The hold-back sprocket which smoothes out the intermittent movement of the film as it leaves the transport sprocket and allows it to enter the take-up spool at constant speed and tension.

15. The drive and hold-back sprockets and the take-up spool derive their motion from the main camshaft via a system of shafts and gearing which is mounted behind the front casting or mainplate of the projector. This system also drives the pointer of the processing cycle indicator. Provision is made for turning the mechanism by hand in order to facilitate film loading.

Electrical interlocks

16. The camera system includes parts of various circuits concerned with the fault warning system described in Sect. 6, Chap. 1. These are:—

(1) A micro-switch in the film cassette which closes when the supply of unexposed film falls to about 30 ft. This operates a warning lamp only.

(2) The film break switch which operates when the film tension sprocket is released by a free end of film passing over it. This operates a warning lamp and a relay. The relay contacts form part of an interlock circuit which shuts off the supply of chemicals to the processing aperture and gives continuous dry cycle conditions.

APPENDIX

PHOTOGRAPHIC NOTES

General

1. The purpose of this appendix is to provide a brief simple explanation of various photographic and optical terms to assist in an understanding of the camera section of the photographic display system.

Lens

2. A simple lens is a piece of glass bounded by two spherical surfaces. The line joining the centre of the two surfaces is known as the optical or principal axis. A camera lens, such as that used here, consists of several lenses mounted in a lens barrel. In such a system of lenses the centres of all the spherical surfaces involved lie on the same principal axis.

Bloomed or coated lenses

3. A bloomed lens is one which has its various glass surfaces coated with a film of some metallic fluoride by evaporation in an evacuated chamber. The purpose of this is to prevent the reflection of light from the surfaces causing losses in the brilliance and contrast of the image on the film. Bloomed surfaces should be treated very carefully though they are normally hard enough to withstand ordinary handling and cleaning provided that normal techniques are followed.

Focus and focal plane

4. Parallel rays of light (e.g., rays from a point on a very distant object) after passing through a lens intersect on a plane which is at right angles to the principal axis. This is known as the focal plane. The point at which the principal axis intersects the focal plane is known as the focus or focal point of the lens. From this it follows that any ray entering the lens in a direction parallel to the principal axis must pass through the focus.

Focal length

5. The focal length of a lens of negligible thickness is the distance between the lens and its focus. Where the thickness of the lens is considerable the focal length is measured from the focus to a point in the lens system which is not necessarily the centre or on any glass surface.

Focusing the image

6. When a photographic lens is placed at a suitable distance from a luminous object (more generally a well-lighted object) it forms an inverted image which may be received sharply on a plane at a determined distance from the lens. This can never be nearer to the lens than the focal plane which represents the nearest plane on which real images can be received, the object then being at an infinite distance away. As the object approaches the lens the image recedes. In a camera it is required to receive a sharp image on a fixed plane (i.e., the plane of the film) of an object whose position is also fixed. Thus, in order to satisfy the required relationship between object and image distances it is necessary to move the lens relative to the film; this operation is known as focusing.

Iris diaphragm

7. An iris diaphragm is a mechanical device consisting of a series of curved leaves arranged in such a manner that they form a flat disc with a central circular hole. The diaphragm is situated within the lens barrel between two of the lens elements so that it restricts the effective diameter of the light beam passing through the lens. The positions of the leaves relative to one another can be varied (thus varying the size of the central hole) by means of the iris ring which surrounds the lens barrel.

Effective aperture

8. The effective aperture of a diaphragm is the diameter before entering the lens of the beam of light rays parallel to the principal axis which just fills the hole in the diaphragm. This is evidently not the diameter of the diaphragm hole itself since the light beam has to pass through some lens elements before reaching it. However, if the real diameter of the diaphragm hole is varied, the effective aperture varies proportionally.

Relative aperture, f/number or stop

9. The relative aperture of a diaphragm is the effective aperture expressed as a fraction of the focal length of the lens. For example:—

The camera lens used in the photographic display system has a focal length of 2 in. and a maximum effective aperture of 1 in., giving a maximum relative aperture of $2/1=2$; this is usually written as f/2. If the iris ring is adjusted until the effective aperture becomes $\frac{1}{4}$ in., then the relative aperture becomes $2/\frac{1}{4}=f/8$.

Effects of varying f/number

10. The brightness of the image obtained on the film depends on the area of the effective aperture which is in turn proportional to the square of the effective aperture. Thus, the brightness of the image is inversely proportional to the square of the relative aperture or f/number. For the sake of convenience, it is usual to calibrate the iris ring of a lens in a series of steps such that each step gives half the image brightness of the one before it, e.g., f/2, 2·8, 4, 5·6, 8, 11, 16, 22.

11. Most lenses when used at full aperture give an acceptable standard of definition only in the central area of the image due to various optical defects too numerous to mention here. The area of sharp definition increases with f/number and usually covers the whole image area two stops down from the maximum (f/4 for this equipment).

12. The degree of blurring obtained in the image in the film plane for a given movement of the lens from its correctly focused position is greater at large relative apertures than at small ones. For this reason the response obtained is "flat" when focusing at small apertures, and some observers find it difficult to determine the correct setting. It is usual to perform the focusing operation at the largest possible relative aperture and then to stop down in order to satisfy requirements of definition and exposure.

Exposure

13. The term exposure means the quantity of light which is allowed to reach the film. It depends both on the strength of the light and the time for which it lasts. In the photographic display system, the exposure time is fixed by the speed of rotation of the radar aerial, and the only factors which can affect exposure therefore are the relative aperture to which the lens is set and the brightness of the CRT display.

Fogging

14. Fogging is the term applied to the effect of stray light reaching the sensitive surface of the film emulsion.

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Chapter 2

LENS UNIT 4124

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LIST OF ILLUSTRATIONS

INTRODUCTION

1. Lens unit 4124 consists mainly of a light-tight shroud extending from the film gate to the main deck of the projector console. Its purpose is to prevent extraneous light from entering the camera lens causing a general fogging of the film, or striking the face of the CRT, causing degeneration in the contrast of the display.

2. The lens unit incorporates an optical system involving a magnifying lens and a scanning mirror. By this means, an element of the CRT face some 2 in. in diameter may be viewed with a magnification of about six times. The use of the scanning mirror enables this element to be moved along a diameter of the tube face. A direct viewing aperture is also provided.

DESCRIPTION

General

3. A general view of lens unit 4124 is given in fig. 1. The eyepiece of the optical system and the scanning mirror are mounted on the shroud which is fabricated from two parts, one cylindrical and the other conical. The eyepiece assembly is bolted on to one side of the cylindrical portion of the shroud. A peep hole, which has a spring-loaded cover, is included in the upper face of the cylindrical portion to enable the CRT face to be viewed directly when setting up the display.

4. The upper extremity of the conical section contains an extension piece known as the lens hood; this carries a male screw thread. The lens hood slides in a felt sleeve stuck to the shroud, so allowing the hood to be screwed up to the camera lens barrel but maintaining the assembly light tight.

5. A schematic diagram of the lens unit is given in fig. 2.

6. Light, from a 2 in. diameter element of the tube face, strikes the scanning mirror and is reflected from it to the eyepiece. After passing through the objective lens, it suffers a further reflection at the eyepiece mirror and passes through the eyepiece lens to the eye of the observer.

Scanning mirror

7. The scanning mirror consists of a piece of surface-aluminized plate glass which turns in a cradle about an axis inclined at approximately 36 degrees to the vertical. A bracket, fixed to the back of the mirror cradle, is pressed against a pointed screw by the action of a coil spring round the mirror shaft. The screw turns in a tapped block and is coupled by a flexible shaft to the scanning knob which is mounted adjacent to the eyepiece. The scanning knob extends into a screw thread which also turns in a tapped block bolted to the shroud. Rotation of the scanning knob thus drives the pointed screw against the mirror bracket and turns the mirror about its inclined axis; the position of the mirror then determines the position of the viewed element of the CRT screen.

8. A stop screw projects into an undercut portion of the scanning knob and limits the extremes of mirror movement.

Eyepiece

9. The housing for the various components of the eyepiece consists of a mirror box which extends into a short tube terminating in a mounting flange fixed to the side of the shroud. A further short tube extends beyond the flange towards the centre of the shroud; this is the mounting tube for the objective lens. The inner end of the mounting tube is normally closed by a spring-loaded cover operated by a trigger control accessible to the observer at the side of the eyepiece. The purpose of this cover is to prevent extraneous light from passing through the eyepiece system and being thrown via the scanning mirror on to the tube face.

Objective lens

10. The objective lens causes an image of the viewed element of the CRT face to be formed at the focal plane of the eyepiece lens. It consists of two cemented elements of differing types of glass. The purpose of this is to apply colour correction to the eyepiece system and so prevent the appearance of multi-coloured blurring at the edges of the image seen by the observer.

Fig. 1. General view

Eyepiece mirror

11. The eye-piece mirror is a piece of surface-aluminized plate glass mounted in a sheet brass cradle. One edge of the cradle is turned up to form a fixing flange. The fixing flange has two elongated holes through which pass screws into hank bushes in the side of the mirror box. This method of fixing allows adjustments to be made to the mirror position during the final assembly of the lens unit. The opposite side of the mirror box carries a removable cover plate giving access to the mirror assembly.

Eyepiece lens

12. The eyepiece lens is screwed into a mounting on top of the mirror box. The focal length of this lens can be altered slightly by rotation of the milled ring surrounding the lens mount. For an observer with normal eyesight, the focus is arranged so that the image formed by the objective lens lies exactly in the focal plane of the eyepiece lens; the observer then sees a sharp magnified version of this image.

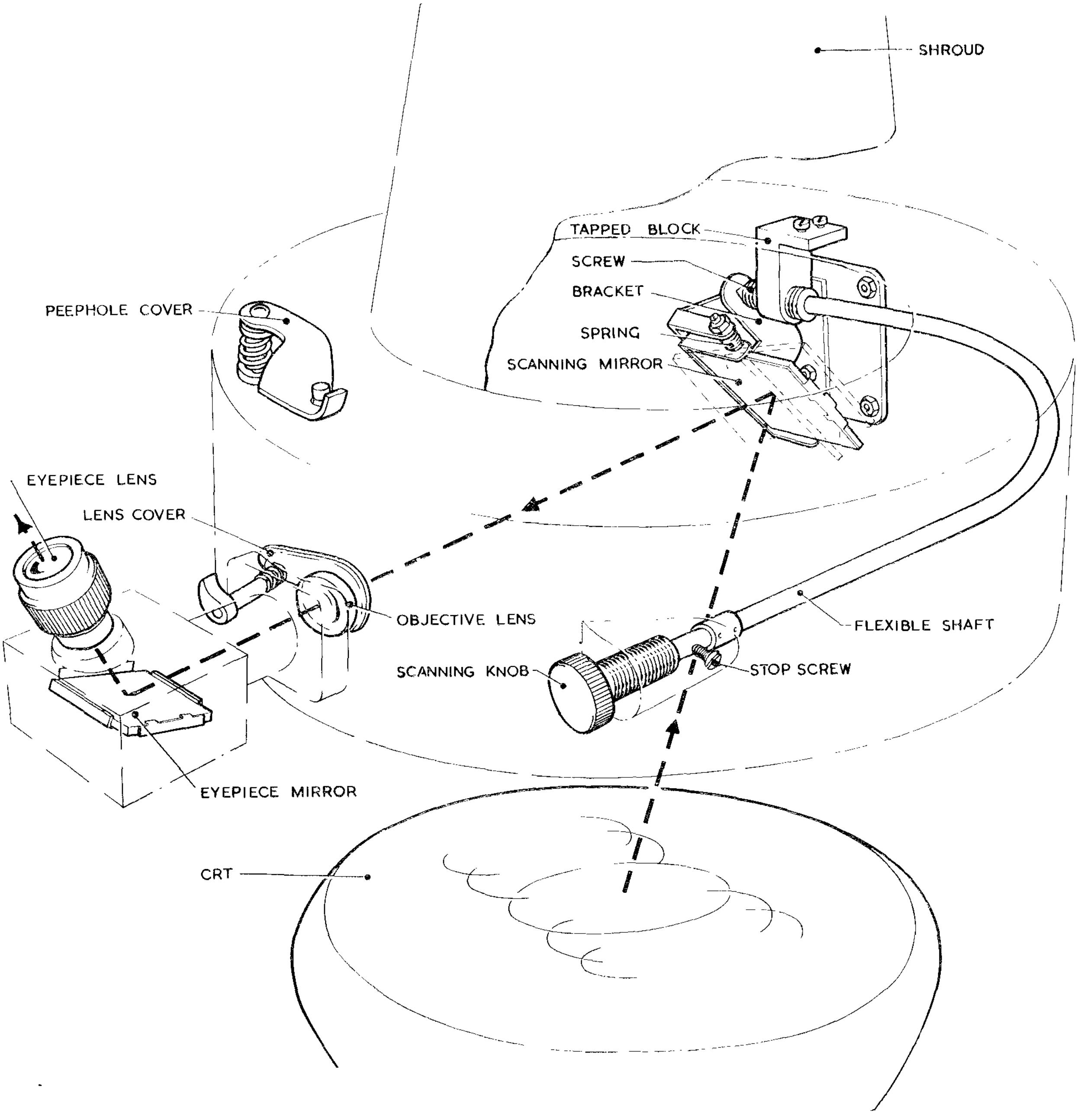

Fig. 2. Schematic diagram

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Chapter 3

FILM GATE

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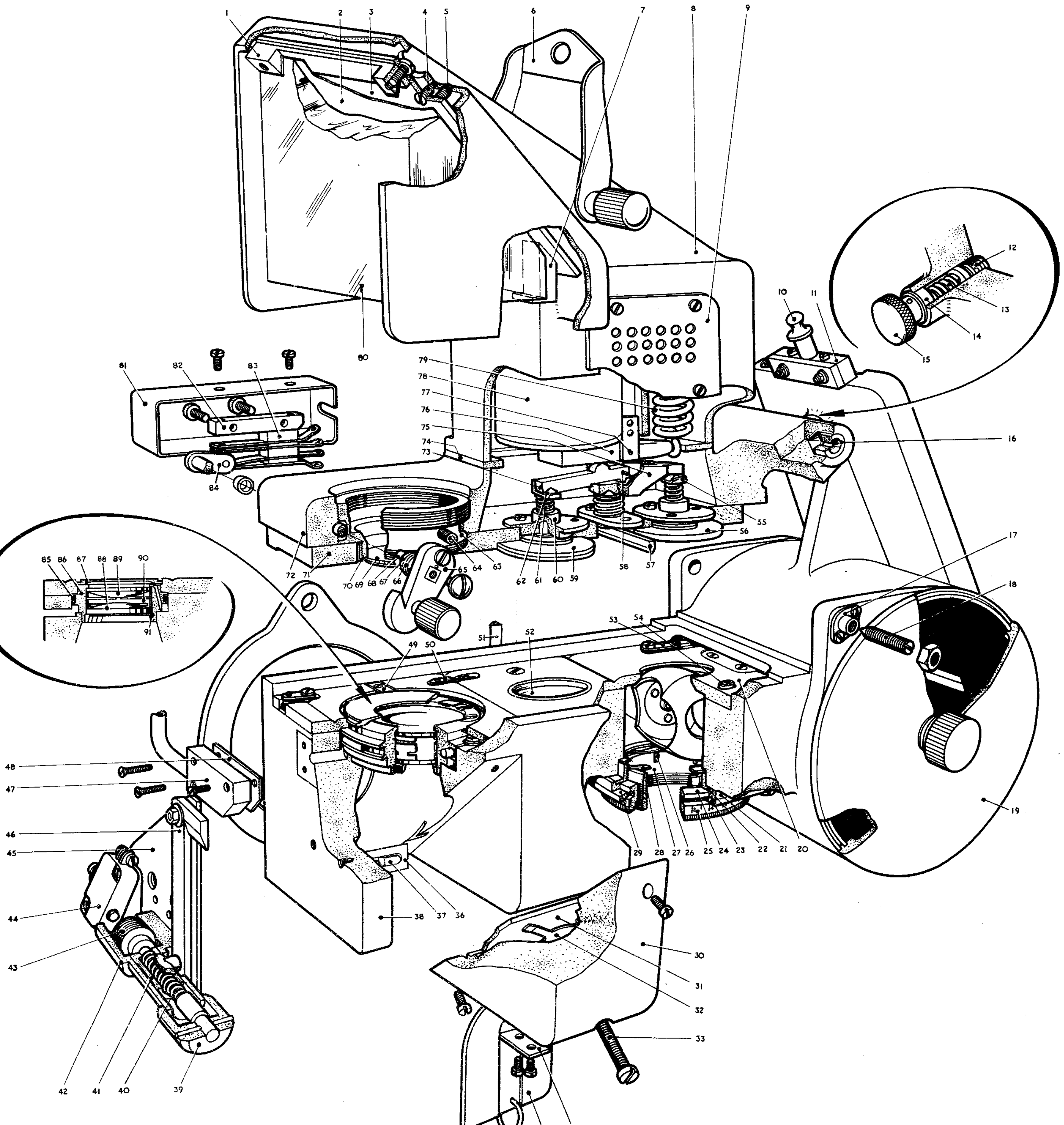

AIR DIAGRAM 6151D/MIN.	RADAR PHOTOGRAPHIC DISPLAY SYSTEM 1498
ISSUE 1 — PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY	

Film gate

Fig. 1

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KEY TO FIG. 1 (FILM GATE)

1 PRISM MOUNTING BLOCK
2 PRISM BACKING SHEET
3 MOUNTING PLATE
4 ADJUSTING SCREWS
5 LOCK SCREWS
6 GATE HOOK
7 PRISM SECURING BLOCKS
8 PRISM MOUNT
9 COVER PLATE
10 PILLAR
11 CONTACT BLOCK
12 CASSETTE SECURING SCREW
13 SPRING
14 BUSH
15 KNOB
16 HINGE BEARINGS
17 BUSHES
18 HINGE PINS
19 COVER
20 LOWER TABLE
21 RETAINING PLATE
22 BUSH
23 WASHER
24 FOCUSING RING
25 FOCUSING BAND
26 LOCATING PIN
27 SLEEVE
28 SPRING
29 RETAINING PLATE
30 MIRROR BOX COVER
31 MIRROR
32 SPRING SPIDER
33 PRESSURE SCREW
34 STOP
35 LIGHT SHUTTER
36 BLOCK
37 LEAF SPRING
38 GATE CASTING
39 GATE CLAMP KNOB
40 PRESSURE SPRING
41 SLEEVE
42 GATE CLAMP HOUSING
43 GATE CLAMP SCREW
44 MICRO SWITCH
45 MOUNTING PLATE
46 GATE CLAMP ARM
47 AIR PIPE ATTACHMENT (HIGH PRESSURE)
48 GASKET
49 CLAMP PLATES
50 GATE SWITCH CONTACT
51 AIR PIPE (LOW PRESSURE)
52 PROCESSING POT
53 SPRING LOADED ROLLERS
54 REGISTRATION PADS
55 FILM CLAMP SPINDLE (CAMERA)
56 PRESSURE PAD (CAMERA)
57 CRIMPER BAR
58 RETAINING PIN
59 PRESSURE PAD (PROCESSING)
60 BUSHES
61 RETURN SPRINGS
62 FILM CLAMP SPINDLE (PROCESSING)
63 PROJECTION LENS MOUNT
64 GRUB SCREW
65 GATE CATCH
66 SPRING
67 SLEEVE
68 SPINDLE
69 BLOOMED GLASS DISC
70 CLAMP RING
71 UPPER TABLE
72 GATE COVER CASTING
73 PROCESSING PRESSURE BAR
74 MOUNTING PLATE
75 CAMERA PRESSURE BAR
76 ARMATURE
77 SPINDLE
78 FILM CLAMP SOLENOID
79 SPRING
80 PROJECTION PRISM
81 SWITCH COVER
82 MOUNTING BLOCK
83 GATE LOCK SWITCH
84 SWITCH ARM
85 RUBBER SEALING RING
86 CONDENSER LENS CELL
87 APERTURE PLATE
88 No. 6 CONDENSER LENS
89 No. 7 CONDENSER LENS
90 SPACER
91 LOCKING RING

RESTRICTED

General

1. The film gate consists of two main castings hinged together at one end; these are known as the gate and the gate cover. A schematic diagram of the film gate is given in fig. 1. In this, the cover is shown lifted a few inches above the gate for the sake of clarity. A view of the film gate in its operational condition can be seen in Chapter 1, fig. 1.

2. The upper surface of the gate and the lower surface of the gate cover are faced with slabs of a special black Bakelite which suitably withstands the action of the various processing fluids, while its matt black finish prevents light from travelling through the film gate by reflection. The Bakelite slabs are known as the upper and lower tables (71) and (20). The film passes between the tables in a clearance space provided by a shallow depression in the upper table. A switch, consisting of a contact (50) in the lower table and a similar contact in the upper table, opens when the gate cover is hinged up and breaks the processing interlock circuit (*Sect.* 6, *Chap.* 1).

3. At the right-hand end of the gate is a light-tight chamber which contains the film feed and tension sprockets described in Chapter 6 and carries a mounting for the film cassette (*Chap.* 5). The front of the chamber is closed by a light-tight lid (19) secured by a central bolt.

4. The gate casting contains three vertical circular apertures arranged with their axes on the centre line of the film track. These are:—

(1) The camera aperture which allows the film to be exposed to the image of the CRT display formed by the camera lens.

(2) The processing aperture which contains the processing pot and jet unit (*Sect.* 4, *Chap.* 2).

(3) The projection aperture which allows the beam of light from the lamp house (*Sect.* 5, *Chap.* 3) to pass through the film and then through the projection lens.

5. Lateral registration of the film is provided by a system of nylon pads (54) and spring-loaded nylon rollers (53) at each end of the lower table. Longitudinal registration is controlled by a corrector mechanism in drive unit (mechanical) film 4119.

6. The gate cover contains the film clamping and crimping mechanism, the projection lens mount and the projection prism.

MECHANICAL DESCRIPTION

Camera aperture

Camera lens mount (fig. 1)

7. The circular vertical hole in the gate casting which allows the passage of light through the camera system is counterbored at its lower end forming a shoulder on which seats a washer (23). The washer is secured by a stainless steel bush (22). The bush is held in position by a square retaining plate (21) which has a circular central hole counterbored to fit the flange of the bush.

8. Into the bush (22) fits a sleeve (27) which carries internal and external threads at its lower end. The sleeve is prevented from rotating by a locating pin (26) which engages one of six vertical slots symmetrically arranged around its upper edge but it is free to move vertically in the bush (22).

9. The external screw thread of the sleeve (27) is engaged by the internal thread of the focusing ring (24). The focusing ring is held by a square retaining plate (29) having a central circular hole which fits an annular slot in the outer surface of the focusing ring and is split to allow it to be fitted.

10. The assembly is held to the gate casting by four screws which pass through holes at the corners of the retaining plates (21) and (29). It can be seen that, since the focusing ring is prevented from moving vertically by the retaining plate (29), and the sleeve (27) is prevented from rotating by the locating pin (26), rotation of the focusing ring causes vertical movement of the sleeve and hence of the camera lens (*Chap.* 1), which is screwed firmly into the internal thread of the sleeve. Backlash between the various items of the assembly is prevented by a crimped spring (28) between the washer (23) and the top of the sleeve (27).

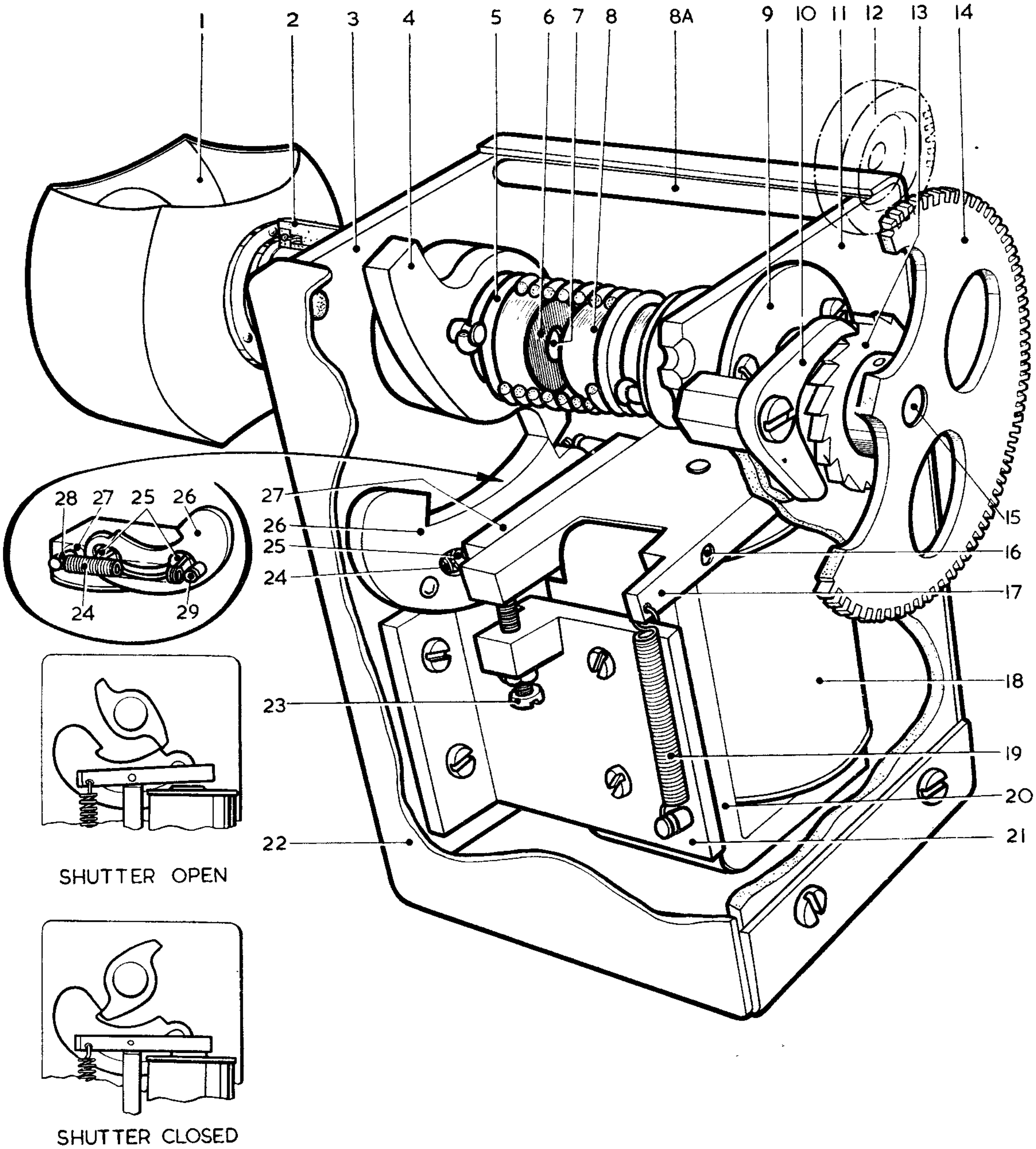
11. The focusing band (25) consists of a strip of black anodized aluminium which is wrapped round the focusing ring and whose ends are secured by studs which screw into the focusing ring. As well as securing the focusing band, the studs engage a stop pin which projects vertically from the retaining plate (29), thus restricting the range of movement of the focusing ring to slightly less than one complete turn. Twelve tapped holes are provided in the focusing ring for the attachment of the band, enabling the studs to be placed so that the position of correct focus for a sample lens is at the centre of the total range of movement. The focusing band carries a scale of twenty-four engraved divisions, which may be read against an index mark on the retaining plate (29); a movement of one division alters the vertical position of the lens by approximately 0·001 in.

12. When a new lens is fitted and screwed fully home into the sleeve (27), it may be found that the scale of stops on the iris ring reaches a position such that it cannot be read by the observer. This may be corrected by arranging the sleeve (27) so that the locating pin (26) engages a different slot, thus bringing the iris ring of the lens to a convenient position. Since this will have the effect of rotating the focusing ring also, it will then be necessary to alter the position of the focusing band (25), by screwing the securing studs into different holes in the focusing ring (24), in order to bring the position of correct focus back to the centre of the available movement.

Shutter and drive (fig. 2)

13. A diagram showing the construction of the shutter and drive mechanism is given in fig. 2.

14. The shutter drum (1) is made of magnesium alloy (chromated to give it a black finish) and is of a very light construction, having walls which are only 0·010 in. thick. The drum is riveted to a flange at the end of the shaft (7), which is carried



1 SHUTTER DRUM
2 BEARING HOUSING
3 FRONT PLATE
4 RELEASE ARM
5 DRIVE SPRING
6 NUT
7 SHUTTER SHAFT
8 SLEEVE
8A PILLARS
9 BEARING HOUSING
10 PAWL
11 BACK PLATE
12 MOTOR PINION
13 RATCHET WHEEL
14 GEAR WHEEL
15 DRIVE SHAFT
16 ARMATURE SPINDLE
17 ARMATURE
18 SHUTTER SOLENOID
19 TENSION SPRING
20 MOUNTING
21 MOUNTING
22 COVER
23 STOP SCREW
24 OVERRIDE SPRING
25 SCREWS
26 PALLET
27 ARMATURE
28 ANCHOR STUD
29 ANCHOR STUD

Fig. 2. Shutter and drive

in bearings in the bearing housing (2) mounted on the front plate (3). The front plate is spaced from the back plate (11) by pillars (8A); a cover (22) encloses the sides and bottom of the space between the plates.

15. A second shaft (15), whose axis is in line with the shaft (7), is carried in bearings in the bearing housing (9) which is mounted on the rear plate (11). The shaft (15) carries a gear wheel (14) and a ratchet wheel (13) engaged by a pawl (10). The gear wheel (14) meshes with a pinion (12) which is fixed to the shaft of a small squirrel cage motor mounted on the front of the projector mainplate behind the film gate. On the inner end of the shaft (15) is a fixed sleeve (8) carrying a coil spring (5) which is anchored to the sleeve at one end. The other end of the spring is located by a nut (6) on the inner end of the shaft (7), and is anchored by a pin on the release arm (4) which is fixed to the shaft (7).

16. The shutter motor drives the shaft (15) via the pinion (12) and the gear wheel (14). The shaft (7), however, cannot rotate since the release arm (4) is engaged by the leading tooth of the pallet (26) and energy becomes stored in the spring (5). When the spring is fully wound, the motor stalls; a series resistor in the motor circuit (*fig.* 3) prevents overheating in the stalled condition.

17. The pallet is mounted on an armature (17) which is pivoted on a spindle (16). Movement of the pallet and the consequent action of the release arm (4) is controlled by a solenoid (18) which is energized at the required times via contacts in drive unit (mechanical) timing 4118 (*Sect.* 4, *Chap.* 5).

18. The details of the pallet and armature are shown in an inset diagram in fig. 2. The pallet contains a curved slot through which pass two screws (25) securing it to the armature (27). The arrangement allows a small amount of movement of the pallet relative to the armature against the tension of an override spring (24) which is tensioned between an anchor stud (28) on the armature and another anchor stud (29) on the pallet. The purpose of this is to absorb shock when the release arm strikes either of the pallet teeth.

19. The states of the mechanism corresponding to the two conditions of the shutter are shown in inset diagrams in fig. 2. The viewpoint in these diagrams is from the rear.

20. In the shutter open condition, the solenoid is not energized and the armature is held to its counter-clockwise limit by the action of the spring (19). The release arm (4) is prevented from moving under the action of the drive spring (5) by the leading tooth of the pallet which engages one of its ends.

21. When the solenoid is energized, the right-hand end of the armature (17) is drawn down; this has the effect of rotating the armature and pallet a small amount in a clockwise direction about the spindle (16). The leading tooth of the pallet falls, releasing the end of the release arm; the trailing tooth rises and catches the end of the release arm after the shutter drum has turned through 90 deg.

22. The opening of the contacts in drive unit (mechanical) timing 4118 releases the armature (17), which returns to its counter-clockwise limit. The trailing tooth of the pallet falls, releasing the end of the release arm; the leading tooth rises and catches the other end of the release arm after the shutter drum has turned through a further 90 deg.

23. Each time the shutter drum rotates, the resulting decrease in tension of the drive spring (5) is made up again by rotation of the shutter motor, which stalls again immediately the spring is fully wound. The ratchet wheel (13) and the pawl (10) hold the mechanism in this condition when the equipment is switched off and current is removed from the shutter motor. This is to prevent the drive spring from unwinding, with the possibility of the spring becoming detached from its anchor studs.

24. The only adjustment possible in the shutter and drive mechanism is that of the stop screw (23). The purpose of this is to fix the released position of the armature to be such that the release arm is satisfactorily caught on the leading tooth of the pallet.

25. The complete assembly is mounted on the rear of the gate casting by means of three screws which pass through the front plate (3). The shutter drum then takes up a position in the camera aperture as seen in fig. 1.

Processing aperture (*fig. 1*)

26. The processing aperture contains the processing pot (52), which, in turn, contains the jet unit (*Sect.* 4, *Chap.* 2). The pot is secured into the gate by two grub screws in such a position that its upper edge is flush with the surface of the lower table. The upper end of the pot is of slightly less external diameter than the aperture in the lower table. Air, at approximately 5 lb./sq. in., is admitted to the annular space so formed via the air entry (51) and a drilling in the gate casting. The purpose of this is as follows:—

(1) To prevent processing fluids from seeping out between the upper edge of the pot and the film, so giving a ragged edge to the processed area.

(2) To ensure that the film is lifted from the edge of the pot immediately the pad (59) rises in order to prevent the slightly damp, swollen emulsion from being torn off the film during transport.

Projection aperture (*fig. 1*)

Mirror box

27. A hollow, conical projection at the rear, left-hand end of the gate terminates in a flange which bolts to the projector mainplate. The flange is counterbored to locate a ring in the mainplate; the lamp house casting (*Sect.* 5, *Chap.* 3) locates at the rear of this ring, ensuring correct alignment between it and the gate. The adjustable mount for No. 5 condenser lens in the lamp house projects through the ring into the conical section of the gate.

28. The two final lenses in the lamp condenser system are mounted in the film gate at the top of a vertical conical bore whose axis intersects that of the conical section, described in the preceding paragraph, at right angles. The lower front corner of the gate casting is machined away at 45 deg. so that a seating is formed whose plane touches the point of intersection. A polished aluminium mirror (31) locates on this seating; this turns the beam of light from the lamp house through 90 deg. and directs it vertically through the projection aperture.

29. The mirror is housed in the mirror box cover (30). This is an aluminium alloy casting whose face is cut away to provide clearance for the mirror and the spring spider (32). The mirror box cover is secured to the gate by screws at its upper and rear edges; a long screw (33), passing through the centre of the cover, locates the centre of the spider (32), which presses the mirror firmly against its locating face on the gate casting.

Note . . .
When the mirror is removed from the gate, the screw (33) should be taken out first and then the four screws holding the mirror box cover (30) to the gate in order to prevent the mirror from leaving the cover as it is drawn away.

30. The mirror box cover casting is cut away to provide clearance for a shutter (35) and a block (36); the gate casting is slotted to provide clearance for the shutter. The shutter is chromium plated to minimize heat absorption, and its purpose is to enable the light from the projection lamp to be cut off when it is required to open the film gate without extinguishing the lamp. A leaf spring (37) mounted on the block (36) presses against the shutter, providing sufficient friction to hold it shut. When in the open position the shutter is prevented from falling out of the gate by a stop (34).

Condenser assembly (fig. 1)

31. The upper end of the projection aperture in the gate is counterbored to accept the lens cell (86), which contains lenses No. 6 and No. 7 of the projection light condenser system (*Sect.* 5, *Chap.* 3). A section through this part of the assembly is given in an inset diagram in fig. 1.

32. The two condenser lenses (88) and (89) are separated by a spacer (90) and are retained in the lens cell (86) by an internal lip at the top and a screwed locking ring (91) at the bottom. The cylindrical surface of the spacer (90) is slotted in order to make it slightly "spongy," thus allowing for the expansion of the lenses under heat.

33. The external diameter of the lens cell (86) is reduced at the bottom, forming a shoulder which seats on the counterbore in the gate casting, leaving an annular space round the cell; above this space, a seal is provided by a rubber ring (85) which is trapped between two parallel external flanges round the cell. Air, at approximately 25 lb./sq. in., is admitted to this annular space via the air pipe attachment (47), and a drilling in the gate casting; a gasket (48) is included between the air pipe attachment and the gate to prevent air leakage.

34. The lens cell is retained in the gate casting by two diametrically opposite cheese-headed screws with washers so arranged that the washers slightly overlap the edges of the upper retaining flange for the rubber air seal. The lower table is cut away to clear the heads of the screws and is bored to fit the top section of the lens cell. This bore in the table is counterbored slightly to accept the aperture plate (87), which is retained by diametrically opposite clamp plates (49). The purpose of the aperture plate is to determine the shape of the projected picture.

35. Air from the annulus round the lower part of the lens cell passes through three drilled holes to three exits in the inner surface of the cell just above the final condenser lens (89). The exits are at approximately $\frac{1}{2}$ in. spacing; the route of the centre air passage can be seen in the inset section diagram of the cell. The high pressure air, emerging from these exits, passes through the aperture plate and blows along the undersurface of the film. It has two purposes:—

(1) To keep the surface of the film cool and prevent the emulsion from melting or burning in the heat from the lamp.

(2) To blow the film upwards against the bloomed glass (69) in the gate cover (*para.* 44), thus keeping it flat and at right angles to the axis of the projection lens.

Film clamping and crimping mechanism *(fig. 1)*

36. This mechanism is housed in the gate cover. It consists of two circular pressure pads (56) and (59) and a crimper bar (57) which are pressed down by the action of a powerful spring (79) via a system of levers. The action of the spring is cancelled by that of a solenoid (78) which operates in synchronism with the camera shutter solenoid (*para.* 17), allowing the pressure pads and crimper to lift under the action of return springs (61).

37. The pressure pads and crimper are mounted in flanged bearing bushes (60), which are secured to the upper table (71); the table is bored to allow the bushes to pass through, and the underface is counterbored to provide housings for the pads (56) and (59) and slotted to provide a housing for the crimper (57). The pressure pad spindles (55) and (62) are screwed into blind holes in the pads and carry knife edges at their upper ends for locating the processing pressure bar (73) and the camera pressure bar (75). The crimper spindle is similarly screwed into the crimper (57) and terminates at its upper end in a conical point which locates a conical recess in the underside of the camera pressure bar. The return springs (61) are retained between the bearing bushes (60) and washers at the upper ends of the spindles.

38. The solenoid and its mechanism are mounted on a plate (74) which is screwed to a machined face on the gate cover casting; this plate has clearance holes for the screws which secure the prism mount (8). The plate has a large central slot to allow operating clearance for the armature (76) and the spring (79).

39. When the solenoid is energized, the armature pivots about the spindle (77), offsetting the action of the spring (79) and removing the load from the pads and crimper. These lift under the action of the springs (61) and allow freedom to the film during transport.

40. When current is cut off in the solenoid, the spring (79) causes the armature (76) to pivot about the spindle (77), applying a load of approximately 24 lb. to the point of contact with the processing pressure bar (73), with the following results:—

(1) The bar (73) rotates about the knife edge (62), applying a load to the bar (75), which, in turn, rotates about the knife edge (55), driving the crimper down under a load of 20 lb.

(2) The bar (73), rotating about its point of contact with the bar (75), drives the processing pressure pad down under a load of 3 lb.

(3) The bar (75), now loaded at the point of contact between it and the bar (73), rotates about the crimper spindle point and drives the camera pressure pad down under a load of 1 lb.

41. The intermittent action of the mechanism causes a tendency for the pressure bars to become unseated from the knife edges and crimper spindle point. In order to prevent this, the processing pressure bar contains a tightly fitting pin (58) which projects through oversize holes in the vertical flanges of the camera pressure bar. It should be noted that this pin is for retaining purposes only and it plays no part in the operation of the mechanism.

42. The processing pressure pad (59) is made of inconel to resist the action of any processing fluid which may come in contact with it; it is faced with a pad of synthetic rubber to ensure an effective seal at the processing pot. The camera pad (56) is made of aluminium alloy. The crimper bar (57) is composed of stainless steel. The reason for this is that it may be necessary to stone the edge slightly when fitting a new crimper in order to achieve a satisfactory crimp without danger of cutting the film. The lower table contains V slots in its surface to accommodate the film crimps.

43. The prism mount (8) carries a cover plate (9) giving access to the clamping and crimping mechanism for routine lubrication. The cover is perforated to assist the removal of heat from the solenoid when the equipment is used for the re-projection of an already processed film, since under these conditions the solenoid is permanently energized.

Projection lens mount *(fig. 1)*

44. The projection lens mount (63) is screwed into the gate cover casting above the projection aperture. The mount is threaded internally to accept the focusing mount of the projection lens (*Sect.* 5, *Chap.* 3). The lower edge of the mount carries an accurately machined face against which locates the upper face of a glass disc (69). This disc is optically worked and is bloomed (*Chap.* 1, *Appendix*) on both faces.

45. The bloomed glass disc is held in position by a clamp ring (70) which screws on to an external thread at the lower end of the lens mount and has an internal bevelled lip which locates the lower bevelled edge of the glass; the lower surface of the glass thus projects below the lower surface of the clamp ring. When the lens mount is assembled to the gate cover, it is screwed down until the surface of the bloomed glass disc is exactly flush with the lower surface of the upper table and is then locked in this position by a grub screw (64) which passes horizontally through the gate cover casting and engages the outer surface of the mount.

Gate lock *(fig. 1)*

46. The gate lock is mounted on a spindle (68) which passes through a hole in the gate cover casting. The outer surface of the projection lens mount (63) contains an annular groove which gives clearance for this spindle. The gate catch (65) has a square hole locking it to the squared end of the spindle, which is drilled and tapped for a fixing screw. The hole through the cover casting is counterbored at the front end to allow clearance for the spring (66) which fits over a sleeve (67) on the shaft (68). One end of the spring is retained in a hole in the gate catch (65), and the other in a hole in the gate cover casting; the spring is wound in such a direction that it resists clockwise rotation of the shaft. The catch (65) is fitted with a knurled finger knob. The amount of movement of the catch is restricted by a stop screw whose inner end projects into a recess in the cover casting.

47. The inner end of the spindle (68) carries an arm (84) bearing a screw with an insulating collar which operates the switch (83). The switch is made up from leaf contacts and insulating spacers mounted on a block (82) which is screwed to the rear of the gate cover casting. Rotation of the gate catch in a clockwise direction thus closes the lower pair of contacts and opens the upper pair. The switch is enclosed by a cover (81) which is screwed to the block (82).

Gate clamp *(fig. 1)*

48. The gate clamp mechanism is built on a mounting plate (45) which is bolted to the gate casting. The clamp arm (46) is in the form of a cranked lever whose shorter leg engages the catch (65) after this has been turned to its clockwise limit. In order to achieve this, the long leg of the clamp arm is moved to the rear by the action of a screw (43) which turns in a threaded housing (42). The screw extends into a spindle which carries a knurled operating knob (39). The housing (42) contains a sleeve (41) carrying a pin which projects through a slot in the housing and engages a hole in the longer leg of the clamp arm. Motion is transmitted from the screw (43) to the sleeve and hence to the clamp arm by a spring (40) which is retained between a shoulder on the screw and an internal flange on the sleeve.

49. The action of the clamp when the knurled operating knob is turned is as follows:—

(1) The first part of the motion engages the short leg of the clamp arm with the gate catch (65), preventing it from moving under the action of the spring (66).

(2) When the clamp arm reaches the limit of its travel, no further movement of the sleeve (41) can take place, so that continued rotation of the screw compresses the spring (40); this applies a downward force to the gate catch (65), ensuring that the gate cover is firmly pressed down on to the gate.

(3) Finally, the last few turns of the screw advance it to the point where it operates the micro switch (44) which is mounted on a block screwed to the mounting plate (45).

Projection prism mount *(fig. 1)*

50. The prism mount (8) has side webs at its base, giving provision for bolting it to the gate cover casting (72). The mounting plate for the film clamp solenoid has clearance holes to allow passage for the fixing screws. The prism mount is an aluminium alloy casting.

51. The prism (80) is carried on a mounting plate (3), to which it is secured by a mounting block (1) at the top and two securing blocks (7) at the bottom. The horizontal and front vertical faces of the prism are bloomed (*Chap.* 1, *Appendix*); the 45 deg. face is silvered, coppered and varnished. The faces of the blocks (1) and (7) which touch the prism are covered with a thin layer of a resilient material; a backing sheet (2) of the same material is placed between the prism and the mounting plate (3).

52. The mounting plate (3) complete with prism is held to the prism mount casting by three countersunk screws (4) which pass through holes in the plate into tapped holes in the mount; two of these are situated at the top corners of the mounting plate and the other in the front lower corner. The screws are slotted at the ends so that they can be turned by a screwdriver through the prism mount casting. Adjacent to each of the screws (4) is a grub screw (5) which is driven in until it presses against the mounting plate (3), thus locking the particular corner in the position set by the adjustment of the screw (4). The arrangement facilitates optical setting up of the equipment by enabling the prism to be set so that the beam of light emerging from the prism has its axis parallel to the film track in the gate.

53. The prism mount also carries the gate hook (6). The purpose of this is to provide a means of retaining the gate cover in the open position for film loading or routine servicing. The hook is made of folded brass sheet and is pivoted on a spindle which passes through the neck of the prism mount casting. Pinned to the front end of the spindle is a knurled operating knob which provides a finger grip for lifting the gate cover while turning the hook in a clockwise direction to engage it on the pillar (10) on the gate casting. When the gate cover is hinged open in this manner, the prism mount may strike the knob (15); accidental damage to the mount is prevented by a synthetic rubber pad which is stuck in a recess in the neck of the casting.

Cassette mounting *(fig. 1)*

54. The right-hand end of the gate casting is shaped to provide a mounting for the film cassette (*Chap.* 5). The mounting face is recessed to fit the mounting block of the cassette, whose weight is taken by a support at the bottom of the face. The cassette is secured in its position by the securing screw (12) when the cassette mouth registers with a slot in the film feed chamber. Light trapping plates along the edges of the slot project into recesses in the mounting block on the cassette.

55. Since the cassette has appreciable weight, making it a little awkward to hold in place with one hand, the securing screw (12) is captive and is spring loaded so that it is pushed towards the tapped bush in the cassette, making it easier to locate and screw home. The spring (13) is retained between a shoulder on the screw and a mild steel bush (14) which is pressed into the casting. The screw extends into a spindle carrying a knurled knob (15).

56. A Bakelite contact block (11), secured to the casting at the top of the cassette mounting face, carries a spring-loaded contact which mates with a contact on the cassette; this is associated with the film supply low warning circuit. The contact block has a clearance hole for the pillar (10).

Gate hinge *(fig. 1)*

57. It is extremely important that the gate and the gate cover should mate together exactly in order to make the optical axis of the projection lens coincide with that of the light condenser system and to ensure that the upper and lower tables are in line. It is also essential that there should be no play in the hinge, otherwise there will be movement of the cover relative to the gate due to the action of the film clamps and crimper. For these reasons the gate hinge is made capable of adjustment.

58. The right-hand end of the gate cover casting contains case-hardened mild steel inserts (16) which are pressed into holes in the casting; the inserts contain conical bearing holes. The screwed hinge pins (18) are carried in tapped bushes (17) which are secured to lugs on the gate casting by screws passing through holes in the bush flanges; these holes are enlarged to allow some adjustment to be made to the positions of the bushes. The hinge pins (18) have case-hardened conical points which are finished by grinding to give accurate bearing surfaces. When the assembly has been set up correctly, the hinge pins are locked in position by lock nuts.

CIRCUIT DESCRIPTION

59. A diagram showing the electrical connections to the film gate is given in fig. 3. The various connections are made via terminal strip GT, which is mounted on the front of the projector mainplate to the right of the film gate. Immediately above the terminal strip is a tagboard carrying resistor R13, which is in series with the shutter motor. The resistor and strip GT are enclosed by a dust cover.

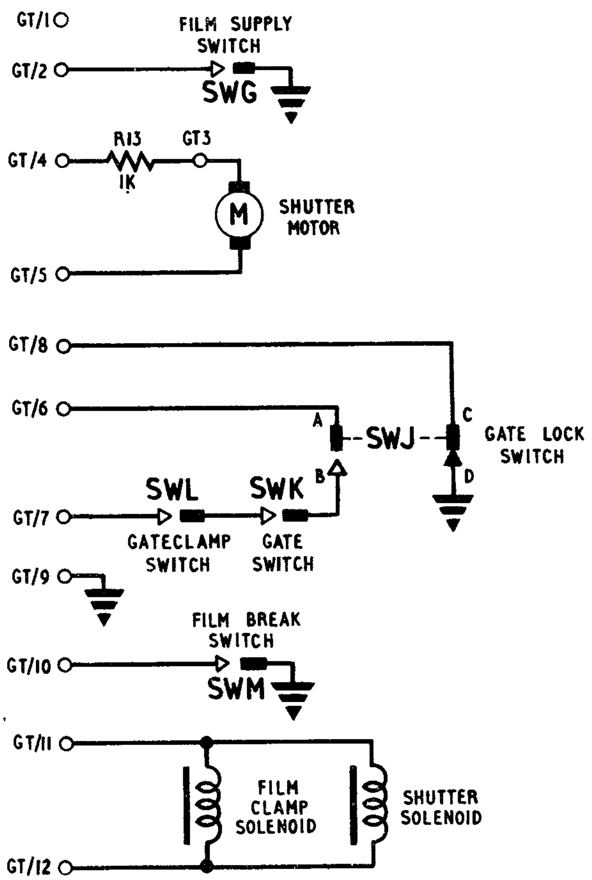


Fig. 3. Circuit diagram

60. The film supply switch SWG is located in the film cassette and closes when the supply of film falls to about 30 ft. The circuit includes the spring-loaded contact in the Bakelite contact block (*item* 11, *fig.* 1) and the contact with which it mates on the film cassette.

61. The shutter motor is fed from the 15A regulated mains supply via the PROJECTOR MECHANISM switch on the control rack. Resistor R13 is included in the circuit to prevent the motor from burning out in the stalled condition.

62. The gate switch SWK is formed by a contact (*item* 50, *fig.* 1) in the lower table of the gate which makes with a similar contact in the upper table when the gate cover is dropped into its operating position. This switch is wired in series with the micro switch SWL, which is operated by the gate clamping mechanism (*para.* 49) and one pair of contacts of the gate lock switch SWJ (*para.* 47). Switches SWL, SWK and contacts A and B of SWJ in series form part of the processing interlocks circuit (*Sect.* 6, *Chap.* 1).

63. Contacts C and D of SWJ open when the gate catch (*item* 65, *fig.* 1) is moved to the left and break the gate open warning circuit. It should be noted that unless SWL has been closed by screwing the gate clamp knob fully home, processing will not be possible even though the gate open warning lamp is extinguished by SWJ.

64. The film break switch SWM is operated by the release of the film tension sprocket in the film feed chamber (*Chap.* 6).

65. The shutter and film clamp solenoids are energized by the 24V DC supply as follows:—

(1) By the operation of contacts in drive unit (mechanical) timing 4118 during normal operation.

(2) By contacts of relay RLJ/1 (*Chap.* 4) if the transport motor stalls.

(3) By contacts of the PROCESSING ON–OFF switch when it is set to OFF. This circuit includes the normally closed contacts of the JET INSPECTION SWITCH.

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Chapter 4

DRIVE UNIT (MECHANICAL) FILM 4119

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION

1. Drive unit (mechanical) film 4119 provides the means of snatching the film through successive frames. Energy for the frame transmission is derived from a continuously-running electric motor.

2. The motor drives a forty-tooth film transport sprocket through an intermittent gearbox. The gearbox contains a clutch which is engaged at the correct instants by the action of a solenoid-operated release arm.

3. The solenoid is actuated by electrical energy which accumulates in a bank of condensers during the periods when the transport sprocket is at rest ; this energy is applied to the solenoid by the changing over of the film shift contacts SWB in drive unit (mechanical) timing 4118 (*Sect.* 4, *Chapter* 5).

4. A view of the drive unit, with the solenoid compartment cover removed, is given in fig. 1.

MECHANICAL DESCRIPTION

General

5. A diagram, showing the mechanical construction of the drive unit is given in fig. 2.

6. The mechanism is housed in an aluminium alloy gearbox casting (18) which is bolted to the projector mainplate at the front left-hand side of the projector (*Chapter* 1). The top cover of the gearbox includes a hole into which screws an oil filler plug and dipstick (25).

