AIR PUBLICATION

2883 R

VOLUME 1

PART 1

TRANSMITTER TYPE T. 2001

(S.T.C. Type D.S. 13 C)

GENERAL AND TECHNICAL INFORMATION

Promulgated by Order
of the Air Council

AIR MINISTRY

TRANSMITTER

TYPE T2001

GENERAL INFORMATION

(S.T.C. Handbook No.1008C, Issue 1, for H.F. Transmitter type DS.13-C).

Printed in England
by
STANDARD TELEPHONES AND CABLES LIMITED,
Radio Division,
New Southgate,
LONDON, N.11.

C O N T E N T S

C O N T E N T S (Cont'd.)

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CONTENTS (AND LIST OF COMPONENTS) ~~(Cont'd.)~~ [redacted]

CROSS-REFERENCE OF TITLES AND CODES

A.M. Title	A.M.Ref.No.	S.T.C. Title	S.T.C. Code No.
Drive Unit Radio Type 6 (RES SC/21349	10D/18732	RF Exciter Unit	181-LU.13E
Mixer Unit Type 25 (RES SC/21402)	10D/18745	Demodulator Unit	109-LRU.8A
Monitoring Unit Type 37 (RES SC/21328)	10T/13108	Monitor Unit	171-LU.30A
Oscillator Unit Type 345 (RES SC/21348)	10V/16216	Oscillator & Negative feedback Unit	28-LU.234G
Oven, Thermo Type 8 (RES SC/21389)	10XAE/43	Crystal Oven	176-LU.12B
Power Unit Type 818 (RES SC/21326)	10K/17209	Supply Unit -500 Volts	94-LU.161B
Power Unit Type 828 (RES SC/21347)	10K/17225	500 volt HT Unit	14-LRU.129A
Power Unit Type 7361 (RES SC/21751)	10K/17932	Rectifier Set	246-LU.3738A
Power Unit Type 7168 (RES SC/21679	10K/17896	Grid Bias Rectifier	22-LU.75A
Monitoring Unit Type 7205 (RES SC/21685)	10T/13118	Monitor Unit	171-LU.30B
Relay Unit Type 7360 (RES SC/21750)	10F/17835	Relay Resetting Unit	498-LSU.231201
Indicator Elec. Type 7366 (RES SC/21752)	10Q/16167	Reverse Current Indicator	248-LU.6A
Transmitter Type T2001 (RES SC/21573)	10D/19151	Transmitter Type DS.13C	4-LE.100D
Indicator Elec.Type 7367 (RES SC/21753)	10Q/16168	Reverse Current Indicator	248-LU.6B

ILLUSTRATIONS

DRAWINGS

CHAPTER 1

BRIEF DESCRIPTION

The DS.13 used as an Independent Sideband (I.S.B.) Transmitter, operates in the frequency range 4 to 27.5 Mc/s and is designed for dual transmission of 4 and 40 kW into independent aerials with the additional facility of complete aerial changeover switching. Thus it is possible to have two transmissions at 4 kW peak envelope power or 1 transmission at 4 kW and 1 at 40 kW peak envelope power.

When employed as a Frequency Shift Transmitter the DS.13 operates in the same frequency range and delivers 25 kW on full output or 4 kW approximately on reduced output operation.

The transmitter consists essentially of a frequency changer followed by a linear power amplifier and incorporates all the necessary power supplies.

An external drive unit supplies a drive based on a fixed carrier frequency of 3.1 Mc/s. In the transmitter this frequency is changed to that required for radiation and the signal is amplified to the appropriate power level.

In conjunction with the Independent Sideband Drive Unit type A.1406B, the DS.13 is used as a single sideband or independent sideband multi-channel telephone and voice frequency telegraphy transmitter, or for low-level modulated double sideband service.

When operated with the Frequency Shift Drive Unit type A.1401, the equipment is utilized as a telegraph transmitter suitable for both "on/off" and frequency shift keying and also facsimile (tele-photo) operation.

On single sideband, high efficiency is obtained due to the use of Class B operation in the Truck Final and output R.F. Amplifier stages. Distortion is kept low since linear amplifiers are employed and negative feedback is incorporated in the exciter unit and output amplifier. For frequency shift working, the final amplifier is operated in Class C.

The use of tetrode and pentode valves in the exciter unit, a pentode valve (air-blast cooled) in the Truck Final Amplifier stage and grounded-grid triodes (air-blast cooled) in the R.F. Output Amplifier renders variable neutralising unnecessary.

Brief Description

The transmitter is continuously tunable throughout its frequency range, with frequency determination by crystals. Tuning to any new frequency is a simple operation since all band switching is ganged from a single control and all tuning scales in the exciter are calibrated in transmitter output frequency.

An auto oscillator may also be switched into circuit for test purposes or, if required, the beating frequency may be derived from an external high-stability variable frequency oscillator such as the type A.1408A.

Meters are arranged at eye level behind glass panels, and inspection ports are provided through which units within the enclosure can be observed. All controls except those for starting and closing down the transmitter, tuning the R.F. Output Amplifier and the E.H.T. Raise/Lower control are concealed behind doors.

Built-in power supplies, employing h.c.m.v. valves, provide grid bias at 500 volts and E.H.T. at 7500 - 10,500 volts for the Final Amplifier, and H.T. at 6000 and 1500 volts for the Truck Final Amplifier. Other supply units employ selenium rectifiers. Filaments are heated from l.t. a.c. supplies.

A system of mechanical and electrical interlocks protects personnel and equipment.

Specially designed components, an air blast cooling system and air filtering arrangements render this apparatus suitable for use in tropical, temperate, or Arctic zones.

CHAPTER 2

TYPICAL PERFORMANCE

These figures represent the designed performance of the equipment. They must not be taken as a specific guarantee.

FREQUENCY RANGE:	4-27.5 Mc/s (75-10.9 metres), continuously tunable.
OUTPUT POWER:	(4-22 Mc/s)
	(Into 500-700 ohm balanced resistive load.)
	Full Power S.S.B. Operation, single channel: 40 kW (peak sideband power)
	Full Power I.S.B. Operation, double channel: 40 kW (peak sideband power) in each sideband.
	Full Power D.S.B.: (10 kW Carrier + 100% Modulation)
	Full Power F.S.K. and on/off keying 25 kW.
OUTPUT POWER:	(22-27.5 Mc/s)
	Full Power S.S.B. Operation 30 kW (peak sideband power)
	Full Power D.S.B.: (7.5 kW Carrier + 100% Modulation.)
	Full Power F.S.K. and on/off keying 15 kW.
	NOTE: In addition a second transmission at about 1/10 of the power specified above for any particular service, may be simultaneously radiated from the other R.F. Exciter.

Typical Performance

AUDIO FREQUENCY RESPONSE:	S.S.B. Operation:-
	Total variation of sideband output power level is less than 3.5 db for variations of input signal frequency between 100 and 6,000 c/s. (including performance of A.1406B Drive Unit.)
	D.S.B. Operation:-
	Total variation in output is less than 3.5 db for variations of input signal frequency between 100 and 8000 c/s. (including performance of A.1406B Drive Unit)
NOISE LEVEL: (S.S.B. or I.S.B. operation)	S.S.B. Operation:-
	The background noise in each sideband from 200 to 6000 c/s will not exceed a level of 50 db on the peak envelope with tone off.
	D.S.B. Operation:-
	The carrier noise is at least 32 db below the level corresponding to 90% modulation at 1000 c/s.
NON-LINEAR DISTORTION:- (S.S.B.)	The level of the 3rd order intermodulation product, using standard two-tone test, will not be greater than -28 db relative to the level of a single tone.
NON-LINEAR DISTORTION (D.S.B.)	Better than 7% at 90% modulation.
MAXIMUM KEYING SPEED:	600 words per minute (480 Bauds), (including performance of A.1401 Drive Unit).
FREQUENCY STABILITY:	) To Atlantic City requirements
FREQUENCY TOLERANCE:	)
MAXIMUM POWER CONSUMPTION:	The Figures given on P.15 apply to the 4-22 Mc/s band and are subject to a tolerance of 5%.

Typical Performance

OPERATING CONDITION:	Main Input	Approx. Additional Input for Second Transmission at About 1/10 Full Power
(a) Sideband Operation		
When operating on S.S.B.		
(1) Without signal	24 kVA	4 kVA
(2) With standard two-tone test signals producing 40 kW peak envelope power	75 kVA	14 kVA
(b) Telegraph Operation		
(1) ON-OFF Keying		
When operating on "ON" telegraphy with an output power of 25 kW, the consumption is		
(a) "Space"	18 kVA	4 kVA
(b) "Mark"	75 kVA	14 kVA
(2) Frequency Shift Keying		
When operating F.S.K. with an output power of 25 kW.	75 kVA	14 kVA
(c) Double Sideband Telephony		
When operating as a low power modulated d.s.b. telephony transmitter with 10 kW carrier power:		
(1) Without modulation	55 kVA	8.5 kVA
(2) 100% "	55 kVA	8.5 kVA

Typical Performance

POWER SUPPLY: 380-415 volts, 50-60 c/s three-phase, 4-wire.