Continuous drive

7. A 24V DC shunt motor is bolted to the underside of the gearbox and is coupled to the worm shaft (14) which drives a worm wheel (23). The worm shaft is surrounded by a tube (15) which is cut away to allow the shaft to engage the worm wheel. The tube is also cut away at the bottom to allow the entry of lubricating oil which is contained in the bottom of the gearbox casting. The oil is forced up the tube by the rotation of the worm shaft; some of it lubricates the worm wheel and the rest proceeds to the top of the tube where it escapes through two side branches on to the Maltese cross (*para.* 12) and the clutch spring and cams (*para.* 9). An oil seal, which is included in the lower bearing of the worm shaft, prevents the leakage of oil.

8. The worm wheel (23) is bolted to a sleeve (24) which runs free on the mainshaft (9) on needle roller bearings (10).

Clutch

9. The rear end of the main shaft (9) carries a cam (21); a hole in this cam retains one end of a spring (22) which is formed of square section steel wire. The other end of the spring is retained in a hole in another cam (12) which is loose on the sleeve (24). The free internal diameter of the spring is slightly less (about 0.005 in.) than the external diameter of the sleeve which rotates in such a direction that it tends to wrap the spring about it thus rotating the cam (21) and the main shaft (9).

10. In quiescent periods, the arm (11) which is loaded by the spring (19) engages the cam (12) thus tethering the forward end of the spring (22) which tends to unwind and allow the sleeve to slip round inside it without turning the main shaft. When a pulse of energy is applied to the solenoid (17), the arm is released from the cam (12) enabling the spring (22) to wrap tightly round the sleeve carrying the cam (21) and the mainshaft (9) with it. After one complete rotation of the cam (12), it is arrested again by the arm (11). The inertia of the mainshaft now causes it to overshoot and unwind the spring (22) until it is free on the sleeve; the cam (21) is then caught by the pawl (13) which is loaded by the pawl spring (16) preventing the spring (22) from retightening on the sleeve.

11. The pawl mount (20) has two tapped holes which accept the screws holding it to the rear of the gearbox casting. The holes in the casting are elongated to allow for anular adjustment of the mount. This is to enable the pawl to be set to a position such that it just catches the cam (21) at the limit of its overshoot.

Driving cam and Maltese cross

12. The cam (7) is secured to the main shaft by a taper pin (26) and spaces two end plates (8) which support a roller pin (28) carrying a roller (27). The periphery of the cam is ground to a fine finish and forms a bearing surface for the curved faces of the Maltese cross (29) which is thus prevented from turning in quiescent periods.

13. The cam makes one revolution each time the solenoid is energized and the Maltese cross is driven through 90 deg. by the roller (27) which engages in the slot presented to it; clearance for the points of the cross is provided by the

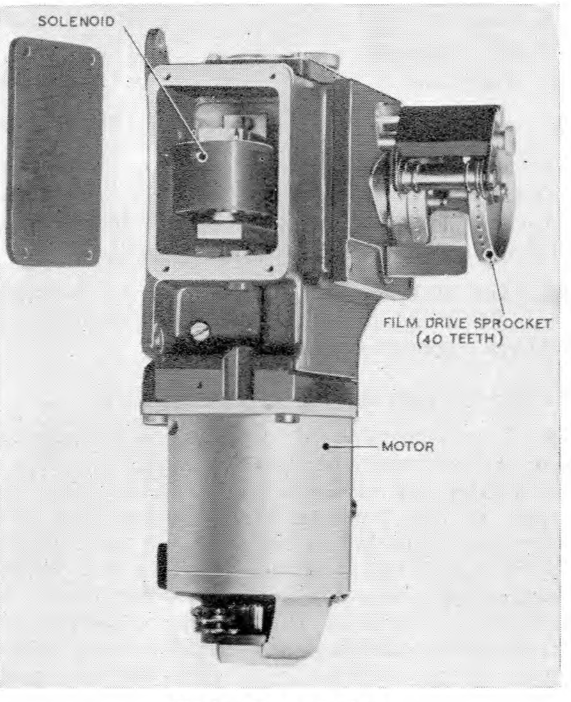
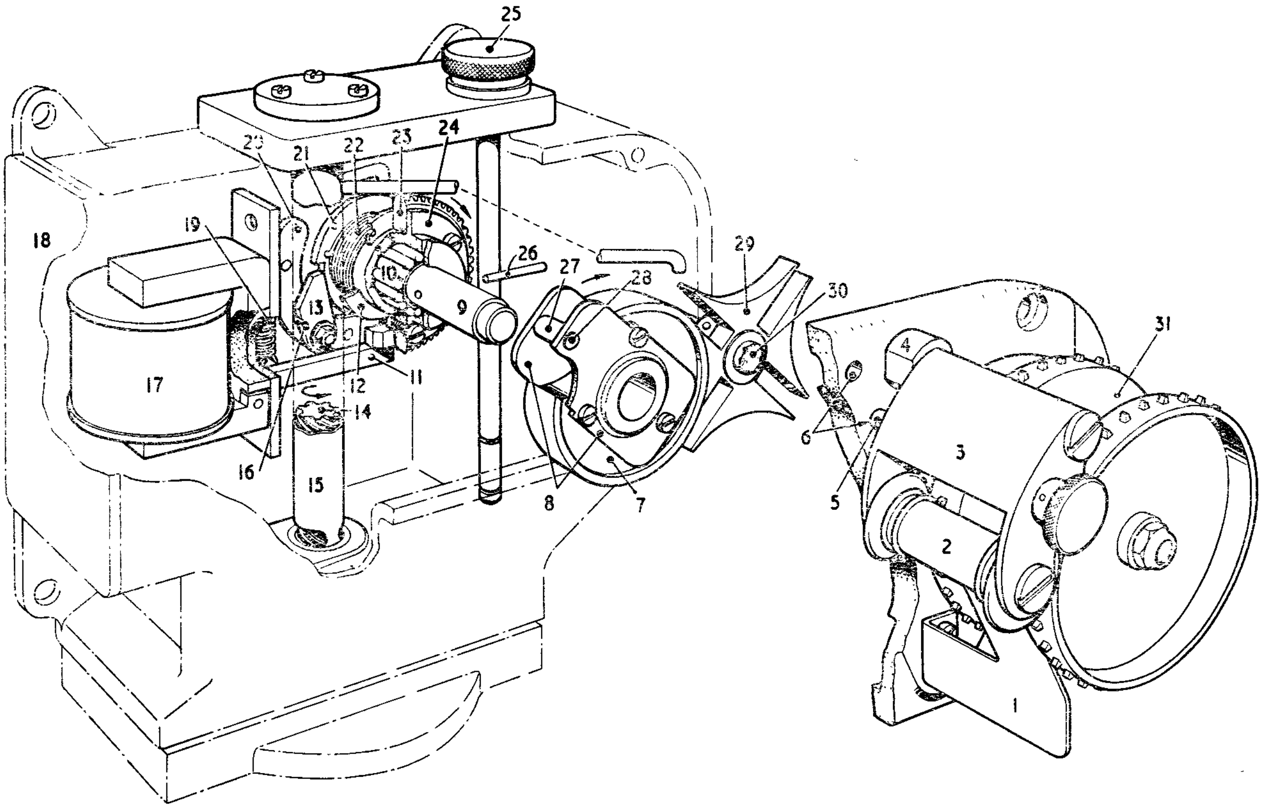


Fig 1. General view



KEY TO FIG. 2

1 FILM STRIPPER
2 FILM ROLLER
3 ROLLER FRAME
4 ROLLER FRAME SPINDLE
5 LOCATING PIN
6 LOCATING HOLES
7 CAM
8 END PLATES
9 MAINSHAFT
10 ROLLER BEARINGS
11 RELEASE ARM
12 CAM
13 PAWL
14 WORM SHAFT
15 TUBE
16 PAWL SPRING
17 TRIP SOLENOID
18 GEARBOX CASTING
19 SPRING
20 PAWL MOUNT
21 CAM
22 CLUTCH SPRING
23 WORM WHEEL
24 SLEEVE
25 FILLER PLUG AND DIPSTICK
26 TAPER PIN
27 ROLLER
28 ROLLER PIN
29 MALTESE CROSS
30 SPROCKET SHAFT
31 TRANSPORT SPROCKET

Fig. 2. Mechanical construction

cut-away portion of the cam periphery. The time required for the 90 deg. of cross movement is approximately 1/25 sec.

14. The Maltese cross is pinned to the sprocket shaft (30) which drives the film transport sprocket (31) via a corrector mechanism.

Corrector mechanism

15. The longitudinal film registration at the gate must be within the limits of $\pm$ 0.0015 in. Since the greater part of this limit will be absorbed by errors in film perforations, it follows that the movement imparted to the transport sprocket by the Maltese cross and cam must be exactly 90 degrees each time the solenoid is energized. A corrector mechanism is therefore employed to facilitate the cancellation of manufacturing tolerances in the Maltese cross and the transport sprocket itself. A diagram, showing the mechanical details of this mechanism is given in fig. 3.

Note . . .

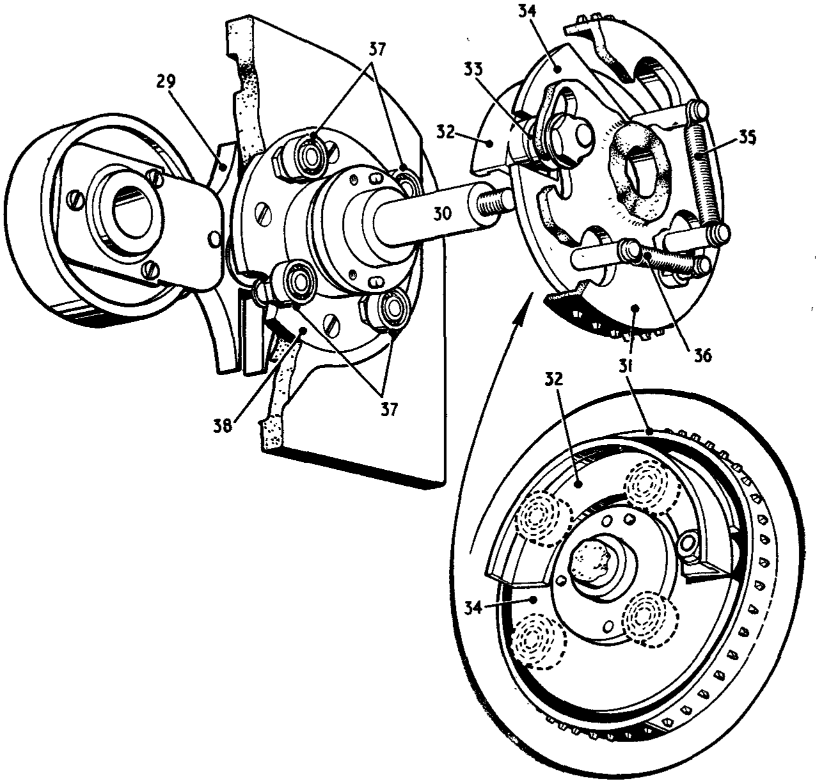
The corrector mechanism is accurately set by the manufacturer and should not normally require subsequent attention.

16. The corrector plate (34) is bolted to a flange on the sprocket shaft (30). A rectangular cut-out in the plate retains a bush which forms part of the corrector arm (32). A pivot (33), which is secured in an anular slot in the rear cheek of the transport sprocket, passes through an eccentric hole in the corrector arm bush and is retained by a 6BA nut and washer. The corrector arm is thus free to move about the pivot as centre giving angular movement of the transport sprocket relative to the corrector plate due to the eccentricity between the bush and pivot. Backlash between the sprocket and corrector plate is taken up by the action of a spring (36) which is tensioned between an anchor pin on the sprocket and another anchor pin on the corrector plate which projects through a large hole in the sprocket cheek.

17. The precise position of the sprocket relative to the sprocket shaft at a given rest position, thus depends on the position of the corrector arm. Provision for adjusting the position of the corrector arm at each of the four quiescent positions is given by the four eccentrically mounted ball races (37).

18. The eccentric spindles for the ball races are riveted into the corrector housing (38) and are sufficiently tight to withstand the shocks of normal operation but are free enough to enable adjustments to be made with the use of a flat spanner. In the diagram of fig. 3, the mechanism is shown in a position approximately halfway through the transport operation. In the quiescent condition, the end of the corrector arm rests on one of the ball races (37) against which it is spring loaded by the action of the spring (35) which is tensioned between an anchor pin on the corrector arm and another anchor pin on the corrector plate; both these anchor pins protrude through large clearance holes in the rear sprocket cheek.

19. The principle of the corrector mechanism is illustrated in the schematic diagram of fig. 4. It will be seen from the diagram that the ball races can be moved through a total of 0.070 in. giving a total excursion of approximately 0.003 in. at the periphery of the film transport sprocket.



KEY TO FIG. 3

29 MALTESE CROSS	34 CORRECTOR PLATE
30 SPROCKET SHAFT	35 SPRING
31 TRANSPORT SPROCKET	36 SPRING
32 CORRECTOR ARM	37 BALL RACES
33 PIVOT	38 CORRECTOR HOUSING

Fig. 3. Corrector mechanism details

Phasing

20. It was mentioned in para. 16 that the corrector arm pivot is secured in an anular slot in the rear cheek of the transport sprocket. The purpose of this arrangement is to enable adjustments to be made to the longitudinal position of the film when setting up the equipment for the projection of film which might have been processed on another photographic display system.

Film roller and stripper (*fig. 2*)

21. The purpose of the film roller is to guide the film round the transport sprocket and prevent the film perforations from leaving the sprocket teeth. The roller (2) is mounted on a spindle in the roller frame (3) which pivots about the spindle (4). The roller frame carries a spring loaded locating pin (5) having a knurled operating knob. The locating pin is inserted in one of two holes (6) in the gearbox front cover enabling the roller either to be pressed against the film for normal operation or to be parked away from the sprocket when the projector is being loaded with a fresh length of film.

22. The tongue of the film stripper (1) projects between the cheeks of the transport sprocket preventing the film perforations from sticking to the sprocket teeth and tightening the take-up loop (*Chapter* 6).

CIRCUIT DESCRIPTION

General

23. The circuit of fig. 5 includes drive unit (mechanical) film 4119 together with other parts of the system associated with its operation. The drive unit includes the motor and trip solenoid only. Relay J/1 and its shunt R12 are mounted on the projector mainplate inside the transport motor cover. The trip reservoir condenser C2 consists of three 8 μF paper condensers connected in parallel and mounted on a bracket behind the mainplate at the right-hand side; the bleed resistor R11 is connected across one of the condensers. The film clamp solenoid is mounted in the film gate (*Chapter* 3). Switch SWB is operated by the main camshaft in drive unit (mechanical) timing 4118 (*Sect.* 4, *Chapter* 5).

Circuit operation

24. During the quiescent periods, condenser C2 is connected across a −250V supply which originates in control unit (selsyn) 921 (*Sect.* 4, *Chapter* 7) and enters the projector at pin P3/B; the connection is made by SWB. When the switch changes over, the condenser is discharged via the trip solenoid and

RESTRICTED

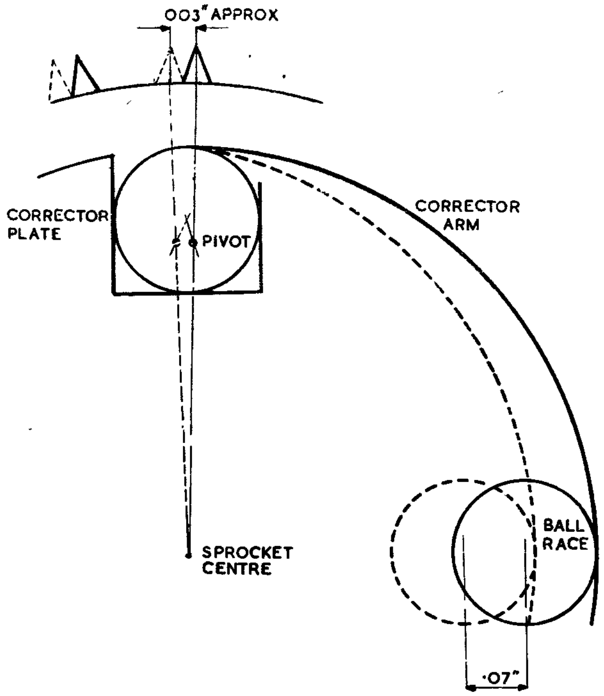


Fig. 4. Correction principle

the film transport action takes place as described in the preceding paragraphs.

25. During the transport of the film, the film clamp is automatically released by the action of contacts which are closed by the main camshaft. If the projector is switched off during transport and is then wound on by hand as when loading a new film, it may happen that the main camshaft is moved beyond the point at which the film clamp is released. On switching on again, the film would be locked in the gate while the Maltese cross mechanism would be attempting to complete the interrupted film transport; this would result in the stalling of the drive motor. The excessive armature current drawn under stalled conditions results in the operation of relay J/1. Contacts J1 close and complete the 24V DC circuit through the film clamp solenoid thus releasing the film and allowing it to be drawn through the gate to complete the film transport. Subsequently, the circuit will operate in the normal manner.

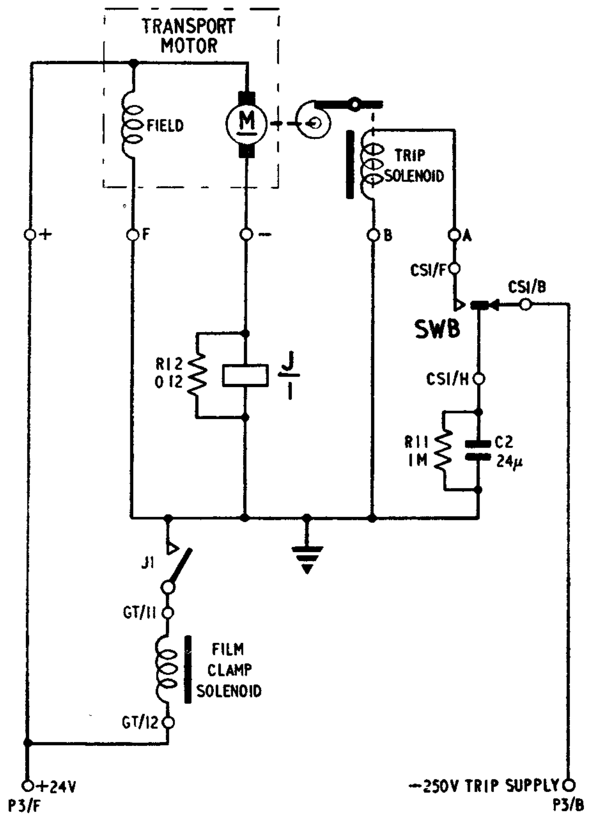


Fig 5. Trip circuit

Chapter 5

FILM CASSETTES

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LIST OF ILLUSTRATIONS

General

1. Unexposed film is stored in a film cassette (Stores Ref. 14B/3478) from which it is drawn by the action of the film feed sprocket (*Chap.* 6). After the film has been exposed, processed and projected, it is wound on to a film take-up spool (Stores Ref. 14C/5688).

2. Each installation, including two projectors, is provided with three cassettes and three take-up spools; this enables each projector to be complete with a loaded cassette and a take-up spool while the remaining cassette is being reloaded and processed film rewound from the full take-up spool.

Film cassette

3. Two cassettes, with their covers removed, are shown in fig. 1. One of these is shown empty, while the other is shown loaded with a length of film. The cassette has capacity for 2,000 ft. of film, but will normally be loaded with 1,000 ft. only; at the normal operating speed of four pictures per minute, this will last for approximately 24 hours. The cassette incorporates a micro-switch which operates when the amount of unexposed film available in the projector falls to about 30 ft. The amount of film remaining in the cassette at any time can be estimated by the use of a manually-operated indicator.

4. The cassette consists of two major parts: the body and a light tight lid. The body consists of a short cylindrical casting which forms the film chamber, and a mounting block which gives provision for fixing the assembly to the film gate and includes a system of rollers for guiding the film from the cassette into the gate.

5. All internal surfaces of the cassette are blackened in accordance with normal photographic practice.

Film spindle

6. A length of film, as supplied by the maker, is wound on a Bakelite centre-piece; this is placed over the cassette centre which consists of a Bakelite bush fixed to a metal spindle which runs free in an axial bearing in the film chamber. The film, which is rolled with its emulsion side inwards, is spooled off in a counter-clockwise direction.

Mounting block

7. A diagram showing some of the details of the mounting block is given in fig. 2.

8. The two rollers (*fig.* 2) guide the film from the film chamber round an " S " bend and through the cassette mouth (*fig.* 1). The purpose of the bend is to provide a light trap, preventing light from entering the film chamber when the cassette is not in position on the projector. The film guide, shown in fig. 2, is only of use when the film is being threaded in the dark room; it plays no part in the normal film transport and the film does not touch it in operation.

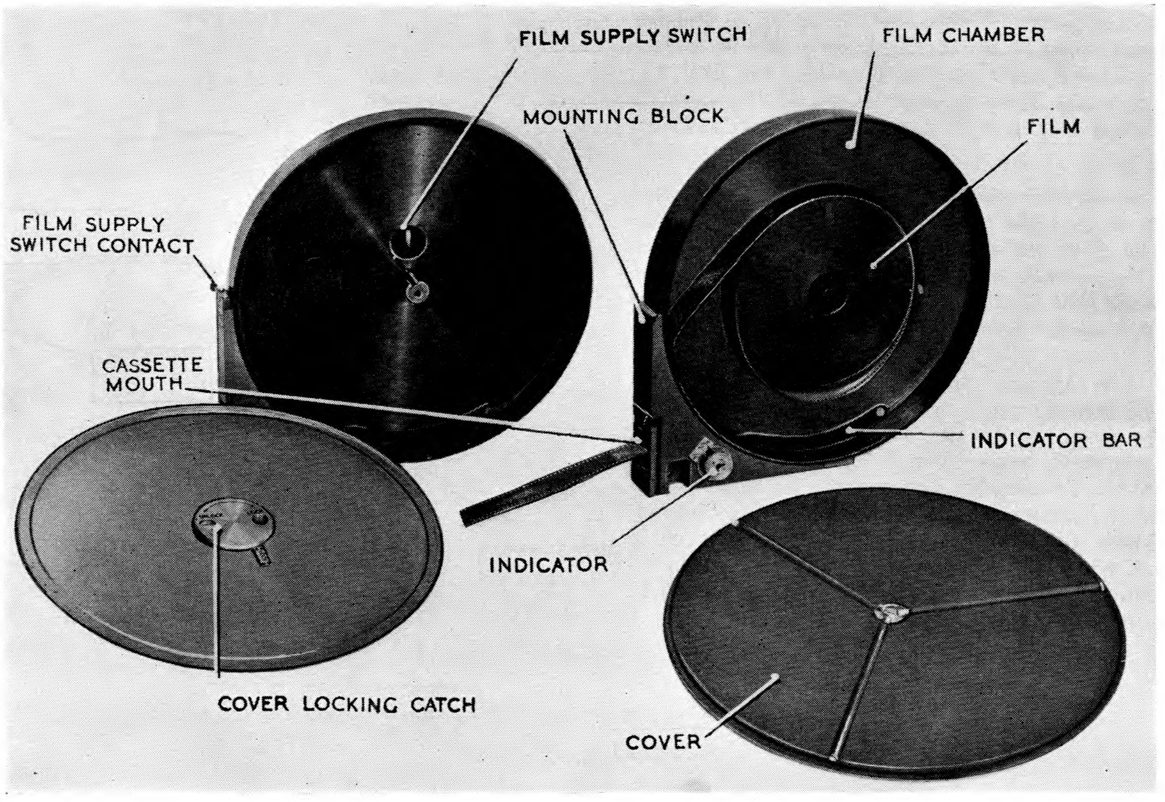

Fig. 1. Film cassettes

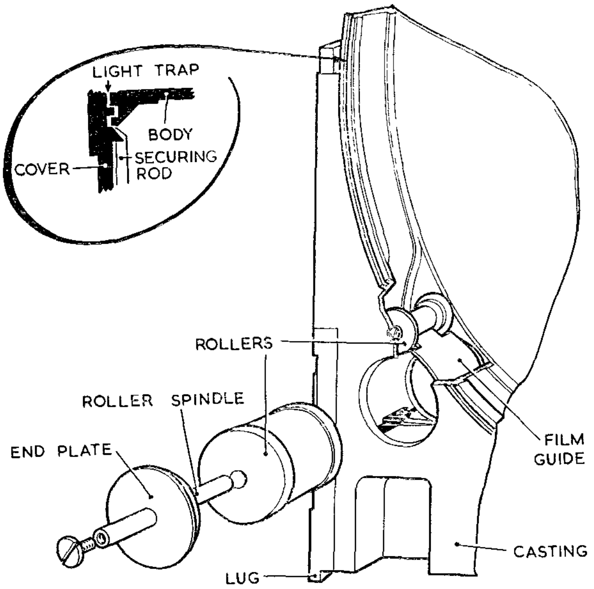

Fig. 2. Mounting block details

9. The lower corner of the mounting block carries a lug which engages in the cassette support on the film gate (*Chap.* 3) and carries the main weight of the cassette. In the upper portion of the mounting block is a tapped bush which accepts the cassette securing screw also on the film gate. Immediately above the tapped bush is a Bakelite block carrying an electrical contact which is wired to the film supply micro-switch (*fig.* 1) in the film chamber. When the cassette is in position on the projector, the contact makes to a sprung contact on the film gate which is wired via terminal GT/2 to the FILM SUPPLY LOW warning lamp on the indicating panel. When the diameter of the unexposed spool of film falls to the point where the spring-loaded micro-switch operates, the 24V DC circuit to the lamp is completed and the warning indication is given.

Note . . .

The circuit operation is such that the micro-switch closes to give the warning indication. No warning will be given unless the contacts between the gate and the cassette are good. Care should be taken to check that the contacts are in order before placing a loaded cassette on the projector.

10. The manual film indicator consists of a curved arm operated by a milled knob at the base of the mounting block. The arm is spring-loaded and normally rests against the wall of the film chamber. To estimate the quantity of film remaining in the cassette, the knob is turned in a counter-clockwise direction to the limit of its available travel, when the arm is arrested by the spool of film. A pointer, which is fixed to the knob, then indicates the quantity on an engraved scale.

Cassette cover

11. The cassette cover (*fig.* 1) is machined round its edge to provide a light-tight joint to the film chamber; a section of this joint is given in the inset diagram in fig. 2. The cover includes a locking mechanism which is shown in fig. 3.

12. An aluminium plate, about 3 in. in diameter, carries a central boss which projects through a hole in the centre of the cover; a spring washer is included between the plate and the cover to provide a certain amount of friction. A cam, fixed to the boss inside the cover, is driven by a pin. Rotation of the plate thus turns the cam which causes longitudinal movement of three aluminium securing rods of semi-circular cross section which are retained under a pressed metal housing which has three radial grooves spaced at 120 degrees to each other. The ends of the securing rods engage under the bevelled lip of the film chamber and retain the cover in its place.

13. Provision for turning the circular aluminium plate is given by two diametrically opposite finger holes; one of these includes a press button. The button is mounted on one end of a short lever pivoted on a spindle which is retained in a radial slot in the underside of the plate. The end of the lever remote from the button carries a locking pin which is pressed by the action of a leaf spring into one of a series of holes in the cassette cover. Cam and securing rods thus cannot be moved until the button is pressed.

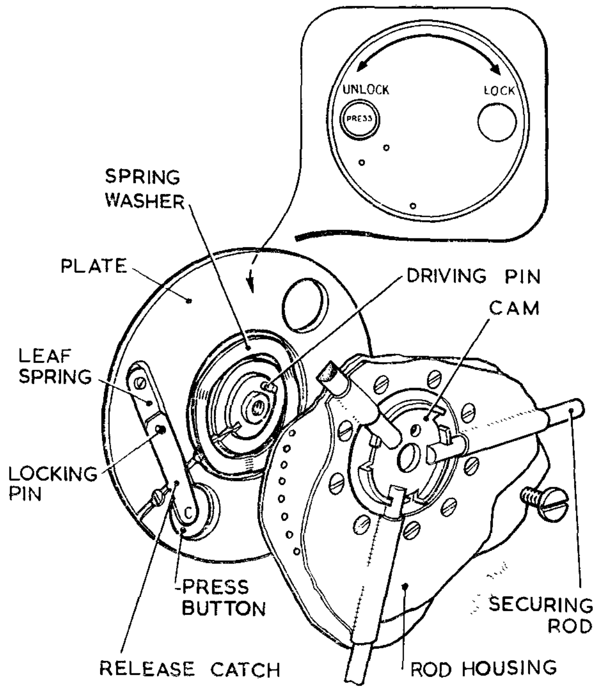

Fig. 3. Cover securing mechanism

39744 446983 5797 9/54 625 CWSLtd964 Gp539-2

Chapter 6

OVERALL FILM DRIVE SYSTEM

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LIST OF ILLUSTRATIONS

INTRODUCTION

1. Film is drawn from the cassette at constant speed by the action of a continuously rotating feed sprocket in the film gate. During the exposure periods the film in the gate apertures is at rest, so that the unexposed film accumulates in a feed loop. At the end of an exposure, film is snatched from the feed loop and through the gate by the action of drive unit (mechanical) film 4119 (*Chapter* 4) and accumulates rapidly in another loop known as the take-up loop.

2. When passing through the gate, the film is maintained at a suitable tension by the action of a spring-loaded sprocket. If the film breaks, the tension sprocket releases and closes a switch. The FILM BREAK lamp and warning buzzer on the indicating panel then operate and a relay in relay unit 4105 is energized, with the result that the processing fluids are cut off and dry air is blown continuously into the processing aperture.

3. The take-up loop is slowly reduced during the exposure periods by the rotation of a hold-back sprocket which turns at the same speed as the feed sprocket. After leaving the hold-back sprocket, the film passes via a chute and two guide rollers to the take-up spool, which is overdriven via a slipping clutch so that the film is spooled under tension.

4. The motion of the driving sprockets and the take-up spool is derived from that of the main camshaft which is part of drive unit (mechanical) timing 4118 (*Section* 4, *Chapter* 5), via a system of gears and shafts. The shafts run in bearings which are retained in brackets mounted on the rear of the projector mainplate. The sprockets used are of standard design for 35 mm. film and each has twenty teeth. Since each frame covers ten film perforations, it follows that one rotation of the sprockets advances the film through two frames; the sprockets therefore turn at half camshaft speed. The gearing also drives the pointer of the cycle indicator at camshaft speed.

5. Provision is made for turning the mechanism by means of a manual control; this is to facilitate film loading and setting-up. The manual control will only turn the mechanism in the normal direction, thus preventing the camshaft from being turned in reverse with consequent damage to the cam-operated contacts.

MECHANICAL DESCRIPTION

General

6. A schematic diagram of the film drive system is given in fig. 1. The mainplate and the various bearings which support the shafting have been omitted from the drawing in the interest of clarity.

Main drive

7. The camshaft of drive unit (mechanical) timing 4118 (26) carries a 30-tooth spur gear (19) which meshes with an idler gear (20). The drive unit is bolted to the rear of the mainplate in such a position that this idler gear meshes with a gear (30) which is pinned to a vertical drive shaft (31). Provision is made in the mounting of the idler (*Section* 4, *Chapter* 5) for small adjustments in meshing. The gear (30) has 60 teeth, so that the shaft (31) turns at half camshaft speed.

Cycle indicator

8. At the lower end of the shaft (31) is a 40-tooth bevel wheel (27) which meshes with a bevel pinion (28) having 20 teeth. The bevel pinion (28) thus turns at twice the speed of the shaft (31) and consequently at the same speed as the camshaft.

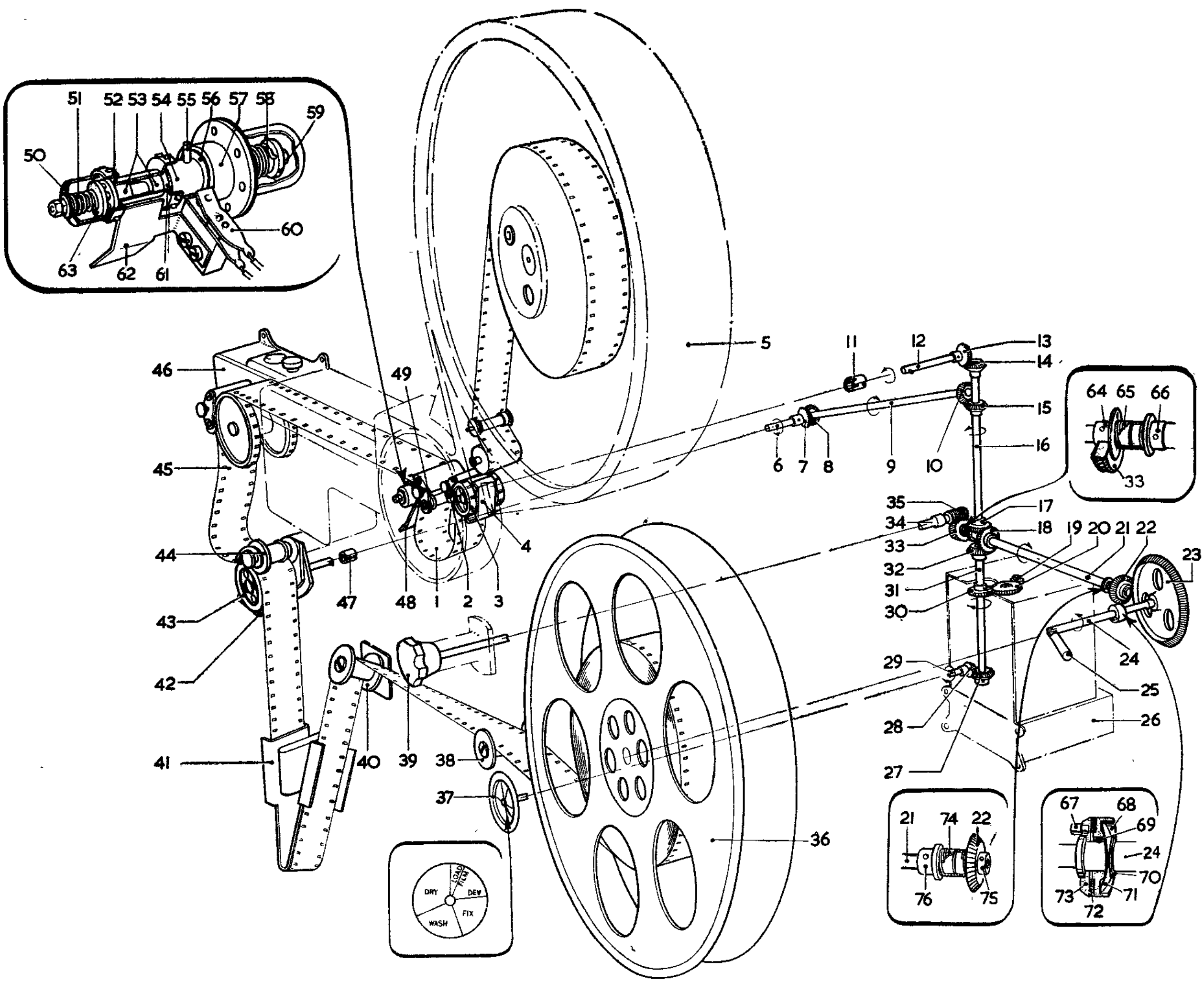
9. The pinion (28) is mounted on a shaft (29) which is at right angles to the mainplate and turns the pointer of the cycle indicator (37). The indicator dial is calibrated in sectors marked according to the processes appropriate to the relevant positions of the camshaft as shown in the inset diagram. The LOAD FILM line indicates the position to which the mechanism should be set before switching on the projector in order to ensure that the camshaft is in a position some few degrees beyond that at which drive unit (mechanical) film 4119 operates. This is to allow plenty of time for the servo mechanism (*Section* 4) to align the magslip receiver shaft with the radar aerial before the film transport occurs. If the camshaft moves at high speed through the transport position, it is possible for the clamping and crimping mechanism (*Chapter* 3) to drop while the film is still in motion, causing the film to be broken.

Take-up spool drive

10. The upper end of the shaft (31) carries a 36-tooth bevel gear (32) which meshes with a similar bevel gear (18) mounted on a horizontal shaft (21) which is parallel to the mainplate. The right-hand end of this shaft (looking from the front of the projector) drives a 36-tooth bevel pinion (22) through a freewheel device whose purpose is to allow the pinion to turn in advance of the rest of the gearing when the take-up spool is rotated manually to start a fresh end of exposed film.

11. The details of the freewheel are shown in an inset diagram in fig. 1. A sleeve (76), which is pinned to the shaft (21), abuts a hub on the pinion (22) which runs free on the shaft and is prevented from slipping off the end by a retaining collar (75). Motion is transmitted from the sleeve to the pinion by a coil spring formed of 20 s.w.g. spring steel wire and lapped internally. The free internal diameter of this spring is slightly less (about 0·005 in.) than the external diameters of the sleeve and pinion hub and it is wound in a direction such that when the shaft turns in the normal direction, the spring tends to wrap tightly round the sleeve and pinion hub, so that a positive drive is applied to the pinion. If, however, the pinion is turned in the normal direction in advance of the shaft, the spring tends to unwrap and allows the pinion hub to slip round inside it.

12. The pinion (22) meshes with a 144-tooth bevel wheel (23) mounted on the end of the take-up spool shaft. The take-up spool mounts loosely on this shaft and is rotated by means of a friction drive; details of the drive are given in the inset diagram.



1 FEED LOOP
2 ROLLER CARRIAGE
3 FEED SPROCKET
4 FILM STRIPPER
5 CASSETTE
6 SHAFT
7 BEVEL GEAR 36T
8 BEVEL GEAR 36T
9 SHAFT
10 BEVEL GEAR 36T
11 COUPLING
12 SHAFT
13 BEVEL GEAR 36T
14 BEVEL GEAR 36T
15 BEVEL GEAR 36T
16 SHAFT
17 BEVEL GEAR 36T
18 BEVEL GEAR 36T
19 SPUR GEAR 30T
◀ 20 SPUR GEAR 60T ▶
21 SHAFT
22 BEVEL PINION 36T
23 BEVEL WHEEL 144T
24 SHAFT
25 LEVER
26 DRIVE UNIT (MECHANICAL) TIMING 4118
27 BEVEL WHEEL 40T
28 BEVEL PINION 20T
29 SHAFT
30 SPUR GEAR 60T
31 SHAFT
32 BEVEL GEAR 36T
33 WORM WHEEL
34 SHAFT
35 WORM (FOUR START LEFT-HAND)
36 TAKE-UP SPOOL
37 CYCLE INDICATOR
38 ROLLER
39 MANUAL DRIVE KNOB
40 ROLLER
41 CHUTE
42 FILM STRIPPER
43 HOLD-BACK SPROCKET
44 ROLLER CARRIAGE
45 TAKE-UP LOOP
46 DRIVE UNIT (MECHANICAL) FILM 4119
47 COUPLING
48 FILM STRIPPER
49 ROLLER CARRIAGE
50 DUST COVER
51 PRESSURE SPRING
52 TENSION SPROCKET
53 OILITE BEARINGS
54 SHAFT
55 CONTACT PIN
56 DUST COVER
57 BEARING HOUSING
58 TENSION SPRING
59 BUSH
60 FILM BREAK WARNING CONTACTS
61 FRICTION PAD
62 FILM STRIPPER
63 THRUST BEARING
64 SLEEVE
65 DRIVE SPRING
66 SPIGOT
67 DRIVING PIN
68 PRESSURE PLATE
69 PIN
70 CIRCLIP
71 FRICTION SPRING
72 FRICTION PAD
73 DRIVING PLATE
74 DRIVE SPRING
75 COLLAR
76 SLEEVE

Fig. 1. Schematic diagram

13. The driving plate (73) is retained by a shoulder on the shaft (24) and carries a driving pin (67) which engages in one of the holes round the hub of the take-up spool (36). A pin (69) protrudes radially from the shaft (24) and engages in a key slot in the pressure plate (68), which thus drives the driving plate via the friction pad (72). The assembly is held under axial pressure by the action of the friction spring (71), which is retained by a circlip (70).

14. The speed of the shaft (24) is such that the peripheral speed of the spool of exposed film, even when its radius is a minimum, tends to be greater than the speed of the film passing over the hold-back sprocket. The difference is taken up by slip in the friction drive described in the preceding paragraphs. The film tension which results depends on the force necessary to cause the slip.

15. The shaft (24) terminates in a spring-loaded lever (25) which is turned over to retain the take-up spool in its place.

Film feed sprocket

16. The bevel gear (18) meshes with a similar gear (17) which is pinned to a shaft (16). This shaft is mounted vertically and turns at half the speed of the main camshaft; at its upper end are two further bevel gears (14) and (15).

17. The gear (14) drives the shaft (12) via the bevel gear (13). The shaft (12) is coupled to the feed sprocket shaft via a coupling (11). The coupling consists of a short hollow cylinder having diametrical slots at each end; these slots engage cross pins in the shafts.

18. The feed sprocket (3) operates in conjunction with a conventional roller carriage (2) and film stripper (4).

Film tension sprocket

19. The purpose of this sprocket is to maintain tension on the film in the gate while allowing a free feed loop to exist between it and the film feed sprocket. Details of the tension sprocket are shown in an inset diagram in fig. 1.

20. The sprocket shaft (54) is mounted in ball-races in a bearing housing (57) which passes ◀through the gate casting; the housing has a flange which is screwed up to the gate. The end of the shaft behind the gate carries a▶ bush (59) having a coil spring (58) round it. One end of the spring is retained in a hole in the bush and the other in a hole in the housing (57). The bush is secured to the shaft by a grub screw and the spring is wound in a direction such that it resists counter-clockwise rotation of the shaft.

21. The sprocket contains Oilite bearings (53) which run free on the shaft. Between the rear cheek of the sprocket and a shoulder on the shaft is a friction pad (61) against which the sprocket is pressed by the action of a pressure spring (51) and a thrust bearing (63). The force necessary to turn the sprocket against the friction of the pad is greater than that required to wind up the spring (58). The first two frame transports after film reloading cause the spring to wind up until the contact pin (55), which protrudes from the shaft, is prevented from further movement by the bakelite block carrying the switch contacts (60). During subsequent frame transports, the spring (58) is held fully wound by the film, which is thus in tension, and the sprocket is pulled round against the friction of the pad (61).

22. The tension sprocket operates in conjunction with a conventional roller carriage (49) and film stripper (48). The purpose of the stripper is merely to provide a convenient guide for the film during the loading process.

Film break warning

23. The spring (58) clearly only remains wound while the film in the gate is under tension. If the film breaks, the action of the spring drives the shaft (54) in a clockwise direction until the contact pin (55) reaches the switch contacts (60). The contacts then close, completing the film break warning circuit described in Section 6, Chapter 1.

Hold-back sprocket

24. The purpose of the hold-back sprocket (43) is to allow the film to be fed at constant speed and tension to the take-up spool. The sprocket rotates at half camshaft speed and derives its motion from the shaft (16) via the gears (15) and (10), the shaft (9), the gears (8) and (7), the shaft (6), and the coupling (47). It is provided with a conventional roller carriage (44) and film stripper (42).

Manual drive

25. Rotation of the manual control knob (39) drives the worm wheel (33) via the worm (35) and the shaft (34). The worm wheel drives the shaft (21), and hence the entire system, via a freewheel device similar to that described in para. 11. Details of the free wheel are given in the inset diagram. When the worm wheel turns in the normal direction (corresponding to clockwise rotation of the manual control knob), the drive spring (65) tends to wrap tightly round the sleeve (64), thus transmitting the drive to the shaft (21). If the knob is turned in a counter-clockwise direction, however, the spring tends to unwind and slips round on the sleeve, giving no rotation of the shaft (21).

26. The arrangement prevents the camshaft from being turned in reverse by means of the manual control knob, and also allows normal operation of the gearing when the manual knob is at rest since it would be impossible for the worm to be driven by the worm wheel.

27. If the take-up spool (36) is turned in reverse for any reason, a driving force depending on the amount of friction in the take-up spool drive (*para.* 13) will be imparted to the shaft (21). The direction in which the springs (74) and (65) are wound is such that this force is only prevented from turning the shaft (21) by the meshing of the worm-wheel (33) with the worm (35).

SECTION 4

PROCESSING

Chapter I

GENERAL DESCRIPTION

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General

1. A photographic emulsion consists of certain compounds of silver suspended in gelatine. This is coated on to a transparent support to make a photographic film.

2. When the film is exposed to light, certain changes take place in the silver compounds. The precise nature of these changes is not known, but when the exposed emulsion is subjected to the action of a reducing agent (a photographic " developer ") it is found that the silver compounds in the areas which have been exposed to light become reduced to grains of metallic silver: these appear black when viewed by transmitted light. The compounds in the unexposed areas remain unchanged.

3. The next stage in the processing operation is to remove the unexposed silver compounds from the film. This is done by means of a solution which will dissolve the compounds but has no effect on the metallic silver. This is known as a fixing agent or " fixer."

4. Finally, the processed film must be washed for a period sufficient to remove all traces of the developer and fixer. It is then dried.

5. In the photographic display system, the four processes (viz., developing, fixing, washing and drying) are done by spraying the appropriate liquids on the film in succession and finally blowing warm dry air on the film to dry it. The three liquid jets and air jet required for the purpose form a complete jet unit which operates in an inconel pot located below the processing aperture in the film gate.

6. The complete processing cycle takes place during one rotation of the radar aerial. The accurate timing is achieved by the use of switches operated from a common camshaft. The camshaft ◀is driven at the speed of the radar aerial▶ by means of a servo system whose information is derived from a selsyn link between the controlling radar and the photographic display system.

Jet unit

7. The jet system ejects solution vertically on to the horizontal film which has been moved by the action of the transport mechanism from the camera aperture to the processing aperture. Each individual jet contains a vertical air line and an inclined liquid line: it is operated at the correct instants by the application of compressed air to the air line. Air is switched to each jet in turn and finally to the air drying jet by means of an electrically operated four-way tap. In order to obtain the rapid processing times required for the equipment, the temperatures of the processing liquids are raised by passing the air emerging from the four-way tap through a thermostatically controlled heater.

8. In order to prevent liquids from seeping between the top of the processing pot and the film, the film is pressed firmly on to the rim of the pot by a spring-loaded pad actuated by the film clamping and crimping mechanism in the film gate cover. Since a positive pressure tends to build up in the pot, any seeping action is further prevented by the application of compressed air to the small annular space between the lower table of the film gate and the outer surface of the processing pot. This compressed air also assists in lifting the film from the rim of the pot when the clamps are released for transport, so preventing the swollen, still moist, emulsion from being scored.

Chemicals

9. The following chemicals are used for processing the film:—

(1) *Developer.* Ilford ID 57, Ref. No. 14N/3312. This is supplied in concentrate form in special black polythene storage bottles (*Ref. No. 14B/3379*) each holding 35 oz. The solution is caustic and any which gets on to body or clothing must be washed off immediately with plenty of water.

(2) *Fixer.* Ilford IF 18, Ref. No. 14N/3313. This is supplied as a concentrate of ammonium thiocyanate in special white polythene bottles (*Ref. No. 14B/3378*) each holding 35 oz. The fixer solution contains a blue identifying dye. Ammonium thiocyanate is poisonous and must be handled with care. No iron from any source must be allowed to contaminate the solution.

(3) *Wash.* In the short time available for the washing operation, it is impossible to remove very much of the processing solutions from the film emulsion. In order to neutralize some of the undesirable after effects (such as staining) of the fixer, the ordinary tap water used for washing requires the addition of a small amount of ordinary photographic hypo (sodium thiosulphate). This is supplied in heat-sealed polythene sachets (*Ref. No. 14N/3325*) each containing 30 g of hypo crystals having an identifying pink dye. The sachet also contains $2\frac{1}{2}$ g of a water-softening agent. This converts the various insoluble compounds, formed by the reaction of some substances which cause hardness in water with the photographic chemicals, into soluble compounds. The formation of insoluble sludge and scale in the system is thereby prevented.

Supply

10. In the projector console the three solutions are contained in glass bottles inverted over constant level chambers. The outlets from the constant level chambers are connected to the liquid lines of the appropriate jets and the levels are such that the liquids in the connecting lines reach to within about $\frac{1}{2}$ in. of the jets.

Disposal

11. After being sprayed on the film, the exhausted liquids fall to the bottom of the processing pot where they are drained off into a vertical polythene pipe known as the fume pipe. The top of this is open to the atmosphere to allow undesirable fumes and vapour to escape. The lower end of the pipe terminates at the waste tank where the waste chemicals accumulate.

12. The waste tank empties automatically every 12 hours. This is brought about by applying compressed air to the tank.

Air supplies

13. Compressed air is connected to the projector console at between 40 and 80 lb./in^2. Its pressure is reduced to about 25 lb./in^2. by a pressure-reducing valve and the air then passes to a filter. There are two outlets from the filter. One of the outlets is from the bottom, and this is connected to the waste tank via a motor-operated valve. This valve opens at 12-hourly intervals, when it is switched by the action of a clock unit. The entry of the air into the tank expels the contents of the tank, together with any oil and water which collects at the bottom of the air filter, to an external drain. The other outlet from the filter consists of filtered air and this is used as follows:—

(1) It is passed via the four-way electromatic tap and the air heater to the jet unit.

(2) It is used finally to dry the film in the projection aperture and to keep it cool during projection.

(3) It operates a safety switch in the projection lamp control circuit preventing the lamp from being switched on if there is no cooling air available for the projection aperture.

(4) It is applied to another pressure-reducing valve, where its pressure is reduced to approximately 5 lb./in^2.

14. The air from the second pressure-reducing valve is used only for the processing pot annulus.

Servo system

15. The object of the servo system is to drive the ◀camshaft at the speed of the radar head.▶

16. The camshaft unit itself is known as drive unit (mechanical) timing 4118. As well as the camshaft and cam-operated switches, the unit contains the servo motor which drives it, together with a magslip receiver and associated gearing.

17. The selsyn transmitter in the radar head is driven at 30 times aerial speed. The stator of this selsyn is connected via the selsyn patching box on the wall of the Udder to a selsyn receiver in control unit (selsyn) 921 in the power supply rack. In the control unit, the selsyn receiver drives the rotor of a magslip transmitter via 1:30 gearing so that it turns at the same speed as the radar aerial.

18. The stator of the magslip transmitter is connected to the stator of the magslip receiver in the camshaft unit. An output is obtained from the rotor of the magslip receiver proportional to the misalignment between it and the rotor of the magslip transmitter, and this output forms the input voltage for the servo amplifier (amplifying unit (servo) 4111).

19. The output from the amplifier drives the servo motor in the camshaft unit, which in turn drives the rotor of the magslip receiver in such a direction as to reduce the misalignment between it and the magslip transmitter rotor. By this means the magslip receiver rotor and the camshaft are made to turn at exactly the same speed as the magslip transmitter rotor, and hence at the same speed as the radar aerial.

▶ ◀

Processing interlocks

20. The four-way electromatic tap, which switches air to the jet unit, is energized from the 24V d.c. supply delivered by control unit (selsyn) 921 in the power supply rack. The various taps are arranged so that those controlling the liquid lines are normally closed and require energizing to operate the jets. The air-drying tap is normally open and requires energizing to stop the flow of air through the drying jet.

21. The negative line of the 24V d.c. supply to the four-way tap includes various switch and relay contacts known as the processing interlocks. When any of these open, processing is shut off giving a continuous supply of drying air (dry cycle conditions) in the processing pot. Any of the following events prevents processing:—

(1) Film gate open or incorrectly locked and clamped. The warning FILM GATE OPEN will only be given if the gate catch is disengaged.

(2) PROCESSING ON–OFF switch set to OFF.

(3) Film broken. This will be accompanied by operation of the FILM BREAK warning light.

(4) No rotation of the camshaft. This will normally be caused by no rotation of the radar head, a fault in the servo system or by setting the rotation switch on amplifying unit (relay) 4076 to OFF. In either event, a relay in the amplifying unit releases, cutting off processing and causing the PROCESSING RELAY OPEN lamp to warn the operator that rotation has ceased.

22. A push-button is provided which overrides the effect of the processing interlocks. It is termed the JET INSPECTION SWITCH and is located under the front left-hand corner of the indicating panel; access is obtained via the left-hand side door of the projector console. The button is intended for use during servicing when the jet unit may be operated with the film gate hinged open with the special perspex window supplied in the tool kit, held in position over the processing pot.

Fault warnings relating to chemicals and waste

23. A fault warning is given by means of a light and the buzzer when the chemical supply in any bottle is becoming low. Another warning light operates when the waste tank is full; if this is ignored, the fume pipe starts to fill up and another warning, which also occurs in the event of a waste blockage, is given.