INPUT POWER FACTOR: 0.8 lagging.

DIMENSIONS: The transmitter is contained in an enclosure approximately 18 ft. 10½ in. long, 7 ft. deep. (5.76 by 2.13 by 3.66 metres).

CHAPTER 3

COMPOSITION OF EQUIPMENT

1.0 GENERAL

All units comprising the DS.13 Transmitter (Code 4-LE.100C) are contained in an enclosure illustrated in the frontispiece and shown in plan in Fig. 2.

The following are the main units of the transmitter:-

R.F. Exciter Equipments (JB) and (JC)
R.F. Output Amplifier (H)
Mains Distribution Unit (E)
Exciter Power Supply Equipment (K)
E.H.T. Power Supply Equipment including Rectifier, E.H.T. Transformer, Smoothing Unit. (G) (D) and (C) respectively.
Automatic Voltage Regulator (B)
Air Cooling Plant (A)

Controls are accessible from the front, those on the Exciter equipment being normally concealed behind a door.

Meters necessary for monitoring the transmitter are arranged at eye level and can be seen through glass windows in the front panels and doors. In the front of the enclosure, inspection ports are provided through which rectifying valves and equipment within the enclosure can be observed. Access to the enclosure may be gained through a door at the side. A system of mechanical and electrical interlocks ensures that the door can be opened only when high voltages have been removed from the equipment.

2.0 MAINS DISTRIBUTION UNIT

2.1 References

Transmitter Layout Plan (Fig. 2) .... Unit E
S.T.C. Code (complete unit) 196-LE.4F

2.2 Composition

The main items in this unit are:-

The main circuit breaker (oil-immersed)
Switch-fuses and ironclad switches for controlling supplies to other equipment.
Transformer for the regulated 110-volt supply.
Transformer for the 50-volt a.c. supply.

Transformer for 24V a.c. meter lighting supply.

2.3 Meters

Supply Voltage (with phase selector switch)
Supply Current (with phase selector switch)
Kilowatt-Hour Meter.
Hour Clock

2.4 Control

Main Circuit Breaker.

2.5 Lamps

Red, Yellow and Blue for phase indication.

3.0 TRANSMITTER CONTROL UNIT

3.1 References

Transmitter Layout Plan (Fig. 2) .... Unit L
Plate .... Frontispiece and I
S.T.C. Code .... I - LU.89C

3.2 Composition

This unit is mounted on the centre of the front of the transmitter, the panel being recessed in the door of the R.F. Output Amplifier.

On the panel are mounted signal lamps and switches for the transmitter control circuits.

3.3 Controls

Exciter Filaments On/Off Switch (Green)
Exciter H.T. On/Off Switch (Red)
R.F. Amplifier Air and Filaments On/Off Switch (Green)
E.H.T. On/Off Switch (Red)

3.4 Signal Lamps

Oil Circuit Breaker Made (Green)
H.C.M.V. Filament Heating Commenced (Green)
H.C.M.V. Filament Heating Completed (Green)

Exciter Filaments On/Off
Exciter H.T. On/Off
R.F. Amplifier Filaments On/Off
E.H.T. Prepared (Green)
E.H.T. On/Off (Green)
A.C. Overload (Red)
D.C. Overload (Red)

4.0 EXCITER POWER SUPPLY UNIT

4.1 References

Transmitter Layout Plan (Fig. 2) .... Unit K
S.T.C. Code 94-LU.156B

4.2 Composition

The principal units mounted in the framework are:-

	Code No.
500V Grid Bias Supply Unit	94-LU.161B Unit KC
500V " " " "	22-LU.75A " KB
500V H.T. Supply Unit	14-LRU.129A " KD

Transformers, valve units and smoothing equipment for the 1,500 and 6,000 volt h.t. supplies.

4.3 Meters

H.T. Volts 6 kV Supply.
H.T. Volts 1500V Supply.
H.T. Volts 500V Supply.
Exciter Grid Bias Volts.
A.C. Input Volts.
R.F. Amplifier Grid Bias Volts.

4.4 Controls

CW/MOD switch for switching H.T. to the Truck Final Amplifier.
Phase switch for A.C. Voltmeter.
R.F. Amplifier grid bias adjustment.