24. Details of the processing interlocks and the various fault warnings are given in Section 6, Chapter 1.

Chapter 2

JET UNIT

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LIST OF ILLUSTRATIONS

General

1. The jet unit contains three jets for applying the develop, fix and wash solutions to the film, in the form of a fine spray; a fourth jet directs warm dry air on to the processed film and substantially dries it.

2. The various jets are operated by compressed air. This is switched by the action of the four-way electromatic tap and is heated by the thermostatically controlled air heater (*chap.* 4).

3. The jet unit is secured in the processing pot (*sect.* 3, *chap.* 3) by means of a clamping ring which engages the screw thread at the bottom of the pot and includes a P.T.F.E. washer providing a moisture-tight seal. The periphery of the clamping ring contains holes to allow the use of a " C " spanner provided in the tool kit.

4. Connections from the various jets to the chemical level chambers (*chap.* 3) and the air heater (*chap.* 4) are made via the union board on the front of the projector mainplate.

5. A schematic diagram of the jet unit is given in fig. 1. The various jets are supported on their supply tubes which are fixed in a base plug. The upper surface of the plug slopes slightly to assist

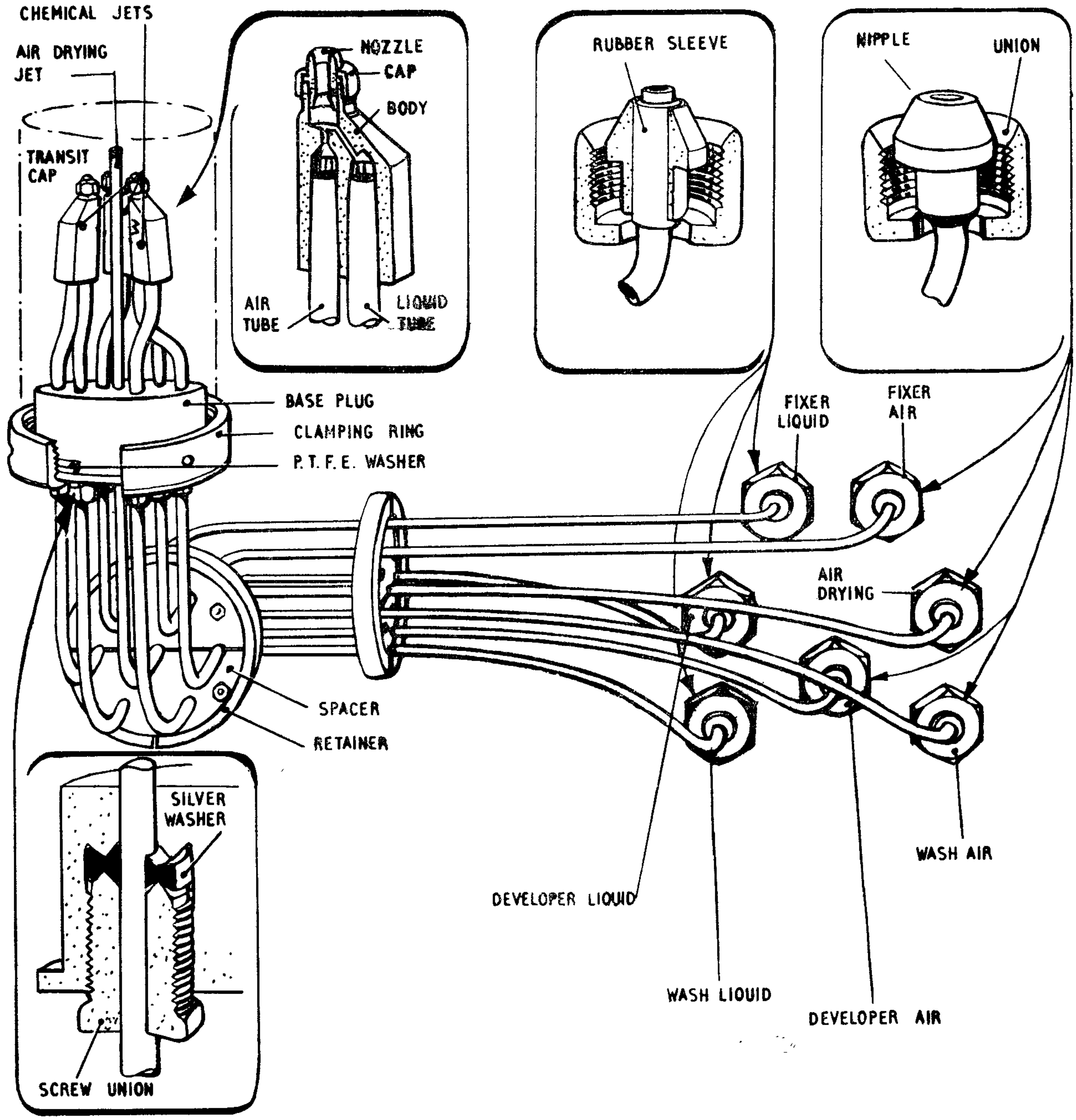

Fig. 1. Jet unit

the flow of exhausted chemicals towards the drain in the processing pot. The air drying tube passes axially through the plug and the three chemical jets are equally spaced around it. The chemical jets converge slightly so that each is directed towards the centre of the processing aperture.

Chemical jets

6. A simple diagram (*fig.* 2) illustrates the principle of a chemical jet.

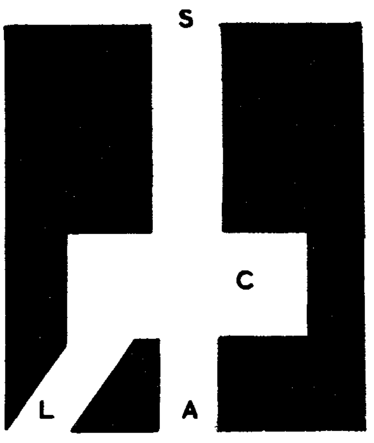

Fig. 2. Chemical jet principle

7. Compressed air enters the small chamber C via a hole A. In the chamber, the air loses pressure energy causing a partial vacuum round the sides of the chamber. Liquid is therefore drawn in through another hole at the side and combines with the air to form a fine high-velocity spray which emerges through a hole S at the top.

8. In practice, the jet is made in three parts :—
a body, a nozzle and a cap. The construction is shown in an inset diagram in fig. 1.

9. The body is drilled to provide the air and liquid inlet holes. The chamber is formed by the space between the nozzle and the body. The nozzle is drilled to provide the delivery hole and is retained in the body by the screwed cap.

10. A slight flare is provided at the bottom of the nozzle hole to provide some manufacturing tolerance. If there were no flare, the axis of the nozzle would be required to coincide exactly with the axis of the air inlet hole in the body otherwise the device would not operate. A flare is also made at the top of the nozzle; the angle of this determines the apex angle of the cone of spray emerging from the jet.

11. It has been determined that increasing the bore of either the liquid or the air hole in the jet body increases the flow of liquid through the jet but also increases the size of the droplets of liquid in the spray. The size of these holes is fixed by the manufacturer to give the best possible spray; the character of this is such that it wets the film evenly without forming into globules.

12. The bore of the nozzle determines the delivery of the jet without affecting the droplet size. This bore is corrected on assembly to give a delivery of approximately a pint and a quarter of the appropriate chemical per hour. Thus, since each jet is turned on for 82 deg. in every rotation of the camshaft, a complete bottle (two and a half pints) of each chemical will be exhausted after eight hours of continuous operation. A very small alteration in the bore of the nozzle has a large effect on delivery.

Note . . .

The three nozzles are not interchangeable since the chemicals differ in specific gravity.

Air drying jet

13. This consists of a simple nozzle driven into the end of the air drying tube. The bore of the nozzle determines the rate of flow of drying air.

Tubing

14. The tubing which connects chemicals and air from the union board on the mainplate to the various jets consists of hard drawn 1/16 in. bore inconel. This tubing is not annealed by the manufacturer to assist bending since in the annealed state the material is liable to corrosion by the various chemicals. For this reason also, soldered connections are not possible since the heat required for the soldering process would cause local annealing.

15. The upper ends of the chemical jet tubes are driven into the jet bodies; a slight taper is employed to ensure a tight and permanent fit. The tubes pass through holes in the base plug and are rigidly fixed in position by means of union screws which seat on silver washers as shown in an inset diagram in fig. 1. When the union screws are tightened up, the silver washers are crushed into the form shown so gripping the tubes securely.

Connections to union board

16. Two types of connection are used at the union board end of the tubes—one for chemicals and one for air. Both employ a cone-ended nipple and a union nut and the difference lies in the method of fixing the tubes to the nipples.

17. Soft soldering is used for the air lines where a little local annealing is unimportant. The following method is used to fix a nipple to a chemical tube :—a piece of rubber tubing is first placed round the end of the inconel tube and is stretched so that its diameter reduces sufficiently to allow the nipple to slip over it. When the rubber tubing is released, it expands and completely fills the space between the nipple and the tube. Surplus rubber is then trimmed off.

18. In their passage to the union board, the tubes are held in position by two sets of split spacers and retainers.

Jet inspection

19. When the jet unit is installed in the projector, the performance of each jet may be inspected by opening the film gate, placing the special perspex jet inspection window over the processing aperture and operating the JET INSPECTION SWITCH. The switch short-circuits the processing interlocks (*sect.* 6, *chap.* 1) and allows the jet unit to operate even though the film gate is open. The equipment can be run under aerial or internal control. If it is required to inspect a particular jet for a period, the switch on amplifying unit (relay) 4076 should be set to STOP when the manual control knob on the front of the projector may be used to turn the camshaft to a position which gives operation of the required jet.

Special note

20. The construction of the jet unit is extremely precise. No servicing is required by the user apart from washing with clean water under a running tap. This will normally be sufficient to clear a partially blocked jet since large particles are excluded from the system by the filters in the chemical level chambers (*chap.* 3). No attempt should be made to clear a badly blocked jet by the use of a piece of wire or similar instrument since this treatment may cause an enlargement of the nozzle and impair the performance of the unit. In the event of a jet unit becoming unserviceable, a replacement unit should be fitted and the unserviceable unit returned for correction and adjustment. A jet unit in store or in transit must be fitted with its protective cap (shown dotted in fig. 1) and installed in a special transit case provided for the purpose.

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Chapter 3

CHEMICAL SUPPLY AND DISPOSAL

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LIST OF ILLUSTRATION

General

1. The chemicals for developing and fixing the film are supplied by the maker in concentrate form in 35 oz. polythene containers. The ordinary photographic hypo crystals and water softening agent, required for the wash solution, are supplied in heat-sealed polythene sachets. Detailed instructions for preparing the chemicals for use are given in Volume 5 of this Air Publication.

2. The chemical solutions are prepared in 50 oz. glass bottles which are subsequently installed in the projector. The developer solution is contained in an amber bottle while the fixer and wash solutions are contained in clear glass bottles. For ease of identification, the fixer solution contains a blue dye and the wash solution a pink dye.

3. When the chemicals have been thoroughly mixed, the bottles are filled to their necks with water and are fitted with black polythene nozzles. They are then placed in their operating positions on the bottle support at the rear of the projector. The position appropriate to each solution is clearly labelled on the bottle support; each identification has a coloured surround.

4. A schematic diagram of the chemical system is given in fig. 1. The various items in the diagram are shown in approximately the positions in which they appear when looking into the projector console from the rear.

5. When in their correct positions in the projector, the bottles (1, 3, 5) are inverted over constant level chambers (4); liquids flow out of the bottles until the levels in the chambers just reach the ends of the bottle nozzles. Atmospheric pressure on the surfaces of the liquids in the chambers then prevents liquids flowing from the bottles until the levels fall sufficiently to allow the entry of air and the displacement of more liquids.

6. Each level chamber has an outlet at the bottom and an overflow outlet near the top. The purpose of the overflow is to prevent liquid from being spilled if a bottle is carelessly inserted or withdrawn or if the joint between the bottle and its nozzle should leak. Overflowing liquid passes through a drain pipe (6) into a tray formed by the chemical shelf (7) on which the level chambers stand. The level chamber also contains a pair of contact probes which becomes uncovered when the liquid level falls about $\frac{1}{4}$ in. below normal. These probes are associated with the chemicals low warning circuit described in Sect. 6, Chap. 1.

◀**7.** Overflow liquids escape through a drain hole in one corner of the chemical shelf and pass through a glass splash trap (23A) and a glass U-tube (23) to the fume pipe (22) which carries waste liquids to the waste tank (16). The purpose of the U-tube is to contain a permanent barrier of liquid between the fume pipe and the interior of the projector console, so preventing the escape of any atomized liquids or gases which may be formed by the combination of waste chemicals. The capacity of the splash trap is greater than that of the U-tube. Thus any increase in air pressure in the fume pipe, due to faulty operation of the clack valve (*para.* 13), will force the contents of the U-tube into the trap. In the absence of the trap, the U-tube liquid would be forced up through the drain in the chemical shelf and into the interior of the projector console. ▶

8. The processing fluids flow from the outlets of the level chambers through synthetic rubber tubes to a union board (10) at the front of the projector; the tubes are routed through pinch cocks on the fluid control panel (24). The union board carries seven unions to which the jet unit (*Chap.* 2) connects; three of these carry the processing fluids from the level chambers and the remaining four carry processing air from the chemical air heater as described in Chap. 4. The purpose of the fluid control panel is to enable the supply of fluids to be cut off if it is necessary to remove the jet unit.

9. After the processing chemicals have been sprayed by the jet unit (9) on to the film, they are drained off from the bottom of the processing pot (8) through a nozzle which is connected by synthetic rubber tubing to the fume pipe (22). The processing waste is composed of approximately 95 per cent solution and 5 per cent fumes. The solution falls down the fume pipe to the waste tank (16); the fumes pass up the pipe to the outside atmosphere.

◀**10.** Any chemicals which leak from the connections at the union board (10) fall on to a deflector plate (11) and then into a moulded polythene drip tray (12) which is mounted below the union board on the front of the projector. A drain nozzle from the drip tray is connected to synthetic rubber tubing (12A) whose end hangs free in a 50oz. glass bottle (15) similar to those used for chemicals (1, 3, 5). The bottle (15) stands in a cadmium-plated mild steel can (15A) at the side of the waste tank.

11. The lower end of the fume pipe is connected to the waste tank via two right-angle bends (21) and (21A), an adaptor (20A) and a stop valve (20). A contact probe (13) mounted on the pipe, and another contact probe (13A) on the adaptor, are included in the 30V AC circuit of the waste blockage warning system described in Section 6, Chapter 1. The situation of the contacts is such that the circuit cannot be operated by a stream of liquid flowing down the inside of the fume pipe during normal operation, so giving a spurious fault warning. ▶

12. The waste tank is hermetically sealed and is emptied by the admission of compressed air. The waste outlet pipe extends nearly to the bottom of the tank. When compressed air is admitted at the top, it displaces the liquid in the tank and forces it up a polythene waste pipe (14) to a suitable drain.

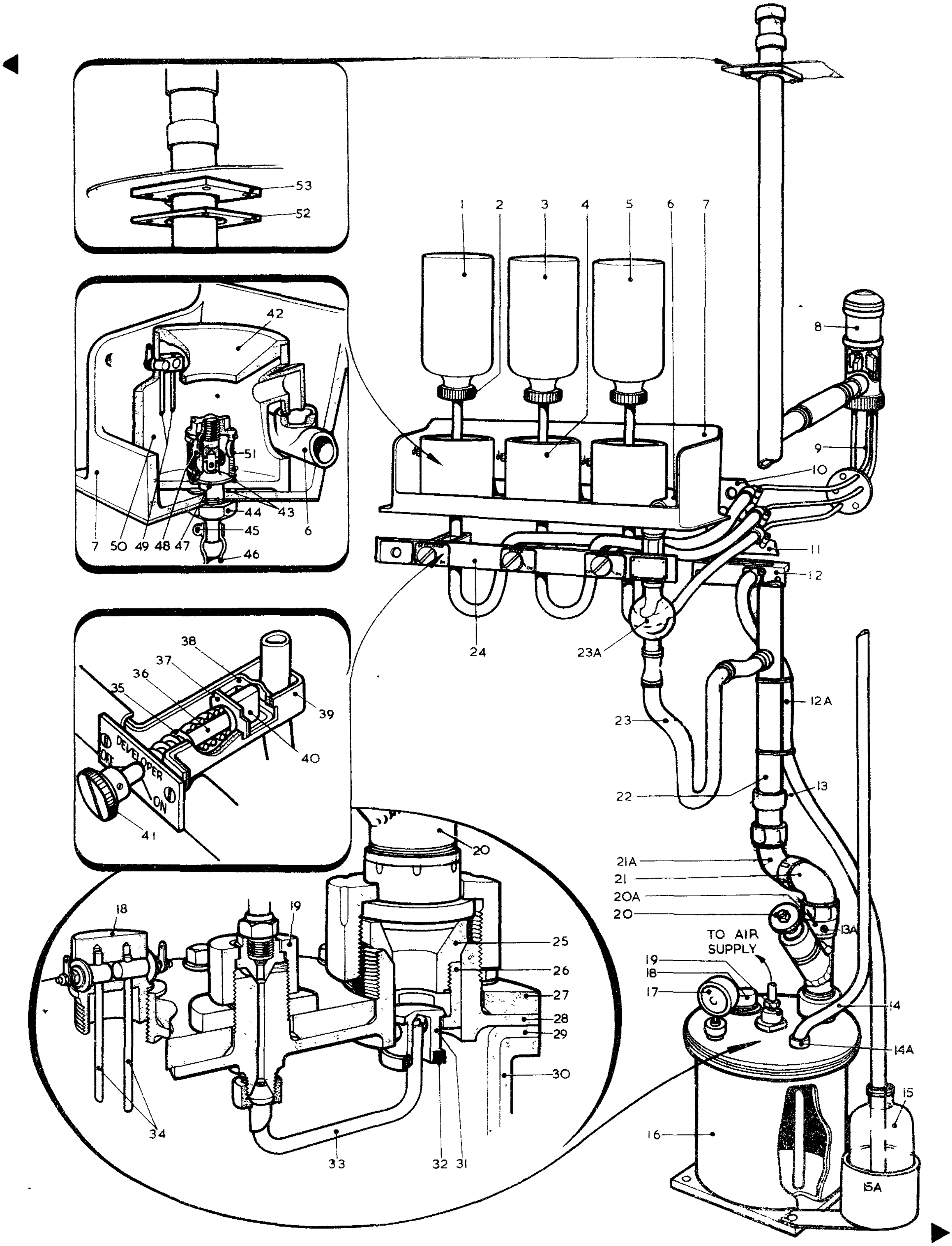

Fig. 1. Schematic diagram of the chemical system

KEY TO FIG. 1

DEVELOPER BOTTLE
BOTTLE NOZZLE
3 FIXER BOTTLE
4 CONSTANT LEVEL CHAMBER
5 WASH BOTTLE
6 DRAIN PIPE
7 CHEMICAL SHELF
8 PROCESSING POT
9 JET UNIT
10 UNION BOARD
11 DEFLECTOR PLATE
12 DRIP TRAY
12A DRIP TRAY DRAIN TUBE
13 WASTE BLOCKAGE WARNING CONTACT PROBE
13A WASTE BLOCKAGE WARNING CONTACT PROBE
14 WASTE PIPE
14A WASTE PIPE BOSS
15 DRIP TRAY WASTE BOTTLE
15A CAN
16 WASTE TANK
17 AIR PRESSURE GAUGE
18 WASTE TANK FULL WARNING CONTACTS
19 AIR INLET BOSS
20 MANUAL STOP VALVE
20A ADAPTOR
21 RIGHT-ANGLE BEND
21A RIGHT-ANGLE BEND
22 FUME PIPE
23 CHEMICAL SHELF U TUBE
23A SPLASH TRAP
24 FLUID CONTROL PANEL
25 VALVE BODY
26 VALVE RETAINER
27 TANK LID
28 TANK LINER LID
29 TANK LINER
30 TANK
31 CLACK VALVE
32 WEIGHTING RING
33 AIR PIPE
34 CONTACT PROBES
35 PRESSURE SPRING
36 SHAFT
37 WASHER
38 INNER BRACKET
39 OUTER BRACKET
40 CLAMP BAR
41 KNOB
42 LEVEL CHAMBER LID
43 SEALING WASHERS
44 SECURING NUT
45 HOSE CLIP
46 RUBBER TUBING
47 FILTER STEM
48 FILTER CASE
49 CONTACT PROBES
50 LEVEL CHAMBER BODY
51 FILTER GAUZE
52 BACKING PLATE
53 FUME PIPE OUTLET SUPPORT

13. The waste entry to the tank includes a "clack" valve which closes automatically when compressed air is applied, so sealing off the fume pipe and allowing air pressure to build up in the tank. The manually operated stop valve (20) is designed for use if the clack valve fails to operate properly due to mechanical failure or dirt.

14. During normal operation, compressed air is applied automatically to the waste tank at 12-hour intervals (*Chap.* 4). If abnormal leakage occurs in the chemical system or if excessive amounts of liquid are poured into the chemical shelf or drip tray, the tank may fill before the automatic emptying process takes place. A manual air control is provided for use when this occurs.

15. The waste tank contains a pair of contact probes which becomes immersed and completes the warning circuit described in Sect. 6, Chap. 1. A gauge (17), which registers the pressure of the air inside, is mounted on top of the tank. If the gauge registers a pressure above atmospheric, it shows that a waste inlet valve is shut and that emptying is in progress. When the waste liquids have been expelled, the air in the tank is allowed a free path up the waste pipe to the outside atmosphere and the pressure shown by the gauge falls to zero, giving an indication that the emptying process is complete.

Chemical shelf

16. The chemical shelf (7) is composed of black polythene and forms the support for the three constant level chambers (4). A polythene drain pipe (6) runs along the back of the shelf. The pipe has an entry under each level chamber overflow outlet. It passes round the right-hand side of the wash level chamber and terminates just short of the front sill of the chemical shelf. In the front right-hand corner of the shelf is a drain which is connected via the splash trap and U-tube to the fume pipe.

Level chamber

17. The detailed construction of a level chamber is given in an inset diagram in fig. 1.

18. The chamber body (50) is made of black polythene in the form of a cylindrical pot which has a central hole in its base and an overflow outlet near the top. Liquid is drawn from the bottom of the chamber body via a filter assembly which also provides a means of fixing the level chamber in place on the shelf. The filter stem (47) passes through the central hole in the base of the chamber and a hole in the chemical shelf. Synthetic rubber washers (43) between a shoulder on the stem and the chamber and between the chamber and the shelf complete a sealing arrangement, and the assembly is secured by a nickel-plated brass nut (44) which screws on to a threaded portion at the lower end of the filter stem. The stem is drilled axially nearly to the top and terminates at its lower end in a nozzle which is inserted into the end of length of $\frac{1}{4}$ in. bore synthetic rubber tubing which conveys liquid to the union board (10). The tubing is secured by a clip (45). The filter consists of a strip of nylon gauze (51) wrapped round a filter case (48). The filter case is screwed on to a threaded portion at the top of the filter stem (47) until its lower end reaches the shoulder on the stem. Liquid passes through the gauze filter via six radial holes in the filter case into a space between the gauze and the filter stem. It then passes into the axial drilling through four radial holes in the stem.

19. The contact probes (49), associated with the chemicals low warning system, are mounted near the top of the level chamber body and project downwards into the liquid space. When the chemical bottle is in its normal position on the bottle support (not shown in fig. 1), the end of the bottle nozzle reaches a position below the level of the overflow outlet in the chamber, but about $\frac{1}{4}$ in. above the lower end of the shorter contact probe.

20. The level chamber has a black polythene lid (42) in the form of an inverted cone which has a hole at its apex to admit the bottle nozzle. The purpose of the lid is to minimize the possibility of dust entering the chamber.

21. The overflow outlet from the chamber bends down at right angles in such a manner that its end is directly above one of the three entries to the drain pipe (6).

Fluid control panel

22. The fluid control panel carries three pinch cocks which enable the supply of liquids to the union board to be cut off, thus preventing chemicals from being spilled when it is required to remove the jet unit.

Pinch cock

23. The details of a pinch cock are given in an inset diagram in fig. 1. The synthetic rubber tube conveying fluid to the union board passes through the space between the inner and outer brackets (38) and (39). When the cock is turned to ON, a clamp bar (40), which is fixed to a shaft (36), is held off by the inner bracket. The clamp bar is held in position by a washer (37), whose shoulders locate in slots in the inner and outer brackets. In order to shut off the fluid line, the clamp bar is turned through 90 deg. by means of the knob (41) on the shaft; it is then able to pass through a horizontal slot in the inner bracket and is forced against the tube by the action of the pressure spring (35).

Waste tank

24. The body (30) of the waste tank is in the form of a mild steel cylinder welded to a square base plate. A circular flange is welded to the top of the cylinder. Into the body fits a black polythene liner (29) with a circular flange at the top on which seats a black polythene liner lid (28) carrying connecting bosses for

(1) Fume pipe.

(2) Waste pipe.

(3) Air inlet.

(4) Air pressure gauge

(5) Waste tank full warning contact probes.

25. The tank lid (27) is a circular mild steel plate having clearance holes for the bosses on the liner lid. It is secured by bolts round its edge which pass through the liner lid and the flanges on liner and tank, making the assembly air tight.

Waste outlet

26. A length of black polythene tubing is screwed into the waste pipe boss inside the tank and extends nearly to the bottom. The portion of the boss outside the tank connects to a long length of polythene tubing (14) which passes up inside the projector console and out through the top to an external drain.

Waste inlet

27. Liquids from the fume pipe enter the waste tank via the clack valve which is contained in the fume pipe boss on top of the waste tank. Details of this are shown in the inset diagram in fig. 1.

28. The valve assembly consists of the body (25), the retainer (26), the valve (31) and the weighting ring (32). The ring is made of inconel; the other parts are of black polythene.

29. The retainer (26) has an internal flange at its base which is cut away to form three prongs. During normal operation, when the tank is filling up with waste liquids, the valve is in its lower position and the shoulder at the top of it rests on the retainer prongs. Liquid from the fume pipe then falls on to the top of the valve and passes between the retainer prongs into the tank.

30. After a period of normal operational processing time, air at 25 lb./sq. in. is automatically admitted to the tank by the system described in Chap. 4. The air enters the tank via the air inlet boss and passes through the pipe (33) to a small orifice situated under the clack valve (31). The valve is then forced on to its seating on the valve body (25), thus sealing off the fume pipe, allowing pressure to build up in the tank; four holes in the cylindrical surface of the valve (31) allow free passage to the air.

31. The air pressure in the tank causes the accumulated liquids to be forced up the waste pipe (14) and out to the external drain. When the level of solution in the tank has fallen sufficiently to uncover the end of the waste pipe, and the pipe has been cleared of solution throughout its whole length, the pressure inside the tank falls to that of the atmosphere; the clack valve is thus able to drop to its normal operating position when the air supply is cut off.

32. If an abnormal amount of liquid is poured into the chemical shelf tray or into the drip tray, or if the automatic system should fail, the liquid in the tank rises to the level of the probes (34) and the waste tank full warning circuit described in Sect. 6, Chap. 1 operates. Provided that the projector compressed air is available, the waste tank can be emptied by manual means. This is done by operating the manual air bypass valve (*Chap.* 4), so admitting air to the tank.

Chapter 4

AIR SUPPLIES

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LIST OF ILLUSTRATIONS

Introduction

1. For satisfactory operation, each projector console requires a high pressure air supply with a flow corresponding to 4 cu. ft. of free air per minute. The equipment also requires a large volume of low pressure air (normally derived from the site equipment cooling air supply) to provide cooling of the electronic chassis and the projection lamp.

2. The high pressure air is normally delivered from a compressor in the site installation at between 40 and 80 lb./sq. in. Its pressure is reduced to 25 lb./sq. in. in the projector console, and it is then passed as required via a four-way electromatic tap and an air heater to the jets in the processing pot. The air, at 25 lb./sq. in. pressure, is also used to cool the film in the projection aperture and to expel waste liquids from the waste tank. Air pressure, in the 25 lb./sq. in. system, closes a switch included in the projection lamp main contactor circuit (*Section* 6, *Chapter* 2) so that the lamp may be started only when the air supply is present at the projection aperture.

3. The air required for the expulsion of waste liquids from the waste tank is controlled by a motor valve. This valve opens once every twelve hours, and remains open for a time sufficient for the waste tank and waste pipe to empty. The emptying time will vary from site to site depending on the difference in level between the projector and the external drain and on the length of the waste pipe. The operation of the motor valve is initiated by a time switch in clock unit 4108 which may be adjusted to vary the period that the valve remains open.

4. Air, at approximately 5 lb./sq. in., is required for the processing pot annulus; this is derived from the 25 lb./sq. in. system by means of another pressure-reducing valve.

5. The two pressure-reducing valves are located below the indicating panel at the right-hand end of the console desk. The valves may be adjusted by means of winged knobs above the panel. Pressure gauges adjacent to the adjusting knobs indicate the air pressures obtained at the valve exits; the dials of the gauges are marked with green sectors which indicate the normal working pressure limits.

HIGH PRESSURE AIR SYSTEM

General

6. A diagram, showing the components associated with the high pressure air system, is given in fig. 1.

Input

7. The pipe line from the site air compressor terminates in an Exactor coupling. This incorporates a shut-off valve which closes automatically when the coupling is broken, so preventing the escape of air.

8. The male portion of the Exactor coupling is fixed to the roof of the projector console and, from here, air is piped to the inlet side of a pressure-reducing valve (21).

25 lb./sq. in. system

9. There are two outlets from the reducing valve (21); one of these is connected to the inlet side of the air filter (8) and the other to the pressure gauge (24). The gauge includes a bleed valve whose purpose is to smooth out pressure variations caused by the action of the four-way electromatic tap.

Air filter (fig. 2)

10. The purpose of the air filter (8) is to remove any particles of dust, oil or water which may be present in the air supply. The construction of the filter is illustrated in fig. 2.

11. The body of the filter consists of a casting carrying the main inlet and outlet connections together with mounting lugs. To this is brazed a vertical hollow stem which passes down the axis of a cylindrical cover. The cover is retained by an end cap, which is secured by a nut on the end of the stem, and its ends are located in annular ditches in the body casting and end cap. The ditches contain neoprene sealing rings, and a neoprene washer is included between the securing nut and end cap, so preventing the leakage of air.

12. Four felt filter elements are mounted round the stem, between perforated brass discs and brass washers, and are located by means of cylindrical brass spacers; the spacers at the lower end of the assembly are perforated to allow the passage of air.

13. Air, at 25 lb./sq. in., from the pressure-reducing valve (*item* 21, *fig.* 1) enters the filter body casting and passes down the hollow stem. It then emerges from the lower end of the stem via radial holes and passes through the perforated spacers and the felt filter elements to the outlet connection.

14. A second outlet connection is provided by the securing nut, allowing unfiltered air to be applied to the waste tank. Any moisture, oil or solid matter which collects at the bottom of the filter assembly is thus blown into the waste tank when the emptying process starts.

Pressure switch (fig. 1)

15. The main outlet of the air filter (8) is connected by tubing to a " T " junction (6) and then to another " T " junction (25) on which is mounted a pressure-operated electrical switch (5). The switch closes when the air pressure at the junction rises to between 18 and 22 lb./sq. in.; it opens if the pressure falls below 12 lb./sq. in. The switch contacts are included in the lamp starter circuit (*Section* 6, *Chapter* 2). One of the outlets from the switch " T " junction (25) is connected to a union (4) on the mainplate and then via an inconel tube to the projection aperture in the film gate (*Section* 3, *Chapter* 3).

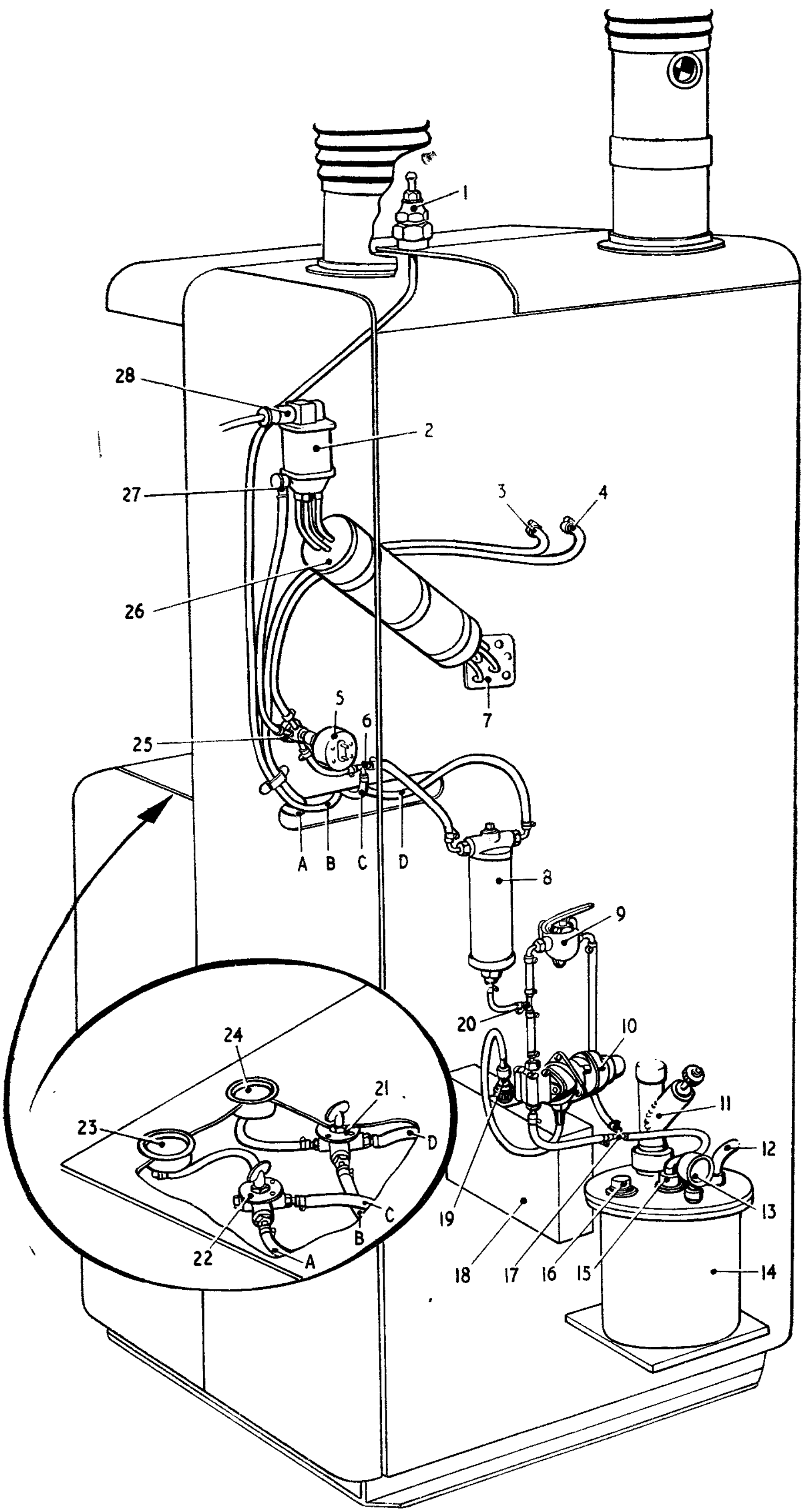


Fig. 1. High pressure air system

KEY TO FIG. 1

1 EXACTOR COUPLING
2 FOUR-WAY ELECTROMATIC TAP
3 AIR UNION TO PROCESSING APERTURE
4 AIR UNION TO PROJECTION APERTURE
5 PRESSURE SWITCH
6 "T" JUNCTION
7 UNION BOARD TO JET UNIT
8 AIR FILTER
9 WASTE TANK MANUAL VALVE
10 WASTE TANK MOTOR VALVE
11 FUME PIPE
12 WASTE PIPE
13 WASTE TANK PRESSURE GAUGE
14 WASTE TANK
15 WASTE TANK AIR INLET BOSS
16 WASTE TANK CONTACT PROBES
17 "T" JUNCTION
18 CLOCK UNIT 4108
19 PLUG AND SOCKET CONNECTION TS7
20 "T" JUNCTION
21 PRESSURE REDUCING VALVE 25 LB./SQ. IN.
22 PRESSURE REDUCING VALVE 5 LB./SQ. IN.
23 AIR PRESSURE GAUGE 5 LB./SQ. IN.
24 AIR PRESSURE GAUGE 25 LB./SQ. IN.
25 "T" JUNCTION
26 AIR HEATER
27 ELECTROMATIC TAP AIR ENTRY
28 PLUG AND SOCKET CONNECTION EV1

Four-way electromatic tap (fig. 1 and 3)

16. The second outlet from the switch "T" junction connects air at 25 lb./sq. in. to the air input line of the four-way electromatic tap (2). A view of this component is given in fig. 3.

17. The tap contains four electrically-operated air valves; three of these are normally closed and the other (drying air) normally open. The outlet air lines from the four valves are connected via an air heater (also shown in fig. 3) to four of the unions on the mainplate union board (7). The remaining three unions, on this union board, carry liquid connections from the chemical shelf (*Chapter* 3).

18. The four air valves are operated in turn by the cam-operated switches in drive unit (mechanical) timing 4118 (*Chapter* 5) and connect the 25 lb./sq. in. air supply via the heater to the develop, fix, wash and dry jets in the jet unit. Electrical connections to the four-way tap are made via socket EV1 (28).

Air heater (fig. 3)

19. This unit has a power consumption of approximately 350 watts. It consists of four parallel nickel tubes carrying unions at either end. The tubes are slightly spaced from one another and are bound round with heating cord and then with woven glass tape. This assembly is mounted between circular end cheeks of silicone-bonded glass fabric laminated board and is surrounded by an asbestos covering secured in place by flexible metal straps. The covering also encloses a thermostat cartridge whose contacts are connected in series with the heating cord. The operating temperature of the thermostat contacts is adjustable by means of a screw accessible through one of the end cheeks; it is factory set at 200 deg. C. Electrical connections to the heater are made to terminals on the other end cheek.

20. The circuit consisting of the heating cord, the thermostat contacts and an indicator lamp (shunted by a resistor) on the fuse panel is supplied from the 15A regulated mains circuit via fuses FS1 and FS2 on the fuse panel and the PROJECTOR MAIN SWITCH on the power supply rack.

Air to waste tank (fig. 1)

21. The compressed air, required for expelling waste liquids from the waste tank, is obtained from the bottom of the air filter (8) and is connected to the waste tank (14) via a motor-driven air valve (10) having a manually operated valve (9) in parallel with it. When air is admitted to the tank, the liquid entry is closed automatically by the action of the clack valve (*Chapter* 3). Operation of the motor valve (10) is controlled by the action of a relay in clock unit 4108. The clock unit is accessible via the door on the left-hand side of the console desk (*Section* 2, *Chapter* 7, *fig.* 1).

Waste tank motor valve

22. This has two main parts: a rotary valve and an actuator consisting of a 24V DC motor and gearbox. The actuator motor field is provided by a permanent magnet, and the direction of rotation thus depends on the polarity of the armature connections. The shaft of the rotary valve is coupled

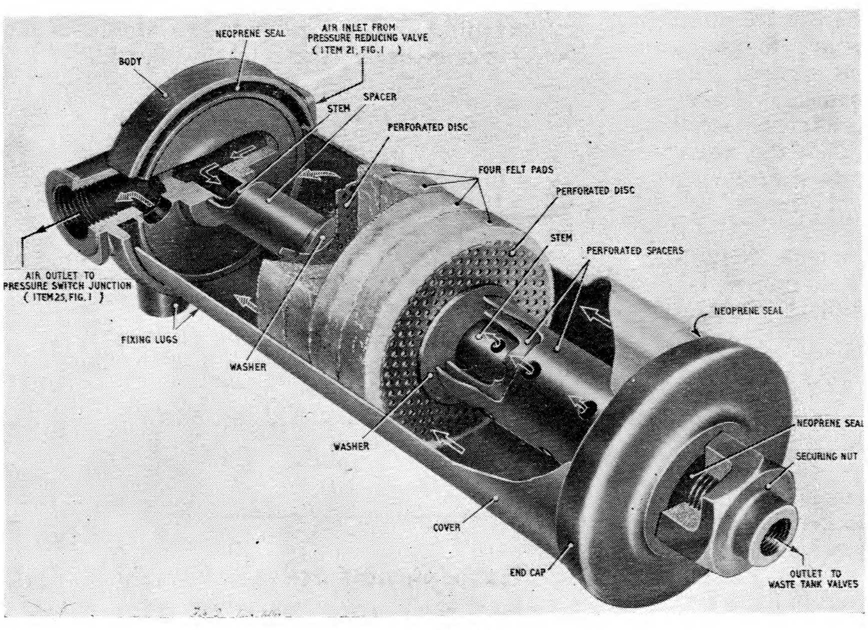


Fig. 2. Air filter

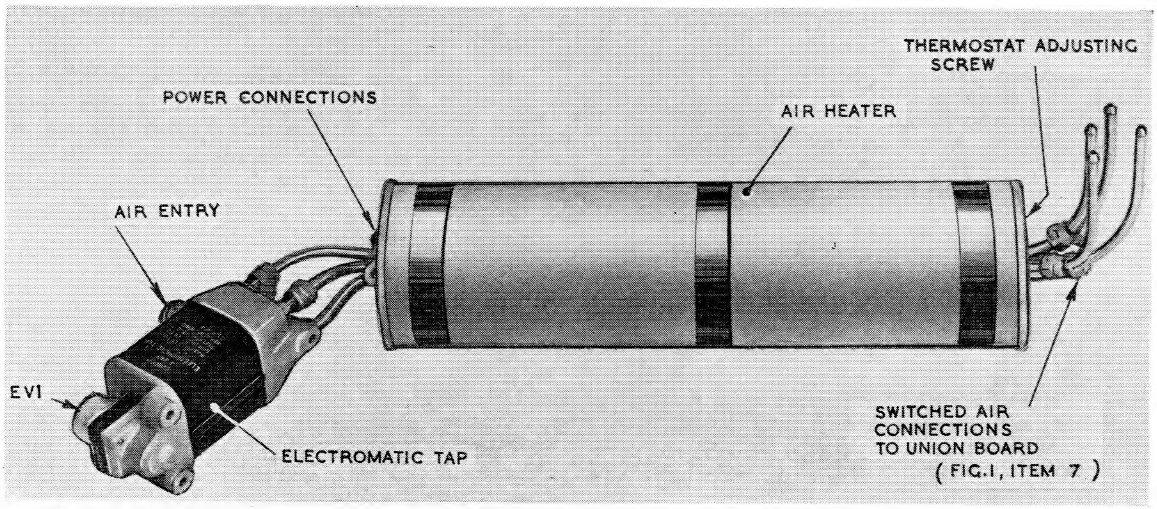


Fig. 3. Four-way electromatic tap and air heater

to the actuator shaft and requires a quarter turn to move from the shut to the open condition; the operation takes approximately 2 sec.

23. A circuit diagram of the actuator is given in fig. 4. The switch contacts shown in the circuit are operated by a Bakelite switch moulding fixed to the output shaft of the actuator and are shown in the positions they occupy when the air valve is shut.

24. In order to open the valve, the 24V DC supply is connected positive on pin 1 and negative on pin 2 of the input socket. The motor then drives in a direction such that the valve starts to open. As soon as it leaves the shut position, contact 4 of the switch makes to contact 6 preparing the closing circuit. When the valve is fully open, switch contact 1 breaks from 3 removing the 24V supply from the motor armature.

25. The circuit now remains inoperative until the 24V supply is connected positive to pin 4 and negative to pin 3 of the input socket. The valve then starts to close. As soon as it leaves the open position, contact 1 makes to contact 3 preparing the opening circuit. When the valve is fully shut, contact 4 breaks from 6 removing the armature supply and stopping the motor.

26. The circuit associated with contacts 2 and 5 of the switch and pins 2 and 6 of the input socket is not used in the photographic display system.

Clock unit 4108 (fig. 5 and 6)

27. The clock unit consists of a Venner time switch mounted in a steel box. A glass door on the front of the box gives access to the switch mechanism. Mounted by the side of this door are two 2·5A service sockets; the regulated mains supply becomes present at these sockets when the wall switch is closed—they are not switched by the PROJECTOR MAIN SWITCH on the control rack. A circuit diagram of the clock unit is given in fig. 5 and a schematic diagram of the switch mechanism in fig. 6.

28. *Mechanical description.* The dial (21) rotates once every 24 hours, being driven by a 230V 50 c/s self-starting synchronous motor via gearing and a friction drive. The dial carries two diametrically opposite pins (20). On some equipments these pins may be mounted on each end of a bar mounted on the dial spindle and locked to the dial by means of a milled nut. The dial may also be calibrated in hours and quarters.

29. At intervals of twelve hours, one of the pins (20) engages the levers (4) and (5); these carry rollers (8) which bear on the contact strips (6) and (10). Movement of the pin about the centre of the dial, in a counter-clockwise direction therefore causes both levers to move, pushing both contacts to the right. At some instant the lever (4) is released by the pin and the contact (6) springs to the left, making to the contact (10). A little later the lever (5) is also released and the contact (10) also springs to the left, breaking from the contact (6). The successive stages of this action are shown in fig. 6, insets (a) to (e).

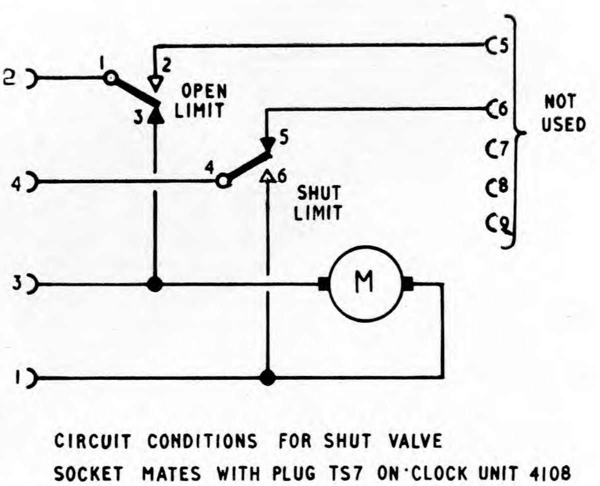


Fig. 4. Waste tank motor valve: actuator circuit

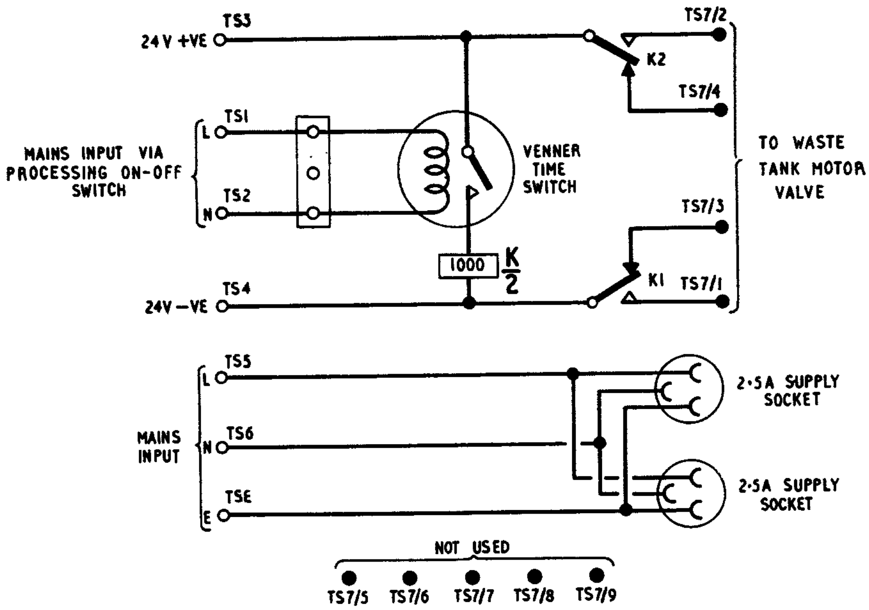


Fig. 5. Clock unit 4108: circuit

30. The lever (4) is pivoted at a fixed point on the base plate (1), but the other lever (5) is pivoted on the pointer (18). The pointer can be rotated slightly about its pivot (12) by means of a milled screw (16) against which it is loaded by the tension spring (15). If the point of the screw (16) is moved downwards, the lever (5) clearly moves upwards so that the make period of the contacts (6) and (10) is increased. The left hand end of the pointer (18) registers against a scale (19) which is calibrated to indicate the duration of this make period.

31. The spring-loaded pawl (3) prevents the dial from being rotated in a clockwise direction to an extent sufficient to damage the levers (4) and (5).

32. *Circuit description*. The energizing winding of the time switch motor is connected via the PROCESSING ON–OFF switch on the indicating panel to the 15A regulated mains supply switched by the PROJECTOR MECHANISM switch on the control rack. The circuit is fused by FS11 and FS12 on the fuse panel. These fuses also protect the supply to the shutter motor (*Section* 3, *Chapter* 3). The time-switch motor thus runs only when processing is in progress, and waste liquids are being supplied to the waste tank.

33. When the time switch contacts close, relay K/2, mounted behind the front panel of the clock unit, is energized and its contacts switch the 24V DC supply via pins TS7/2 and TS7/1 to the waste tank motor valve; the valve opens admitting compressed air to the waste tank. When the time-switch contacts open again, relay K/2 releases connecting the 24V DC supply to the motor valve via TS7/3 and TS7/4; the valve then closes.

Waste tank manual valve (fig. 1)

34. The manual air valve (9), in parallel with the motor valve (10), is included to allow waste liquids to be expelled from the tank, should it become full before the expiry of a twelve hours' running period (due, for example, to the pouring of an excessive amount of water into the chemical shelf). An indication that the tank is full is given by the operation of the warning system (*Section* 6, *Chapter* 1).

35. In order to empty the tank, the manual valve is opened by pressing on the handle while observing the pressure gauge (13) on top of the tank. The gauge reading should rise to approximately 25 lb./sq. in. and remain there during the emptying process. When the tank and waste pipe are empty, indicated by a fall in the pressure gauge reading, the manual air valve is released.

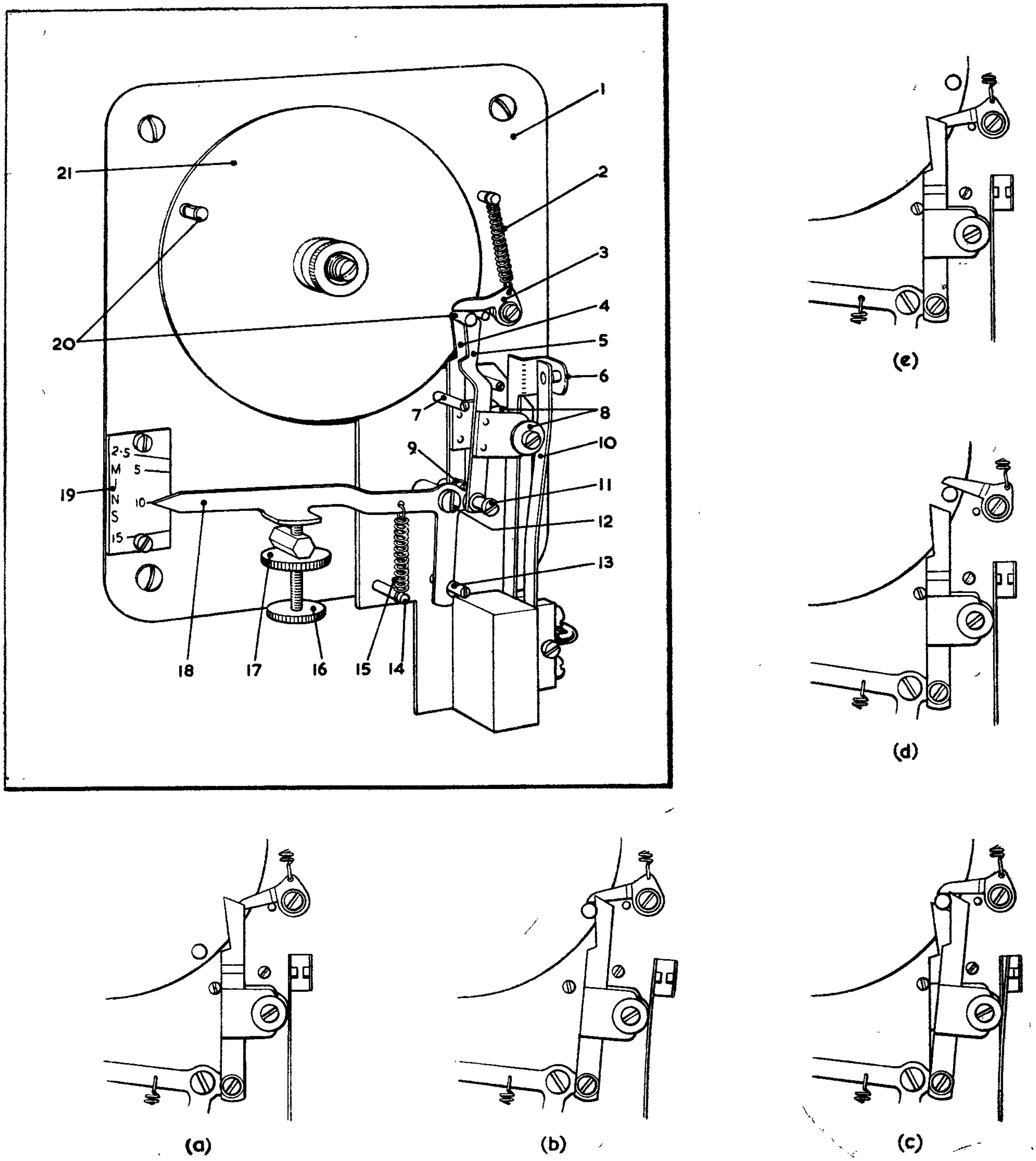
5 lb./sq. in. system *(fig 1)*

36. Compressed air, at 25 lb./sq. in., is obtained from the "T" junction (6) and is connected to the pressure reducing valve (22). The valve carries a winged knob, which is accessible from the indicating panel and which enables the outlet pressure to be set precisely; it has two outlet connections. One of these is connected to the pressure gauge (23) which shows the pressure reduced to between 5 and 8 lb.; this gauge does not include a bleed valve since the load on the 5 lb./sq. in. system is a constant one. The second outlet from the valve (22) is connected to a union (3) on the projector mainplate and thence via an inconel tube to the air annulus in the processing aperture (*Section* 3, *Chapter* 3).

CONSOLE COOLING SYSTEM

37. Air, for cooling the electronic chassis and lamphouse, is derived from the site equipment cooling air supply and is connected to an inlet pipe at the top of the projector console via 6 in. bore flexible trunking. A schematic diagram, showing the routing of this air, through the console, is given in fig. 7.

38. The air passes into a compartment in the right-hand side of the projector roof panel and then through a slot into a vertical cavity inside the right-hand side door. It then passes down through the door and emerges from another slot at the bottom. Baffle plates, in the floor compartment, deflect the air into two streams. One of these passes up through the electronic units and then combines with the other stream to pass via ducting into the lamphouse. Exhaust air from the lamphouse returns to the site cooling air system via



KEY TO FIG. 6

1	BASE PLATE
2	TENSION SPRING
3	PAWL
4	LEVER
5	LEVER
6	CONTACT STRIP
7	STOP PIN
8	ROLLERS
9	PIVOT
10	CONTACT STRIP
11	PIVOT
12	PIVOT
13	STOP PIN
14	SPRING ANCHOR PIN
15	TENSION SPRING
16	ADJUSTING SCREW
17	LOCK NUT
18	POINTER
19	SCALE
20	PINS
21	DIAL

Fig. 6. Clock unit 4108: time switch mechanism

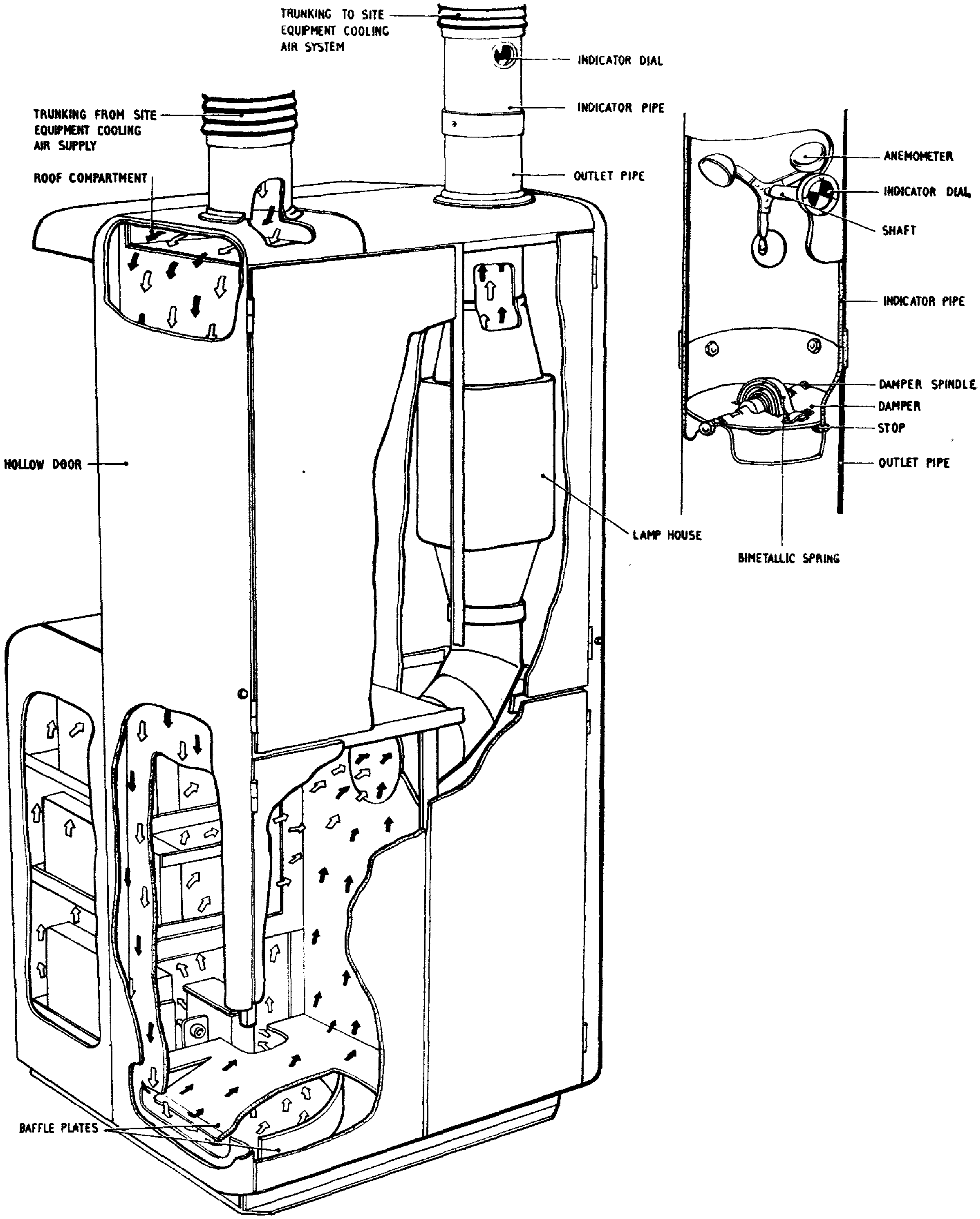


Fig. 7. Console cooling system

a short length of 6 in. pipe, fixed to the console roof and containing an automatic damper, followed by another short length containing an air flow indicator.

39. The damper consists of a metal disc which is pivoted in the tube on a diametral spindle. The controlling element is a spiral spring, formed of a bimetallic strip. When the air emerging from the lamphouse is cold, this spring loads the damper against a stop, so closing off the pipe and restricting the air flow. This enables the projector lamp to reach its operating temperature as quickly as possible after the equipment is switched on.

40. As the lamp warms up, the air temperature in the outlet pipe rises. This causes the bimetallic spring to unwind, so opening the damper and allowing an increase in the flow of cooling air.

41. The air flow indicator consists of an anemometer rotor mounted on the inner end of a radial shaft in a short pipe section interposed between the outlet pipe from the console and the flexible return trunking. The outer end of the radial shaft is mounted in a ball bearing, and carries an indicator dial marked in alternate red and white quadrants; this dial is visible through a window in the surface of the pipe section. The rotor turns at a speed depending on the rate of air flow through the pipe; the indicator dial allows the operator to assess this speed.

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Chapter 5

DRIVE UNIT (MECHANICAL) TIMING 4118

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. Drive unit (mechanical), timing, 4118 provides the motive force for driving the various shafts and sprockets concerned with the overall film drive system described in Section 3, Chapter 6. The main shaft of the unit carries cams which operate the various switches controlling the timing of the processing cycle, film transport and shutter and film clamp operation. The camshaft is driven through gearing by a two-phase induction motor. The speed of the motor, and hence the speed of the camshaft, is controlled by a servo system. The input to the servo system may be derived from a magslip receiver mounted on the camshaft unit; in this case the motion of the camshaft is related to that of the radar whose display is to be photographed. Alternatively, the input to the amplifier can be derived from a potentiometer on amplifying unit (relay) 4076; this potentiometer enables the operator to vary the speed of the camshaft at will and provides a means of using the equipment for the re-projection of a previously processed film.

2. Two views of the unit are given in figs. 1 and 2. It consists of a hollow casting which houses the gearing and provides a mounting for the other components. The casting is bolted to the rear of the projector mainplate in such a manner that an idler gear, which is driven by a pinion on the camshaft, meshes with one of the gears on a vertical drive shaft at the rear of the mainplate.

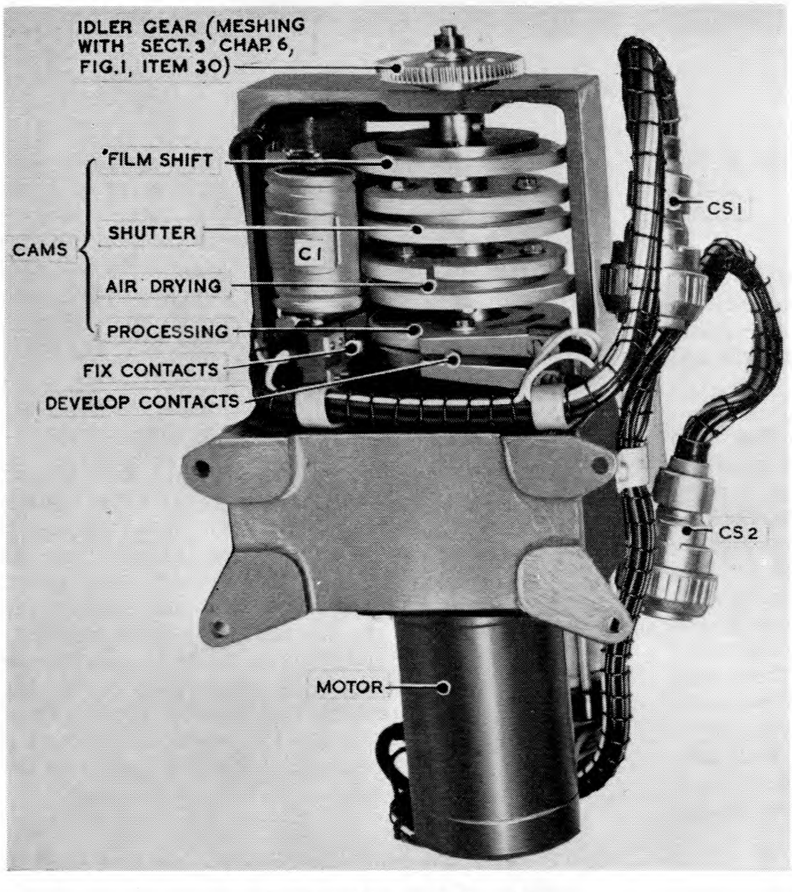


Fig. 1. General view (1)

MECHANICAL DESCRIPTION

Gearbox (*figs.* 1 *and* 2)

3. The form of the gearbox can be seen in figs. 1 and 2. It is divided into two sections. The camshaft is mounted between ball bearings in the upper section; the lower section provides a housing for the gearing.

4. The servo motor generator and the magslip are mounted on a rectangular Dural mounting plate. The various gears associated with them are mounted in ball bearings in the plate. A second plate, spaced from the first by pillars, carries ball bearings providing supports for the upper ends of the two intermediate gear shafts. The assembly is entered into the lower space in the gearbox and is secured by screws.

Gearing (*fig.* 3)

5. A simplified diagram, showing the contents of the gearbox, is given in fig. 3. The gearbox casting and the mounting plates for the magslip, motor generator and gearing have been omitted from this diagram for the sake of clarity.

6. The motor generator shaft (15) drives the magslip shaft (21) through three stages of gearing involving 20-tooth pinions and 117-tooth gears. The overall gear ratio so obtained is very close to 200:1. As explained in the circuit description, the magslip shaft is ultimately driven at the same speed as the radar aerial when the equipment is under aerial control. ◀The camshaft is driven from the magslip shaft via 1:1 gearing formed by a 56-tooth gear (22) on the magslip shaft and a 56-tooth gear (20) fixed to the camshaft.

7. The gear (22) is secured to the magslip shaft by three screws which pass through a keep plate (23a) into a flange pinned to the hub (21). The keep plate also retains the gear (23) which is free to rotate on the spigot of the gear (22). The drive from the gear (23) is transmitted to the magslip shaft by means of a pawl (19), fixed to the gear and loaded by a pawl spring (18), which engages a tooth of the gear (22).

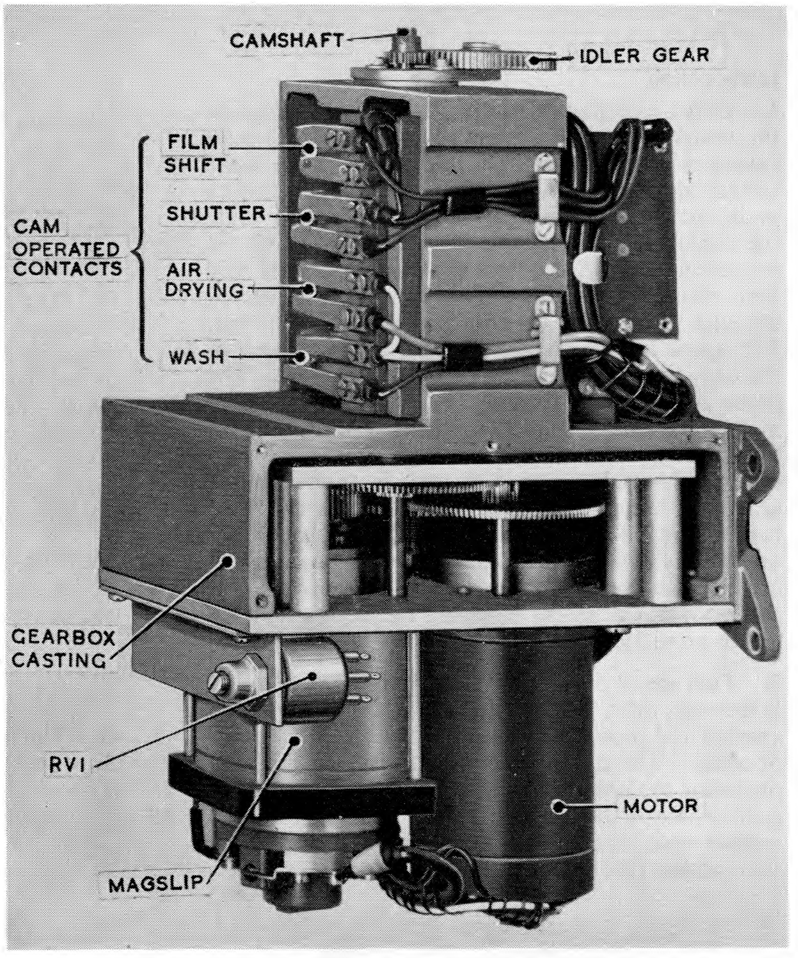
8. The method of driving the magslip from the gear (23) ensures that the magslip shaft and camshaft cannot be driven in reverse with consequent damage to the cam-operated contacts.

9. Reverse rotation is demanded if the system is run up on aerial control with the starting position of the magslip shaft in advance of the radar aerial. Under these conditions, the phase of the magslip rotor output is such that the motor drives in reverse and the pawl (19) runs over the teeth of the gear (22) without turning the magslip. This state of affairs continues until the radar aerial has caught up with the magslip position. Continued rotation of the aerial causes the magslip output to change phase and the motor then starts to drive in the normal direction.▶

Cams and switches

10. The camshaft carries seven cams of which six are grouped in three pairs. Each pair is mounted on a Dural carrier by means of screws which pass through slotted holes in the cams enabling them to be adjusted relative to one another. The carriers are secured to the camshaft by means of grub screws so providing a means of adjusting one cam pair relative to the others. The uppermost cam is mounted alone on a single carrier. The position of this cam (29) is fixed relative to its carrier (4) but the carrier is again fixed to the shaft by means of grub screws.

11. Associated with the cams are switches formed of beryllium-copper leaves having silver or tungsten contacts. Tungsten contacts are used only for the film transport and shutter switches since these have to pass large currents.



◀ **Fig. 2. General view (2)** ▶

Cam profiles (*fig.* 4)

12. The six paired cams have identical profiles (*fig.* 4a). The profile of the single cam is slightly different (*fig.* 4b). In both cases, a sharp step is followed by a period of dwell, a period of rise and a further period of dwell.

Processing switches

13. These are spaced round the lowest pair of cams (25). In order to meet the requirements of precise timing and sharp make and break operation, the circuits are made by one of the cams (25) and broken by the other.

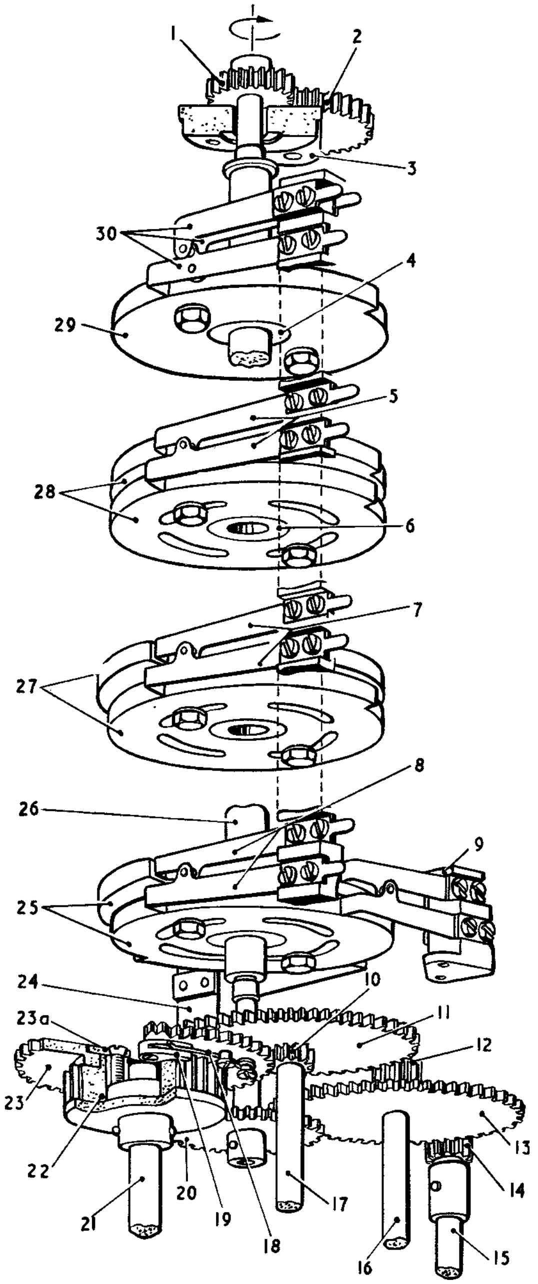
14. When the cam pair is turned such that both contacts of a switch dwell in the outer position, the switch is broken. As the cam rotates, a point is reached when the lower contact reaches the step in the lower cam and springs inwards so making to the upper contact. The switch now remains made until the step in the upper cam reaches the upper contact allowing it to spring inwards and break the switch. Following this action, both contacts dwell in the inner position for a short time and then the lower contact starts to move outwards due to the rise of its cam; a little later, the upper contact also moves outwards. Finally, both contacts dwell in the outer position until the cycle is repeated when the step of the lower cam reaches the lower contact again.

15. Evidently, the duration of the make period of a switch is determined by the angular spacing between the cam steps, and this is set to be 82°. The switch leaves are built up on S.R.B.F. carriers which are secured to the gearbox casting in such positions that the angles between the develop and fix switches and between the fix and wash switches are 82°. The make of the fix switch is thus coincident with the break of the develop switch; similarly, the break of the fix switch coincides with the make of the wash switch.

Air drying switch

16. This switch is operated by the middle cam pair (27) and its operation is similar to that of the processing switches. The cam steps are again spaced at 82°, but the upper cam is the leading one so that the switch is broken for 82°, not made. The reason for this is that the electromatic tap associated with the air drying cycle is normally open and the circuit must be made to shut off the air. This is a protective measure to ensure the prevalence of dry cycle conditions if the circuit of the processing interlocks (*Section* 6, *Chapter* 1) is broken for any reason or if the 24V supply to the projector should fail.

17. The cam pair is oriented on the cam shaft in such a position that the air drying switch breaks at the same instant as the wash switch.



◀**Fig. 3. Mechanical details: simplified diagram**▶

KEY TO FIG. 3

1 PINION (30T)
2 IDLER GEAR (60T)
3 GEAR CARRIER
4 CARRIER (SINGLE CAM)
5 SHUTTER AND FILM CLAMP SWITCH
6 CARRIER (DOUBLE CAM)
7 AIR DRYING SWITCH
8 WASH SWITCH
9 FIX SWITCH
10 PINION (20T)
11 GEAR (117T)
12 PINION (20T)
13 GEAR (117T)
14 MOTOR—GENERATOR PINION (20T)
15 MOTOR—GENERATOR SHAFT
16 INTERMEDIATE GEAR SHAFT
17 INTERMEDIATE GEAR SHAFT
18 PAWL SPRING
19 PAWL
20 GEAR (56T)
21 MAGSLIP RECEIVER SHAFT
22 GEAR (56T)
23 GEAR (117T)
23A KEEP PLATE
24 DEVELOP SWITCH
25 PROCESSING CAMS
26 CAMSHAFT
27 AIR DRYING CAMS
28 SHUTTER AND FILM CLAMP CAMS
29 FILM TRANSPORT CAM
30 FILM TRANSPORT SWITCH

Shutter and film clamp switch

18. This is associated with the upper cam pair (28). Its operation is similar to that of the processing switches. The cam steps are set at 7·2°. ◀The cam pair is so arranged▶ on the camshaft that the switch makes approximately 1° after the air drying switch.

Film transport switch

19. The single cam (29) drives the centre contact of a changeover switch (30). When the cam step reaches this centre contact leaf, the leaf springs inwards and makes to a rigid inner leaf. This action connects a fully charged large capacitor across the solenoid in drive unit (mechanical), film, 4119 and initiates the film transport action. The cam is so set on the camshaft that this occurs 1·25° after the shutter switch is made. At some point during the subsequent rise of the cam, the centre contact makes to the outer contact and initiates recharging of the capacitor from the −250V trip supply. The precise point at which this occurs is unimportant.

Overall film drive

20. A pinion (1) mounted on the top end of the camshaft, meshes with an idler gear (2) on a carrier (3). Three screws, passing through slotted holes, secure the carrier to the gearbox casting. This method of fixing permits the centre of the idler (2) to be rotated slightly about the centre of the pinion (1) for adjustment of the mesh between the idler and a gear on the vertical shaft at the rear of the mainplate.

CIRCUIT DESCRIPTION

21. A circuit diagram of drive unit (mechanical), timing, 4118 is given in fig. 5.

22. The operation of the cam driven switches SWA, SWB, SWP, SWQ, SWR and SWS is discussed in Section 6, Chapter 1. Connections to the switches are made via socket CS1 which is located on the servo panel (*Chapter* 6). The servo motor generator and the magslip receiver are connected via socket CS2 which is also mounted on the servo panel.

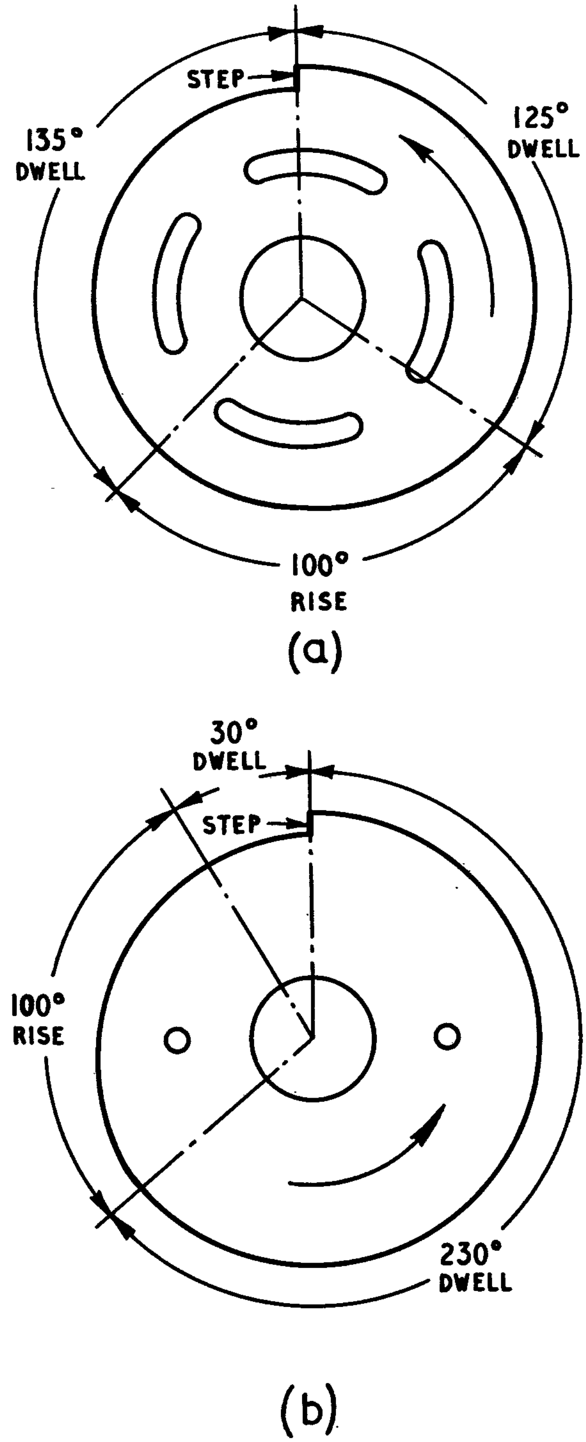


Fig. 4. Cam profiles

Servo system

23. The servo system includes parts of the following units:

(1) Control unit (selsyn) 921 (*Chapter* 7).

(2) Amplifying unit (servo) 4111 and power unit (servo) 4128 (*Chapter* 6).

(3) Amplifying unit (relay) 4076 (*Section* 6, *Chapter* 3).

(4) Relay unit 4105 (*Section* 6, *Chapter* 1).

(5) Drive unit (mechanical, timing, 4118).

A simplified circuit, which includes the relevant parts of all these units, is given in fig. 6.

Aerial control

24. The radar aerial drives the rotor of a selsyn transmitter through gearing of ratio 1:30. Connections are made from this transmitter to a selsyn receiver in control unit (selsyn) 921 in the radar photographic display system. The rotor of the selsyn receiver thus turns at 30 times aerial speed. The rotor of the selsyn receiver drives the rotor of a magslip transmitter through 30:1 gearing; the magslip transmitter rotor therefore turns at the same speed as the aerial.

25. The magslip transmitter rotor is energized by the 50V, 50 c/s reference supply derived from power unit (servo) 4128. This supply is routed through relay contacts RLG1 in relay unit 4105. The operating coil of the relay is connected across the 24V d.c. supply from control unit (selsyn) 921 so that the relay operates immediately the PROJECTOR MECHANISM switch on the power supply rack is closed.

26. Voltages are induced in the stator windings of the magslip transmitter and these are connected to the stator windings of the magslip receiver in the camshaft unit.

27. The voltage induced in the receiver magslip rotor will depend on the position of the rotor relative to the field produced by the stator windings. It will be zero when the axis of the rotor winding is at right angles to the field; this is the condition of exact alignment. If there is any misalignment between the magslip rotors, a voltage depending on the amount of misalignment will be developed across the receiver magslip rotor winding. The characteristics of the magslips are such that the phase of this misalignment voltage leads that of the 50V reference voltage by 30°.

28. The misalignment voltage is connected via the rotation control switch (set to AERIAL CONTROL) on amplifying unit (relay) 4076 to the input circuit of the servo amplifier (amplifying unit (servo) 4111). The output of the amplifier is applied to one of the motor windings of the servo motor-generator in the camshaft unit. The motor section of this unit is a two-phase induction machine requiring two alternating voltages differing in phase by 90° to drive it. One of these is the reference voltage from the servo power unit which is connected via the rotation control switch (relay amplifier) to terminals X and Y of the motor; the other is the servo amplifier output connected to terminals 1 and 2. Of the required 90° phase difference, 30° is provided by the magslip link (*para.* 27) and the remaining 60° by the servo amplifier.

29. The motor rotor is designed to have a large resistance in order to obtain a high starting torque. This torque falls off in almost a linear manner as the speed of the machine increases. For a given speed, the variation of torque with control phase (servo amplifier output) voltage is approximately linear.

30. Mounted on the motor shaft is a copper drag cup which operates in conjunction with two more stator windings. These windings are arranged at right angles to each other and one of them (X, Y) is energized from the 50V reference supply; the

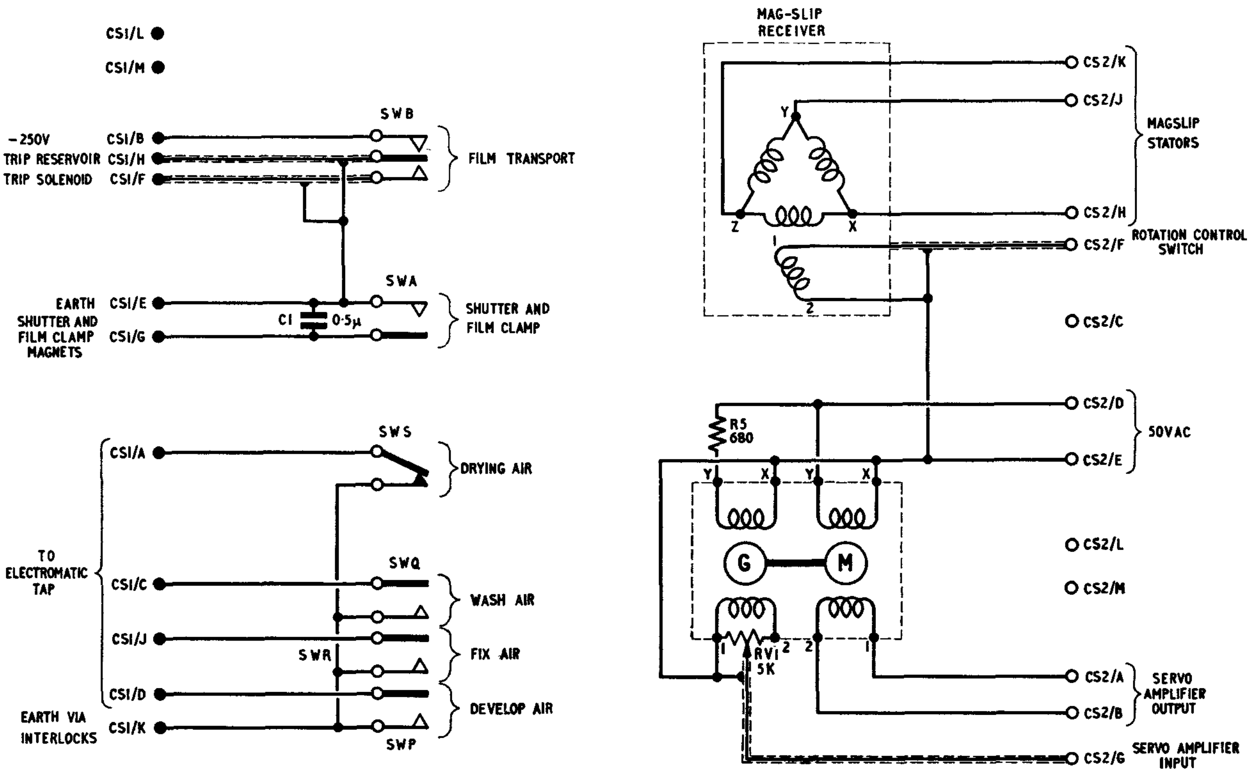


Fig. 5. Drive unit (mechanical) timing 4118: circuit

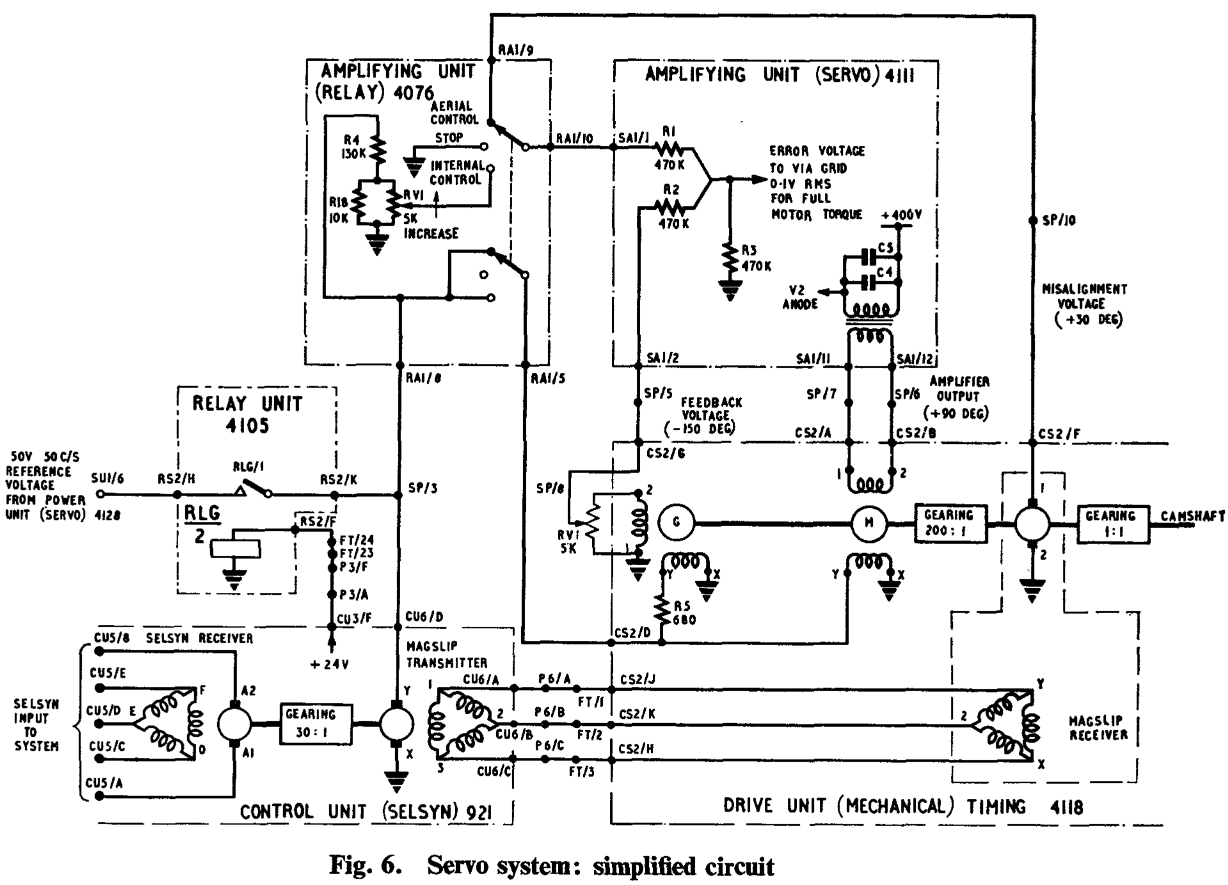


Fig. 6. Servo system: simplified circuit

other (1, 2) forms an output winding. When the motor is at standstill, there is no coupling between the two windings since the alternating field set up by the energizing winding, is at right angles to the output winding.

31. When the motor shaft rotates, eddy currents flow in the copper drag cup due to its rotation in the energizing field. Since the energizing field is an alternating one, the eddy currents alternate and generate an alternating flux which links with the output winding. An a.c. output is therefore produced whose amplitude is proportional to the speed of rotation. The exact phase of this output depends on iron losses, the inductance of the eddy current paths and other factors in the design of the machine.

32. The servo amplifier and motor generator may be considered as a complete amplifier employing negative feedback. The input to this amplifier is the misalignment voltage from the magslip applied via a feed resistor R1. The output from the amplifier is the generator output and this is applied ◀across the stator of potentiometer R1. The voltage at the slider of the potentiometer is applied via a feedback resistor R2 to the input grid of the amplifier. Since R1 and R2 are of equal value, it follows that the overall gain, from pole SA1/1 to CS2/9, is unity.

33. From this, it follows that a given misalignment voltage will cause the motor to drive at such a speed that the generator produces an output, at RV1 slider, equal in magnitude to the misalignment voltage.▶ Actually, there must be a small difference between input and output voltages in order to provide a voltage at the input grid of the servo amplifier. This is known as the error voltage and, since an error of 0·1V r.m.s. is sufficient to cause the motor to drive at full speed, it can be neglected.

34. In order to satisfy the requirements of negative feedback operation, the generator output must be in antiphase to the misalignment voltage which is 30° in advance of the reference voltage. The generator energizing winding is supplied from the reference supply; and the required phase adjustment to ensure that the generator output lags the misalignment voltage by 180° (and therefore lags the reference voltage by 150°) is obtained by the inclusion of a resistor in series with the energizing winding; this resistor and the inductance of the winding form a phase shift circuit.

◀**35.** The generator output, at pole CS2/9, is adjusted by means of RV1 to be 0·75V r.m.s. per 1,000 rev/min. The method of adjusting RV1 is given in Part 2, Sect. 1, Chap. 12.▶ Optimum performance is obtained from the photographic equipment at one picture each 15s though tolerable results are obtained at one picture each 8s. A 15s cycle corresponds to a motor speed of 800 rev/min. and this would require a misalignment voltage of approximately 0·6V r.m.s.

Internal control

36. An artificial misalignment voltage, to enable the projector to be run without the control of a radar, is provided from the slider of the INCREASE potentiometer RV1 in amplifying unit (relay) 4076. This potentiometer is part of a resistive network connected across the 50V reference supply; its slider is connected to the servo amplifier input circuit via the rotation control switch (set to INTERNAL CONTROL).

37. The voltage obtained from the potentiometer is in phase with the reference voltage and therefore leads the feedback voltage by only 150°. The error voltage is therefore the vector difference between feed and feedback voltages and the amplifier output is advanced by 60° on the phase of this error voltage. The voltages applied to the motor are not therefore 90° apart in phase but satisfactory operation is obtained. The setting of the INCREASE control determines the amplitude of the artificial misalignment voltage and therefore sets the speed of the motor and camshaft.

Rotation control switch

38. This switch, which is mounted on amplifying unit (relay) 4076 has two wafers. One of these controls the input to the servo amplifier. The operation of this for AERIAL CONTROL and INTERNAL CONTROL is described in the preceding paragraphs. When the switch is set to STOP, the amplifier feed resistor is connected to earth. The other wafer of the switch completes the 50V reference supply from the servo power unit to the servo motor-generator windings in the two running positions but interrupts it in the STOP position. The reason for this is to prevent the servo motor from idling as a single phase machine when there is no output from the servo amplifier.

Chapter 6

AMPLIFYING UNIT (SERVO) 4111
AND POWER UNIT (SERVO) 4128

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LIST OF ILLUSTRATIONS

Introduction

1. Amplifying unit (servo) 4111 provides an output which supplies one winding of the two-phase induction motor which drives the camshaft in drive unit (mechanical) timing 4118.

2. The input to the amplifier consists of the 50 c/s voltage proportional to the angular misalignment between the magslip transmitter in control unit (selsyn) 921 and the magslip receiver in the camshaft unit, together with feedback from the motor generator which drives the camshaft. A description of the servo system as a whole is given in Chap. 5.

3. Power unit (servo) 4128 provides the HT and heater voltages for the servo amplifier. In addition, it supplies 50V at 50 c/s (known as the reference voltage) for the permanently energized windings of the camshaft motor generator; this voltage also energizes the rotor of the transmitter magslip in control unit (selsyn) 921, from which the magslip misalignment voltage applied to the servo amplifier input is ultimately derived.

Amplifying unit (servo) 4111

4. A view of this unit, showing the layout of components, is given in fig. 1; a circuit diagram is given in fig. 2.

5. The circuit consists of a two-stage voltage amplifier, formed by the two sections of a double triode valve V1, followed by a single stage power amplifier V2.

6. The misalignment voltage from the coincidence magslip and the feedback voltage from the motor generator are applied to the grid of V1a, via SK1, R1 and SK2, R2 respectively. R3 forms a grid leak and is returned to earth via SK3. Both inputs are 50 c/s voltages and, since they are in antiphase, the resultant voltage at V1a grid is the difference between them; this is known as the error voltage.

7. The amplified voltage at the anode of V1a is applied via C1 to V1b grid, where it is developed across R8. The values of C1 and R8 are so chosen that the phase of the voltage at V1b grid leads that at V1a anode by 30 degrees. The output at V1b anode is applied via C3, R10 to the grid of the output valve V2. Again, C3 and R10 introduce a phase change of +30 deg.

8. The output from V2 is developed across the primary winding of transformer T1 in the anode circuit of the valve. This transformer winding is shunted by C4 and C5, giving a circuit approximately tuned to 50 c/s. The output from the secondary winding is applied to one winding of the camshaft motor. Since the misalignment voltage from the coincidence magslip is advanced by 30 deg. on the reference voltage applied to the other winding of the motor, it follows that the output of the amplifier is advanced on the reference voltage by the 90 deg. required for two-phase motor operation.

9. An input of 0·1V RMS at V1a grid is sufficient to cause full motor torque, and it is convenient to consider that a " virtual earth " exists at this grid. In this case, the current flowing in R1 at any instant must equal that flowing in R2. Consequently, since R1 and R2 are of equal value, the generator feedback voltage proportional to the speed of the camshaft at SK2 must be equal and in antiphase to the magslip misalignment voltage at SK1. From this, it follows that the amount of magslip misalignment which exists in the steady state is proportional to the speed of the camshaft since it must always cause the motor generator shaft to turn fast enough to develop a balancing feedback voltage.

10. The preceding description applies to the amplifier when the projector is run under radar aerial control. When it is required to run the projector for the projection of a previously processed film, the magslip misalignment voltage is removed by the

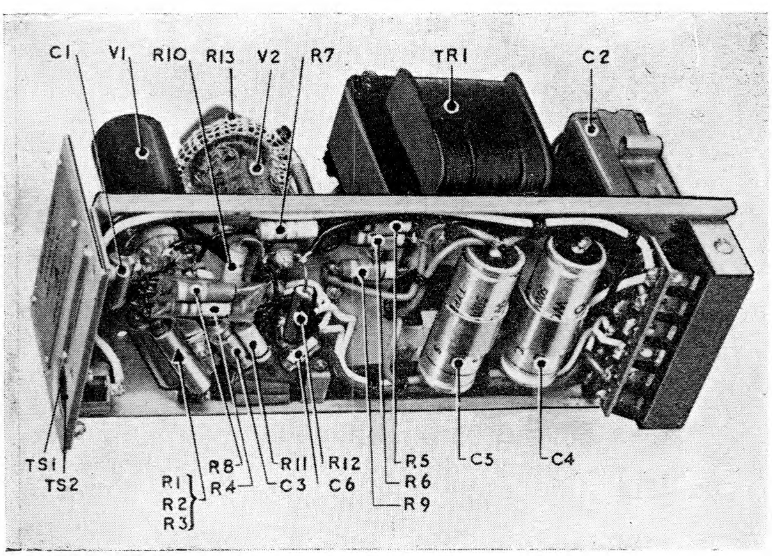

Fig. 1. Amplifying unit: general view

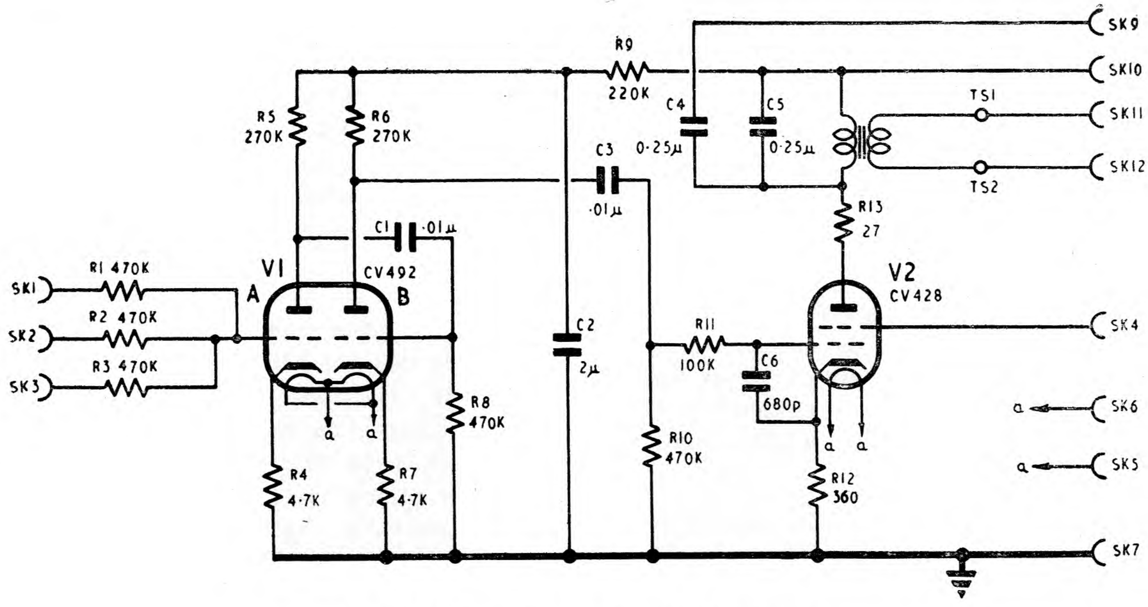

Fig. 2. Amplifying unit (servo) 4111: circuit

action of the AERIAL CONTROL—STOP—INTERNAL CONTROL switch on amplifying unit (relay) 4076 (*Sect.* 6, *Chap.* 3), and is replaced by a small 50 c/s voltage derived from a potentiometer across the reference voltage. The output of the amplifier (and hence the speed of the camshaft) then depends on the setting of the potentiometer—the control marked INCREASE on the relay amplifier.

Power unit (servo) 4128

11. A view of the power unit, showing the layout of components, is given in fig. 3; a complete circuit diagram is given in fig. 4.

12. The primary of the mains transformer T1 is supplied via fuses FS7 and FS8 in the fuse panel from the 15A regulated mains supply; this becomes present immediately the PROJECTOR MAIN SWITCH on the power supply rack is closed (*Sect.* 6, *Chap.* 1).

13. A secondary winding on the transformer supplies the anodes of two half-wave rectifier valves V1 and V2 which are connected in a full-wave rectifier circuit. The output from the common cathode connection is at +400V DC and provides the HT voltage for the servo amplifier valves (*fig.* 2). Some smoothing is provided by capacitors C1 and C2. Further smoothing is provided in the amplifier, for the anodes of V1a and V1b, by the decoupling circuit consisting of R9 andC2.

14. The screen grid voltage for the amplifier output valve is derived from the network R1, R2, R3 in the power unit. The +270V so obtained is smoothed by capacitor C3.

15. The heaters of the two rectifier valves are supplied from an LT winding on the transformer. This winding also supplies the heaters of the servo amplifier valves.

16. A third secondary winding on the transformer delivers a 50V AC supply for:—

(1) The rotor of the transmitter magslip in control unit (selsyn) 921.

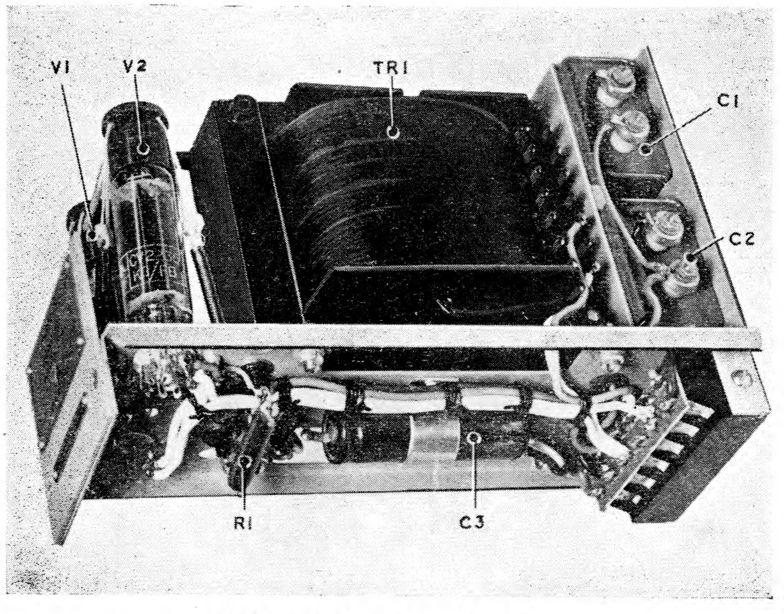

Fig. 3. Power unit: general view

(2) The permanently energized windings of the motor generator in drive unit (mechanical) timing 4118.

(3) The INCREASE potentiometer in amplifying unit (relay) 4076 which provides the input voltage for the servo amplifier when the rotation control switch is set to INTERNAL CONTROL.

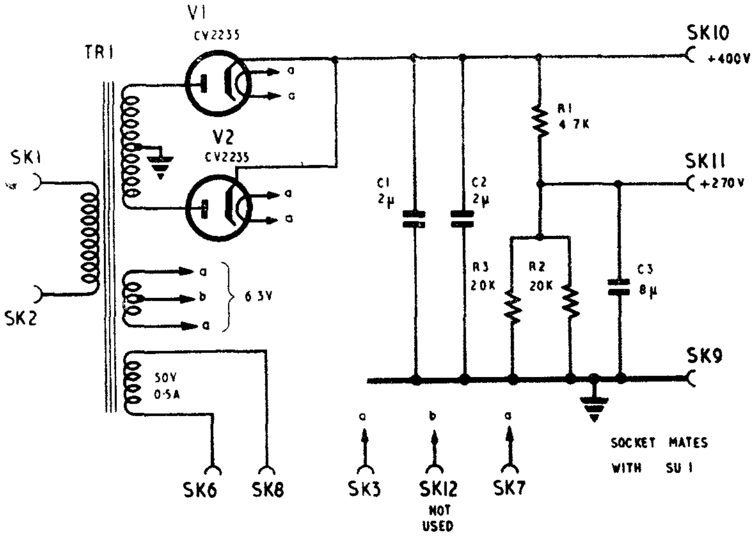

Fig. 4. Power unit (servo) 4128: circuit

Interconnections

17. The servo amplifier and its power unit are mounted together with amplifying unit (relay) 4076 on a panel (known as the servo panel) immediately below the chemical shelf at the rear of the projector. As well as providing a mounting for the units, the servo panel forms a distribution panel for the interconnections between them and to other units in the projector.

18. The servo amplifier and power unit carry Jones sockets which mate with Jones plugs SA1 and SU1 on the servo panel when the units are in place. The relay amplifier connections are made in a similar manner, but in this case a Jones plug on the unit mates with a socket RA1 on the panel.

In addition, the servo panel carries sockets CS1, CS2 (camshaft unit) RS1, RS2 (relay chassis) and an 18-way terminal strip SP. A diagram showing the servo panel connections concerned with the operation of the servo system and the relay amplifier is given in fig. 5. Sockets CS1 and RS1 are not included on this diagram since they are mounted on the servo panel for convenience only; details will be found in the interconnection diagram for the complete equipment (*Sect.* 1, *Chap.* 2).