5.0 E.H.T. RECTIFIER EQUIPMENT

5.1 References

Plate V

Transmitter Layout Plan (Fig. 2) .... Unit G
S.T.C. Code 22-LE.18B

5.2 Composition

The four principal units of the E.H.T. Rectifier Equipment are:-

	Code No.
Valve Unit	22-LU.76A Unit GC
Valve Unit	22-LU.76B " GD
Control Unit	1-LU.90A " GB
Contactor Unit	183-LU.13A " GA

The panels mounting the Control and Contactor Units are hinged to provide rear access.

A blower unit is fitted in the lower part of one valve unit supplying air through suitable ducts to cool the h.c.m.v. valves.

5.3 Meters

Filament Volts V1	E.H.T. Current, Amps D.C.
Filament Volts V2	Filament Volts V4
Filament Volts V3	Filament Volts V5
10 kV E.H.T. Volts	Filament Volts V6

5.4 Controls

Raise-Lower Voltage Control

6.0 E.H.T. SMOOTHING CIRCUIT

6.1 References

Plate IV
Transmitter Layout Plan (Fig. 2) .... Unit C
S.T.C. Code 7-LU.24A

6.2 Composition

This circuit includes ten 2 µF smoothing capacitors, a smoothing choke and surge limiting resistors.

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7.0 AUTOMATIC VOLTAGE REGULATOR

7.1 References

Plate IV
Transmitter Layout Plan (Fig. 2) .... Unit B
S.T.C. Code RL-7018.9

7.2 Composition

The regulator is built into a steel tank and is oil-immersed. Fixed to the side of the tank is a box containing the Astatic Voltage Relay and other control equipment, while the main contactor is housed in a separate control box.

8.0 E.H.T. TRANSFORMER

8.1 References

Plate II
Transmitter Layout Plan (Fig. 2) .... Unit D
S.T.C. Code DS.8-1-86

8.2 Composition

This is a three-phase, delta-star, oil-immersed transformer mounted in a steel tank. Tap-changing controls project through the side of the tank. A drain plug is fitted.

A Suppressor Unit, Code No. 242-LU.5A is mounted upon the transformer. This unit consists of series-connected resistors and capacitors connected between secondary phase terminals and neutral.

9.0 R.F. EXCITER EQUIPMENT (JB) and (JC)

9.1 References

Plates .... VI, XIX
Transmitter Layout Plan (Fig. 2) .... Units JB and JC
S.T.C. Code (JB) ....)
S.T.C. Code (JC) ....) 389-LE.2M

9.2 Composition - Units JB, JC

The R.F. Exciter Equipments are housed in rectangular trucks in which the following units or assemblies are mounted:-

Composition of Equipment

	Code No.
Monitor Unit	171-LU.30A
Line Balancing Equipment	
R.F. Exciter Unit	181-LU.13E
Truck Final Amplifier	28-LU.233A
Oscillator and Negative Feedback Unit	28-LU.234G
Isolator and Contactors	
Demodulator Unit	109-LRU.8A
Relay Unit	82-LRA.1C

The trucks can be drawn forward on runners for servicing purposes. Hinged side panels, some transparent, give access to the units. The panel keys are located on the front of the cabinet and can only be withdrawn when the isolator is in the OFF position. Similarly, they cannot be withdrawn from the panels unless the bolts are turned and the truck cannot be moved back into the working position unless all panels are locked.

The Oscillator and Exciter Units are built on chassis and can be withdrawn from the truck. Prisoner screws in the framework behind the front panels screw into the latter to hold them in position. Cabling to the removable units terminates in plug and socket connections.

The 3rd amplifier i.e. V6 on the R.F. Exciter (181-LU.13E) is air blast cooled by a motor driven fan situated adjacent to the valve.

Forced air cooling of the output valve (i.e. Truck Final Amplifier valve) is effected by a second motor-driven fan situated at the rear of the assembly from which the air-blast is directed by trunking. The intake at the rear of the truck incorporates a detachable Vokes air filter. A thermostatically controlled relay fixed to the fins of the valve anode and connected in the electrical interlock system removes the filament and screen grid supplies in the event of the valve overheating.