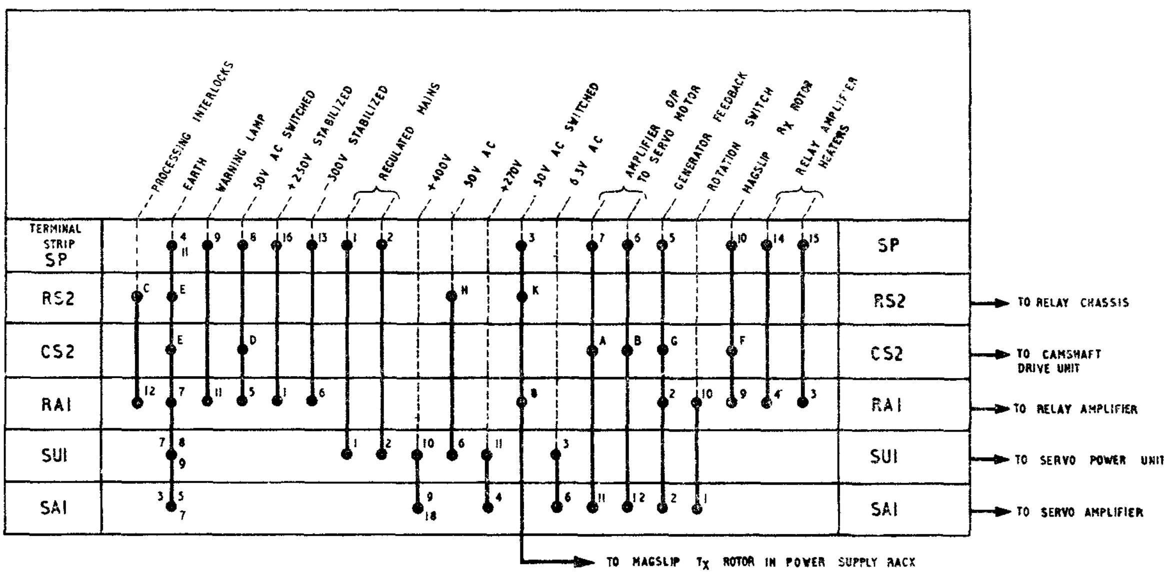

Fig. 5. Servo panel: interconnections

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Chapter 7

CONTROL UNIT (SELSYN) 921

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LIST OF ILLUSTRATIONS

General

1. Control unit (selsyn) 921 is located in the second shelf of rack assembly (power supply) 340. The unit contains the following:—

(1) A selsyn receiver driving the rotor of a magslip transmitter through a gearbox. This is known as magslip unit 4125; it is associated with the camshaft servo system described in Chapter 5.

(2) A power pack which generates:—

(a) The negative 250V trip supply associated with film transport (*Sect.* 3, *Chap.* 4).

(b) 30V AC for the chemicals low, waste tank full and waste blockage warning systems (*Sect.* 6, *Chap.* 1).

(c) 24V DC for various relays and warning lamps in the projector console (*Sect.* 6, *Chap.* 1).

(3) The HEAD SELECTOR SWITCH which enables selection of the particular radar whose information is to be displayed on the projection screen.

(4) A HEAD COMBINING key. This enables the display of the selected radar to be combined with that of a " backward looking " radar when there is one present on the site. When this facility is used, the resultant picture is semicircular since 180 deg. of the picture from each radar is displayed alternately.

(5) The 180 DEG. SELECTOR SWITCH. This is operative only when head combining is used. It then enables the operator to select the bearing of the semi-circular display.

(6) The CALIBRATION VM/RM switch. This enables the operator to apply range marks or video map to the picture as required.

(7) A CALIBRATION FINE/COARSE key. This enables range marks to be selected at 5 or 10 mile intervals. It also alters the type of video map.

2. A front panel view of the control unit can be seen as part of the complete power supply rack in Section 1, Chapter 2. A view, showing the lay-out of components, is given in fig. 1 of this chapter.

CIRCUIT DESCRIPTION

Power pack

3. The primary winding of the mains transformer T1 is energized by the 15A regulated mains supply routed via the PROJECTOR MAIN SWITCH and the PROJECTOR MECHANISM switch in control unit (projector) 4075. This enters the selsyn control unit at a three-pole terminal strip CU and is fused by FS1 and FS2.

Trip supply

4. This is derived from a 200V secondary winding on the transformer. The output from this winding is rectified by the half-wave metal rectifier MR1 and is passed via fuse FS3 to socket CU3/B and thence to the projector console.

30V AC output

5. A secondary winding on the transformer supplies 30V AC for the chemicals low, waste tank full and waste blockage warning systems. Connected across this supply (in the projector console) is a circuit consisting of the three chemical level chambers on the chemical shelf and a bridge rectifier in the relay unit. An AC supply is necessary for the chemicals circuit since DC would cause the build up of deposits on the probes in the level chambers and the possible release of poisonous gases. Owing to inevitable slight unbalance in the bridge rectifier, a small amount of DC tends to flow in the circuit. To prevent this, a blocking capacitor C1 is included in the control unit.

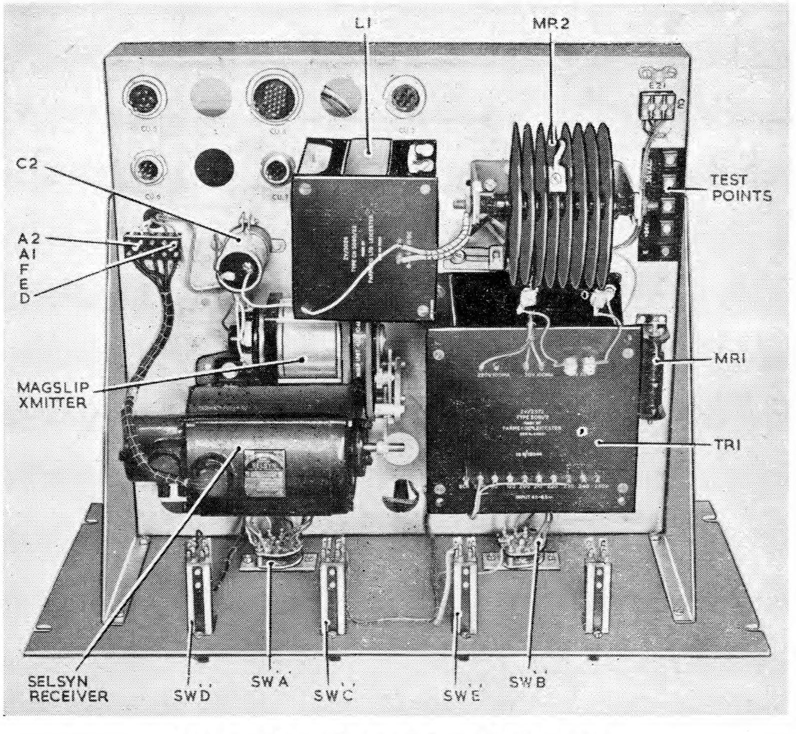

Fig. 1. Control unit (selsyn) 921: top view

6. Two further circuits are connected across the 30V AC lines. One of these consists of the waste tank probes in series with a bridge rectifier and the other of the fume pipe probes and a bridge rectifier.

7. In each case, the DC outputs from the bridge rectifiers are used to operate relays on the relay chassis; these control the appropriate warning circuits (*Sect.* 6, *Chap.* 1).

24V DC output

8. This is derived from a secondary winding on the transformer by means of the bridge rectifier MR2. The output from the rectifier is fused by FS5 and filtered by L1 and C2.

Magslip unit 4125

9. This consists of a receiver selsyn which drives a magslip transmitter through gearing having a step-down ratio of 30:1. The selsyn receives its input voltages from a selsyn transmitter in the radar which is driven at 30 times aerial speed; the magslip rotor is thus driven at aerial speed. Selsyn information from the various radars is connected via the radar office to a selsyn patching box on the wall of the projector room (*Sect.* 1, *Chap.* 2). This consists of a junction box having five pairs of Jones sockets. In order to select the selsyn information from a particular radar, the two free Jones plugs (one for each projector control rack) must be inserted in one pair of sockets.

Switches

10. The HEAD SELECTOR SWITCH, the 180 DEG. SELECTOR SWITCH, the HEAD COMBINING key and the CALIBRATION FINE/COARSE key are connected, via plug CU4 and the junction box on the wall of the projector room, to the radar office.

11. The CALIBRATION VM/RM key controls the 24V DC circuit to relays A and B in amplifying unit (video) 4133 (*Sect.* 2, *Chap.* 2), so connecting range marks or video map signals into the video channel if required.

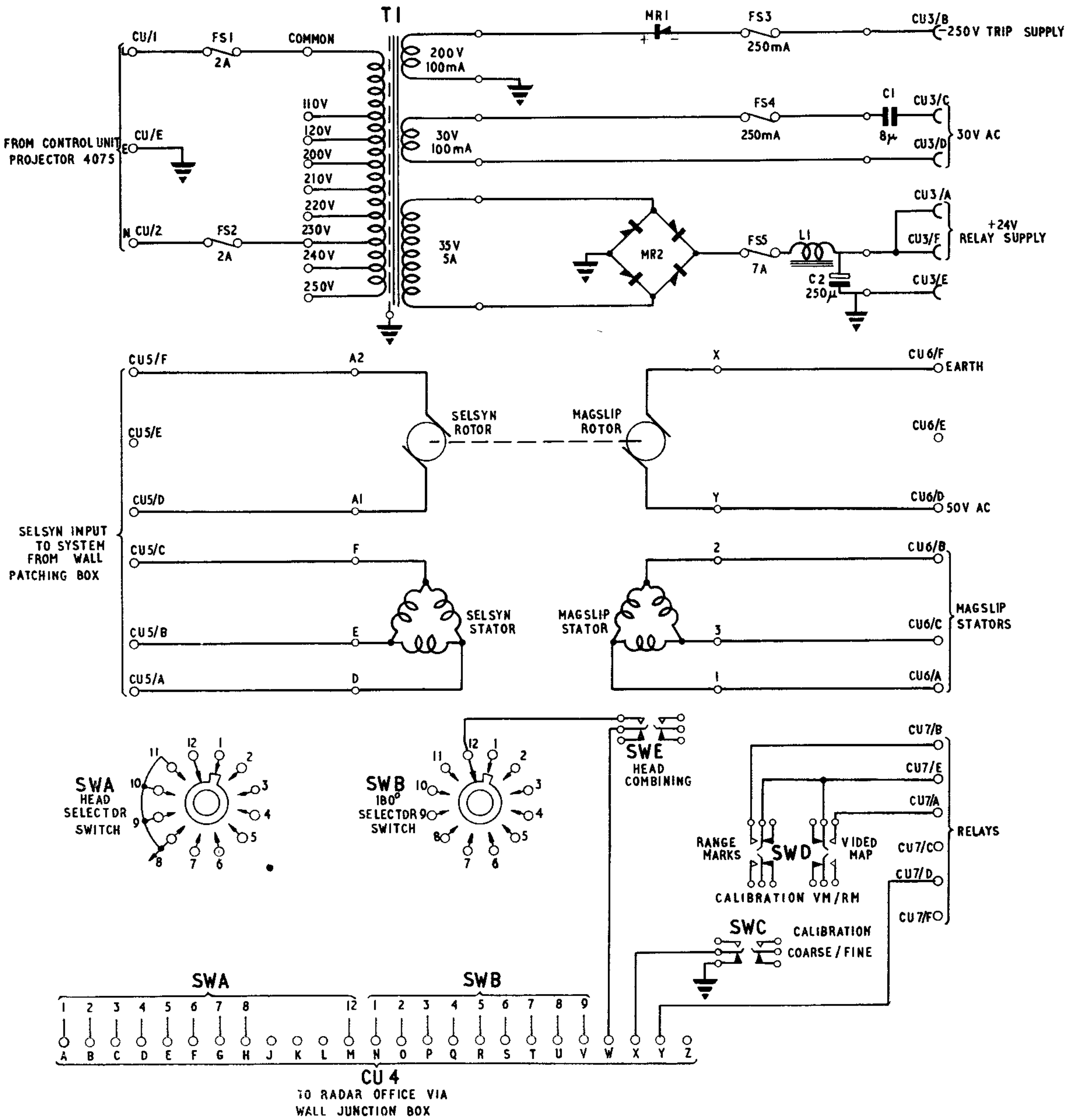

Fig. 2. Control unit (selsyn) 921: circuit

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SECTION 5

PROJECTION

Chapter I

GENERAL DESCRIPTION

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General

1. In the projection system, the light given out by a mercury vapour arc lamp is collected by a condenser system and is passed through the film in the projection aperture of the film gate.

2. The various signal echoes, which compose the CRT display, appear after processing as dark areas on the film. The light, from the condenser system, passes only through the parts of the film unaffected by signal echoes and is focused by the projection lens on to the projection screen where an enlarged picture, consisting of dark echoes on a bright ground, is obtained.

Light source

3. The power required for operating the mercury vapour lamp is derived from the 230V 50c/s 30A unregulated mains supply. This supply is controlled by one of the ironclad switches on the wall of the Udder and enters the equipment via control unit (projector) 4075 in the power supply rack. The control unit contains ballast chokes, which limit the current taken by the lamp, together with meters which monitor the lamp current and voltage. An hour meter is included which registers the aggregate lamp circuit operating hours.

4. The lamp current is applied to the lamp via a Siemens H.F.S.7 high-frequency lamp starter unit. This delivers pulses some 30kV in amplitude which strike the mercury arc. Once struck, the arc is maintained by the main lamp supply.

5. The lamp control circuit includes two safety switches, in the projector console, which prevent current from being applied to the lamp if the lamp house cover is not properly in place or if there is no cooling air supply to the projection aperture in the film gate.

6. A large volume of low pressure air is passed through the lamp house to keep it cool. To prevent overcooling of the lamp, resulting in inefficient vapourizing of the mercury and poor light output, it is surrounded by a metal shroud which prevents the cooling air from sweeping directly over it. In order that the lamp may attain its working temperature quickly, the cooling air is initially cut off by a butterfly valve in the outlet air duct; this opens when the lamp is up to temperature. The cooling air system is described in Section 4, Chapter 4.

Optical system

7. In the lamp house, light from the mercury arc passes horizontally through five condenser lenses into the film gate. Mounted behind the lamp is a concave mirror so situated that the lamp is at the centre of the concave surface. Those rays of light which leave the arc and pass towards the rear of the projector console thus strike the reflecting surface of the mirror normally and are reflected back to the centre of the arc again, so making the light source more efficient.

8. A piece of special glass, mounted between the second and third condenser lenses acts as a barrier to infra-red rays and reduces the amount of heat allowed to reach the projection aperture.

9. After entering the film gate, the light is reflected through 90 deg. by a plane mirror and passes vertically through two more condenser lenses. The final lens in the lamp house can be moved axially to vary the cross-section of the beam as it enters the first lens in the film gate. By this means, some of the light may be made to fall outside the system so giving a smaller light intensity at the film.

10. Between the final lens and the film is an aperture plate which determines the shape of the final picture. It is normally circular but other shapes may be used if required.

11. In the projection aperture, the film is blown against an optically flat glass plate which accurately locates it in the object plane of the projection lens. Since the film and the plate are in near optical contact, reflections from the surface of the glass and the back of the film tend to cause interference fringes which appear as coloured rings on the final picture. In order to prevent this phenomenon, the surfaces of the glass are heavily bloomed to minimize reflection. The blooming has a limited life due to the movement of the film against it during transit. The glass plate is made to very close tolerance enabling it to be replaced when necessary without affecting the location of the film.

Projection lens

12. The projection lens used in this equipment has a relative aperture of f/2 and a focal length of 2 in. The lens is fitted with a special focusing mount which screws into the projection lens mount in the film gate cover (*Section 3, Chapter 3*). Unlike the camera lens, the projection lens has no iris diaphragm and the relative aperture cannot be adjusted. The reason for this is that the conventional iris consists of a series of thin metal leaves which would warp when subjected to the temperatures experienced in the projection aperture. Control of the amount of light passing through the lens is achieved by moving the fifth condenser lens (*para. 9*).

13. An alternative lens of 1½ in. focal length may be used in the projector if required. This will give a greater enlargement of the picture for the same position of the projection screen. It is supplied with a different focusing mount since the height of the lens above the film plane will be different. Any lens in its focusing mount is interchangeable with any other lens in its mount.

Projection prism

14. Above the projection lens is a right-angled prism which turns the vertical beam of light passing through the lens into a horizontal beam. A plush-faced shroud, between the lens and the lower face of the prism, prevents dust from reaching the glass surfaces.

Projection mirror

15. When two projectors are used in one installation, a large plane mirror is mounted between them. This can be rotated about a horizontal axis, enabling the picture from either projector to be thrown vertically on to the projection screen as required. The mirror is silvered on both sides and is lacquered to prevent tarnishing. The thickness of the lacquer coating is sufficient to prevent the appearance of interference fringes.

General

16. The optical system is of high efficiency and approximately 10 per cent of the light output from the lamp reaches the projection screen. In order to achieve this, all glass surfaces are bloomed to minimize losses consequent on light reflection. The system is free from optical distortion except at the extreme edges of the picture. Any distortion evident in the projected picture (e.g., in the grid lines of the video map) will invariably be due to faults in the electronic units.

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Chapter 2

LIGHT SOURCE

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LIST OF ILLUSTRATIONS

General

1. The light source for the projection system consists of a one kilowatt mercury vapour lamp containing Xenon gas at a pressure of two atmospheres. The use of mercury vapour gives a high light efficiency and the addition of Xenon ensures a reasonable light output during the period immediately after switching on while the mercury is being vaporized.

2. Although the lamp will occasionally strike when cold immediately the LAMP MAIN SWITCH on control unit (projector) 4075 is closed, the lamp starter unit will normally be needed: it is always required when the lamp is hot since a very high voltage is necessary to strike the arc when the mercury is vaporized due to the high pressure built up inside the quartz envelope.

3. The lamp is mounted inside the lamp house through which passes a stream of cooling air (*sect.* 4, *chap.* 4). Also surrounding the lamp, inside the lamp house, is a metal shield. The purpose of this is to prevent local cooling of the quartz envelope, which might cause fracture due to uneven expansion, and to allow the lamp to reach its operating temperature.

WARNING

The lamp must not be run without the lamp house cover in place. The internal pressure rises to about 30 atmospheres when the lamp is hot and severe injury may be caused to personnel in the event of lamp failure. In addition to this, a large amount of dangerous ultra violet light is emitted. If it is required to remove the lamp for any reason, it should always be allowed to cool thoroughly before the lamp house cover is removed.

4. A view of the lamp house with the covers removed is given in fig. 1. The concave mirror behind the lamp and the system of condenser lenses is described in chapter 3.

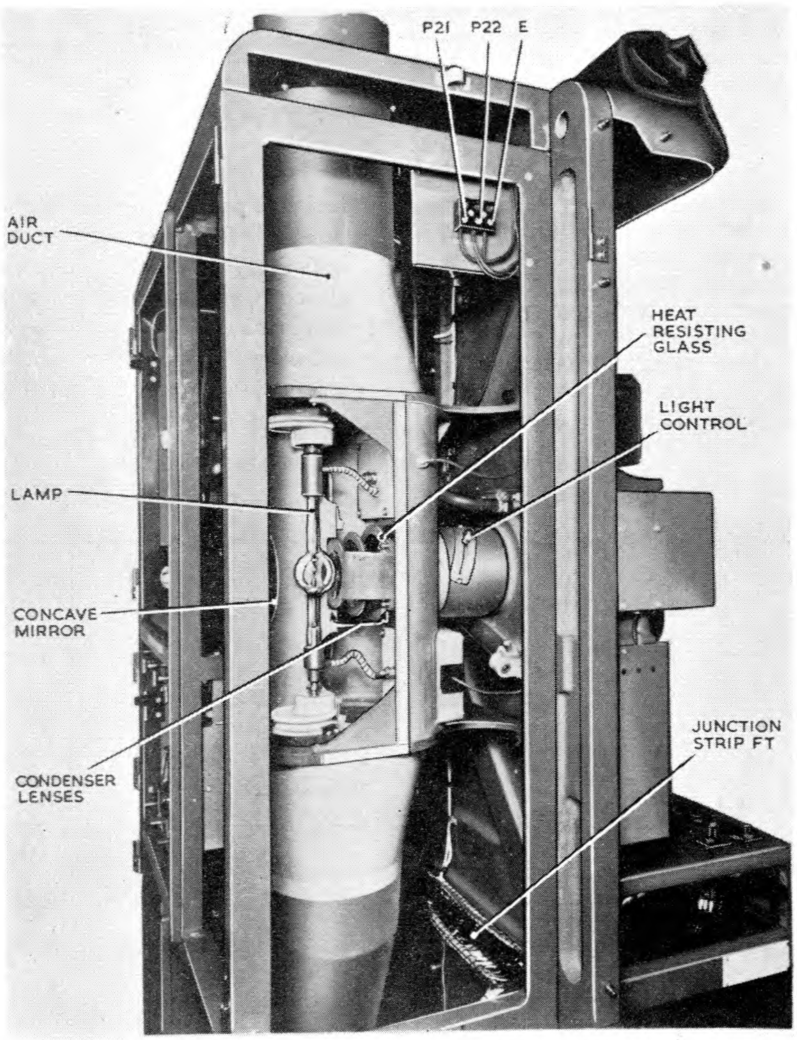

Fig. 1. Lamp house

5. The lamp should not be run unless the console air cooling system is operating as indicated by the air flow indicator in the exhaust air pipe at the top of the console. This rotates slowly when the lamp is cold and quickly when the automatic air flow damper opens under the influence of warm exhaust air (*sect.* 4, *chap.* 4).

6. After being handled, the lamp must be wiped carefully with methylated spirits or alcohol before being put into service. If this precaution is neglected, any finger marks will burn into the quartz envelope and spoil the lamp. The guaranteed life of a lamp is 500 hours; no lamp should be used for longer than this. The total lamp running time is recorded by the hour meter in control unit (projector) 4075.

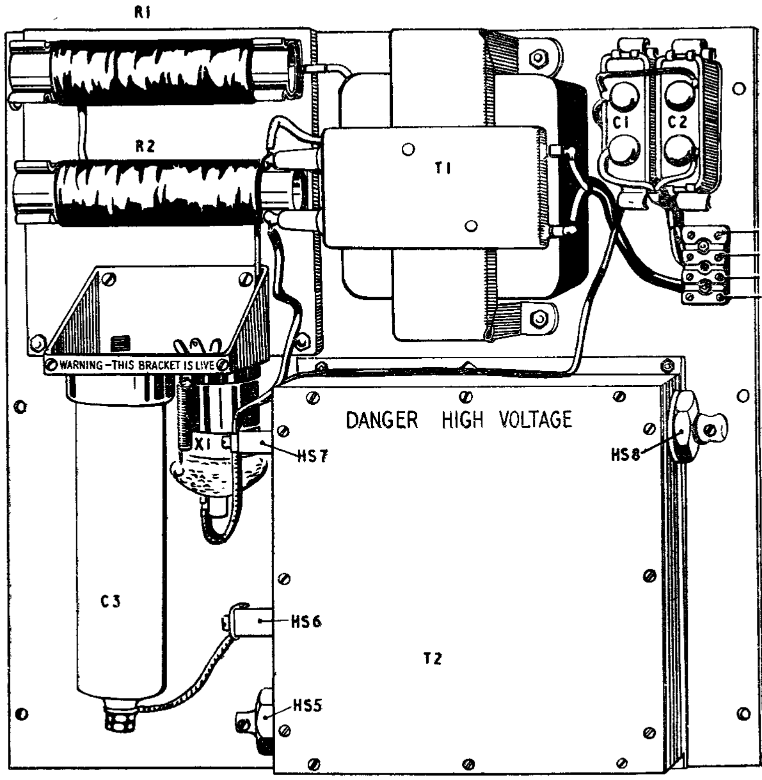

Fig. 2. Lamp starter unit

Circuit description

7. Electrical power for the mercury arc lamp is controlled by control unit (projector) 4075 in the power supply rack. A diagram of the overall lamp circuit is given in fig. 3. The relevant portions of control unit (projector) 4075 are included in this diagram in simplified form.

8. The 230V 30A unregulated mains supply is connected to the 30A INPUT terminals at the rear of the control unit. When the LAMP MAIN SWITCH is closed, the supply is connected to the operating coil of the lamp main contactor via a microswitch and air pressure switch in the projector console. Assuming these switches to be made, the lamp main contactor operates connecting the 30A supply via the lamp chokes to terminals P21 and P22 in the projector console (*fig.* 1). The red light labelled LAMP on the control rack operates indicating that the lamp main contactor is closed. The microswitch is situated at the left-hand side of the lamp house (viewed from the rear) and closes when the lamp house cover is fitted. The air pressure switch operates as described in section 4, chapter 4.

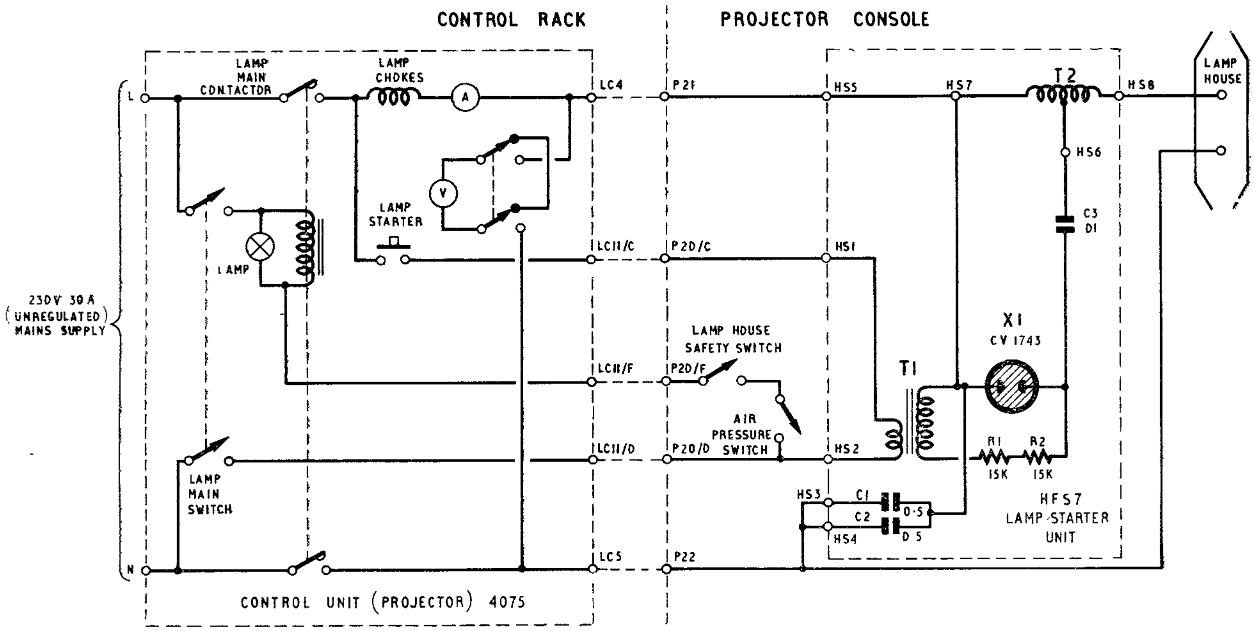

Fig. 3. Overall lamp circuit

9. The lamp chokes limit the current to the lamp without themselves dissipating any power except that due to the DC resistances of their windings. Four lamp chokes are normally used connected in parallel. A fifth choke is added in parallel during the warming up period giving increased lamp current and a faster warm up. This fifth choke is automatically switched out of the circuit two minutes after closing the LAMP MAIN SWITCH as described in Section 6, Chapter 2.

Lamp starter unit

10. This unit generates a series of high-voltage pulses which strike the arc when the lamp is hot. It is a standard Siemens Type H.F.S.7 high frequency starter and is situated behind the projector mainplate at the top of the console. The unit is illustrated in fig. 2.

11. The lamp supply is connected to the lamp from terminals P21,P22 (*fig.* 1) via the auto transformer T2 in the starter (*fig.* 3). If the lamp does not strike immediately the supply is applied, operation of the starter is required.

12. When the LAMP STARTER button on the control rack is pressed, the mains supply is connected via the LAMP MAIN SWITCH and the lamp main contactor to the primary of transformer T1 in the starter unit. Since the circuit includes contacts of the main contactor it follows that the starter cannot be operated unless the lamp house cover is in place and the high pressure air supply is present.

13. The mains voltage is stepped up to approximately 6kV RMS in transformer T1 and is applied to the circuit consisting of R1,R2,C3 and the primary of the auto transformer T2. At some point during a half cycle of the voltage sine wave from T1, the charge on C3 becomes great enough to strike the spark gap X1 enabling the capacitor to discharge through the primary of T2. At the end of this discharge, the current through the spark gap falls to zero and the gap extinguishes. C3 now recharges via R1 and R2 to a value which allows the spark gap to strike again giving another current pulse through T2 primary. The process continues until the voltage from T1 reaches a point on the sine wave near the end of the half cycle when it falls below the striking value for the spark gap.

14. Each time the spark gap strikes, a high-voltage pulse of some 30kV amplitude is developed across the secondary winding of T2 and is applied in series with the lamp main supply connected to the lamp via terminal HS8. Approximately five high-voltage pulses are developed each half cycle of the voltage from T1. These pulses strike the mercury arc which then continues to operate from the lamp main supply.

15. Immediately the mercury arc strikes, the LAMP STARTER button must be released otherwise the high-voltage starting pulses may damage the lamp or the insulation of the wiring.

16. Capacitors C1 and C2 are connected in parallel across the lamp main supply to the lamp starter. The purpose of these is to prevent the lamp starting pulses from being fed back to control unit (projector) 4075. The voltmeter on the control unit, which is used to monitor the arc voltage, is fitted with a press-to-read switch; this is to protect the instrument against the small amount of starter voltage which gets through in spite of C1 and C2.

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Chapter 3

OPTICAL SYSTEM

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LIST OF ILLUSTRATIONS

Introduction

1. The purpose of the optical system is to collect as much as possible of the light emitted by the mercury vapour arc lamp and to ensure that all this light passes through the film and projection lens so producing an enlargement of the photographic image at the projection screen.

2. The light output from the lamp falls off with obliquity due to the blanking effect of the electrode structure. The optical problems involved (e.g., aberrations in the condenser system and the relative aperture of the projection lens) set a further limit to the solid angle of light which may be used. The cone of light actually collected from the lamp has an apex angle of 82 deg. and this represents the best compromise.

3. A schematic diagram of the optical system is given in fig. 1. The condenser consists of seven lenses: for convenience of identification, these lenses are numbered 1 to 7 starting at the lens immediately in front of the arc lamp.

4. Lenses 1 to 4 are situated in the lamp house and are therefore subjected to the stream of cooling air. Lens 5 is situated in a telescopic mount protruding from the front of the lamp house into the film gate casting. Lenses 6 to 7 are mounted in the projection aperture of the film gate casting (*Section* 3, *Chapter* 3). The optical axis of the system is horizontal in the lamp house and vertical in the film gate. The transition is made by means of a plane mirror. The number, shapes and materials of the condenser lenses have been carefully chosen to minimize optical aberrations. All glass surfaces are bloomed to minimize loss of light by reflections.

5. Mounted behind the arc lamp is a concave mirror whose centre of curvature is positioned accurately at the centre of the arc; this mirror also subtends an angle of 82 deg. Light from the arc strikes the surface of the mirror normally and is reflected back to the centre of the arc. By this means, some of the light, which would otherwise be lost, is redirected into the condenser system as if it originated from the arc. The effect of this is to increase the eventual illumination of the projection screen by about 30 per cent. The illumination is not doubled, as might be expected, since light reflected by the mirror has to pass through the lamp and some of it is absorbed by the glass envelope and vapour filling.

6. Lenses 1 and 2 are made of fused quartz which is the only material capable of withstanding the temperature existing so near the lamp. A piece of special glass (Chance ON20, toughened) situated between lenses 2 and 3 acts as a filter to infra red rays. This glass is 3 mm. thick and it holds back 99 per cent of the dangerous infra-red rays which would otherwise cause serious overheating of the film in the film gate in spite of the high-pressure cooling air supplied to the projection aperture. The heat collected by the filter glass is conducted away by the lamp house cooling air.

7. Lenses 3, 4 and 5 are made of Zinc Crown glass which is an optical glass with heat resisting properties. Lenses 6 and 7 in the film gate casting are made or ordinary crown glass.

8. Lens 5, in its adjustable mount, can be moved along the optical axis to act as a light control. The effect of the adjustment on the light rays passing through the system is illustrated in fig. 2.

9. When the lens is in its fully forward position, the image of the arc formed by the combination of lenses 1 to 4 occurs at a point in lens 5 such that any ray of light incident on lens 5 emerges in a direction parallel to its incident path. The boundaries of the light passing through the system are indicated by the full lines in fig. 2, where it will be seen that the apex angle of the cone of light passing the lens 6 is the same as that leaving lens 4. The aperture of lens 6 is such that it will accept all this light. After passing through lenses 6 and 7, the light converges on a point in the projection lens. By this means, all the light collected by lens 1 passes through the film, which lies just above lens 7, and enters the projection lens.

10. If lens 5 is moved towards lens 4, its effect is to increase the convergence of the light rays before the point of intersection and to increase the apex angle of the cone of rays passing towards lens 6 as indicated by the dotted lines in fig. 2. A certain amount of light therefore spills outside the system and is lost. This method of light control enables the intensity of illumination at the projection screen to be reduced to about one-third of the maximum.

11. The axis of the beam of light emerging from the projection lens is made horizontal and parallel to the projector mainplate by the action of the projection prism on the film gate cover casting (*Section* 3, *Chapter* 3). It is then reflected from the surface of the projection mirror and passes vertically to the projection screen.

MECHANICAL DESCRIPTION

12. A view of the lamp house is given in Chapter 2. The main structure consists of a body casting and two cast end plates.

13. The centre of the body casting carries a cylindrical extension which is bored to provide the bearing for No. 5 lens mount. The end of this extension is machined to locate in a hole in the projector mainplate and to abut the rear face of a machined locating ring. The other face of the ring locates a counterbore in the film gate casting. By this means, the optical access of the lamp condenser system is held accurately in line with the axis of the projection aperture in the film gate.

14. The end plates, which are bolted to the body casting carry fixing feet for bolting the assembly to the rear of the mainplate.

Lamp mounting

15. The mercury vapour arc lamp is held between porcelain supports in the cast end plates. The form

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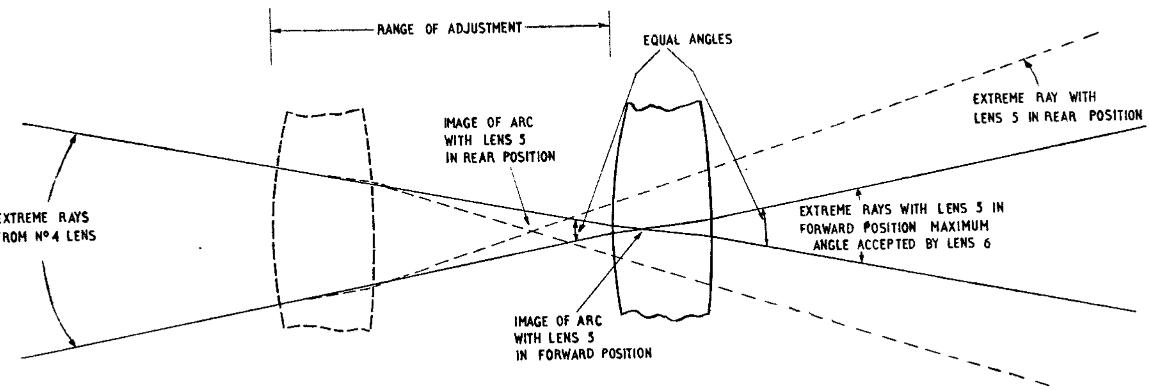

Fig. 2. Effect of moving lens 5

of these supports can be seen in fig. 1. The upper support contains a prefocus socket which is accurately machined to ensure that the centre of the arc lies in the horizontal plane containing the optical axis of the condenser system. The lower socket contains a spring-loaded plunger which engages a depression in the base of the lamp and ensures that the lamp is pushed correctly into the upper socket. The prefocus socket and the spring loaded plunger are eccentrically situated with respect to the porcelain supports which are held to the end plates by phosphor-bronze clips. By slackening the clips and rotating the supports, it is possible to adjust the lateral position of the arc to ensure that it lies on the optical axis of the system. The method of making the adjustment, using a special alignment gauge, is given in Section 7, Chapter 1.

16. Connections to the lamp are made via terminal boxes in the body casting.

Concave mirror

17. The concave mirror, behind the lamp, is retained in a cast aluminium alloy housing by spring clips. The housing is fixed to a strut which bridges the lamp house end plates. The mirror itself is made of a low-expansion boro-silicate glass and its concave surface is aluminized.

18. Three grub screws, which pass through tapped holes in the strut, provide a three-point location for the back of the mirror housing. The housing is held firmly back against these screws by two cheese-headed screws which pass through clearance holes in the strut and enter tapped holes in the housing. This method of fixing allows the mirror to be set so that its centre of curvature coincides with the centre of the arc. No arrangement exists for moving the mirror bodily either vertically or laterally since the manufacturing tolerances are close enough to make such adjustment unnecessary.

Lenses 1 to 3

19. Lenses 1 to 3 are mounted in a housing which is fixed to the back of the body casting. The housing consists of an aluminium alloy casting having a square mounting flange which extends into side webs carrying three coaxial rings. The ring nearest the mounting flange carries the special infra-red filter glass and is machined away at top and bottom to allow a sufficient flow of cooling air over the surface of the glass. All three rings are counterbored on the side away from the arc lamp to provide seatings for the three condenser lenses. Lens 1 is retained on its seating by a stainless steel wire ring which is held in position by three clips. Lenses 2 and 3 are retained by sheet stainless steel rings having four small internal projections. The rings are crimped and are left slack on assembly to allow for expansion.

20. The infra-red filter glass is mounted in a square channel-section frame, open at the top, formed of sheet stainless steel. The glass is slack in the frame to allow for expansion.

Lens 4

21. Lens 4 is mounted in a counter-bore at the rear end of the cylindrical portion of the lamp house body casting. It is held in position by a ring similar to that used for lens 3.

Lens 5

22. The mount for lens 5 consists of an aluminium alloy casting having a tapered bore. The rear end of this casting is machined externally into a cylindrical form and is undercut to provide suitable bearing surfaces; these enable it to slide easily in the cylindrical bore of the body casting. The body casting contains a machined helical slot through which passes a screw fixed into the lens mount. Movement of the screw along the slot causes the lens mount to rotate and move along the optical axis so varying the amount of light reaching the projection screen as described in para. 10.

23. Lens 5 is retained in a counterbore at the forward end of the mount by a threaded brass ring.

Projection prism

24. A description of the projection prism and its mounting on the film gate cover casting is given in Section 3, Chapter 3. Adjustments are provided to enable the axis of the beam of light, emerging from the prism, to be set horizontal and parallel to the face of the projector mainplate.

Projection mirror

25. As described in Section 1, Chapter 1, a complete installation normally includes two projector consoles. These are arranged so that the axis of the beam of light emerging from the prism of one exactly coincides with that emerging from the prism of the other. The projection mirror is pivoted between the projectors on a horizontal axis which is at right angles to the line joining the centres of the two projection prisms.

26. The support for the mirror pivot axis is provided by a casting which bridges the two projectors. The mirror frame casting is arranged to rest against a stop screw in the support casing in such a manner that its plane is at 45 deg. to the line joining the centres of the projection prisms. Both sides of the mirror are silvered. The picture from one projector is thus thrown vertically upwards to the projection screen and the picture from the other is thrown vertically downwards on to a setting board on the floor between the projectors.

27. The functions of the two projectors are interchanged by rotating the mirror through 90 deg. about the horizontal pivot axis; the mirror frame then rests against another stop screw in the support casting. The stop screws are adjusted during the initial setting up of the installation. The mirror may be locked in position by means of a clamp nut.

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SECTION 6

SWITCHING AND CONTROL CIRCUITS

Chapter I

GENERAL DESCRIPTION

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

General

1. The purpose of this chapter is to give an overall description of the electrical circuits of the photographic display system, excluding those concerned with the servo system and the generation of the CRT display.

Mains supply

2. The equipment has two 230V 50c/s AC supplies. One of these is regulated and capable of delivering 15A; the other is unregulated and capable of 30A.

3. Each projector has an air compressor associated with it, and facilities are provided on the projector control rack (rack assembly (power supply) 340) for remote switching of the compressor which may be situated at some distance away. When projectors are used in pairs, as in a normal installation, they may draw compressed air from a common air main.

CIRCUIT OPERATION

4. Overall circuit diagrams of the power supply rack and projector console are given in fig. 5 and 6; these circuits exclude details of the electronics and servo system.

5. A general convention throughout the projector and control rack is that wherever a pair of pins or terminals carries a mains supply, the terminal with the lower number or letter always carries the line side of the mains supply. The same is true of fuses.

6. The following points should be noted in the projector circuit:—

(1) All fuses in the 15A regulated supply are located on the fuse panel at the right of the projector. The fuse panel also carries the thermostat indicator lamp LP11. A circuit diagram of the fuse panel is given in fig. 1.

(2) Relays RLA to RLH inclusive are located in relay unit 4105 at the rear of the projector. This unit also includes the metal rectifiers MR1, MR2 and MR3. A circuit diagram of the relay unit is given in fig. 2.

(3) The fault warning lamps LP1 to LP8 are mounted on the indicating panel which forms the front desk of the projector console. This panel also carries the PROCESSING ON–OFF switch SWN, the JET INSPECTION SWITCH SWO, the warning buzzer X8 and the STOP BUZZER switch SWT. A circuit diagram of the indicating panel is given in fig. 3.

(4) Panel 899, which is the remote fault warning panel installed in the radar office, is connected to the projector via socket P5. It carries a set of warning lamps which duplicates the action of the warning lamps on the projector indicating panel, excluding those for gate open and 24V supply on. Panel 899 also has a warning buzzer but does not have a stop buzzer button. A circuit diagram of the unit is given in fig. 4.

7. The 3-core 15A mains cable from the wall switch is connected to the L (line), N (neutral) and E (earth) 15A INPUT terminals at the rear of control unit (projector) 4075 in the projector control rack (*fig.* 5). Immediately the wall switch is closed, the mains voltage becomes available at the following points:—

(1) The two three-pole 5A SUPPLY OUTLET sockets on the front of the control rack. These are fused by FS5 and FS6 (*fig.* 5).

(2) Sockets LC10/F and LC10/D (*fig.* 5). From here it is connected to P4/D and P4/F on the projector console and then to

  (a) The two three-pole 2·5A SUPPLY OUTLET sockets at the left-hand side of the projector console. These are fused by FS5 and FS6 (*fig.* 6).

  (b) The interior lights in the projector console. These are controlled by switches which close automatically when the appropriate doors (giving access to the chemicals compartment and the servo units) are opened. The circuit is fused by FS3 and FS4 (*fig.* 6).

Projector main switch

8. The PROJECTOR MAIN SWITCH (control rack) controls all supplies derived from the regulated mains with the exception of those to the service sockets and lights detailed in para. 7.

9. When the switch is closed, the regulated mains supply becomes available at sockets LC10/A and LC10/B and is connected to the projector fuse panel via pins P4/A and P4/B (*fig.* 6).

(1) The primaries of the two heater transformers are supplied via FS9 and FS10: heater current is supplied to the various valves in the projector.

(2) The primary of the mains transformer in the servo power unit is supplied via fuses FS7 and FS8 (*fig.* 6). The power unit delivers HT voltages and heater voltages to the servo units, but the servo system does not operate since the 50V AC output circuit from the servo power unit is broken by relay contacts which do not close until the 24V DC supply becomes present (*para.* 15).

(3) The chemical air heater is supplied via fuses FS1 and FS2 (*fig.* 6) and the thermostat contacts. A lamp LP11, which is mounted on the fuse panel, lights during the periods when the thermostat contacts are closed and indicates that the heater is operating.

10. The regulated mains supply is also connected to terminals HT4 and HT5 on the rack frame (*fig.* 5) and thence via the HT ON–OFF switch to the mains input terminals of power units 4109 and 4110 (*Sect.* 2, *Chap.* 4 *and* 5). A delay switching circuit in the power units prevents the supply of HT voltages to the electronic units until approximately a minute after the PROJECTOR MAIN SWITCH is closed.

Compressor motor switching

11. The compressor motor and starter are not part of the photographic display system, but the relevant circuit details are included in fig. 5 for the sake of convenience.

12. The compressor motor starting facilities on the control rack will normally only be used when one projector and control rack form a complete installation. Where projectors operate in pairs, the starter will usually be controlled by other means and the control rack push buttons and AIR lamp will be inoperative.

13. A third pair of contacts on the PROJECTOR MAIN SWITCH completes the hold-on circuit of the compressor motor contactor. Assuming the switch to be closed, the circuit action is as follows:—

The green AIR CONTROL button on the control rack is wired in parallel with a similar button on the compressor gear which may be situated at some distance from the photographic display equipment. When either button is pressed, the regulated mains circuit is completed via the motor contactor operating coil and the normally closed contacts of the starter STOP button. The contactor operates.

(1) Contacts 1 and 2 complete a hold-on circuit in parallel with the start button via terminal LC2, the normally closed contacts of the AIR CONTROL STOP button on the control rack, the closed contacts of the PROJECTOR MAIN SWITCH and terminal LC3. The AIR indicator lamp LP2 lights.

(2) Contact 3 makes to 4 and 7 makes to 8, completing the mains circuit to the compressor motor. Overload coils, in series with the motor leads, are wound on the same bobbin as the contactor operating coil; these cause the contacts to open and break the motor supply in the event of an overload.

Note . . .

Operation of either start button will energize the contactor coil and the motor will start whether the PROJECTOR MAIN SWITCH *is closed or not since the switch is in the holding circuit. If the switch is open, however, the motor will stop again as soon as the start button is released.*

Projector mechanism switch

14. The PROJECTOR MECHANISM switch SW3 on the control rack (*fig.* 5) completes the 15A regulated mains supply to the following:—

(1) Sockets LC11/A and LC11B (*fig.* 5) and P20/A and P20/B (*fig.* 6). From there, it is connected via fuses FS11 and FS12 to

(a) The camera shutter motor via a limiting resistor R13 (*Sect.* 3, *Chap.* 3).

(b) The Venner time switch coil in the clock unit. The coil circuit includes contacts of the PROCESSING ON–OFF switch so that the clock only operates during processing.

(2) Control unit (selsyn) 921.

(3) The PROJECTOR indicating lamp LP3 on the control rack.

15. Control unit (selsyn) 921 in the control rack generates three power supplies which become present immediately the PROJECTOR MECHANISM switch is closed and are relevant to this chapter. These are:—

(1) 24V DC which supplies

(a) Relays.

(b) The warning lamps and buzzer on the projector indicating panel and on the remote warning panel in the radar office.

(c) The film transport motor (*Sect.* 3, *Chap.* 4).

Note . . .

The PROJECTOR MECHANISM *switch must be closed before relays requiring 24V DC in amplifying unit (video) 4129 and amplifying unit (deflection) 4130 can be operated.*

(2) 30V AC at 50 c/s which initiates the CHEMICALS LOW, WASTE TANK FULL and WASTE BLOCKAGE warnings.

(3) A negative 250V supply which provides energy for the trip solenoid (*Sect.* 3, *Chap.* 4).

Unregulated 30A mains circuit

16. The circuits operating from the 30A unregulated mains circuit (viz., the lamp starter and main lamp circuits) are included in fig. 5 and 6 for the sake of completeness. The overall lamp circuit is described in Section 5, Chapter 2.

Circuits operated by the main camshaft (*fig.* 6)

17. The switches SWA, SWB, SWP, SWQ, SWR and SWS are operated cyclically by rotation of the main camshaft in drive unit (mechanical) timing 4118; a description of this unit is given in Section 4, Chapter 5.

18. Switch SWA closes for approximately 7·2 deg. of camshaft rotation. During this period the 24V circuit is completed to the shutter and film clamp magnets X1 and X2. The shutter closes and the film clamps and crimping bar are lifted, thus freeing the film in the gate. When SWA opens, the shutter opens and the film is again clamped. Since the magnets draw a heavy current, condenser C1 is included across SWA to minimize sparking at the switch contacts.

19. During the greater part of the camshaft cycle, switch SWB is in the position shown in fig. 6 and condenser C2 is charged by the −250V supply generated in control unit (selsyn) 921 (*para.* 15). The moving contact of SWB changes over when the camshaft has advanced approximately 3 deg. from the point at which the shutter closes and the film is unclamped. Condenser C2 is then discharged via the solenoid X3. The solenoid operates and engages the clutch mechanism of drive unit (mechanical) film 4119 (*Sect.* 3, *Chap.* 4); the mechanism is driven by the action of the transport motor X9 which is permanently connected across the 24V supply and starts to run immediately the PROJECTOR MECHANISM switch on the control rack is closed.

20. If the projector should be switched off during the transport operation and is then wound on by hand, as when loading a new length of film, it may happen that the camshaft is moved beyond the point at which SWA opens and the film clamp is released. On switching on again, the film would be locked in the gate while the transport mechanism would be attempting to complete the interrupted film transport. This would result in the stalling of the drive motor X9. The excessive armature current drawn under stalled conditions results in the operation of relay RLJ/1, whose operating coil is connected in parallel with R12 in the motor armature circuit. Contacts RLJ1 are in parallel with SWA, so that when the relay operates, the film clamp and shutter magnets are energized; the film clamps and crimping bar are lifted, enabling the transport to be completed without damage to the film perforations.

21. Switches SWP, SWR, SWQ and SWS are associated with the electromatic tap which opens the develop, fix, wash and dry air lines to the chemical air heater. SWP closes immediately after the camera shutter is opened by the action of SWA and remains closed for 82 degrees of camshaft rotation; solenoid X4 in the electromatic tap operates and hot air is admitted to the develop jet in the jet unit. The operation of SWP is followed consecutively by that of SWR and SWQ for 82 degrees, each operating the fix and wash jets respectively.

22. Switch SWS controls the drying air line to the jet unit. The associated valve in the electromatic tap is so arranged that it is closed when the solenoid X7 is energized. This is a safety precaution which ensures that dry air is blown into the processing chamber in the event of a failure of the 24V supply. Switch SWS therefore is closed for the greater part of the camshaft rotation. It opens at the instant when SWQ opens, and closes simultaneously with SWA (shutter and film clamp).

Processing interlocks

23. The common earth return line from the cam switches SWP, SWQ, SWR and SWS contains interlock switches designed to break the circuit in certain eventualities, so cutting off the fluid jets and allowing warm dry air to be admitted to the processing chamber. The interlocks are as follows:—

(1) One pole of the gate lock switch SWJ. This switch is operated by the gate catch shaft and closes when the catch is moved to the left, where it is normally held by the clamp arm.

(2) The gate switch SWK. This makes when the gate cover is hinged down in its operating position.

(3) The gate clamp switch SWL, which closes when the clamp knob is turned clockwise to the limit of its travel.

(4) One pole SWN–2 of the PROCESSING ON–OFF switch. This is made when the switch is set to ON.

(5) Contacts RLD1. Relay RLD/1 is included in the film break warning circuit (*para.* 36).

(6) Contacts of the processing relay (*para.* 38). These open if the radar aerial stops rotating or if the rotation control switch on the relay amplifier (*Chap.* 3) is set to ◀ STOP. ▶

Processing on-off switch

24. The PROCESSING ON–OFF switch SWN is used to facilitate the reprojection of a processed film. The circuit action when the switch is set to OFF is as follows:—

(1) SWN–1 completes the 24V circuit to the film clamp and shutter magnets via resistor R14 and the normally closed contacts of the JET INSPECTION SWITCH SWO. This has the effect of lifting the clamps and crimping bar per- ◀ manently. Resistor R15 reduces the power ▶ consumption of the magnets X1 and X2, which are then within their rating for continuous operation.

(2) SWN–2 breaks the circuit to the cam operated processing switches (*para.* 23), bringing about a continuous dry cycle.

(3) SWN–3 breaks the 15A regulated mains circuit to the clock unit since the clock is only required to operate when waste liquids are being passed to the waste tank.

Jet inspection switch

25. The JET INSPECTION SWITCH is a push-button (spring loaded to OFF) located under the front left-hand corner of the indicating panel. Access to the switch is obtained via the door at the left side of the projector. The switch is intended to be used for servicing purposes when a faulty jet unit is suspected. It should only be operated with the film unloaded, the film gate hinged open and the special perspex window (supplied in the tool kit) held in place over the processing chamber.

26. When the JET INSPECTION SWITCH is closed, the interlocks described in para. 23 are short circuited, allowing the processing valves to operate as appropriate to the position of the camshaft.

Venner time switch

27. This is located in the clock unit and is asso- ◀ ciated with the waste tank motor valve and the ▶ automatic emptying of the waste tank. The circuit is discussed in Section 4, Chapter 4.

Fault warning circuit

24V supply on

28. The 24V SUPPLY ON warning lamp LP8 lights immediately the 24V supply becomes present on closing the PROJECTOR MECHANISM switch on the control rack.

Buzzer circuit

29. The common line to the warning lamps LP1 to LP7 is connected to the +24V line via the operating coil of relay RLE/2. This relay requires about 200mA for satisfactory operation. The current passed by a single warning lamp (100mA) would be insufficient to operate it. Each lamp is therefore shunted by a 220-ohm resistor. When the circuit to any of the lamps LP1 to LP7 is completed, relay RLE/2 operates and the results are as follows:—

(1) Contacts RLE1 close, completing the 24V circuit through contacts RLF1 to the buzzer, which gives audible warning of a fault.

(2) Contacts RLE2 close, preparing a circuit for the operation of RLF/2.

30. If the STOP BUZZER button on the indicating panel is now pressed, switch SWT closes, completing the 24V circuit through the operating coil of relay RLF/2 and the relay operates.

(1) Contacts RLF1 open, breaking the 24V circuit to the buzzer, which becomes silent.

(2) Contacts RLF2 close, completing a holding circuit for the relay.

Note . . .

When the buzzer has been cancelled by the use of the STOP BUZZER *button, it will not operate again until the fault causing the warning has been cleared. The occurrence of a second fault will be indicated by the appropriate fault warning lamp only.*

31. When the fault causing the warning circuit to operate is cleared, the warning lamp is extinguished and RLE/2 is released. The relay contacts then open, breaking the circuit to relay RLF/2 and resetting the buzzer circuit.

Chemicals low

32. The 30V AC supply derived from control unit (selsyn) 921 in the control rack enters the projector console at pins P3/C and P3/D and is applied across a circuit consisting of the three chemical level chambers and the bridge rectifier MR1. Provided that each chamber contains sufficient liquid to immerse the contact probes, AC current passes through the rectifier and a DC output is obtained which is applied to relay RLA/1. The relay operates and contacts RLA1 are held open. If the level in any chamber falls below the contact probes, the input circuit to the rectifier is broken and the relay releases; contacts RLA1 then close, completing the 24V circuit to the CHEMICALS LOW warning lamp LP1.

Waste tank full

33. A pair of contact probes in the waste tank becomes immersed when the tank is full and the 30V AC circuit is completed to the bridge rectifier MR2. The DC output from the rectifier energizes relay RLB/1. Contacts RLB1 close and complete the 24V circuit to the WASTE TANK FULL warning lamp LP2.

Waste blockage

34. If no action is taken by the operator on receipt of the WASTE TANK FULL warning, or if a blockage occurs in the "clack" valve at the entry to the waste tank, the fume pipe carrying waste ◀ liquids to the tank starts to fill up and another pair of contact probes becomes immersed, com- ▶ pleting the 30V AC circuit to the bridge rectifier MR3. The DC output from the rectifier energizes relay RLC/1; contacts RLC1 close and complete the 24V circuit to the WASTE BLOCKAGE warning lamp LP3.

Film supply low

35. A micro switch SWG in the film cassette (*Sect.* 3, *Chap.* 5) is normally held open by the spool of unexposed film. When the stock of film remaining in the cassette falls to about 30 ft. (enough for about 30 minutes operation) the micro switch closes and completes the 24V circuit to the FILM SUPPLY LOW warning lamp LP4.

Film break

36. If the FILM SUPPLY LOW warning is ignored and the film becomes exhausted, or if the film should break, the film tension sprocket in the film gate is released and a switch SWM closes (*Sect.* 3, *Chap.* 6). This completes the 24V circuit to the FILM BREAK warning lamp LP5 and also to the operating coil of relay RLD/1. The relay operates and its contacts break the circuit of the processing interlocks (*para.* 23), giving dry cycle conditions in the processing chamber. This prevents the gate from being flooded with chemicals when the free end of the film passes the processing aperture.

Gate open

37. The 24V circuit to the GATE OPEN warning lamp is completed by one pole of the gate lock switch SWJ, which closes when the gate catch is released from the gate clamp arm. The other pole of the switch opens and breaks the processing interlocks circuit, giving dry cycle conditions at the processing chamber (*para.* 23).

Note . . .

If the gate is closed and the gate clamp knob has been advanced to the point where the clamp arm engages the catch (thus cancelling the GATE OPEN *warning lamp), processing will still not be possible until the clamp knob is screwed fully home to close the gate clamp switch SWL. No warning lamp indication is given of this fault.*

Processing relay open

38. The processing relay is situated in the anode circuit of valve V2 in amplifying unit (relay) 4076 (*Chap.* 3) and it is not included in the circuit of fig. 6. When the relay operates, its contacts complete the earthy end of the processing interlocks circuit (*para.* 23) and, provided that the interlocks are made, normal processing may proceed. ▶◀ Provided that the relay amplifier is serviceable, any fault which prevents the generation of the feedback voltage from the servo motor generator will cause the processing relay to release; its contacts then change over.

(1) The processing interlocks circuit is broken and dry cycle conditions prevail in the processing chamber.

(2) The 24V circuit to the PROCESSING RELAY OPEN warning lamp LP7 is completed and the lamp lights.

▶◀

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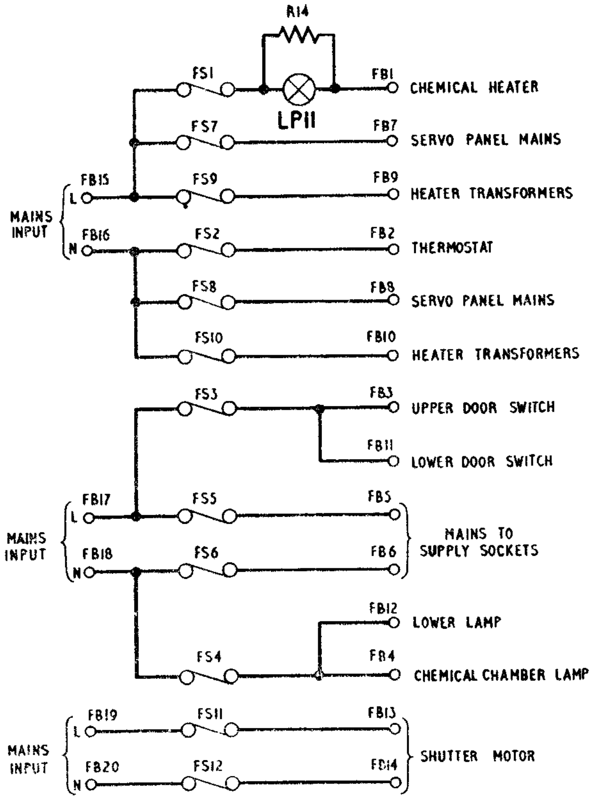

Fig. 1. Fuse panel: circuit

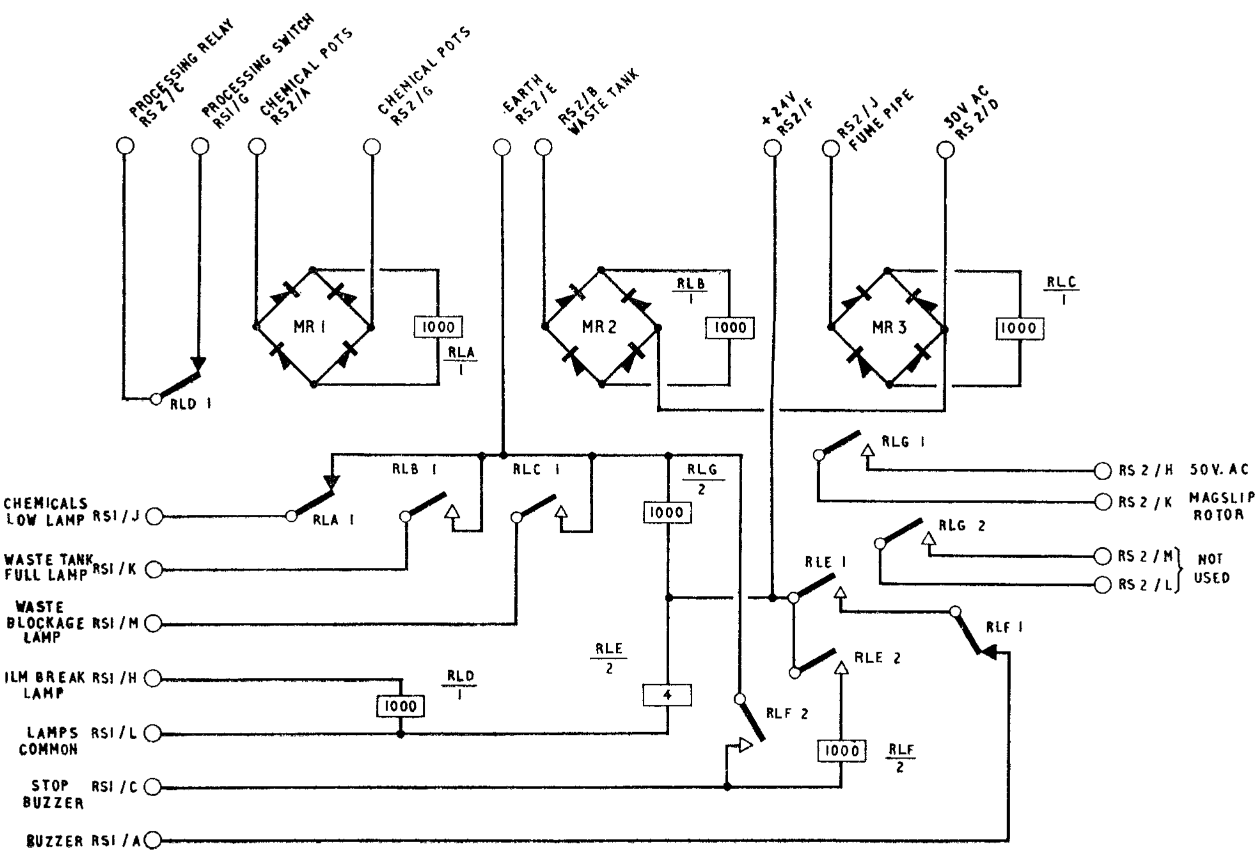

Fig. 2. Relay unit 4105: circuit

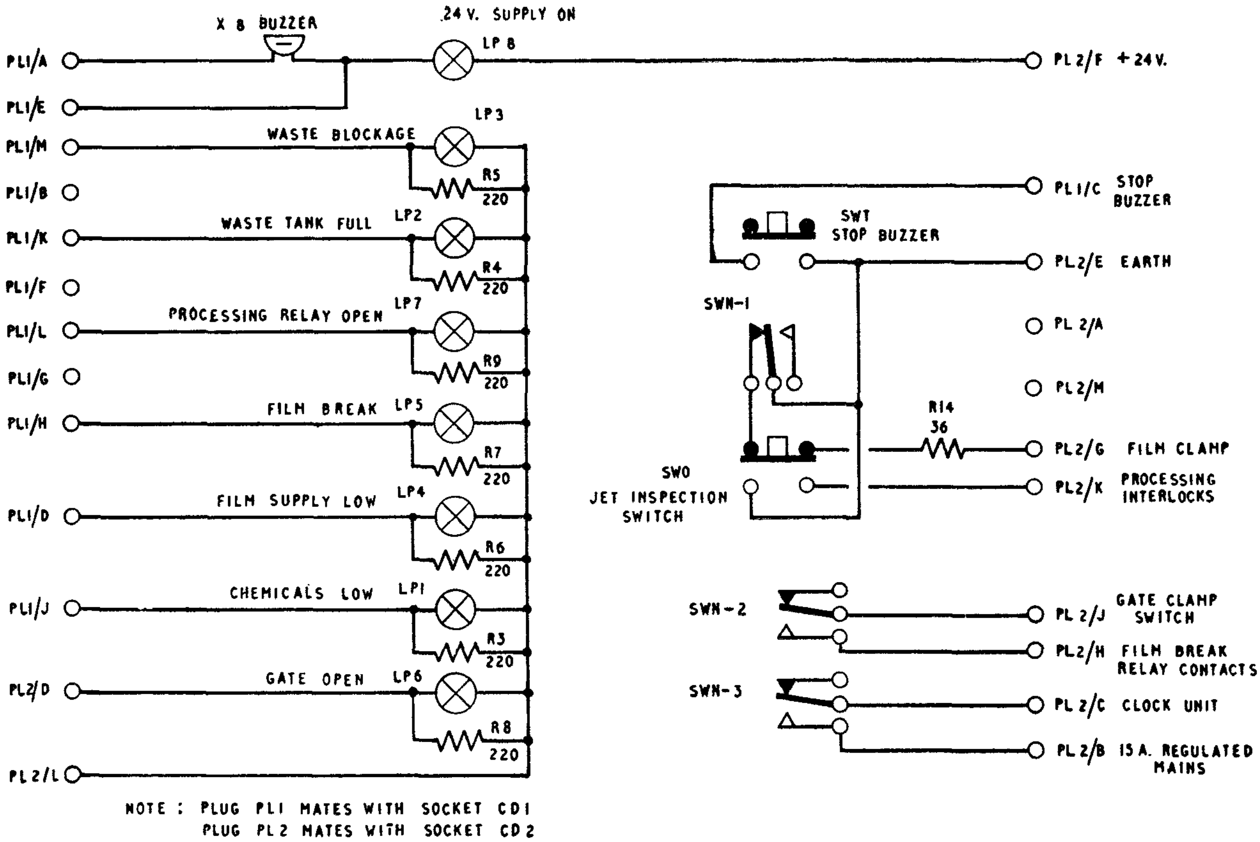

Fig. 3. Indicating panel: circuit

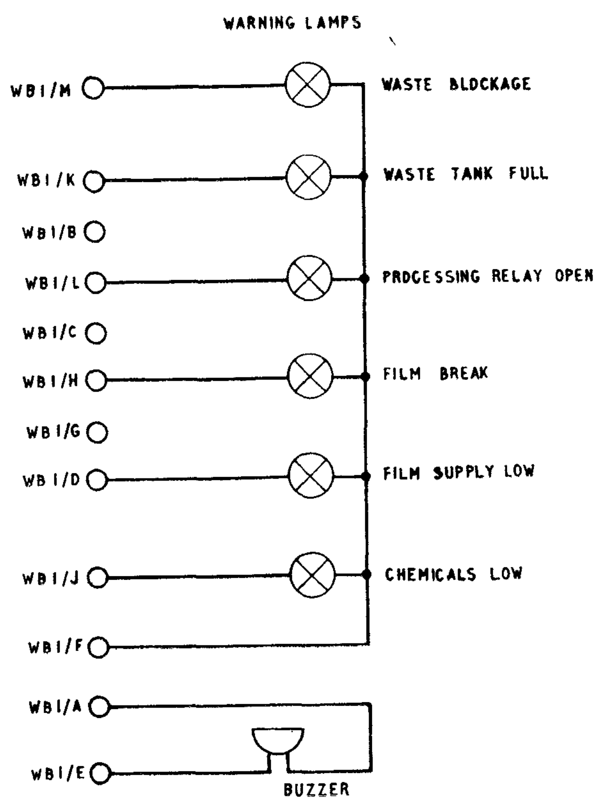

Fig. 4. Panel 899: circuit

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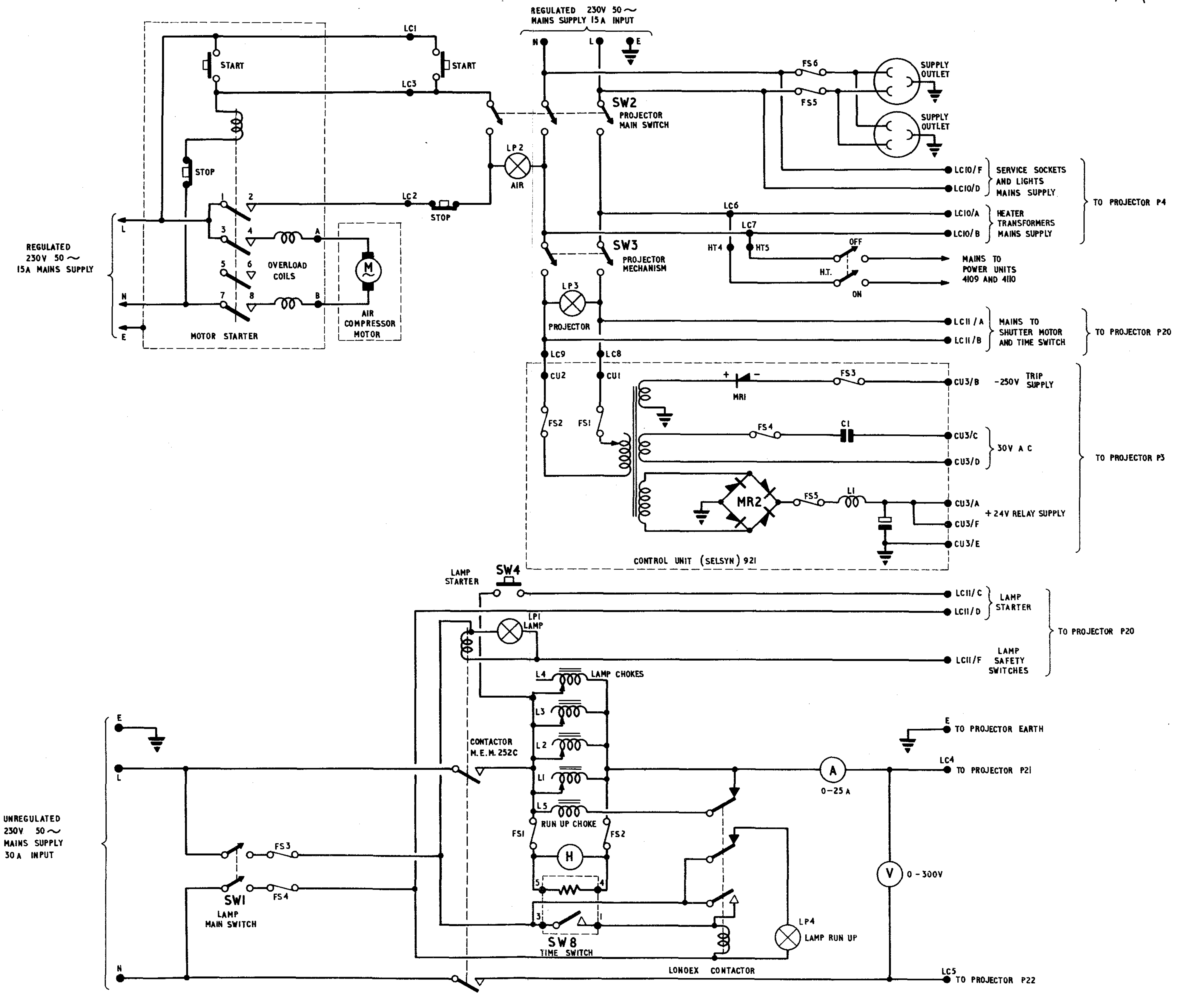

AIR DIAGRAM
6151 C /MIN.
ISSUE 1 | PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY

Rack assembly (Power supply) 340: Simplified circuit

Fig. 5

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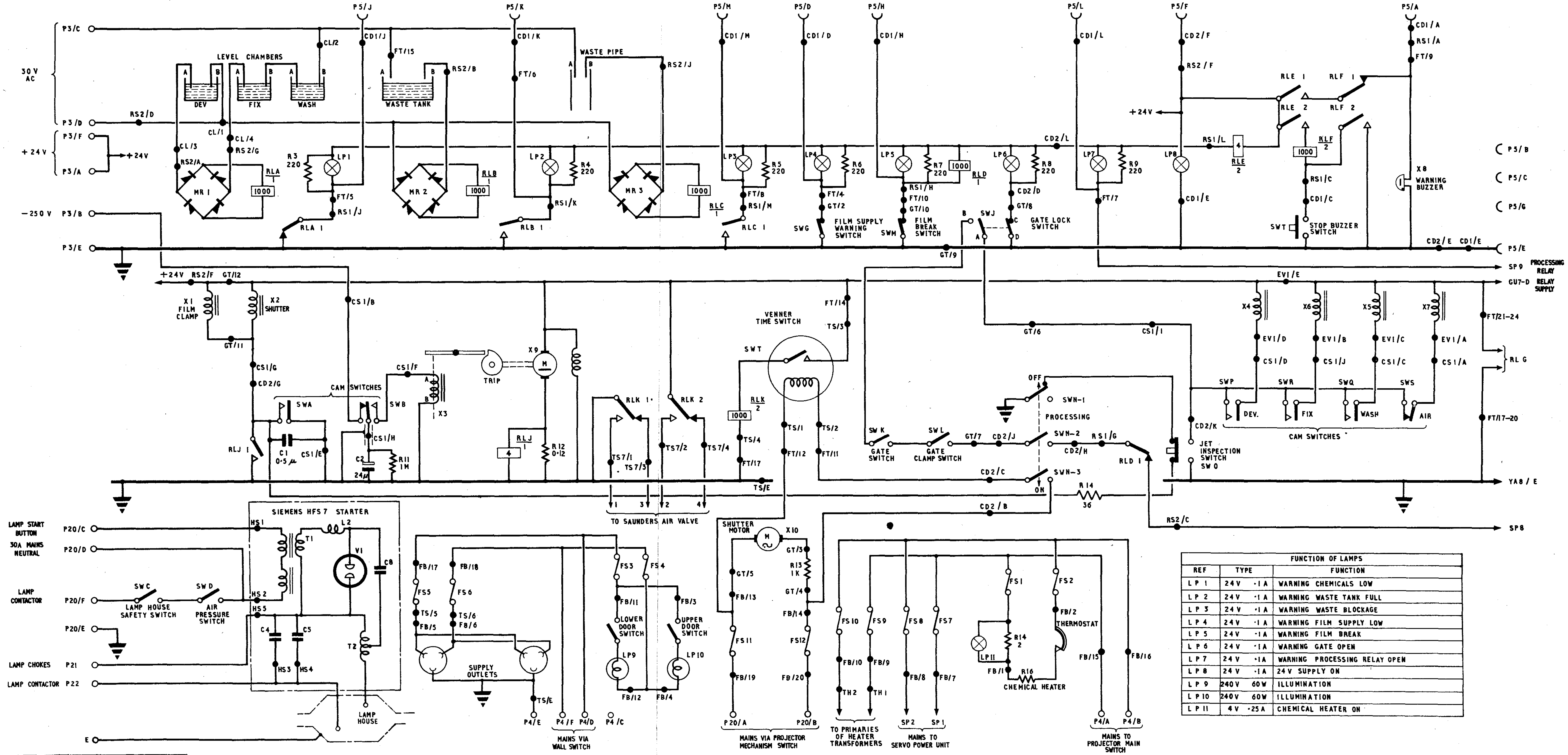

FUNCTION OF LAMPS		
REF	TYPE	FUNCTION
LP 1	24 V ·1 A	WARNING CHEMICALS LOW
LP 2	24 V ·1 A	WARNING WASTE TANK FULL
LP 3	24 V ·1 A	WARNING WASTE BLOCKAGE
LP 4	24 V ·1 A	WARNING FILM SUPPLY LOW
LP 5	24 V ·1 A	WARNING FILM BREAK
LP 6	24 V ·1 A	WARNING GATE OPEN
LP 7	24 V ·1 A	WARNING PROCESSING RELAY OPEN
LP 8	24 V ·1 A	24 V SUPPLY ON
LP 9	240 V 60 W	ILLUMINATION
LP 10	240 V 60 W	ILLUMINATION
LP 11	4 V ·25 A	CHEMICAL HEATER ON

AIR DIAGRAM
6151 B /MIN.
ISSUE 1
PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY

Projector unit 100: simplified circuit

Fig. 6

RESTRICTED

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461933 49212 7369 10/54 625 CWSLtd1035 Gp979-2

Chapter 2

CONTROL UNIT (PROJECTOR) 4075

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LIST OF ILLUSTRATIONS

Introduction

1. Control unit (projector) 4075 is located in the top shelf of rack assembly (power supply) 340. A front panel view of the unit can be seen as part of the complete power supply rack in Sect. 1, Chap. 2.

2. The control unit forms a distribution box for the 15A regulated mains supply; it includes the PROJECTOR MAIN SWITCH, the PROJECTOR MECHANISM switch and a pair of push buttons for remote control of an air compressor.

3. The unit also includes part of the 30A unregulated mains circuit which provides current for the projection lamp in the projector console. This circuit is controlled by the LAMP MAIN SWITCH on the front panel and includes chokes which limit the current taken by the lamp.

CIRCUIT DESCRIPTION

General

4. A circuit diagram of control unit (projector) 4075 is given in fig. 2, and a top view of the chassis, showing the layout of components, in fig. 1.

Regulated mains circuit

5. The 15A regulated mains supply to the photographic display system enters the control unit at the 15A INPUT terminals at the rear of the chassis. The subsequent routing of this supply is discussed in Chap. 1.

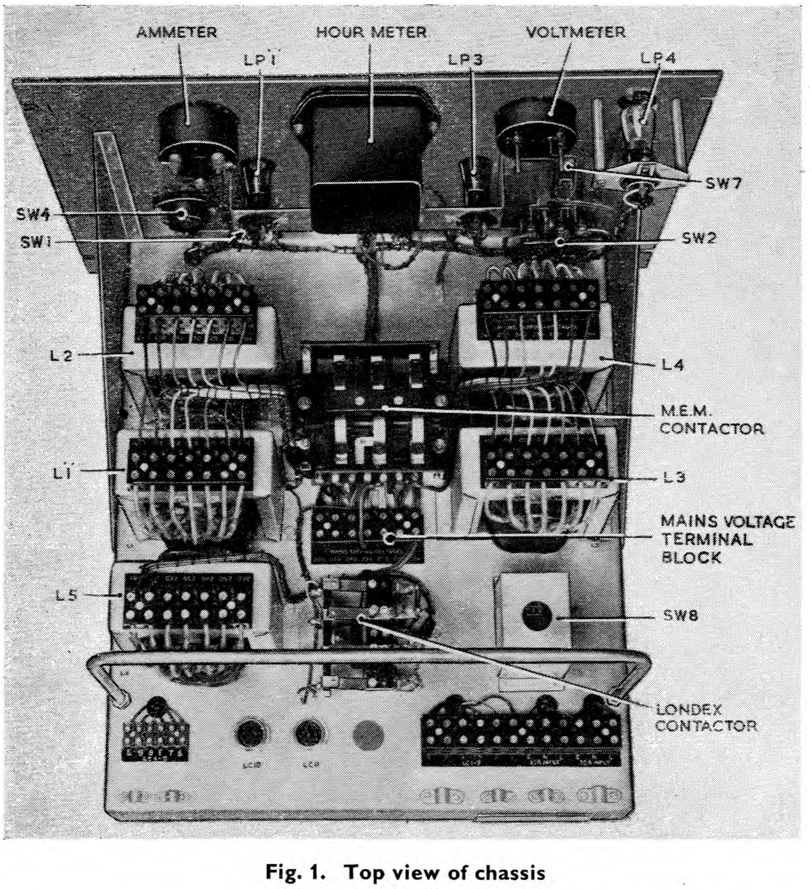

Fig. 1. Top view of chassis

Projector lamp supply

6. The unregulated mains supply is connected to the 30A INPUT terminals at the rear of the chassis. When the LAMP MAIN SWITCH, SW1, is set to ON, the supply is routed through fuses FS3 and FS4 and appears across the operating coil of the main lamp contactor providing that the circuit between LC11/D and LC11/F is completed by safety switches located in the projector console; these close when the lamp house cover is correctly in place and there is a supply of cooling air to the projection aperture in the film gate. When the contactor operates, its contacts connect the supply to the projection lamp via the lamp chokes in the control unit and the lamp starter unit in the projector. The LAMP indicator lamp LP1 lights, indicating that the contactor is energized.

7. The projection lamp in the projector console will occasionally strike immediately the 30A circuit to the lamp starter unit is complete, but it will normally be necessary to use the LAMP STARTER button on the control unit. When this button SW4 is pressed, the lamp starter circuit is completed via LC11/C, provided that the main contactor is energized: a 30–40 kV pulse is generated which strikes the mercury arc. When SW4 is released, the lamp continues to run from the normal mains supply. The operation of the lamp starter circuit is described in Sect. 5, Chap. 2.

Lamp chokes

8. The lamp chokes L1 to L4 provide a series ballast for the lamp. They are each tapped to allow the inductance to be varied for different mains voltages. A fifth choke, L5, is included in the circuit for the first two minutes after switching on from cold. The current passed by this choke assists in heating the lamp rapidly, so providing a high initial light output during the period required for the mercury in the lamp to vapourize.

Hour meter

9. Immediately the projection lamp strikes and the chokes pass current, a voltage appears across them which is applied via fuses FS1 and FS2 to an hour meter and the heater of a time switch SW8. The hour meter enables a check to be made on the actual running hours of the particular lamp in use in the projector.

Delay circuit

10. A lamp LP4 (labelled LAMP RUN UP) on the front panel lights during the period that L5 is in circuit. Two minutes after switching on, the time switch SW8 closes, energizing the operating coil of the Londex contactor with the following results.

(1) The run-up choke L5 is disconnected from the circuit and the projection lamp current falls to its normal operating level.

(2) The LAMP RUN UP lamp on the front panel is extinguished.

(3) A holding circuit is completed in parallel with the time switch SW8. This prevents the contactor operating coil circuit from breaking in the event of failure of the time switch during operation, so causing L5 to be reconnected when the lamp is hot.

11. It should be noted that the time switch heater is constantly in circuit during operation and therefore remains hot. Thus if the lamp is switched off by means of the LAMP MAIN SWITCH, and is then switched on again before the time switch heater gets cold, the period which elapses before L5 is switched out of circuit will be less than two minutes, so compensating for the residual heat in the projection lamp.

12. As explained in para. 10 (3), the projection lamp is protected if the time switch heater fails during operation. However, if the lamp is switched off and then on again, L5 will remain in circuit since SW8 will not operate to switch it out. The operator should observe the LAMP RUN UP lamp for a short period after switching on in order to ensure that it extinguishes in the proper manner.

Meters

13. The control unit carries an ammeter and a voltmeter mounted on the front panel. These instruments monitor the projection lamp current and the voltage across the arc. The voltmeter is normally out of circuit and will not provide a reading unless the PRESS TO READ VOLTS switch SW7 is closed. The reason for the switch is to prevent the meter from being damaged by the high voltage pulse developed at the lamp starter unit.

14. Under normal conditions, the ammeter reading should be about 25A during the two minutes warming-up period, falling to the normal running current of 14A to 18A when the LAMP RUN UP lamp goes out. The voltmeter reading should be between 70V and 80V. The product of the meter readings (multiplied by a correction of 0·9 since the voltmeter is a moving-coil instrument) gives the lamp dissipation in volt-amperes. This figure should never be allowed to exceed 1,300 otherwise damage to the equipment will result.

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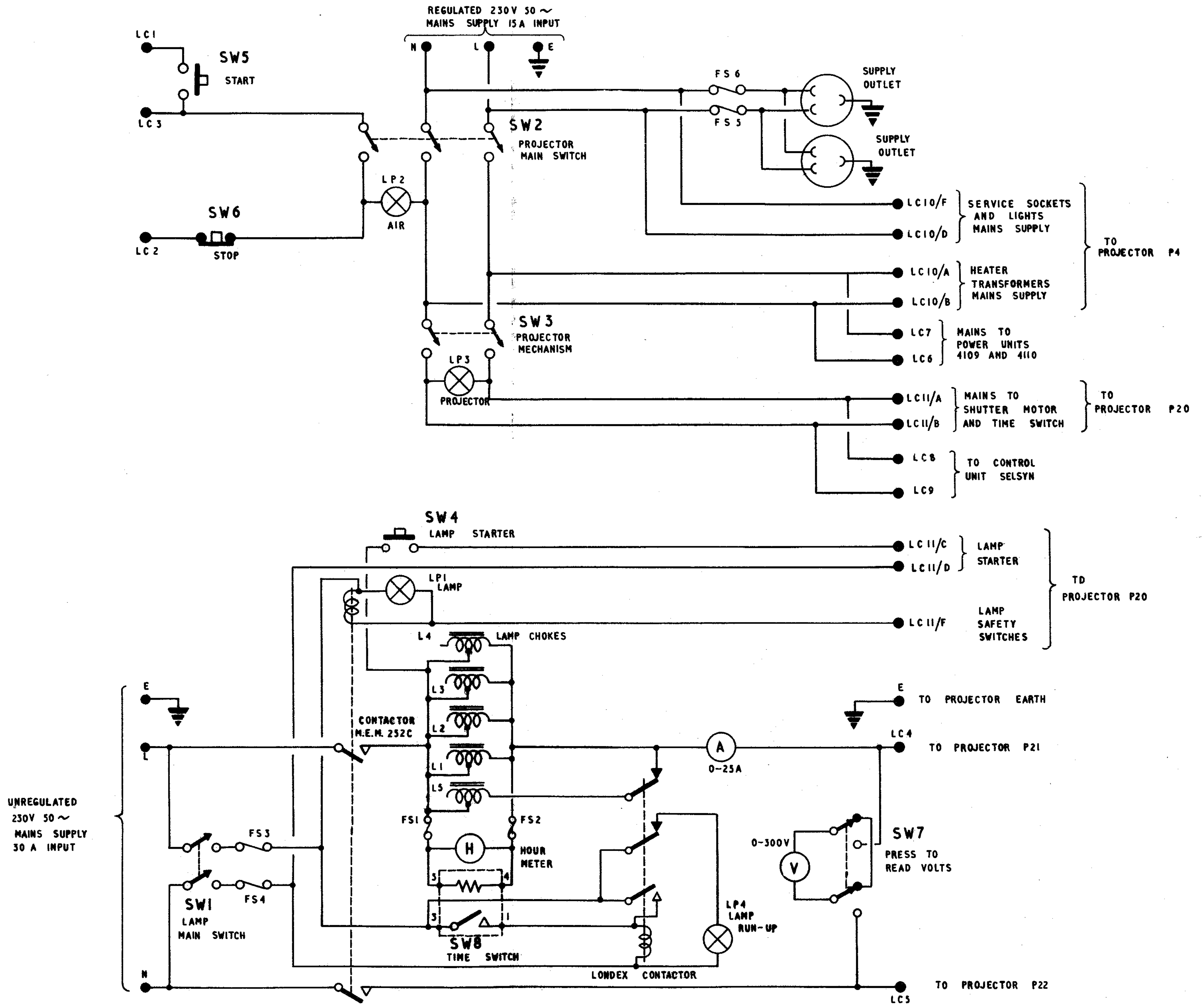

AIR DIAGRAM 6151J/MIN.	RADAR PHOTOGRAPHIC DISPLAY SYSTEM 1498
ISSUE 1 — PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY ADMIRALTY	

Control unit (projector) 4075: circuit

Fig. 2

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Chapter 3

AMPLIFYING UNIT (RELAY) 4076

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LIST OF ILLUSTRATIONS

Introduction

1. Amplifying unit (relay) 4076 monitors the rotation of the camshaft and stops the operation of the chemical jets in the jet unit when the camshaft is at a standstill. The unit also initiates the operation of a warning system which indicates to the operator that rotation has ceased.

2. The input to the amplifier consists of the feedback voltage from the motor generator in the camshaft unit; this is only present when the camshaft is being driven. The voltage is amplified and applied to a half-wave rectifier circuit, and the positive DC voltage so obtained is used to cancel the grid bias on a valve which has the operating coil of a changeover relay as its anode load. Thus, when the camshaft is being driven, the relay operates and completes the circuit of the processing interlocks (*Chap.* 1) and allows processing to proceed. If the camshaft stops rotating for any reason the relay valve is biased to cut-off and the relay releases. The processing interlocks circuit is then broken and processing ceases. The changeover contacts of the relay then complete a circuit through the PROCESSING RELAY OPEN warning lamp on the indicating panel.

3. The unit also carries a three-position switch labelled AERIAL CONTROL–STOP–INTERNAL CONTROL, known as the rotation switch, and a potentiometer marked INCREASE. These are mounted on the amplifier for convenience only. When the switch is set to AERIAL CONTROL the input to amplifying unit (servo) 4111 is derived from the coincidence magslip and the camshaft rotates in step with the radar aerial for normal operation. When it is set to INTERNAL CONTROL the magslip output is replaced by a small 50 c/s voltage derived from the INCREASE potentiometer, whose setting then determines the speed of the camshaft. In the STOP position the servo amplifier input terminal is earthed and the camshaft does not then rotate. The rotation switch also has a wafer which interrupts the 50V 50 c/s reference from the servo power unit to the camshaft motor generator when the rotation switch is set to STOP; this is to prevent the motor generator from idling as a single-phase machine.

4. The amplifier is located on the servo panel at the rear of the projector. When it is in place, a Jones plug on the amplifier mates with a Jones socket RA1 on the panel. A diagram in Sect. 4, Chap. 6 gives the interconnections between the servo panel and the amplifier. Other connections will be found in Sect. 1, Chap. 2, and Sect. 6, Chap. 1.

Circuit description

5. Two views of the amplifying unit, showing the layout of components, are given in fig. 1 and 2; a circuit diagram is given in fig. 3.

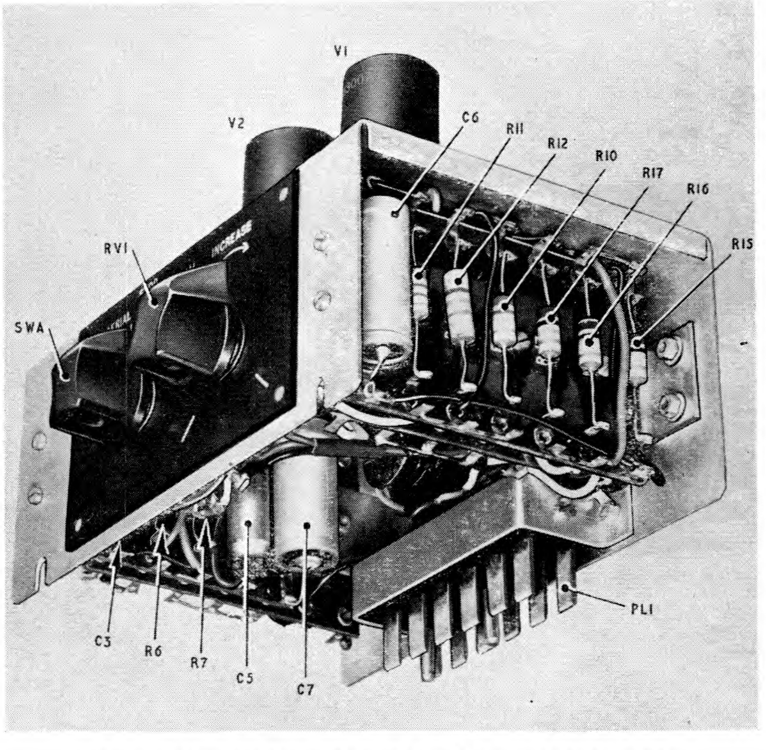

Fig. 1. Amplifying unit (relay) 4076: general view (1)

6. The output of the motor generator in drive unit (mechanical) timing 4118 is a 50 c/s voltage proportional to the speed of the machine; its value is approximately 0·75V per 1,000 r.p.m., which corresponds to a camshaft speed of about 5 r.p.m. This voltage is connected to the input circuit of the relay amplifier via pin 2 of the Jones plug.

7. Valve V1 is a double-triode connected as a two-stage voltage amplifier. The grid circuit of V1a contains a high-pass filter C1, R1 followed by a low-pass filter R2, C2; the component values are such that the response of the circuit is a maximum at 50 c/s. The reason for this is to ensure that the circuit operates only on the 50 c/s voltage from the motor generator and is unaffected by stray pick-up.

8. The amplified 50 c/s voltage at the anode of V1b is applied via C5 to the grid circuit of V2a, which is one section of another double-triode, connected as a cathode-follower. The output from the cathode of this valve is rectified by the metal rectifier MR1, and the positive voltage so obtained is developed across R16 and smoothed by the action of R17 and C7.

9. In the absence of an input to the amplifier (i.e., when the camshaft motor generator is not rotating) valve V2b is biased beyond cut-off since its grid is returned via R17 and R16 to the slider of RV2 which is part of a network across the −300V stabilized supply. When the camshaft is rotating, a positive voltage is derived from the rectifier MR1 and this offsets the standing bias of V2b. The valve therefore conducts and relay RLA/1 in its anode circuit operates, thus completing the circuit of the processing interlocks. Potentiometer RV2 is mounted at the rear of the unit (*fig.* 2). It provides a means of adjusting the circuit so that the relay releases when the camshaft speed is very low.

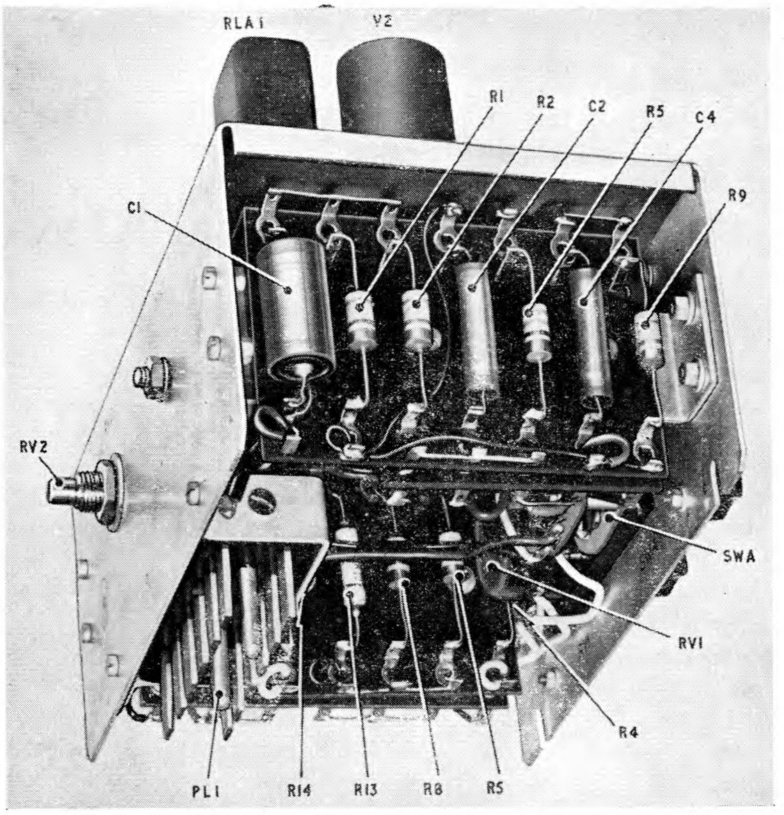

Fig. 2. Amplifying unit (relay) 4076: general view (2)

Test points

10. Sockets SK1 to SK4, accessible at the top of the chassis, are included to facilitate servicing.

Power supplies

11. The HT voltage for the relay amplifier is derived from the +250V stabilized supply generated by power unit 4109 in the power supply rack. The −300V stabilized supply, which provides the bias for V2, is obtained from power unit 4122. Heater supplies for valves V1 and V2 are obtained from the main heater transformers in the projector console.

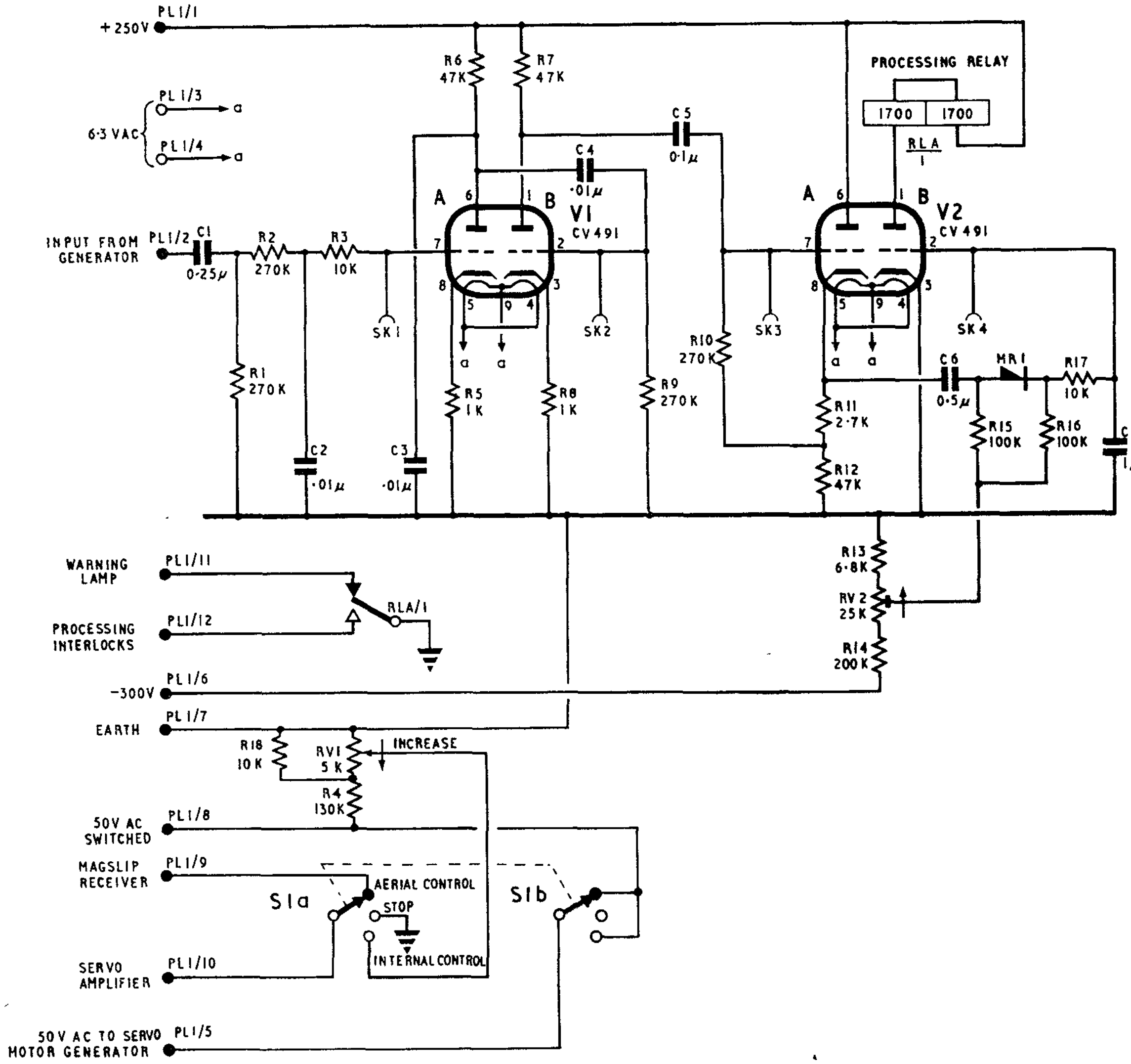

Fig. 3. Amplifying unit (relay) 4076: circuit

SECTION 7

SETTING-UP AND OPERATING

Chapter 1

INITIAL SETTING-UP

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LIST OF ILLUSTRATIONS

Projection lamp

Setting

1. A special gauge (gauge, alignment, *Stores Ref.* 10AG/621) is provided for setting the lamp supports to their correct positions. A view of this gauge is given in fig. 1. Individual lamps are manufactured to close tolerances. When the lamp supports have been set by use of the gauge, the electrode positions of any lamp fitted to the equipment will be satisfactory.

2. The gauge consists of a steel ring having two diametral rods projecting from it to represent the lamp terminals. The longer rod has a machined rectangular block at its outer end which fits the upper lamp support. The shorter rod has a depression in the end which locates the spring-loaded plunger of the lower lamp support. When the gauge is mounted between the lamp supports, the centre of the brass ring lies accurately in the horizontal plane containing the optical axis of the lamp condenser system.

3. Two short rods with rounded ends project inwards from the ring to represent the lamp electrodes. Two more inwardly projecting rods, having pointed ends, define the vertical axis through the centreline of the electrodes.

4. The method of using the gauge to check the lamp supports is as follows:—

(1) Check that the film gate cover is correctly closed, locked and clamped.

(2) Check that the mirror box cover in the gate casting is correctly fitted and that the mirror pressure screw is tight.

(3) Remove the cover from the lamphouse and remove the lamp shields. Set the light control to its uppermost position.

(4) Press down the spring-loaded plunger in the lower lamp support and insert the rectangular block, at the top of the gauge, into the upper support. Release the plunger, being careful to locate it in the hole at the base of the gauge.

(5) Place a piece of white card or paper between the gauge and the concave mirror at the back of the lamphouse.

(6) Check that the light shutter, below the projection aperture in the film gate, is open.

(7) Illuminate the gauge by placing an inspection lamp close to it.

(8) Look into the square, vertical face of the projection prism from a distance of about twelve inches and observe the image of the dummy electrodes. Eliminate parallax by moving the eye until the circles formed by the projection lens elements appear concentric. Check that the image of the dummy electrodes is symmetrically disposed in the field of view.

5. The projection prism has the effect of twisting the image of the lamp electrodes through 90 deg. Thus, if the image of the gauge appears displaced vertically, the lamp supports require adjustment to move the gauge laterally. The lamp support cannot be adjusted to move the gauge vertically and manufacturing tolerances of the lamphouse and projection lamp are sufficiently close to hold the electrodes in the correct horizontal plane. The image of the gauge will therefore appear on the vertical diameter of the field of view.

6. If the image of the gauge appears above or below the horizontal diameter of the field, the lamp supports require adjustment. Proceed as follows:—

(1) Slacken the six screws which secure the phosphor bronze clips holding the lamp supports (three at the top and three at the bottom).

(2) Rotate the porcelain supports slightly. Be careful to rotate them both in the same direction and by the same amount to avoid tilting the lamp axis from the vertical.

(3) Tighten the clips and view the new position of the image through the projection system.

(4) Repeat the adjustment until the image lies correctly on the horizontal diameter of the field.

7. Remove the white card and again look into the projection prism. There should now be a secondary image of the gauge; it should be the same size as the directly viewed one and apparently superimposed on it. Move the eye from side to side to induce parallax. If the two images are in line but not in coincidence, the secondary image will appear to move relative to the direct image.

8. If the two images are not coincident, the concave mirror must be adjusted to make them so. The adjustment can be achieved by setting the three grub screws which determine the position of the mirror relative to its supporting strut. The mirror can be moved bodily towards the gauge and it can also be swung vertically or laterally. Proceed as follows:—

(1) If the secondary image is larger than the direct image, move the mirror away from the lamp by unscrewing the three grub screws and then tightening the two cheese-headed securing screws.

(2) If the secondary image is smaller than the direct one, slacken the cheese-headed screws and screw in the three grub screws. Tighten the securing screws.

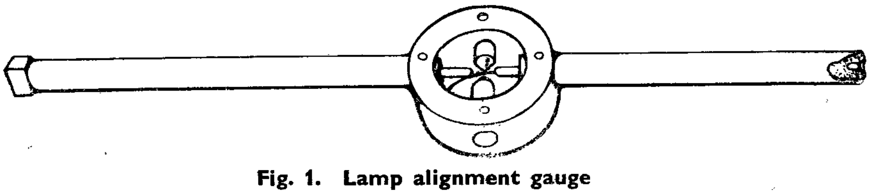

Fig. 1. Lamp alignment gauge

(3) If the secondary image is not in line with the direct image, slacken the securing screws and screw each grub screw in or out as necessary. Tighten the securing screws after the adjustment.

9. When the lamp supports and mirror are correctly adjusted, remove the alignment gauge.

To fit a new projection lamp

10. A projection lamp should be handled by its endcaps only. Be very careful not to touch the quartz envelope with the fingers since any greasy marks will burn into the surface and spoil the lamp.

11. Take a new H/P, mercury/xenon lamp and clean the surface of the quartz envelope with alcohol and a clean selvyt cloth from the tool kit. Depress the spring-loaded plunger in the lower lamp support and fit the rectangular end of the lamp into the upper lamp support. Release the plunger, making sure that it locates the depression in the base of the lamp. Connect the lamp leads to the appropriate terminals on the front casting of the lamphouse. Fit the lamp shields round the lamp and replace the lamphouse cover.

Lamp safety devices

12. Proceed to check the lamp safety circuits as follows:—

(1) Switch on the 230V, 50 c/s, 30A mains supply by means of the ironclad switch on the wall of the udder.

(2) Turn on the compressed air supply. Turn the left-hand pressure reducing valve on the projector indicating panel until the gauge immediately in front of it registers 10 lb./ sq. in.