9.3 Meters

Line Current
Line Current
Cathode Current (Exciter Valves)
Grid Current)
Screen Current)(Truck Final Amplifier)
Cathode Current)
Cathode Current (Oscillator Unit Valves)

9.4 Controls

Line Balance	Osc. Frequency Trimmer
Exciter Output Trimmer	Line Reactance
Meter Switch	Crystal Selector
Exciter Tuning	Drive Level
Monitor U-Link Selector	Feedback On/Off Switch
Feedback Control	Meter Switch
Truck Final Amplifier Tuning	Phase Adjustor
Waveband Selector	Isolator Switch
Oscillator Tuning	F.S.K. Reversal Switch
Local/Remote Switch	Bias Selector

10.0 R.F. OUTPUT AMPLIFIER

10.1 References

Transmitter Layout Plan (Fig. 2) .... Unit H
Plates .... I & XX
S.T.C. Code 28-LU.295A

10.2 Composition

The R.F. Output Amplifier consists of a steel framework in which are mounted the following units and components:-

	Code No.
R.F. Monitor Unit	171-LU.30B
Anode Tuning Coil	20-LU.188B
Coupling Coil	45-LU.30A
1 Aerial Changeover Switches 112-LU.67A, Unit HS,	
A second R.F. Monitor Unit	171-LU.30A

In addition, there are R.F. Contactors for band switching and a number of smaller components.

10.3 Meters

Input Monitoring	V2 Cathode Current
Total Grid Current	Output Monitoring
V1 Cathode Current	Output Monitoring

10.4 Controls

Input Tuning
Line Tuning
Anode Tuning
Line Coupling
Grid Bias Raise/Lower
C.W./S.S.B. Switch
R.F. Truck Selector Switch

10.5 Signal Lamps

H.T. Overload (red)
Not used (green)

11.0 AIR COOLING PLANT

S.T.C. Code RL.7060-150

The plant consists of the following:-

Motor with star-delta starter
Centrifugal fan and housing with four oil film type filters
Cleaning tank and re-oiling tank for filters
Ducting

Three alternative ducting assemblies are available depending on whether the air cooling plant is to be mounted behind the transmitter or to the left or right.

Rear	L.101124/1
Left	L.101124/2
Right	L.101124/3

12.0 ARTIFICIAL AERIAL LOAD

An Artificial Aerial Load, capable of dissipating the total output power of the Transmitter, can be supplied under code number 140-LRU.55B. The load is cooled by a circulating water system fed from a self-contained supply. The unit is illustrated in Plate XIII and Fig. 32 gives approximate adjustment of inductors.

CHAPTER 4

CIRCUIT DESCRIPTION

1.0 OUTLINE OF OPERATION

(Fig. 1)

1.1 Input

The input drive to the DS.13 transmitter will depend on the type of external drive unit employed, but in all cases it will be based on a carrier frequency of 3.1 Mc/s.

The DS.13 employed as a single sideband (s.s.b.) or double sideband (d.s.b.) transmitter requires the type A.1406B Drive Unit. This supplies an input consisting of pilot carrier at 3.1 Mc/s plus two sidebands corresponding to two independent speech channels, or several voice frequency channels, or a combination of speech and telegraph channels.

The DS.13 can also be used in conjunction with the type A.1401 Drive Unit as a telegraph transmitter with frequency shift keying (f.s.k.). The inputs on "mark" and "space" are two frequencies spaced equally above and below 3.1 Mc/s. The deviation frequency can be preset between 0 and 700 c/s from 3.1 Mc/s giving a maximum shift of 1400 c/s between "mark" and "space".

2.0 DESCRIPTION OF AN R.F. CABINET (389-LE.IN)

2.1 Construction

(Frontispiece)

Each Radio Frequency Cabinet houses a rectangular truck (Code No. 389-LE.2M) upon which is mounted an Oscillator and Negative Feedback Unit, an R.F. Exciter Unit, a power amplifier, and ancillary gear. The cabinet is fitted with a steel door, suitably panelled to conform with the general lines of the transmitter and designed to protect controls from accidental movement. Facilities for observation of line current meters are provided by the inclusion of a glass window in the upper section of the door. To facilitate servicing and offer complete frontal access to all apparatus, the internal truck, previously mentioned, is arranged in such a manner that, with the door open, it may be drawn forward without disconnection of supplies. A further facility, in the form of hinged interlocked Perspex Acrylic Plastic and sheet metal panels, fitted to the sides of the truck, enable personnel to view the various units under operating conditions without risk of shock. The keys required to open these panels are located on the front of the truck and so arranged that they can only be withdrawn when the local isolator is in the off position.