(3) Set the LAMP MAIN SWITCH on the power supply rack to ON. The neon indicator lamp above the switch should not light.

(4) Gradually increase the air pressure and check that the LAMP neon glows when the pressure reaches between 18 and 22 lb./sq. in.

(5) Reduce the air pressure and check that the neon extinguishes at not less than 12 lb./ sq. in.

(6) Adjust the pressure reducing valve until the gauge needle is within the green sector of the dial.

(7) Check that the lamphouse safety switch operates by removing the lamphouse cover. The neon should extinguish immediately. There is a screw adjustment for the safety switch.

Lamp performance

13. Check that the tappings of the lamp chokes in control unit (projector) 4075 are set to a value of 10V above the nominal value of the unregulated mains supply. This is to allow for off-peak rise.

14. Press the LAMP STARTER button on the power supply rack and simultaneously start a stop watch. Check that the LAMP RUN UP indicator lamp operates. Read the lamp current as indicated on the meter: it should be between 22 and 26 amperes. Observe the speed of the red and white indicator disc in the outlet air trunking at the top of the projector console.

15. Observe the LAMP RUN UP indicator lamp and check that it extinguishes between $1\frac{1}{2}$ and $2\frac{1}{2}$ minutes after pressing the LAMP STARTER button. Five minutes after pressing the LAMP STARTER button, check that the automatic air flow damper in the outlet air trunking has opened by observing that the speed of the red and white indicator disc has increased since switching on the lamp.

16. When the lamp has been running for twenty minutes, check the readings of the ammeter and voltmeter on the power supply rack. The product of the two readings (multiplied by 0·9 to allow for form factor) must be between 900 and 1,100 volt amperes.

Alignment of projection prisms, interconnecting mirror, hood and screen

17. Proceed as follows:—

(1) Set the interconnecting mirror into the position for throwing the picture from projector No. 1 on to the projection screen. Place a clinometer on the face of the mirror and adjust the stop screw and locknut on the mirror support casting until the mirror is at 45 deg. to the axis of the light beam.

(2) Swing the mirror into position for the other projector and adjust the other stop screw until the mirror is at 45 deg. to the axis of the beam.

Note . . .
When the mirror has been swung from one projector to the other the securing nut on the mirror pivot axis should only be tightened gently. If the nut is handled severely, the mirror will not rest correctly on its stop screw. The securing nut is only intended to hold the mirror casting gently against the bearing face on the support casting: it is not intended to lock the assembly against attempts to move the mirror by hand.

(3) Define, by measurement, a centreline on the setting board parallel to the mirror axis. Mark it with a chinagraph pencil.

(4) Locate the centre of the projection screen and mark it with a chinagraph pencil.

(5) With no film in the film gate of projector 1, direct the light beam on to the projection screen and bring the edge of the circle, caused by the edge of the gate aperture plate, into sharp focus by means of the projection lens.

(6) Check that the projected circle of light is central in the screen area.

(7) Swing the interconnecting mirror to throw the light on to the setting board. Check that the centre of the circle of light is approximately $\frac{1}{4}$ in. from the centreline measured towards projector 1. It will be necessary to refocus the projection lens.

(8) With no film in the film gate of projector 2, bring the edge of the circle, caused by the edge of the gate aperture plate, into sharp focus by means of the projection lens.

(9) Check that the projected circle of light is central in the screen area.

(10) Swing the interconnecting mirror to throw the light from projector 2 on to the setting board. Refocus the projection lens and check that the centre of the circle of light is approximately ¼ in. from the centreline measured towards projector 2.

18. The projected circles of light from projectors 1 and 2 should have coincident centres and should be central in the screen area. They will not necessarily be the same size due to the manufacturing tolerances of projection lenses. The projected circles on the setting board should have centres spaced by about ½ in. owing to the thickness of the interconnecting mirror. The point midway between the centres should fall on the marked centreline. In order to achieve the desired result, some slight adjustment may be necessary to the projection prisms and to the position of the projection screen. Slight adjustment to the position of the screen hood may be required to ensure that the light beams clear the baffle plate at the base of the hood.

19. The adjusting screws for the projection prisms are described in Section 3, Chapter 3. When making any adjustment, support the weight of the prism with a selvyt cloth held in the hand. Be careful not to screw the adjusting screws in too far, otherwise the prism will fall away from the mount. The point where the head of an adjusting screw becomes flush with the face of the mount should be regarded as the limit of adjustment.

Marking out the setting board

20. Proceed as follows:—

(1) Erase the centreline marked in para. 17 (3).

(2) Set the interconnecting mirror to throw the light from projector 1 on to the setting board.

(3) Focus the projection lens.

(4) Mark four small arcs at 90 deg. spacing to define the edge of the light circle. Use indian ink to make the marks and identify each by marking P1 adjacent to it.

(5) Swing the interconnecting mirror to throw the light from projector 2 on to the board.

(6) Focus the projection lens.

(7) Mark four arcs to define the circle from projector 2 and mark them P2.

21. The markings on the calibration screen provide a reference for resetting the optical system should any part of it become disturbed at any time. The markings will not be coincident owing to the thickness of the interconnecting mirror and a possible difference in the magnifications of the two projector lenses.

Light distribution

22. It is required to set the light control in the lamphouse to give a satisfactory level of illumination at the projection screen. The measurements are to be made using a photometer capable of reading up to 50 ft. candles. The upper glass of the projection screen must be lifted and the paper screen removed. The photometer is then to be placed face downwards on the armoured glass.

(1) Adjust the light control until the illumination at the four cardinal points of the screen is at least 40 ft. candles. The absolute reading in ft. candles is 10 per cent greater than that registered on the meter since mercury vapour light has a factor of 1·1.

(2) Take readings at several other points over the screen area and check that the highest reading obtained does not exceed the lowest by more than 70 per cent.

23. If the light distribution does not prove satisfactory, the reason may be one or more of the following:—

(1) The 45 deg. mirror in the film gate out of position, dirty or tarnished.

(2) Projection lamp incorrectly set.

(3) Lamp output poor or lamp envelope marked.

(4) Condenser system dirty.

Resolution

24. The combination of camera lens (set to full apperture), film and projection lens is required to define, on the screen, a high contrast subject having detail corresponding to 1,400 lines evenly spaced across the face of the CRT. A piece of special test gear is supplied to assist in assessing the performance of a projector. It is known as a dummy tube (registration), Stores Ref. 10S/16685.

Dummy tube

25. The dummy tube is illustrated in fig. 2. It consists of a metal can having a metal tube protruding from its base. The dimensions of the can and tube are the same as those of a CRT bulb and neck enabling the assembly to be installed in place of the CRT in indicating unit 4123. The base of the can rests on the deflector coils and the tube passes through the coils and CRT neck support ring (*Section* 2, *Chapter* 7, *fig*. 2). A test scale fits into the top of the can, where it is secured by three spring clips. The scale consists of a graticule sandwiched between two pieces of glass: the lower glass is flashed opal to diffuse the light obtained from four neon bulbs mounted in the base of the can and connected in parallel.

26. The only markings on the graticule of interest for testing this equipment are as follows:—

(1) The five sets of concentric circles marked (a) in fig. 2. These provide the 1,400 line subject (234 lines per inch).

(2) The four cross lines marked (b) in fig. 2. These may be used for checking film registration.

(3) The two circles marked (c) in fig. 2. The outer of these is 6 in. diameter and the inner 5·8 in. They may be used to check circularity of range rings in advanced servicing.

To remove the CRT

27. Open the door on the indicating unit compartment and depress the foot pedal. Swing the mounting framework forward to the extent of the retaining chains and release the foot pedal.

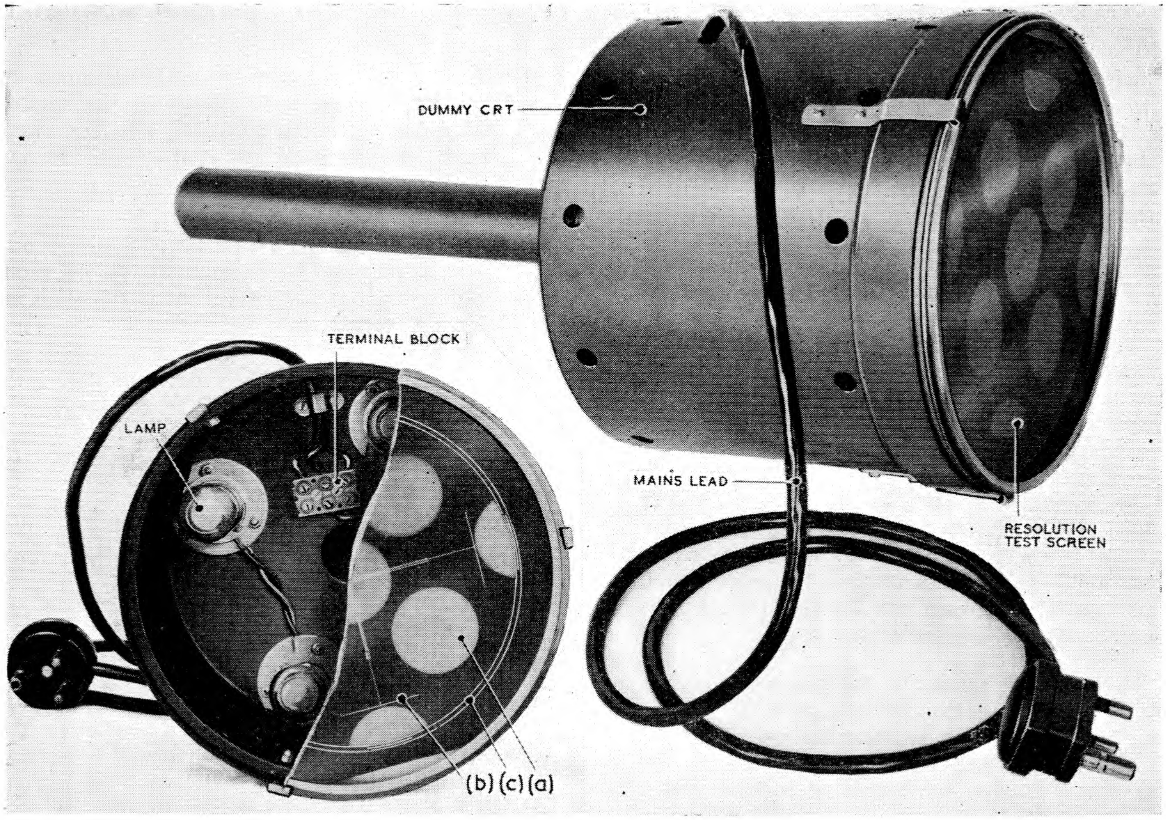

Fig. 2. Dummy tube (registration)

(1) Remove the connectors from the CRT mounting tube. Disconnect the CRT anode cap and base socket.

(2) Twist the two locking knobs on the gimbal ring through 90 deg. and lift the locking plates. Lift the whole tube unit clear from the mounting frame.

(3) Slacken the three adjusting screws at the top of the mounting tube and remove the two 2 BA screws at the side. Holding the CRT clamp, pull out the tube complete with clamp.

To install the dummy tube

28. Insert the dummy tube into the CRT mounting tube.

(1) Place the mounting tube into the mounting frame, ensuring that the pivots drop into the slots in the gimbal ring. Drop the locking plates and secure them with the locking knobs.

(2) Clean the face of the scale with the wash leather and selvyt cloth provided in the tool box.

(3) Depress the foot pedal and swing the mounting frame into the operating position, being careful to locate the spigot under the tube casting in the lug at the back of the mounting tube.

To check resolution

29. Load the projector with film and thread it as described in Chapter 2.

(1) Switch on the 230V, 50 c/s, 15A regulated supply by closing the ironclad switch on the wall of the udder.

(2) Close the PROJECTOR MAIN SWITCH and the PROJECTOR MECHANISM switch. Close the HT switch inside the right-hand door of the power supply rack but do not switch on the projector EHT. Turn the switch on amplifying unit (relay) 4076 to INTERNAL CONTROL and adjust the INCREASE control until the period between transport operations is between 12 and 15 sec. Set the PROCESSING ON-OFF switch to ON.

(3) When several frames have been processed, check by inspection that the film is being crimped and that processing is satisfactory.

(4) Switch on the 230V, 50 c/s, 30A unregulated circuit by means of the ironclad switch on the wall and then start the projection lamp by closing the LAMP MAIN SWITCH and pressing the LAMP STARTER button. Allow sufficient time for the lamp to warm up and then check that the LAMP RUN UP light extinguishes and that the air flow indicator in the air outlet pipe rotates rapidly. Set the light control in the lamphouse to the position found in para. 22.

(5) Set the camera aperture to f/2. Plug the mains lead of the dummy tube into one of the service sockets at the left-hand side of the projector console.

(6) Allow processing to proceed until several frames have been transported and then adjust the projector lens focusing ring to obtain the best definition of film grain on the projection screen.

(7) Adjust the camera lens focusing ring until the projected picture has the best possible definition. Remember that three transport operations are required before the effect of a camera focus adjustment becomes evident on the screen.

(8) When it is certain that the best possible focus has been achieved, examine the projected image. Check that the individual circles of the test pattern can be resolved.

30. If the resolution of the equipment does not prove satisfactory, check:—

(1) That the test scale is correctly located against the rim of the tube casting under the console desk.

(2) That the film is held flat in the camera and projection apertures.

(3) That the camera lens is not strained out of the vertical by the hood of lens unit 4124.

Registration of individual projectors

31. Place a sheet of paper on the projection screen and secure it against movement with adhesive tape.

(1) Select the image of a pair of cross lines on the test scale and mark the crossing point on the paper with a pencil.

(2) Repeat the operation until the same point has been plotted for fifty successive frames.

(3) Check that all the pencil marks fall within a square having sides of $\frac{5}{16}$ in.

The detailed method of checking registration and the adjustments required to correct it, if faulty, are given in Volume 5, Appendix J.

Optical registration of a pair of projectors

32. With a dummy tube fitted in place of the CRT in each projector, plot successive images, first from one projector and then from the other. All these images should fall within a square having sides of $\frac{5}{8}$ in.

To fit a new CRT

33. Place a new CRT, face down, on a flat surface using a sheet of clean paper to prevent the face from being scratched.

(1) Place the clamp ring over the bulb of the CRT with the two steel securing strips uppermost. Lower the ring until its edge is in the same plane as the CRT face. Rotate the clamp ring until one of the breaks is in line with the CRT anode cap and tighten the clamp screws.

(2) Push the assembly into the CRT mounting tube. A smear of Hellerman's sleeve lubricant on the CRT neck will help it to enter the rubber neck support at the base of the focus and deflector coil assembly.

(3) Push the CRT into the mounting tube until the flare rests on the coil assembly. Locate the hank bushes at the ends of the steel strips with the slotted holes in the mounting tube and secure with two 2 B.A. screws.

(4) Drive in the three securing screws at the top of the mounting tube to contact the CRT clamping ring. Secure the screws with their milled locking nuts.

(5) Lower the assembly into the mounting frame making sure that the pivots engage the slots in the gimbal ring. Secure the locking plates and locking nuts.

(6) Make the connections to the plugs under the CRT mounting tube. Fit the CRT anode cap and base socket.

(7) Clean the face of the CRT with the wash leather and selvyt cloth from the tool kit.

(8) Depress the foot pedal and swing the mounting tube into the operating position. Release the pedal gently making sure that the spigot under the tube casting below the console desk engages the lug behind the mounting tube. Close the door of the CRT compartment.

Electronic setting up and marking setting board

34. The procedure for aligning and setting up the electronic units is given in Volume 5. When the circuits are correctly aligned, proceed to mark out the setting board as follows:—

(1) Determine, by measurement, the mid-points of the north and south sides of the projection screen. Fix a wire between the points, so defining a line down the centre of the screen from north to south. Switch on the track-telling room lighting so that the shadow of the wire is visible from the projector room.

(2) Run up the photographic display system and check that processing is satisfactory.

(3) Switch off the X deflection amplifier of projector 1 (by operating switch SWB on amplifying unit (X deflection) 4131) and set the range switch to position 3.

(4) Turn up the brilliance control. Use the X SHIFT control to give a line trace which passes approximately through the centre of the CRT face.

(5) Release the CRT coil assembly fixing screws (*Section* 2, *Chapter* 7) and adjust the position of the deflector coils until the projected image of the trace does not deviate by more than $\frac{1}{2}$ in. from a line parallel to the shadow of the wire. Remember that three transports are required before the effect of an adjustment is evident on the screen.

(6) Switch off the X deflection amplifier of projector 2 and set the range switch to position 3. Perform operations (4) and (5) for projector 2. It will be necessary to swing the interconnecting mirror.

(7) Swing the mirror to throw the picture from projector 1 on to the screen. With the X deflection amplifier switched off and the tube brilliance turned up, adjust the X SHIFT control until the image of the trace passes through the centre of the screen and does not deviate from the wire by more than $\frac{1}{4}$ in. at the ends.

(8) Switch on the X deflection amplifier and switch off the Y amplifier (by operating switch SWB on amplifying unit (Y deflection) 4132).

(9) Operate the Y SHIFT control until the image of the trace falls along the east-west centreline (defined by the inner edges of the armoured glass sheets) to within ¼ in. measured at the ends.

(10) Swing the interconnecting mirror to throw the picture on to the setting board. Switch the deflection amplifiers alternately and mark the trace crossover point on the setting board. Identify this point by writing P1 against it.

(11) With the X deflection amplifier of P2 turned off and the brilliance turned up, adjust the X SHIFT control until the image of the trace passes through the centre of the screen and does not deviate from the wire by more than ¼ in. at the ends.

(12) Perform operations (8) to (10) for P2. Write P2 against the trace cross-over point on the setting board.

(13) From the centres, marked P1 and P2 on the setting board, describe circles of 14½ in. radius. These circles may be used for checking the CRT display against the 160 miles range ring with the range switch at position 2.

Orientation of displays

35. The method of setting up the displays to make picture north occur at any desired side of the screen, or to make the station position occur other than at the centre of the picture, is given in Volume 5.

Alignment of displays from two projectors

36. This includes the marking of the setting board with a chinagraph pencil. The procedure is given in Volume 5.

Scale (test pattern) 328

37. The scale is illustrated in fig. 3. It is a piece of test gear supplied for use when setting up the electronic units. It consists of a piece of $\frac{1}{16}$ in. thick, clear perspex marked with circles for checking the deflection amplifiers.

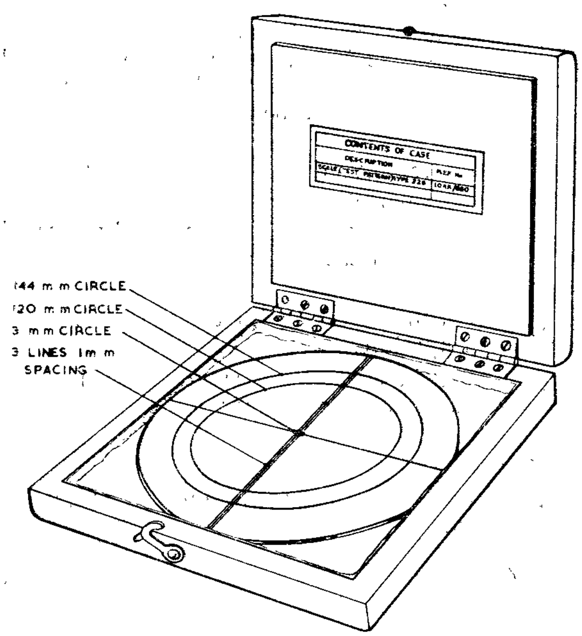

Fig. 3. Scale (test pattern) 328

38. The scale may also be used for checking registration since it provides a stable pattern which can be illuminated by means of the rotating CRT trace with the RADAR SIGNAL control turned fully counter-clockwise and the brilliance turned up.

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To set the bearing for film transport

39. Run up the photographic display system in the normal manner (*Vol.* 5) and adjust the display on the projection screen according to local requirements using projector No. 1.

(1) On projector No. 1, open the left-hand front door of the projector console and swing out the indicator.

(2) Switch off the X-deflection amplifier of projector No. 1 by operating switch SWB on amplifying unit (X deflection) 4131. A single trace will now be displayed on the display tube. Mark the position of this trace with a chinagraph pencil (*line N fig.* 4). Switch the deflection amplifier on again.

(3) Using the north heading line as reference, mark a line X (*fig.* 4) at the bearing required for film transport. From this bearing line X set off an angle of 25° in the direction of trace rotation and mark another line R (*fig.* 4). Delete the line N.

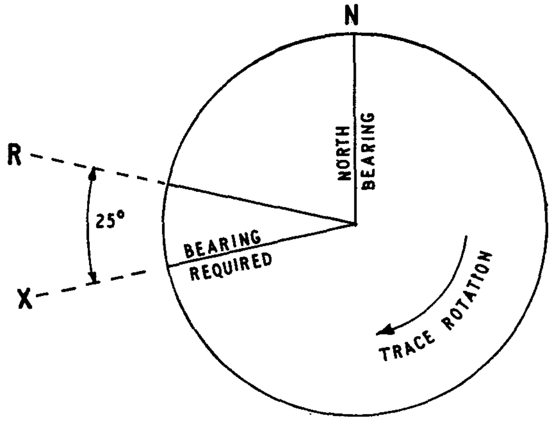

Fig. 4. Film transport setting

(4) Just before the pointer of the cycle indicator on the projector mainplate reaches the FILM LOAD line, stop the selsyn receiver in rack assembly (power supply) 340 No. 1 by withdrawing the appropriate plug from the selsyn patching box on the udder wall. Check that the cycle indicator pointer stops at FILM LOAD.

(5) Observe the c.r.t. trace and insert the plug in the patching box at the instant the c.r.t. trace is aligned with the line R on the display tube.

(6) Check, by observing the c.r.t. and listening to the transport mechanism, that transport occurs when the trace is roughly aligned with the line X.

(7) Make any fine adjustment required by rotating the body of the magslip transmitter in control unit (selsyn) 921 in the power supply rack. It will be necessary to slacken the clamp bolts to do this. Take care to tighten the clamp bolts after the adjustment.

(8) Swing the interconnecting mirror and set projector No. 2 in a similar manner.

40. When the position of film transport has been satisfactorily set, remove unwanted chinagraph marking from the c.r.t. face. It will only be necessary to reset the mechanism if the electrical link between the selsyn in the rack assembly (power supply) 340 and the selsyn in the radar head is broken. The setting should always be checked when running up the equipment or if services have been interrupted.

Chapter 2

OPERATING INSTRUCTIONS

LIST OF CONTENTS

ILLUSTRATION

General

1. This chapter gives the procedures for loading new film into the projector and for unloading exposed film. All other routine operating instructions are covered in Volume 5.

To unload film from the projector

2. Check that the film cassette is empty by using the film supply indicator. To do this, turn the indicator knob on the cassette mounting block in a counter-clockwise direction as far as it will go. Read off the quantity indicated on the scale adjacent to the knob.

3. If the cassette proves to be empty, remove the cover of the film feed chamber by releasing the milled screw in its centre.

(1) Park the roller carriages, adjacent to the film feed, tension, transport and hold-back sprockets, in their open positions.

(2) Cut the film in the film feed chamber using a pair of scissors.

(3) Support the weight of the cassette by placing the right hand at about 4 o'clock.

(4) Using the left hand, undo the cassette securing screw on the film gate above the film feed chamber. When it is fully released, place the left hand on the cassette at about 10 o'clock.

(5) Allow the cassette to rotate slightly in a clockwise direction to clear the end of the securing screw. Check that the film perforations are clear of the feed sprocket.

(6) Lift the cassette from the film gate casting and remove it to the darkroom for recharging.

Note . . .

The cassette will contain a short length of film wound on a Bakelite centre. Discard the film but do not discard the centre: it will be required for film rewinding.

4. Remove the exposed film from the projector as follows:—

(1) Release the gate clamping mechanism and the gate catch. Open the gate cover and secure it by engaging the gate hook (located above the prism mount) with the pillar at the top of the cassette mounting face.

(2) Lift the film perforations from the teeth of the tension, transport and hold-back sprockets and wind the film on to the take-up spool.

(3) Close the film gate cover and the film feed chamber to prevent the entry of dust.

(4) Remove the full take-up spool to the darkroom and fit an empty spool in its place.

To fit a charged cassette

5. Before fitting a cassette to the projector it is necessary to ensure that the film gate is clean. The method of cleaning the gate is given in Vol. 5, Part 2, Sect. 2. After cleaning, close the film gate cover to give easy access to the cassette securing screw.

(1) Turn the manual control on the front of the projector until the cycle indicator registers LOAD FILM.

(2) Remove the cover from the film feed chamber.

(3) Clean the film supply low warning contact on the film gate casting and the contact on the fresh cassette.

(4) Trim the end of the film protruding from the cassette mouth to about 2 in.

(5) With the right hand at about 4 o'clock and the left hand at about 10 o'clock, lift the cassette so that its axis is horizontal with the mounting block to your left.

(6) Engage the lug at the bottom of the mounting block with the cassette support at the right hand, lower corner of the film gate casting.

(7) Support the weight of the cassette with the right hand and use the left hand to feed the end of the film through the entry slot in the film feed chamber. Then rotate the cassette slightly in a counter-clockwise direction and locate the cassette securing screw at the top of the gate casting into the tapped bush in the cassette mounting block.

(8) Tighten the cassette securing screw.

To thread the film

6. The references in this paragraph apply to Sect. 3, Chap. 6, Fig. 1.

(1) Check that the roller carriages (2, 49, 44) and the one on drive unit (mechanical) film 4119 are parked in their open positions. Open the film gate cover and engage the hook.

(2) Take the end of the film, in the film feed chamber, between the thumb and forefinger of the right hand and draw it along the following route:—

(a) Between the film feed sprocket (3) and the roller carriage (2).

(b) Between the film tension sprocket (52) and the roller carriage (49).

(c) Through the slot formed by the film stripper at the right-hand end of the lower table in the film gate and the gate casting.

(3) Now pull the end of the film until a length of about 6 ft. is drawn from the cassette.

(4) Place the forefinger of the right hand above the film between the film feed sprocket (3) and the tension sprocket (52). Draw the film down into a loop which touches the bottom of the feed chamber. Use the fingers of the left hand to prevent the film perforations from catching up on sprocket teeth.

(5) Return the roller carriages (2) and (49) to their operating positions.

(6) Pull the film horizontally through the gate until the loop in the film feed chamber corresponds with the painted white curve on the back wall of the chamber. Locate the film perforations on the teeth of the transport sprocket and then pass the film between the sprocket and its roller carriage. Turn the carriage to its operating position.

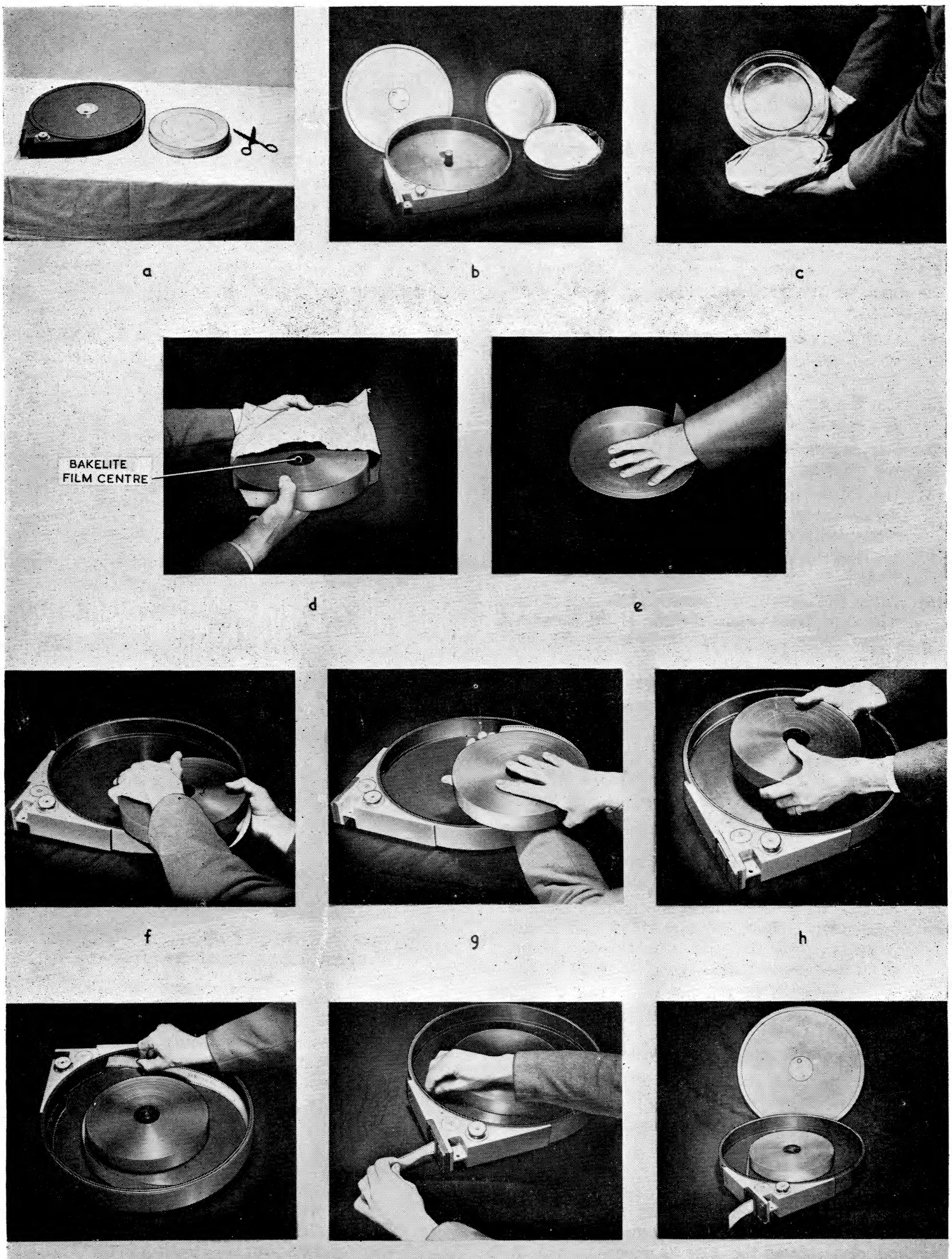

Fig. 1. Film cassette loading

(7) Form the film into a loop conforming with the painted white line on the front of drive unit (mechanical) film 4119 and then pass it between the hold-back sprocket (43) and its roller carriage (44). Turn this carriage to its operating position.

(8) Pass the film round the chute (41), and over the rollers (40) and (38). Enter the end of the film into one of the slots in the hub of the take-up spool. Rotate the take-up spool by hand in a counter-clockwise direction to take up the slack in the film. Check the route of the film against Sect. 3, Chap. 6, Fig. 1.

(9) Check that the film lies flat in the film gate between the side pressure rollers and pads.

(10) Close, lock and clamp the film gate. Replace the cover on the film feed chamber.

7. After threading the film, the manual control on the front of the projector should not be turned unless power is switched on to the equipment with the PROJECTOR MECHANISM switch on the control rack closed. If this precaution is neglected, the take up loop will be drawn tight (since there will be no operation of the transport sprocket) and a large feed loop will accumulate in the film feed chamber. The accumulation of film in the feed chamber will then probably cause a complete jam at the tension sprocket when the equipment is eventually switched on.

Film cassette loading

8 The job of loading a new length of film into a cassette must be done in complete darkness otherwise the film will be fogged. It is a good plan to practise loading with a spool of out-dated or otherwise scrap film until you are quite familiar with the method. It should then be quite easy to do the job in the dark.

9. A series of photographs is given in fig. 1 which should help operators to understand the problem. The procedure is as follows:—

(1) Lock the darkroom door and draw the curtain across it.

(2) Lay the cassette down, on the working surface of a darkroom storage rack, with its mouth to your left and the lid uppermost. Remove the lid of the cassette and place it conveniently to hand. Inspect the interior of the cassette for dust or other foreign matter. If necessary clean it out with the 1 in. flat brush from the tool kit. If it contains a Bakelite film centre from a previous loading, remove this to use later for rewinding. Select a tin of new film and check the label on it for type, length, date, etc. Place the tin to the right of the cassette. It may be necessary to trim the end of the film during the loading procedure, so it is as well to have a pair of scissors conveniently to hand (*fig.* 1a).

(3) Remove the sealing tape from the tin of film and immediately put out the light.

(4) Remove the lid from the tin (*fig.* 1b).

(5) Inside the tin, the film will be found in a paper bag—there will also be a few pieces of scrap paper packing. Discard the pieces of packing, making sure that they do not fall into the cassette.

(6) Hold the tin with your right hand under it and your left hand above it pressing on the bag of film. Invert the tin so that the bag drops on to the left hand enabling the tin to be drawn away and placed on one side (*fig.* 1c).

(7) Identify the open end of the bag. Hold the base of the bag in your left hand and insert the right hand into the bag with the thumb uppermost and the fingers below spanning the film from the outside to the Bakelite centre (*fig.* 1d). An under view, showing the position of the right hand, is given in fig. 1e. From this stage, until the film is safely in the cassette, it is important that the Bakelite centre be supported the whole time. Otherwise, there is a danger that the centre will fall out, resulting in 1,000 ft. of loose film reaching the darkroom floor.

(8) Identify the free end of the film. It should reel off in a counter-clockwise direction. If it does, place your left hand with the fingers hooked under the edge of the spool and the thumb resting on the centre (*fig.* 1h). If the film reels off in a clockwise direction as shown in fig. 1d and fig. 1e, place your left hand over the spool with the fingers round the edge and your left wrist resting on the centre (*fig.* 1f). Invert the spool so that it lies along your left forearm (*fig.* 1g). Move your right hand and place it so that the fingers again span the underside of the spool right in to the centre. Use your left hand to check that the film now reels off correctly in a counter-clockwise direction and then place your left hand so that the fingers hook round the edge of the spool and the thumb rests on the centre (*fig.* 1h).

(9) Locate the cassette centre with the finger-tips of the right hand and register the film centre with it. Press the film centre down with the left thumb withdrawing the fingers of both hands at the same time.

(10) Examine the end of the film. It should be clean cut and free from buckle. Trim it with the pair of scissors if it appears necessary. Ensure that the trimmings do not drop into the cassette.

(11) Enter the end of the film into the aperture in the curved wall of the cassette and push it through until it emerges from the cassette mouth (*fig.* 1j). This operation should be quite simple, but if there appears to be any difficulty, trim the end of the film again and have another try.

(12) Pull the end of the film until a length of about 6 in. protrudes from the cassette mouth (*fig.* 1k). Check that the film is not caught up in the end of the film supply indicator bar. This can quite easily happen where there is a loose outside turn as in fig. 1j.

(13) Check that the spool of film is correctly loaded into the cassette. It should lie flat in the cassette with the outer end reeling off in a counter-clockwise direction. There should be about 6 in. of film protruding from the cassette mouth (*fig.* 11).

(14) Fit the cassette lid and lock it by turning the locking device in a clockwise direction You may now turn on the light.

(15) Reclaim the empty film tin and stow it in the storage rack. It will be needed to contain exposed film.

Film rewinding

10. The film rewinder is normally stored in the darkroom in one of the storage racks. The exposed film, on the full take-up spool removed from the projector, should be rewound on to the Bakelite film centre, obtained from the exhausted film cassette, as follows:—

(1) Draw the film rewinder forward from its stowage position in the rack. Place it in position on the working surface of the rack with the driving spindle to your right.

(2) Mount the full take-up spool on its spindle in such a manner that it rotates in a clockwise direction as the film is wound off.

(3) Withdraw the retaining bar from the driving spindle and mount the Bakelite film centre on the spindle.

(4) Insert the free end of the film into the slot in the Bakelite film centre and restore the retaining bar to its normal position.

(5) Turn the handle in a counter-clockwise direction to start winding off the film from the take-up spool. If there is any tendency for the spool to overrun the driving spindle, tighten the friction device on the spool spindle.

(6) Continue to turn the handle until all the film is wound on to the Bakelite centre.

(7) Remove the take-up spool (now empty) and stow it in the rack.

11. The spool of film on the Bakelite centre must now be transferred to an empty film tin.

(1) Withdraw the retaining bar from the driving spindle and swing it out of the way.

(2) Grasp the locating disc and the spool of film with one hand and turn the handle in a clockwise direction with the other. The locating disc, complete with its hub, the Bakelite centre and film will now unscrew from the driving spindle. When the assembly is fully disengaged from the spindle, release the handle and turn the locating disc into a horizontal plane so that it supports the film.

(3) Invert the bottom section of the film tin over the film. With one hand under the disc and the other over the film tin, invert the whole assembly and place it on the work bench.

(4) Lift off the disc and hub. Take care that the hub slides easily out of the Bakelite centre without disturbing the inner turns of the film.

(5) Fit the lid of the film tin and secure it with adhesive tape. Mark the label on the tin with sufficient information to identify its contents.

(6) Restore the locating disc to its position on the machine. Refit the retaining bar and replace the machine in its stowage position in the rack.

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PART 2

SERVICING

SECTION 1

DISMANTLING AND REASSEMBLING INSTRUCTIONS

Chapter I

DRIVE UNIT (MECHANICAL) FILM 4119

General

1. A description of this unit is given in Part 1, Sect. 3, Chap. 4. If a mechanical fault is suspected in the gearbox, the gearbox must be replaced by a serviceable spare. Do not attempt to remove the top or front cover plate.

To remove the complete unit from the projector console

2. (1) Remove the motor cover by unscrewing one 6 BA and two 4 BA screws.

(2) Disconnect the three input leads to the motor terminal block and the two input leads to the gearbox terminal block.

(3) Slacken the four 2 BA screws securing the unit to the projector mainplate.

(4) Remove two diagonally opposite 2 BA fixing screws.

(5) Support the unit with one hand and remove the two remaining 2 BA fixing screws.

(6) Draw the unit carefully away from the projector mainplate taking care not to damage the teeth of the transport sprocket.

(7) Remove the drain plug at the base of the unit and drain off the oil. Replace the drain plug.

Drive motor

3. The drive motor may be removed from th gearbox by removing three screws. When with drawing the motor, note the fibre coupling washer Take care to replace this washer when reassemblin and then fit the motor to the gearbox with th terminal blocks in line. Fit the three securin screws.

To refit the complete unit to the console

4. Place two 4 BA securing screws convenientl to hand and then offer the unit to the projecto mainplate taking care not to damage the transpor sprocket teeth.

(1) Insert the two screws into diagonally opposit fixing holes; start but do not tighten th screws.

(2) Start two more 2 BA fixing screws into th two remaining holes.

(3) Tighten the four screws gradually, usin "cross corner" order.

(4) Fill the gearbox with oil to the correct leve as indicated by the dipstick. The correct oi is designated in Volume 5 of this Air Publication.

Adjustment

5. Check film registration as given in Volume 5

Chapter 2

LENS UNIT 4124

Removal

1. (1) Hold the barrel of the camera lens firmly and unscrew the lens hood.

(2) Push the lens hood down into the shroud.

(3) Release the four 2 BA screws securing the unit to the console desk, but do not remove them completely.

(4) Twist the unit slightly to allow the heads of the screws to pass through the fixing holes and then lift it clear.

Inspection

2. Examine the interior finish of the shroud and repair any damage, using a matt finish black paint.

(1) Ensure that the springs loading the peephole cover, lens cover, and scanning mirror are undamaged and free from corrosion.

(2) Clean the inside of the shroud, using a dusting brush.

(3) Use a sable hair brush and a selvyt cloth to clean and polish the scanning mirror.

Replacement

3. Replace the unit on the console desk and engage the fixing holes with the four 2 BA screws. Twist the unit slightly and tighten the screws.

(1) Check that the lens hood at the top of the shroud is aligned with the camera lens barrel. If it is not, strain the shroud carefully to make it so.

(2) Screw the lens hood on to the camera lens body making sure that the alignment is correct. Any strain between the hood and lens will tilt the camera lens and affect focus.

Chapter 3

FILM GATE

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LIST OF ILLUSTRATIONS

Camera lens

1. It is necessary to remove the camera lens from the film gate at fortnightly intervals to remove the particles of film emulsion, dust and dirt which collect during the course of normal operation.

(1) Remove lens unit 4124 (*Chap.* 2).

(2) Grasp the camera lens by its barrel and unscrew it from the camera focusing mount. Handle the lens very carefully since its glass surfaces are bloomed and can easily be damaged.

(3) Remove dust and dirt, using a sable hair brush.

(4) Clean the glass surfaces, using a selvyt cloth.

WARNING

Do not attempt to dismantle the lens.

2. When refitting the lens to the focusing mount, screw it home firmly but do not force it. Finally, replace lens unit 4124 (*Chap.* 2).

Processing pot

3. The face of the pot, which contacts the film in the film gate, is precisely flat and highly polished. Care must be taken not to damage it. It is not usually necessary to remove the pot from the gate casting.

Removal

4. (1) Remove the jet unit (*Chap.* 4).

(2) Release the hose clip which secures the waste tube to the processing pot waste stub. Withdraw the tube from the stub.

(3) Slacken the two Allen screws in the centre front face of the gate casting, using the hexagon wrench from the tool kit.

(4) Carefully withdraw the processing pot.

(5) Clean the thread at the base of the pot.

(6) Ensure that the outer surface of the pot is clean and free from burred edges.

Fitting

5. (1) With the waste stub towards the projector mainplate, insert the pot into the processing aperture of the film gate. The pot is a close fit in the gate, but it should slide in quite easily. Do not force it; if it appears tight, withdraw it again and inspect the outer surface for dirt or burrs.

(2) Gently screw in one of the securing screws at the front of the gate casting while rotating the pot slightly in each direction to locate the end of the screw in the pot keyway.

(3) Tighten both screws until they just clamp the pot with its upper edge slightly below the level of the lower Bakelite table in the gate.

(4) Place the gauge, pot processing (*Stores Ref. 10AG/635*) in position on the lower Bakelite table of the film gate and press it down firmly over the processing aperture. Get another person to slacken the securing screws and press the processing pot up until it meets the gauge. Tighten the two securing screws alternately until the pot is firmly clamped in position. The upper lip of the pot has now been set to between 0·0015 in. and 0·002 in. above the surface of the table.

(5) Ensure that the hose clip is in position on the waste pipe.

(6) Moisten the bore of the waste pipe with a little water and then connect the pipe to the pot waste stub.

(7) Check that the pipe is not kinked or restricted in any way and then tighten the hose clip in a position such that it will not foul the jet unit clamping ring when the jet unit is replaced.

Bloomed glass disc

6. After a time, the action of the film passing through the gate will cause the bloomed glass disc over the projection aperture to become scratched and worn. Scratch marks will appear on the projected picture and the worn blooming will be shown up by the presence of colour contours (interference fringes). The bloomed glass disc must then be removed and replaced by a new one.

Removal

7. Hinge back the gate cover casting and secure it open by means of the gate hook. Unscrew the clamp ring securing the bloomed glass, using the spanner (key) 125 (*Stores Ref. 10AG/597*).

Fitting

8. Note that the clamp ring has a lip with an internal bevel which locates the lower bevelled edge of the glass disc. The lower surface of the glass, when mounted, is required to project below the lower surface of the clamp ring.

(1) Clean the new disc carefully, using a selvyt cloth.

(2) Place the glass disc into the clamp ring with its bevelled edge lowermost.

(3) Screw the clamp ring on to the underside of the projection lens mount. Make sure that it screws right home—there must be no play between the clamp ring and the glass.

(4) Clean the exposed face of the glass again, using a selvyt cloth.

Adjustment

9. The glass plate is made to close mechanical tolerance both for thickness and flatness. Adjustment after fitting should not normally be required. It may be necessary to adjust the assembly if the position of the projection lens mount has been altered for any reason. The method is as follows:—

(1) Run up the photographic display system with the switch on the relay amplifier at INTERNAL CONTROL and the PROCESSING ON-OFF switch at OFF (*Volume 5, Appendix D*).

(2) Allow the film transport mechanism to operate for three or four frames, thus ensuring that the crimper bar and film clamps are up.

(3) Set the relay amplifier switch to OFF.

(4) Remove the cover of the film feed chamber and cut the film in the feed loop, using a pair of scissors.

(5) Lift the tension sprocket roller carriage and release the sprocket teeth from the film perforations, so allowing the sprocket spring tension to relax.

(6) Cut the film between the end of the film gate and the transport sprocket close to the sprocket.

(7) Slacken the grub screw securing the projection lens mount with a hexagon wrench from the tool kit.

(8) Screw the projection lens mount down until the bloomed glass just clamps the film.

(9) Slacken the mount just sufficient to release the film. Test for clearance by holding the free ends of the piece of film in the gate and drawing the film from side to side. Tighten the lens mount securing grub screw.

(10) Re-thread the film (*Part* 1, *Sect.* 7, *Chap.* 2) and run up the equipment including processing.

(11) Allow a warming-up period of twenty minutes and check by inspection that the film is being snatched freely through the gate. Any tightness will be shown by scores in the film emulsion or damage to the film perforations at the transport sprocket. If necessary, raise the projection mount a little further (not more than 0·001 in. to 0·002 in.). If the bloomed glass is too high, it will be found impossible to achieve uniform focus over the entire projected picture.

Prism mount and prism

Prism mount removal

10. (1) Unscrew the four 4 BA cheese-head screws securing the prism mount casting to the gate cover casting. Note that the two screws at the rear also secure cable cleats for the gate cover wiring.

(2) Remove the four screws and lift off the prism mount. Take care not to damage the gate cover wiring.

Prism removal

11. If required, the prism may be removed without first removing the prism mount casting.

(1) Support the prism with one hand.

(2) Unscrew the two screws securing the prism mounting block to the prism mount casting. Access to these screws is obtained through two large holes at the top of the casting.

(3) Lower the prism from its mounting.

Prism replacement

12. The screws holding the prism mounting block pass through slotted holes in the prism mounting plate.

(1) Place the prism in position making sure that the backing sheet is in place.

(2) Slide the mounting block downwards until the prism is firmly held and then tighten the two screws securing the block. A screwdriver, used as a lever between the mounting block and the prism mount casting, will assist in this operation.

Prism mount replacement

13. Ensure that the projection lens is clean and that its shroud is in place. Clean the under-surface of the prism with a selvyt cloth from the tool kit.

(1) Place the prism mount in position on the film gate cover taking care not to damage the gate cover wiring.

(2) Secure the mount to the gate cover, using four 4 BA × $\frac{5}{8}$ in. cheese-head screws. The rear two screws must also secure the two cable cleats.

Adjustment

14. Check the adjustment of the interconnecting mirror and then switch on the projection lamp.

(1) Adjust the projection lens focus until the projected circle of light on the setting board is sharp.

(2) Loosen the screws holding the prism mount casting and, by moving the casting slightly, attempt to align the light circle with the four calibration marks on the setting board. If alignment cannot be obtained, tighten the prism mount casting in the best position possible and then adjust the prism relative to its mount, as follows.

15. The adjustment of the prism is a matter of trial and error and may be tedious until experience is gained. Three adjusting screws, with a locking screw adjacent to each, are provided. These are accessible through the prism mount casting. The securing screws are turned by means of a hexagon wrench from the tool kit; the locking screws require a screwdriver whose blade is not more than $\frac{3}{32}$ in. wide. To make an adjustment, first loosen the locking screw, then set the adjusting screw. Finally, lock the locking screw. When the light circle on the setting board has been correctly aligned in this manner, check that all three locking screws and the four screws securing the prism mount are tight.

Film clamping and crimping mechanism

Magnet assembly removal

16. (1) Remove the prism mount casting, complete with prism, as described in para. 10.

(2) Unsolder the two wires connecting to the solenoid.

(3) Remove the four 4 BA countersunk screws securing the mounting plate to the gate cover casting.

(4) Lift off the magnet assembly.

Clamp pads, crimper bar and spindles

17. The two pressure bars form a complete sub-assembly, since they are held together by a retaining pin. They may be removed by simply lifting them upwards when the magnet assembly has been removed. If the raised portion of the processing pressure bar which normally bears on the armature is bady worn, new bars should be fitted.

18. Check that the spindles of the processing and camera pressure pads and the crimper bar spindle are free in their bearings and that the return springs function correctly. The crimper bar spindle screws into a 6 BA tapped hole in the crimper bar and a pair of flats is provided at the upper end of the spindle to enable it to be unscrewed, using a pair of parallel pliers. After the spindle is unscrewed, the crimper bar may be removed from the underside of the gate cover casting. When re-assembling the crimper bar to its spindle, take care that it is firmly home, otherwise the crimper bar will rock during operation.

19. The camera and processing pressure pad spindles are screwed into tapped holes in the pads.

Packing washers, which have been carefully fitted during manufacture, are included to ensure that the faces of the pads take up their correct positions. Do not lose or interchange these washers.

20. When replacing the pressure bar assembly, note that the lower portion engages the crimper bar spindle and the camera pressure pad spindle; the upper portion engages the processing pressure pad spindle and the magnet armature.

Magnet Assembly fitting

21. (1) Ensure that the pressure bars are in place.

(2) Place the magnet assembly in position on the gate cover casting and secure it in position with four 4 BA × $\frac{3}{8}$ in. countersunk screws.

(3) Solder the connecting wires to the magnet coil.

Adjustments

22. No adjustments are provided in the clamping and crimping mechanism. Faulty operation may be caused by wear at the pressure bars, magnet armature or tension spring or by tension spring fatigue. Any looseness in the pressure pad or crimper bar spindles will also be a source of trouble.

23. If it is required to replace a tension spring, the job should be done with the magnet assembly in position on the gate cover casting. To remove the spring, pass one end of a piece of stout cord, about 18 in. long, through the top eye and lift the spring from its anchor stud by pulling on both ends of the cord.

Projection lens

General

24. It is not usually necessary to remove the projection lens, since it is protected from dust and dirt by a spring-loaded shroud between the lens and the under-surface of the projection prism. The glass surfaces are bloomed and must be carefully handled.

WARNING

Do not attempt to dismantle the lens.

Removal

25. (1) Remove the prism mount as described in para. 10.

(2) Remove the lens shroud.

(3) Unscrew the lens (normal thread) from the lens mount.

Cleaning

26. Carefully remove any dust or dirt from the outer surfaces of the lens and lens barrel with a squirrel hair brush from the tool kit. Finally, polish the glass surfaces with a selvyt cloth.

Fitting

27. (1) Screw the lens into the lens mount. Ensure that it is firm but do not force it.

(2) Replace the lens shroud making sure that it is freely spring loaded.

(3) Fit the prism mount casting and adjust the casting and projection lens focus as given in para. 13 to 15.

Film gate cover

Cleaning

28. The gate cover may be opened to approximately 45 deg. by securing it with the gate hook in the normal manner. This should be sufficient for routine cleaning. The cover may be opened to approximately 90 deg. if the prism mount is removed (*para.* 10).

29. Remove any dust or particles of film emulsion, using a small dusting brush. Ensure that the film processing and camera pressure pads are clean and smooth. Clean the bloomed glass plate and ensure that it is firm in its mount.

Hinge Adjustment

30. The gate cover hinges should not be disturbed unless it is certain that adjustment is required. Gate cover castings must not be interchanged between projectors.

31. The hinge pins pass through tapped bushes which are secured to the gate casting. The fixing holes are oversize, which allows the hinge pins to be moved laterally or vertically after slackening the screws which secure the bushes to the gate. The lateral adjustment of the cover is correct when the crimper bar accurately engages the "V" slot in the lower bakelite table. Fore and aft movement of the cover casting (i.e., movement towards or away from the mainplate) is achieved by slackening the lock-nuts on the hinge pins and adjusting the pins by means of a screwdriver. After adjustment the sides of the upper bakelite table must locate the gate accurately when the cover is closed. The gate cover must hinge freely without play at the pivots.

Interlens mirror

Removal

32. (1) Slacken the pressure screw in the centre of the front, lower corner of the mirror box cover.

(2) Hold the mirror box cover. Slacken and remove the four 6 BA fixing screws.

(3) Hold the light shutter and draw the mirror box cover away, being careful not to drop the mirror.

Cleaning

33. The mirror is a piece of carefully prepared metal. Carefully brush off any dust and dirt. Clean the mirror with methylated spirit and then polish it with a selvyt cloth.

Fitting

34. (1) With the pressure screw loosened off, place the spring spider in position in the mirror box cover.

(2) Place the mirror on the spider with its reflecting surface uppermost.

(3) Place the block and mirror in position on the gate casting.

(4) Ease the block away from the gate at the bottom and insert the light shutter. Ensure that the keyway in the gate correctly engages the stop.

(5) Insert four 6 BA × $\frac{5}{16}$ in. cheese-head screws and screw them up tightly.

(6) Screw home the pressure screw. It is important that the pressure screw is right in since it ensures that the mirror surface is at 45 deg. to the axis of the light beam from the lamphouse. Misalignment of the mirror will cause poor projection performance.

Film registration

Roller assemblies

35. There is a roller assembly at each end of the lower table of the film gate. The assemblies are right- or left-hand depending on the direction of the spring loading. The construction is shown in fig. 1.

36. To remove a roller assembly, proceed as follows:—

(1) Remove the prism mount complete with prism (*para.* 10).

(2) Open the gate cover to its fullest extent and secure it in this position.

(3) Remove the pivot screw (*fig.* 1) and lift out the roller assembly. Be careful not to lose the washer.

37. If the nylon roller is badly grooved, remove the bearing screw, lift out the roller and replace it with a new one. Note that the new roller must be fitted with the chamfered end uppermost as this facilitates film loading. When replacing the bearing screw, make sure that the roller is quite free to rotate.

38. To replace a roller assembly, proceed as follows:—

(1) Ensure that the assembly is the correct one (right- or left-hand).

(2) If the tension spring is weak or damaged, obtain a new one. Place it in position in the arm and pass the pivot screw through the arm and through the bore of the spring. The top end of the spring is straight and bears against the arm. The lower end is bent at right angles and bears against the side of the recess in the lower table.

(3) Check that the washer is in place and then start the pivot screw.

(4) Load the lower end of the spring and depress the assembly until the spring end locates properly in the gate recess.

(5) Hold the assembly in position and screw the pivot screw right in, taking care that the arm and the washer locate correctly.

(6) Check that the assembly is free to pivot against the loading of the spring.

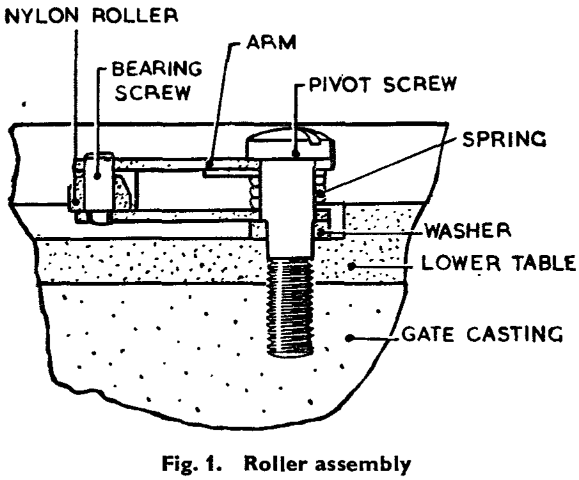

Fig. 1. Roller assembly

Pads

39. There is a pad mounted opposite each roller assembly. On early models, the pads are made of Nylon and have a life of about 2,000 hours. When worn on one face, a pad may be reversed after which it will last a further 2,000 hours; it will then need replacing. Later models are fitted with agate faced metal pads; replacement pads should be agate faced and these must be fitted with the agate faces towards the film track.

General

40. After replacing or adjusting any component concerned with the registration of the film in the gate, the check detailed in Vol. 5, Appendix J must be made.

Film gate casting assembly

Removal from mainplate

41. Proceed as follows:—

(1) Remove the film cassette.

(2) Remove lens unit 4124 (*Chap.* 2).

(3) Remove the camera lens (*para.* 1).

(4) Remove the jet unit (*Chap.* 4).

(5) Remove the waste pipe from the processing pot drain stub.

(6) Remove the cover from terminal strip GT. This is located on the main plate in the area normally covered by the film cassette.

(7) Remove the cable cover plate from the main plate. It is held by four 6 BA cheese-head screws. When the cover is removed, it will be seen that there are two leads to the camera shutter torque motor which is mounted on the mainplate. These two leads are tied to the main cable run at one point only. Release the tie and it will not be necessary to remove the torque motor.

(8) Disconnect the cable run from terminal strip GT.

(9) Disconnect the air pipes from the projection and processing apertures by unscrewing the union nuts at the mainplate.

(10) Slacken the three bolts ($\frac{1}{4}$ in. BSF hexagon head) securing the casting to the mainplate at the right-hand end.

(11) Slacken the two bolts ($\frac{1}{4}$ in. BSF hexagon head) securing the gate casting to the mainplate at the left-hand end.

(12) Remove the three bolts at the right-hand end.

(13) Support the casting firmly at the right-hand end and then remove the two bolts at the other end.

(14) The casting is located in the mainplate at the projection end on a spigot. Pivoting at this end, rotate the casting in a clockwise direction through about 15 deg. in order to clear the camera shutter gear wheel from the torque motor pinion and cover.

(15) Remove the gate casting.

Note . . .

Take care not to lose the loose coupling between the film feed sprocket and its drive shaft. This coupling is shown in Part 1, Sect. 3, Chap. 6, fig. 1.

Camera lens mount

42. Details of the camera lens mount are given in Part 1, Sect. 3, Chap. 3, fig. 1. Item numbers quoted here refer to that illustration.

43. *Removal.* To remove the mount:—

(1) Remove the gate casting from the projector mainplate as detailed in para. 41.

(2) Remove the four 6 BA countersunk screws securing the split retaining plates (29).

(3) Remove the stop pin and take off the retaining plates.

(4) Withdraw the focusing ring (24) and the sleeve (27). Note the spring washer (28) and remove it.

(5) Remove the retaining plate (21) and bush (22) very carefully—these parts must be regarded as fragile. It may be necessary to remove the shutter assembly (as detailed in *para.* 48) to allow the plate and bush to be removed by tapping gently on the washer (23) which is secured by the bush.

44. *Reassembly.* Before attempting to reassemble the mount, check that all the parts are scrupulously clean and undamaged. Check that the spring washer (28) has a free height of approximately 0·2 in. Make sure that the focusing ring (24) screws freely on to the sleeve and that the sleeve is a sliding fit in the bush (22). Check that the bore in the gate casting is clean and that the locating pin (26) is in place and undamaged.

45. Rest the gate casting upside down with the front face towards you.

(1) Fit the washer (23).

(2) Fit the bush (22) making sure that its slot engages the locating pin (26) and that the flange seats correctly on the face of the casting.

(3) Fit the retaining plate (21). The recessed side must be towards the bush (22) and the tapped hole for the stop pin must be at the far right-hand corner.

(4) Fit the spring washer (28).

46. The sleeve (27) has six slots equally spaced. One of these has to be selected to engage with the locating pin (26). To select the correct slot, proceed as follows:—

(1) Screw the sleeve (27) into the focusing ring (24).

(2) Take the camera lens and screw it firmly into the sleeve.

(3) Offer the assembly to the camera aperture in the gate casting, turning it so that the iris stop index mark on the lens barrel is towards you. Engage the locating pin (26) in the nearest slot to this point and push the assembly home.

(4) Fit the split retaining plates (29). One plate has an index mark—this must be fitted at the front of the assembly. The other plate carries a clearance hole for the stop pin and this must be aligned with the tapped hole in the retaining plate (21).

(5) Secure the retaining plate (29) with four 6 BA × $\frac{3}{8}$ in. countersunk screws.

(6) Remove the camera lens.

(7) Screw the focusing ring (24) carefully in a counter-clockwise direction as far as possible without forcing.

(8) Fit the focusing stop pin.

Camera shutter and drive mechanism

47. Details of the camera shutter and drive mechanism are given in Part 1, Sect. 3, Chap. 3, fig. 2. Item numbers quoted here refer to that illustration.

48. *Removal.*

(1) Dismount the film gate casting from the mainplate as detailed in para. 41.

(2) Remove the two 6 BA cheese-head screws securing the cover (22) and draw off the cover.

(3) Hold the gear (14) and lift the pawl (10) from the teeth of the ratchet wheel (13). Allow the drive spring to relax. Unhook the end of the drive spring.

(4) Unsolder the two leads to the terminal strip.

(5) Remove the four 6 BA countersunk screws securing the back plate (11) to the four pillars (8A) and remove the plate. At this stage, the drive spring (5) may be replaced without further stripping.

(6) Remove the three 6 BA cheese-head screws which secure the front plate (3) to the gate casting. Remove this plate complete with shutter drum (1) taking great care. The shutter drum is fragile since it has a wall thickness of only 0·001 in. If the shutter drum (1), solenoid (18) or nylon release arm (4) be damaged, the whole assembly should be replaced.

49. *Fitting.*

(1) Check that the shutter drum is undamaged and is quite free to rotate.

(2) Offer the front plate (3) and the components mounted on it to the gate casting taking care not to damage the shutter drum. If a complete new assembly is being fitted, the cover and back plate must first be removed (*para.* 48).

(3) Secure the front plate to the gate casting with three 6 BA × $\frac{5}{16}$ in. cheese head screws.

(4) Thread an end of the drive spring (5) over the nut (6) and engage it with the anchor pin on the release arm (4).

(5) Check that the drive shaft (15) is quite free to rotate in its bearing in the back plate.

(6) Check that the pawl (10) is quite free. Note that this pawl is gravity operated—it is not spring loaded.

(7) Offer the back plate to the pillars (8A) making sure that the sleeve (8) enters the drive spring correctly.

(8) Secure the plate to the pillars using four 6 BA × $\frac{1}{4}$ in. screws.

(9) Engage the end of the drive spring with the anchor pin on the sleeve (8).

(10) Solder the leads to the terminal strip.

(11) Load the drive spring by turning the gear (14) but take care not to overload it.

(12) Check that the shutter operates correctly by depressing the armature (17).

Note . . .

On early types of shutter, overloading may completely destroy the drive spring. A modification embodied in later types overcomes this but care must still be taken not to overload the spring.

(13) Fit the cover (22) and secure it with two 6 BA × $\frac{3}{16}$ in. screws.

◀ ***Film tension sprocket***

50. Details of this assembly are given in Part 1, Sect. 3, Chap. 6, fig. 1. Item numbers quoted here refer to that illustration.

51. *Removal.*

(1) Remove the prism mount (*para.* 10).

(2) Open the gate cover and secure it open with a length of string.

(3) Slacken the two 6 BA countersunk screws securing the film stripper at the feed end of the film gate.

(4) Hinge open the roller carriage (49).

(5) Remove one of the screws securing the film stripper (62) and loosen the other. Swing the stripper clear of the sprocket (52).

(6) Remove the 2 BA nut at the front end of the shaft (54).

(7) Remove the dust cover (50) and pressure spring (51).

(8) Lift the film stripper (loosened in (3)) clear of the sprocket (52). Withdraw the thrust race (63) and sprocket (52).

(9) Using a screwdriver through the film feed slot in the gate casting, unscrew the contact pin (55).

(10) Remove the three 6 BA cheese-head screws securing the housing (57) to the gate casting and withdraw the rest of the assembly from the rear.

52. *Replacement of components.* Certain components of the tension sprocket assembly may be replaced without removing the whole assembly from the film gate. The pressure spring (51), thrust bearing (63) or tension sprocket (52) may be replaced with the film gate in place on the projector. The tension spring (58) and bush (59) may be removed without removing the whole tension sprocket assembly, but the film gate must first be dismounted from the projector. If a complete tension sprocket assembly is drawn from stores, it must be dismantled to the extent required by para. 51 before it can be fitted to the film gate.

53. *Fitting.*

(1) Assemble the housing (57) complete with bearing and shaft (54) to the gate casting and secure it with three 6 BA × $\frac{5}{16}$ in. cheese-head screws.

(2) Fit the contact pin (55) using a screwdriver through the film feed slot in the gate casting.

(3) Note the friction pad (61) and then mount the sprocket (52) on the shaft after making sure that the end face contacting the friction pad is clean and undamaged. The sprocket contains self-lubricating bearings.

(4) Fit the thrust bearing (63).

(5) Fit the pressure spring (51) and dust cover (50).

(6) Fit the 2 BA retaining nut to the front end of the shaft (54) and tighten it until it just compresses the pressure spring.

(7) Secure both film strippers.

54. *Adjustment.*

(1) Loosen the grub screw in the bush (59).

(2) Loosen the locknut at the rear end of the shaft (54).

(3) Adjust the loading of the tension spring by rotating the bush (59). To check that the adjustment is correct, lift the contact pin (55) about $\frac{1}{16}$ in. from the contacts (60) and then release it. It should return and cause the contacts to close positively.

(4) Lock the bush (59) by its grub screw and tighten the locknut.

(5) Release one end of the tension spring on the film clamping and crimping mechanism as described in para. 23. The film clamps and crimper bar will then lift.

(6) Place a length of film in the gate with one end passing through the film feed aperture. Close the film gate and then engage the film perforations with the tension sprocket teeth and close the roller carriage.

(7) Tighten the 2 BA nut on the front end of the shaft (54) until the tension sprocket friction is sufficient to cause the shaft to turn when the film is drawn slowly through the gate by hand.

(8) Wind the tension spring fully by pulling the film. Stop pulling and check that the shaft (54) does not run back under the action of the tension spring. If it does, tighten the 2 BA nut still more.

(9) Refit the tension spring to the clamping and crimping mechanism.

(10) Fit the prism mount (*para.* 13).

(11) Dispose of the length of film.

55. *General.* Further adjustments to the tension sprocket friction may be necessary when checking registration (*Vol. 5, Appendix J*). It is a general rule that any adjustments to the tension sprocket assembly must always be followed by a registration check.

Lenses 6 and 7

56. This assembly is illustrated in Part 1, Sect. 3, Chap. 3, fig. 1. Item numbers quoted here refer to that illustration.

57. It is not normal practice to remove the lenses as a complete assembly in the cell (86) since the operation would require extensive dismantling of the film gate. The lenses are removed from the cell, leaving the cell in the gate casting.

58. *Removal.*

(1) Remove the interlens mirror (*para.* 32).

(2) Unscrew the locking ring (91) using the spanner 125 provided in the tool kit.

(3) Remove lens (6) (88).

(4) Remove the spacer (90).

(5) Remove lens 7 (89).

59. *Cleaning.*

(1) Clean the lens cell (86) and the spacer (90).

(2) Clean lenses 6 and 7 using a sable hair brush and selvyt cloth. Methylated spirit may be used if necessary. Note that the lens surfaces are bloomed and must be handled with great care.

60. *Fitting.* Note that lens 7 has one flat face. Lens 6 has two convex faces.

(1) Fit lens 7 with its flat face towards the projection lens.

(2) Fit the spacer (90).

(3) Fit lens 6 with the more curved of its surfaces towards lens 7.

(4) Start the threads of the locking ring (91) and screw it home with the spanner 125.

(5) Refit the interlens mirror (*para.* 34).

Fitting to mainplate

61. (1) Fit the coupling on the film feed sprocket drive shaft where it projects through the mainplate (*para.* 41 *note*). The bore at one end of the coupling is different to that at the other so that it cannot be replaced incorrectly.

(2) Offer the gate casting to the mainplate with the film feed end tilted downwards by about 15 deg. Locate the spigot at the projection end in the hole in the mainplate and swing the assembly into position, ensuring that the shutter motor drive pinion engages the shutter drive gear and that the film feed drive coupling is picked up.

(3) Start two $\frac{1}{4}$ in. BSF hexagon-head bolts at the projection end.

(4) Start the three $\frac{1}{4}$ in. BSF hexagon-head bolts at the feed end. Tighten all five securing bolts.

(5) Connect the air pipes to the processing and projection apertures and tighten the union nuts.

(6) Connect the leads from the gate to the gate terminal block GT.

(7) Tie the two leads from the shutter motor to the gate cable form.

(8) Fit the cable form cover plate and the cover for the terminal strip.

(9) Connect the waste pipe to the processing pot (*para.* 5).

(10) Fit the jet unit (*Chap.* 4).

(11) Fit the camera lens.

(12) Fit lens unit 4124 (*Chap.* 2). ▶

Chapter 4

JET UNIT

General

1. Each jet unit is carefully tested and calibrated at the manufacturer's works. The jets are set so that each covers the whole area of the film over the processing pot. Although fairly rigid in construction, the jet unit should be regarded as fragile and must be carefully handled. The following points should be noted.

(1) Jet bodies and nozzles are not interchangeable.

(2) A jet will not function if there is any leakage at the points where the air and liquid lines join the jet body.

◀ (3) It is permissible to clear the air drying tube with a 0·043 in. dia. (No. 57) drill. The treatment should only be necessary after at least three months of continuous operation. On no account should attempts be made to clear the develop, wash or fix jets with drills or other sharp instruments. If the performance of the jets is suspect, the jet unit should be returned for repair and re-calibration.▶

2. The chemicals and air entering the jet unit are filtered to minimize the possibility of jets becoming blocked. If a blockage is suspected, remove the jet unit from the equipment.

Removal

3. (1) Close the developer, fixer and wash pinch cocks situated at the rear of the projector console below the chemical shelf.

(2) Place a pad of cotton waste on the console desk below the union board.

(3) Slacken the jet unit clamping ring with the spanner (jet) 124 (*Stores Ref. 10AG/596*) from the tool kit.

(4) Unscrew the jet union board nuts in the following order: *FA, AD, WA, DA, W, D, F.*

(5) Unscrew the jet unit clamping ring fully and turn the unit to draw the union nuts away from the union board. Draw the unit out of the processing pot.

(6) Remove the P.T.F.E. washer from the jet unit base plug.

(7) Wash the unit in hot water.

Cleaning

4. (1) Wash the unit thoroughly in hot water.

(2) Blow through each tube in turn with the mouth.

(3) Blow through each tube in turn with compressed air.

(4) Wash again with hot water.

(5) Continue in this manner until any blockage is cleared. If it cannot be cleared, return the unit to the manufacturer for repair. Do not, on any account, use a piece of wire or similar instrument in an attempt to clear a jet.

(6) Protect the jets with the transit cap provided if the unit is not to be replaced on the projector console immediately.

Fitting

5. (1) Remove the transit cap.

(2) Ensure that the P.T.F.E. washer is in place on the base plug.

(3) Smear some petroleum jelly from the tin in the tool kit on to the cylindrical surface of the base plug.

(4) Wipe the inside of the processing pot with a piece of muslin.

(5) Carefully fit the jet unit into the processing pot and align the union nuts roughly with the union board.

(6) Start the clamping ring on the threads of the processing pot but do not tighten it yet.

(7) Screw on and tighten the union nuts in the following order: *F, D, W, DA, WA, AD, FA.*

(8) Tighten the clamping ring, using the spanner (jet) 124 from the tool kit.

(9) Check that the hose clip on the processing pot waste stub does not foul the clamping ring.

Chapter 5

INDICATING PANEL

General

1. When the indicating panel is removed from the console, access can be obtained to the compressed air piping, the pressure gauges, reducing valves and the CRT locating casting.

Removal

2. (1) Remove the take-up spool.

(2) Remove lens unit 4124 (*Chap.* 2).

(3) Remove sockets CD1 and CD2; these are located in the top left-hand corner at the rear of the CRT compartment to which access can be gained by opening the front or left-hand side door of the projector console.

(4) Open the side door of the electronics compartment to obtain access to the underside of the indicating panel. Unscrew and remove the 4BA screws and nuts which secure the two pressure gauges.

(5) Unscrew and remove the 4BA screws securing the pressure reducing valves.

(6) Unscrew and remove the two 2BA screws (one at each end) which secure the indicating panel to the mainplate.

(7) Using a cranked screwdriver, loosen the three 2BA screws securing the panel to the console framework. The three holes in the panel are slotted to allow the panel to be removed without completely removing the fixing screws.

(8) Raise the back of the panel to clear the CRT shroud and withdraw the indicating panel from the console.

Replacement

3. (1) Place the panel approximately in position.

(2) Secure the pressure reducing valves with 4BA screws.

(3) Secure the pressure gauges with 4BA screws and nuts.

(4) Slide the front of the panel under the heads of the three 2BA fixing screws making sure that the washers are between the screw heads and the panel.

(5) Spring the top of the panel over the CRT shroud and fit the two 2BA screws to secure the panel to the mainplate.

(6) Use a cranked screwdriver to tighten the three 2BA screws at the front of the panel.

(7) Fit sockets CD1 and CD2 at the top, rear, left-hand corner of the CRT compartment.

(8) Fit lens unit 4124 (*Chap.* 2).

Chapter 6

WASTE TANK

LIST OF CONTENTS

WARNING

Before attempting any dismantling of the waste tank, ensure, by reference to the pressure gauge mounted on it, that the pressure within the tank is zero.

General

1. Details of the waste tank are illustrated in Part 1, Sect. 4, Chap. 3, Fig. 1. Item numbers quoted here refer to that illustration.

To remove the clack valve

2. (1) Unscrew the union nuts at each end of the right-angle bend (21A) and remove the bend.

(2) Plug the open end of the fume pipe with cotton waste.

(3) Disconnect the lead to the probe (13A).

(4) Unscrew the union nut at the base of the manual stop valve (20) and remove the valve.

(5) Lift out the clack valve assembly (25, 26, and 31).

(6) Wash the assembly and make quite sure that the valve (31) is quite free to move up and down.

◀ (7) Wash and clean the two bends (21) and (21A) and the manual stop valve (20). ▶

To remove the waste tank

3. (1) Unscrew the compressed air inlet union nut (19).

(2) Disconnect the leads to the waste tank full warning contact probes (18).

(3) Unscrew the waste pipe union nut (14A).

(4) Using a box spanner, unscrew and remove the four ⅜ in. BSF bolts securing the waste tank to the base of the projector console.

(5) Remove the drip tray waste bottle (15) and can (15A).

(6) Remove the waste tank.

Removal of top cover and inner lining

4. Mark the edge of the cover and the edge of the tank flange to provide a reference for reassembly.

(1) Unscrew and remove the sixteen ⅜ in. BSF bolts round the edge of the cover.

(2) Lift off the cover.

(3) Remove the polythene liner, wash it out and clean it.

5. If required, the polythene liner lid may be separated from the tank lid (27).

(1) Unscrew the locking nut on the air inlet boss.

(2) Unscrew the union nut securing the pressure gauge and remove the gauge.

(3) Unscrew and remove the waste tank full warning contacts assembly. If necessary, replace the inconel probes with new ones.

(4) Check the general condition of the air pipe (33) and make sure that it is not blocked. If it requires replacing, it may be removed simply by unscrewing the union nut.

(5) Ensure that the short length of ¼ in. bore polythene waste pipe attached to the liner lid is free from obstruction.

Waste tank re-assembly

6. (1) Replace the polythene liner in the tank and align the holes in the liner flange with those in the tank flange.

(2) Fit the liner lid to the tank lid. Ensure that the outlet end of the air pipe (33) is located at the centre of the bore of the clack valve boss and that the air pipe union nut is tight.

(3) Place the liner lid and tank lid on to the liner and tank ensuring that the reference marks made in para. 4 coincide.

(4) Start the sixteen ⅜ in. × 1½ in. bolts making sure that there is a steel washer under the head of each.

(5) Tighten two diametrically opposite bolts (call these numbers 1 and 9).

(6) Tighten bolts 5 and 13.

(7) Tighten bolts 3, 7, 11, 15.

(8) Tighten the remaining bolts.

(9) Tighten each bolt securely in turn.

(10) Coat the thread of the waste tank full warning contacts assembly with sealing compound Detel Red Grade A and screw the assembly securely into its position in the liner lid.

(11) Fit the pressure gauge and secure its union nut.

(12) Fit the locking nut to the air inlet boss.

To fit the waste tank

7. (1) Turn the tank into the correct position to line up with the fume pipe and then slide it into the console.

(2) Secure the tank to the console framework with four ⅜in. BSF × 1 in. bolts. Replace the drip tray waste bottle and can, securing the bracket at the base of the can under the two securing bolts at the right of the waste tank base (viewed from the rear).

(3) Connect the waste pipe to the tank and tighten the union nut securely.

(4) Connect the leads to the waste tank full warning contacts.

(5) Connect the compressed air pipe to the waste tank air inlet boss.

To replace the clack valve

8. (1) Insert the clack valve assembly (items 25, 26, 31) into the waste tank boss.

(2) Fit the manual stop valve (20) but do not tighten the union nut fully.

(3) Remove the cotton waste plug from the lower end of the fume pipe and replace the bend (21A).

(4) Tighten the unions at each end of the bend (21A). Tighten the union nut on the manual stop valve.

(5) Connect the lead to the probe (13A).

Testing

9. (1) Ensure that the manual stop valve is open (fully counter-clockwise).

(2) Using one of the 50 oz. chemical bottles, pour six bottles of clean water into the waste tank via the chemical shelf. This quantity represents the waste from 12 hours of normal processing plus 1 to $1\frac{1}{2}$ bottles.

(3) Turn on the compressed air supply to the projector and check the pressure at the gauge on the indicating panel. It should be between 25 and 30 p.s.i.

(4) Close the waste tank manual stop valve. Depress the manual air valve (*Part* 1, *Sect.* 4, *Chap.* 4, *Fig.* 1, *item* 9) and start a stop watch.

(5) Note the time taken for the reading of the pressure gauge on the waste tank to fall to a steady level of 10 to 15 p.s.i. This time must not exceed 9 min. During the process, check all unions for air and liquid leaks.

(6) Release the manual air valve. Open the manual stop valve and pour another six bottles of water into the chemical shelf.

(7) Check the emptying time again by depressing the manual air valve, leaving the waste tank stop valve open. This brings the clack valve into operation. The emptying time must not differ by more than one minute from the time found in (5) and is to be regarded as the true emptying time.

(8) Check that the emptying time set on the clock unit scale (*Part* 1, *Sect.* 4, *Chap.* 4) is between $1\frac{1}{2}$ and $2\frac{1}{2}$ min. longer than the time measured in (7).

◀ (9) Set the time switch on clock unit 4108 to zero hours with the waste tank empty. ▶

Chapter 7

.PROJECTION MIRROR

Removal

1. The mirror is held in its frame by four clamp plates each secured by three 2BA × ⅜ in. cheese head screws.

(1) Swing the mirror on its pivots until the clamp plates are uppermost.

(2) Remove the clamp plate at the top of the frame, then remove the side plates and finally the bottom plate.

(3) Obtain the assistance of a second person.

(4) Protect the hands with selvyt cloths.

(5) Place one hand at the bottom of the frame to ensure that the mirror does not slip out. Push the mirror upwards at the top from underneath until the second person can grasp it securely with both hands and lift it clear.

Refitting

2. (1) Ensure that the rubber faced seating in the frame is clean and in good condition.

(2) With the hands protected with selvyt cloths, locate the lower edge of the mirror in the lower end of the frame.

(3) With assistance, lower the mirror into position.

(4) Refit the clamp plates.

(5) Clean the mirror carefully on both faces using a squirrel hair brush and selvyt cloth.

Adjustment

3. Check and adjust the mirror assembly as described in Part 1, Sect. 7, Chap. 1, Para. 17.

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Chapter 8

CLOCK UNIT 4108

General

1. The clock unit is described in Part 1, Sect. 4, Chap. 4.

Removal

2. (1) Withdraw plug TS7.

(2) Remove the six 2 BA cheese-head screws securing the clock unit box assembly to its front panel.

(3) Withdraw the box assembly by an amount sufficient to give access to connecting leads. Disconnect leads TS1, 2, 3, 4, 5, 6 and E.

(4) Remove the box assembly leaving the front panel fixed to the projector framework.

Servicing

3. Relay K/2, which switches the motor-actuated valve of the waste ejection system, may need replacing; it may be sufficient merely to clean the contacts of the relay.

4. The common faults on the time switch mechanism concern the clock motor and the time switch contacts. These items may be replaced without replacing the whole time switch.

Fitting

5. (1) Offer the clock unit box assembly to its front panel in the projector framework.

(2) Connect leads TS1, 2, 3, 4, 5, 6 and E.

(3) Align the fixing holes in box and panel and secure with six 2 BA cheese-head screws.

(4) Connect plug TS7.

(5) Run up the projector.

(6) Set the PROCESSING ON–OFF switch to ON.

(7) Check that the clock operates by observing movement of the dial over a period of 15 minutes or so.

(8) Rotate the dial by hand until the contacts close.

(9) Check that the waste tank motor valve operates and that tank emptying proceeds normally.

(10) Rotate the clock unit dial by hand in a clockwise direction until the contact pin is arrested by the pawl.

Chapter 9

AIR FILTER

General

1. The air filter is described in Part 1, Sect. 4, Chap. 4.

Removal and stripping

2. (1) Disconnect the three hose connections and remove the filter assembly from the projector console.

(2) Unscrew the securing nut at the base of the filter assembly.

(3) Tap off the end cap using a hide or wooden mallet and draw off the cover.

(4) Remove the four felt pads.

Servicing

3. The metal parts of the filter assembly should be cleaned using carbon tetrachloride. The felt pads may be either replaced with new ones or washed in carbon tetrachloride.

Assembly and fitting

4. (1) Assemble the filter with reference to Part 1, Sect. 4, Chap. 4, fig. 2. Take particular care with the neoprene seals in the body and end cap.

(2) Screw on the securing nut.

(3) Offer the assembly to the projector console and bolt it in position.

(4) Connect the three hoses (*Part* 1, *Sect.* 4, *Chap.* 4, *fig.* 1).

Chapter 10

INDICATING UNIT (CRT) 4123

LIST OF CONTENTS

General

1. Indicating unit (CRT) 4123 is described in Part 1, Sect. 2, Chap. 7. Item numbers quoted in this text refer to fig. 2 of that chapter.

Removal

2. Check that the mains supply is switched off. Proceed to dismount the indicating unit from its framework as follows:—

(1) Grasp the handle (29) and depress the foot pedal (23).

(2) Pull the unit forward to the limit of the retaining chains (21) and release the pedal gently.

(3) Withdraw the miniature cable socket TU3 and the two single-pole sockets TU1 and TU2 from the underside of the mounting tube.

(4) Remove the CRT anode connection and the CRT base socket.

(5) Turn the locking knobs (12) on the gimbal ring through 90 deg. and lift the two locking plates (15).

(6) Remove the mounting tube complete with CRT from the mounting framework and place it on the bench.

Dismantling

3. *To remove the CRT.*

(1) Slacken off the three adjusting screws (33).

(2) Remove the two 2 BA CRT clamp fixing screws (8).

(3) Slacken the two screws in the CRT clamp (34) and remove the clamp.

(4) Withdraw the CRT. It may be necessary to rotate the CRT slightly in order to free it from the CRT neck support ring.

4. *To remove the focus and deflector coil assembly.*

(1) Remove the four 2 BA screws securing the two pivots (14) to the mounting tube and remove the pivots.

(2) Remove the three $\frac{1}{4}$ in. BSF hexagon screws with plain and spring washers securing the coil assembly to the CRT mounting tube.

(3) Withdraw the coil assembly.

5. *To remove the focus coil.* After the coil assembly is removed from the mounting tube, the focus coil may be removed as follows:—

(1) Remove the three $\frac{5}{16}$ in. BSF nuts securing the base plate to the three main pillars.

(2) Remove the base plate with the focus coil attached, taking care not to strain the electrical connections to the coil.

(3) Unsolder the two leads of the focus coil where they connect to plugs TU1 and TU2.

(4) Remove the four 2 BA nuts and washers securing the insulated clamp ring to the four small diameter pillars.

(5) Remove the focus coil.

6. *To fit the focus coil.*

(1) Place the focus coil in position on the base plate with its leads in line with plugs TU1 and TU2 but remote from the base plate.

(2) Fit the insulated clamp ring making sure that the coil assembly locates correctly in the counterbore in the clamp.

(3) Fit the four 2 BA nuts and washers to secure the clamp ring to the pillars.

(4) Tighten the nuts making sure that the bore of the focus coil is aligned with the bore of the CRT neck support ring.

(5) Solder the focus coil leads to TU1 and TU2.

(6 Secure the base plate to the three main pillars on the cast mount, using three $\frac{5}{16}$ in. BSF nuts and washers, in such a manner that plugs TU1 and TU2 are approximately aligned with tags 4 and 5 of the deflector coil.

7. *To remove the deflector coil.*

(1) Remove the base plate and focus coil (*para.* 5 (1) *and* (2)).

(2) Unsolder the five leads from plug TU3 at the deflector coil tags.

(3) Remove the four 2 BA screws securing the deflector coil to the cast mount.

(4) Remove the coil.

8. *To fit the deflector coil.*

(1) Offer the deflector coil to the cast mount with the connecting tags towards the mount and tags 3 and 4 in line with one of the main pillars.

(2) Secure the coil with four 2 BA screws and washers.

(3) Solder the five leads from TU3 to the coil tags as follows:—

Colour	*Tag No.*
White	1
Red	2
Blue	4
Green	6
Yellow	8

(4) Fit the focus coil and base plate (*para.* 6 (6)).

9. *To fit the focus and deflector coil assembly.*

(1) Insert the assembly in the CRT mounting tube in such a manner that plugs TU1, TU2 and TU3 are aligned with the holes in the base of the tube.

(2) Secure the assembly to the mounting tube with three $\frac{1}{4}$ in. BSF hexagon-head screws using a plain and a spring washer under each screw head.

(3) Fit the two tube pivots (14) and secure each with two 2 BA screws.

10. *Adjustment.* The adjustments required to the deflector coils are detailed in Part 1, Sect. 7, Chap. 1. No mechanical adjustment is required to the focus coil.

Fitting

11. Instructions or fitting a CRT to the CRT mounting tube and replacing the assembly in the mounting framework are given in Part 1, Sect. 7, Chap. 1.

Mounting framework

12. *Removal.*

(1) Dismount the CRT in its mounting tube.

(2) Remove the CRT anode lead cleats.

(3) Withdraw TM1, TM2 and TM3.

(4) Unhook the two retaining chains.

(5) Remove the four $\frac{5}{16}$ in. BSF hexagon screws securing the mounting framework to the base of the console.

(6) Remove the mounting.

13. *Fitting.*

(1) Ensure that all pivots are free.

(2) Place the mounting in the console and bolt it to the console floor plate with four $\frac{5}{16}$ in. BSF hexagon-head screws.

(3) Hook on the retaining chains.

(4) Cleat the CRT anode lead.

(5) Fit plugs TM1, TM2 and TM3.

(6) Replace the CRT (*para.* 11).

Chapter 11

CHEMICAL SHELF

General

1. A description of the chemical system is given in Part 1, Sect. 4, Chap. 3. Item numbers quoted here refer to the illustration given in that chapter.

2. Before commencing work on the removal of any parts of the chemical shelf assembly, it is important to ensure that the system is reasonably dry and free from chemicals. To do this, perform the operations detailed in Vol. 5, Appendix C, para. 1 to 7, omitting para. 5. The period of ten minutes specified in para. 7 must be extended until no further liquid is sprayed on to the film.

Removal

3. *Cover plate and bottle support panel.*

(1) Unscrew the two captive 2 BA screws fixing the top cover plate to the projector framework.

(2) Remove the four ¼ in. BSF cheese-head screws fixing the bottle support panel to the projector framework.

(3) Remove the lids from the chemical constant level chambers.

4. *Chemical filter elements.*

(1) Remove the filter assembly from each constant level chamber by unscrewing in a counter-clockwise direction.

(2) Wash each filter assembly in warm water. If a filter requires a new filter gauze (*Stores Ref. 14C/5767*), remove the two "O" rings and filter gauze from the filter body. Wrap the new filter gauze round the filter body and secure it by refitting the two "O" rings.

(3) Replace the filter assemblies in the level chambers.

5. *Chemical shelf tray and level chambers.*

(1) Disconnect the leads to the chemicals low warning probes at terminal strip CL.

(2) Unscrew the hose clips (45) clamping the solution feed tubes to the ends of the filter stems (47).

(3) Check that the pinch cocks are set to ON and carefully pull the tubes off the filter stems.

(4) Remove the securing nuts (44) and draw out the filter stems complete with filters. Note the sealing washers (43).

(5) Unscrew the hose clip securing the hose from the splash trap (23A) to the shelf drain stub. Pull off the hose.

(6) Lift out the chemical shelf.

Fitting

6. (1) Place the chemical shelf tray in position on the bakelite shelf in the console.

(2) Connect the splash trap hose to the shelf drain stub and secure it with the hose clip.

(3) Place a set of three sealing washers (43) in position.

(4) Place the three constant level chambers in position noting that their overflow stubs engage the apertures in the horizontal pipe at the rear of the tray.

(5) Place a sealing washer (43) in position in each level chamber.

(6) Fit a filter stem and filter to each level chamber and secure each assembly with a nut (44).

(7) Check that the chemical feed tubes are fed through the correct pinch cocks by reference to the jet union board on the mainplate. Place a hose clip over the end of each tube. Moisten the bores of the tubes with water and push them over the filter stems. Secure the hose clips.

(8) Connect the chemicals low warning leads to terminal block CL.

(9) Fit the bottle support panel using four ¼ in. × ⅜ in. BSF cheese-head screws.

(10) Fit the top cover plate and tighten the captive 2 BA screws.

(11) Fill the level chambers with clean water and check all joints and hose connections for leaks.

(12) Use the siphon bottle to empty the chambers.

(13) Fit the level chamber lids and re-charge the projector with fresh chemicals.

(14) Check that the chemicals low warning system operates by removing a chemical bottle and siphoning off solution from the level chamber.

Chapter 12

DRIVE UNIT (MECHANICAL) TIMING 4118

LIST OF CONTENTS

ILLUSTRATION

To remove the complete unit

1. (1) Unscrew the two 4 BA screws securing the amplifying unit (relay) 4076 and remove the unit.

(2) Withdraw plugs CS1 and CS2 from the servo panel.

(3) Remove the four 2 BA cheese-head screws securing the drive unit to the projector main-plate.

(4) Lift out the drive unit carefully.

Dismantling and reassembly

2. (1) Remove the camshaft cover.

(2) Remove the five 6 BA countersunk screws securing the gearbox cover plate and take off the plate.

Motor generator

3. *Removal.*

(1) Disconnect the leads and remove the cable cleat from the end plate of the motor.

(2) Remove four 2 BA screws securing the motor to the gearbox mounting plate.

(3) Withdraw the motor.

4. *Fitting.*

(1) Locate the motor on the gearbox mounting plate and ensure by observation that the pinion meshes correctly.

(2) Secure the motor to the gearbox mounting plate with four 2 BA × $\frac{7}{16}$ in. screws.

(3) Connect the leads in accordance with fig. 1.

(4) Fit the cable cleat.

Magslip receiver

5. *Removal.*

(1) Disconnect the five leads from the magslip.

(2) Remove the four long screws securing the moulded bakelite clamp plate.

(3) Withdraw the magslip.

6. *Fitting.*

(1) Locate the magslip on the gearbox mounting plate and ensure by observation that the driving pinion meshes correctly.

(2) Place the moulded bakelite clamp over the end of the magslip and secure it in position with the four long screws.

(3) Connect the five leads to the magslip in accordance with fig. 1.

(4) Replace the gearbox cover plate and secure it with five 6 BA countersunk screws.

Drive unit

7. Clean and adjust the drive unit as follows:—

(1) Check all electrical connections.

(2) Check the cams and leaf contacts for wear.

(3) Remove all dust and dirt with a fine dusting brush.

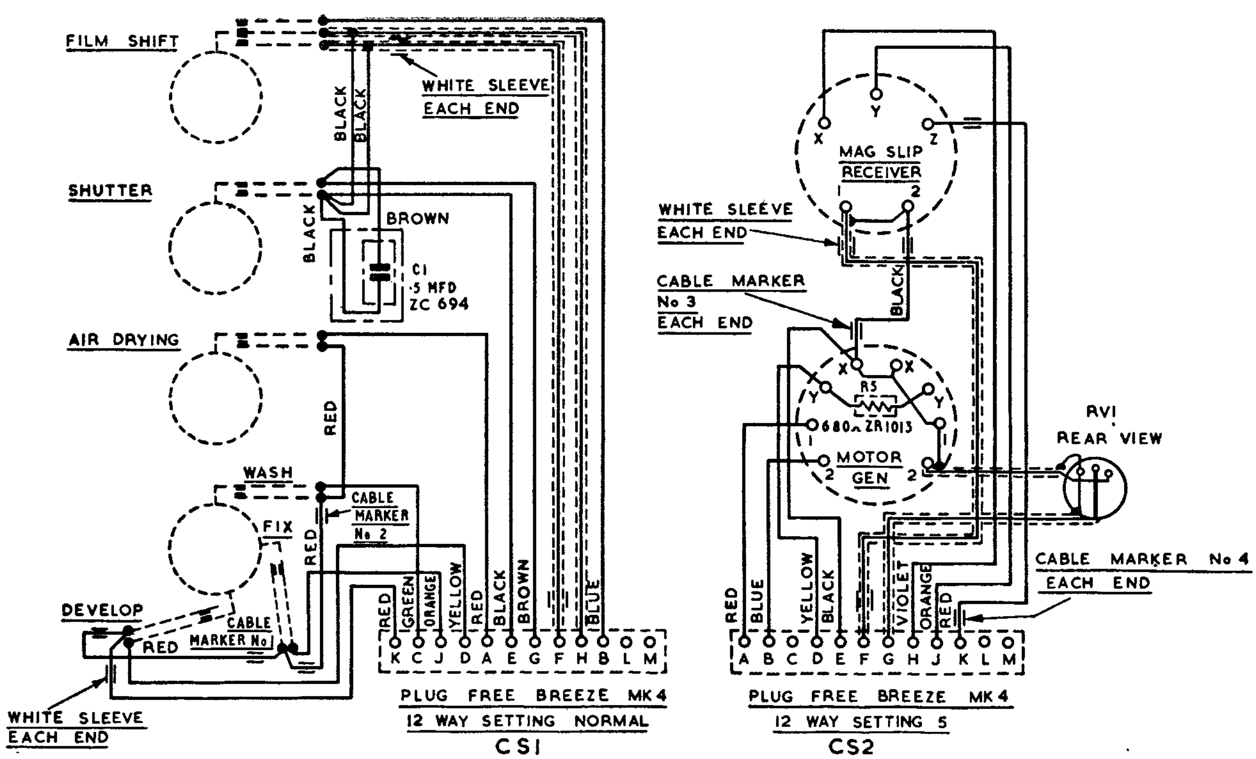

Fig. 1. Drive unit (mechanical) timing 4118: wiring diagram

(4) Clean all contacts and set them with tools from a standard contact servicing kit. Brush pressures must be between 2 and 10 gm. measured at the end of the brushes when in their lowest operating positions.

WARNING.—*The cams and contact leaves are accurately set by the manufacturer, who uses special equipment. It is inadvisable to disturb them, since they control the precise timing of the processing cycle, film transport, and shutter and film clamp operation.*

8. Leaf contacts may be replaced provided that the exact position relative to the cam is noted.

Fitting and adjusting

9. (1) Loosen the three screws which clamp the gear carrier arm at the top of the unit.

(2) Place the drive unit in position on the main-plate and secure it with four 2 BA × $\frac{5}{8}$ in. cheese-head screws. Swing the idler gear out of mesh.

(3) Turn the manual control knob on the front of the projector until the pointer of the cycle indicator is at the start of the DRY sector.

(4) Turn the camshaft of the drive unit by hand in a counter-clockwise direction (looking from the top) until the inner contact of the third set from the top just drops (start of dry cycle).

(5) Swing the gear carrier arm to mesh the gearing.

(6) Lock the carrier arm by tightening the three clamp screws using a cranked screwdriver.

(7) Check that there is slight backlash between the gear and pinion at several positions of rotation.

(8) Check that the cycle indicator and camshaft are synchronized. If they are not, remove the window of the cycle indicator and adjust the pointer after slackening the locking screw. Re-tighten the locking screw after adjustment.

(9) Fit the camshaft cover.

(10) Fit plugs CS1 and CS2.

(11) Fit amplifying unit (relay) 4076.

Adjustment of RV1

10. (1) Run up the projector.

(2) Set the switch on amplifying unit (relay) 4076 to INTERNAL CONTROL.

(3) Set the INCREASE control (amplifying unit (relay) 4076) until the camshaft speed is a maximum.

(4) Adjust potentiometer RV1 on the drive unit until the cycle time is 6 seconds.

Adjustment of relay amplifier

11. Set the INCREASE control on the relay amplifier until the cycle time is between 30 and 40 seconds.

(2) Check that the PROCESSING RELAY OPEN lamp is not lit. If it is lit, adjust RV2 (relay amplifier) until it goes out.

(3) Adjust RV2 until the lamp lights.

(4) Set the INCREASE control until the cycle time is 15 seconds.

Chapter 13

LAMP STARTER UNIT

General

1. The lamp starter unit is described in Part 1, Sect. 5, Chap. 2.

Replacement of spark gap

2. To obtain access to the CV1743 spark gap, remove the chemical bottles and the top cover plate of the chemical shelf.

Removal of complete unit

3. Proceed as follows:—

(1) Remove the chemical bottles.

(2) Remove the top cover plate of the chemical shelf.

(3) Remove the four $\frac{1}{4}$ in. BSF screws securing the bottle support panel.

(4) Disconnect the leads to terminals HS1, 2, 4, 5 and 8.

(5) Remove the six 2 BA × $\frac{5}{8}$ in. screws fixing the starter unit to the mainplate.

Fitting of complete unit

4. (1) Place the starter unit in position with transformer T2 at the bottom and the spark gap to the left. Secure it with six 2 BA × $\frac{5}{8}$ in. cheese-head screws.

(2) Connect the leads in accordance with Part 1, Sect. 5, Chap. 2, fig. 3.

(3) Check that the spark gap is firm in its base and that the top cap is fitted.

(4) Fit the bottle support panel and chemical shelf top cover plate.

Chapter 14

AIR HEATER

General

1. The air heater is described in Part 1, Sect. 4, Chap. 4.

(1) It operates at 230V AC.

(2) The heater element resistance is between 135 and 165 ohms.

(3) The built-in thermostat controls the temperature within the limits of 185 to 215 deg. C.

(4) The insulation resistance between the element and earth must be greater than 10 megohms.

Removal

2. (1) Ensure that the mains supply is off.

(2) Remove the chemical bottles.

(3) Remove the top cover of the chemical shelf and the bottle support panel (*Chap.* 11).

(4) Disconnect the mains leads at the heater.

(5) Slacken the four union nuts connecting the heater assembly to the four-way electromatic tap using the $\frac{1}{4}$ in. × $\frac{3}{16}$ in. spanner from the tool kit.

(6) Release the four union nuts connecting the heater assembly to the back of the union board on the mainplate.

(7) Take the weight of the assembly and release the union nuts connecting the heater assembly to the electromatic tap.

(8) Remove the heater.

Fitting

3. (1) Place the air heater in position with the mains terminals towards the electromatic tap.

(2) Start the four union nuts on the electromatic tap.

(3) Start the four union nuts at the back of the union board.

(4) Tighten all union nuts.

(5) Connect the mains leads to the heater terminals.

(6) Run up the projector and check the unions for air leaks.

Note . . .
When a new heater is switched on for the first time, it may give off some fumes as the lagging dries out. Fuming should cease after a few minutes.

(7) Switch off the projector.

(8) Replace the bottle support panel and chemical shelf top cover.

Chapter 15

LAMPHOUSE

LIST OF CONTENTS

General

1. The lamphouse is described in Part 1, Sect. 5.

2. Before starting any work on the lamphouse, the projection lamp must be cool.

Projection lamp

3. *Removal.*

(1) Unscrew the four milled, captive nuts of the lamphouse cover and remove the cover.

(2) Lift the four catches of the inner lamp shroud and remove the two halves of the shroud.

(3) Unscrew the nuts retaining the two lamp leads using the spanner provided in the tool kit.

(4) The lamp is held between a spring-loaded plunger at the bottom and a rectangular recess at the top. Using both hands, remove the lamp, by pressing down against the plunger taking care not to strain the glass. Take care not to contaminate the bulb with finger marks.

4. *Fitting.* Before fitting a lamp, make sure that the quartz envelope is clean. Methylated spirits or alcohol may be used on a selvyt cloth for the cleaning operation. When fitting a lamp, avoid touching the envelope and be very careful not to strain it.

(1) Locate the bottom of the lamp on the spring-loaded plunger.

(2) Press down against the plunger and then allow the lamp to lift slowly as the top engages the rectangular recess in the top support.

(3) Connect the leads to the terminals and screw on the nuts. It may be necessary to break one of the ceramic insulating beads on one or both leads in order to give greater flexibility and relieve the lamp from strain.

(4) Fit the two halves of the inner shroud, making sure that the connecting leads pass centrally through the clearance holes.

(5) Fit the lamphouse cover and secure with the four milled captive nuts.

(6) Ensure that the cover is correctly in place and that fitting it has caused the safety circuit microswitch to close.

Lenses 1 to 3

5. *Removal.*

(1) Remove the lamphouse cover, inner shroud and lamp (*para.* 3).

(2) Remove the four 2 BA cheese-head screws securing the lens housing assembly to the lamphouse body. This housing contains lenses 1 to 3 and the infra-red filter glass. Do not invert the assembly otherwise the filter glass will drop out.

(3) Lay the assembly on a clean sheet of paper on a flat surface with lens 3 uppermost.

(4) Remove the infra-red filter glass.

(5) Remove the retaining ring of lens 3 by unscrewing the four 6 BA cheese-head securing screws.

(6) Remove lens 3.

(7) Remove the retaining ring of lens 2 by unscrewing the four 6 BA cheese-head securing screws.

(8) Remove lens 2.

(9) Remove the retaining ring of lens 1 by unscrewing the three 6 BA cheese-head screws securing the three clamps.

(10) Remove lens 1.

6. *Cleaning.*

(1) Clean the lens housing and retaining rings.

(2) Clean lenses 1 to 3 using a sable hair brush from the tool kit, methylated spirits and a selvyt cloth. All the lens surfaces are bloomed and must be treated very carefully.

7. *Fitting.* Lenses 1 to 3 are all fitted with their convex surfaces uppermost.

(1) Place lens 1 in the housing. Place the retaining ring in position.

(2) Fit the three clamps and secure them with three 6 BA × $\frac{5}{16}$ in. cheese-head screws. Lens expansion is accommodated by the method of clamping.

(3) Place lens 2 in the housing.

(4) Fit the retaining ring and secure it with four 6 BA × $\frac{5}{32}$ in. cheese-head screws. The retaining ring should allow slight axial movement of the lens.

(5) Place lens 3 in the housing.

(6) Fit the retaining ring and secure it with four 6 BA × $\frac{5}{32}$ in. cheese-head screws. The retaining ring should allow slight axial movement of the lens.

(7) Clean the infra-red filter glass and slide it into its holder.

Lens 4

8. It is not normally necessary to remove lens 4 from the lamphouse. The exposed face should be cleaned in the same manner as lenses 1 to 3. If it is necessary to remove the lens

(1) Remove the retaining ring by unscrewing the four 6 BA cheese-head screws.

(2) Remove the lens and clean it using a sable hair brush, methylated spirit and a selvyt cloth.

9. *Fitting.*

(1) Place lens 4 in its seating in the lamphouse body with the more convex surface to the rear.

(2) Fit the retaining ring and secure it with four 6 BA × $\frac{1}{4}$ in. cheese-head screws. The retaining ring should permit slight axial movement of the lens.

(3) Fit the lens housing assembly containing lenses 1 to 3 and secure it in position with four 2 BA × $\frac{5}{8}$ in. cheese-head screws.

Reflector

10. *Cleaning.* The reflector may be cleaned in situ. The operation must be done with care using a sable hair brush and selvyt cloth.

11. *Removal and fitting.* If it is necessary to replace the reflector, proceed as follows:—

(1) Unscrew the two 4 BA cheese-head holding screws and remove the reflector assembly from the lamphouse strut.

(2) Unscrew the two 6 BA screws securing the reflector retaining clips.

(3) Remove the reflector.

(4) Before fitting the new reflector, make sure that it is clean.

(5) Place the reflector in position in the housing.

(6) Fit the retaining clips using two 6 BA × $\frac{1}{4}$ in. cheese-head screws.

(7) Fix the reflector housing assembly to the lamphouse strut using two 4 BA × $\frac{3}{8}$ in. cheese-head screws.

Lamp supports

12. Either the top or bottom lamp support assembly may be removed by unscrewing six 4 BA cheese-head screws securing three retaining clips.

13. The metal inner portion of the support is held in a ceramic housing by two shouldered screws. These ensure clearance between the two parts and allow for expansion under heat.

14. *Fitting.* Clean the lamp support assemblies and ensure that the plunger of the lower support operates correctly. Fit the supports to the lamphouse and secure them with the retaining clips. Before finally tightening the 6 BA screws, turn the supports until the metal lamp contacts are towards the assembly of lenses 1 to 3.

Adjustment

15. The procedure for checking the projection optical system and setting the position of the lamp is given in Part 1, Sect. 7, Chap. 1.

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