So that the truck can be easily withdrawn, it is fitted on either side with flanged wheels which travel on horizontal runners projecting from either side of the cabinet. When the truck is pushed home, the runners, which are hinged, can be folded back into the cabinet in a vertical position. The runners are shaped to prevent the truck running too far forward, although the truck can be entirely released if it is desired to remove it completely from the cabinet and place it on the floor of the transmitter building. For such an eventuality, wheels are provided on the base of the truck to facilitate movement to any point. The limit of movement is determined by the length of the cables between cabinet and truck, which are necessarily as short as possible. If the distance to be moved were considerable it would be necessary to disconnect the cables.

The lower portion of the truck is occupied by an Oscillator and Negative Feedback unit, supply contactors and an isolator switch. The centre section is allocated to the output stage, and the upper section to an R.F. Exciter and to aerial coupling equipment. The R.F. Exciter and the Oscillator and Negative Feedback Units may be individually withdrawn.

Forced air cooling of the output valve is effected by a motor driven fan situated at the rear of the assembly.

Trunking is used to direct the air supply and is terminated in a specially designed valve holder. The intake is at the back of the truck and incorporates detachable air filters of the Vokes pattern. A wire mesh outlet, at the top of the cabinet acts as an exhaust port for heated air.

2.2 Circuit Description of the R.F. Truck (Code No. 389-LE.2M)

(The circuit diagram is given in Fig. 4 and Plates XI, XIX illustrate the unit.)

2.2.1 General

The r.f. truck contains the following:-

1 - Oscillator and Negative Feedback Unit, Code No.28-LU.234G
1 - R.F. Exciter Unit, Code No. 181-LU.13E

1 - Demodulator Unit, Code No. 109-LRU.8A
1 - Output Amplifier
1 - Isolator and Terminal Unit
Miscellaneous contactors, transformers, and a blower motor.

The various functions of these units and the associated apparatus is described in the sub-sections below:-

2.2.2 The Oscillator and Negative Feedback Unit (Code No.28-LU.234G)

(The circuit diagram is given in Fig. 3 and Plates VII, VIII and XII illustrate the unit.)

The Oscillator and Negative Feedback Unit contains a heterodyne oscillator followed by a doubler and buffer amplifier, a 3.1 Mc/s input amplifier, a negative-feedback frequency converter and a 3.1 Mc/s buffer amplifier.

The oscillator functions within the range 3.45 to 12.45 Mc/s and its frequency is doubled before being used for heterodyning purposes. It converts the 3.1 Mc/s output of the s.s.b. drive unit to the required radiation frequency. For example:-

7.1 Mc/s - 3.1 Mc/s = 4 Mc/s
13.0 Mc/s - 3.1 Mc/s = 9.9 Mc/s
6.9 Mc/s + 3.1 Mc/s = 10 Mc/s
18.9 Mc/s + 3.1 Mc/s = 22 Mc/s
24.9 Mc/s + 3.1 Mc/s = 28 Mc/s

With regard to the above table, it should be observed that, up to 10 Mc/s, the radiation frequency is equal to the difference between the oscillator frequency and the drive unit carrier frequency. At or above 10 Mc/s it is equal to the sum of the two frequencies.

Because of this changeover a manually-operated F.S.K. Reversal key, is provided on the truck. The key enables a relay in the type A.1401 Drive Unit to be switched and thereby change the direction of shift. This compensates for reversal of shift which occurs when changing from sum to difference mixing.

The oscillator uses a double triode valve, V1, and functions, according to switching, either as a Miller crystal-controlled oscillator or as a Colpitts self-excited oscillator. It can also be switched for use as an amplifier or a doubler following an external high-stability oscillator such as the type A.1408. A choice of any one of six crystals is available or, alternatively, continuous tuning can be effected by the test oscillator. Tuning arrangements consist of a ganged inductor of the rotating coil type with trimmers L1, C8 providing for initial alignment at the upper and lower frequency ends of the band. Trimmer capacitor C5 affords adjustment for slight inaccuracies in crystal grinding.

For the purpose of frequency stabilisation, the oscillator crystals are contained in an oven heated by a thermostatically controlled element. This holds the temperature of the oven to a differential of ± 2°C. The crystals are plugged into a removable strip, with the crystal of the lowest frequency at the top ranging to that of the highest frequency at the bottom corresponding respectively to positions "Crystal 1" to "Crystal 6" of switch S1.

The control circuits for the heating element consists of two thermostats TH1, TH2 and a relay Rel.1. At temperature below 60°. thermostat TH1 is closed thereby completing a 50 volts a.c. supply to bridge rectifier, Rect. 1, and so causing Rel.1 to be energized. Under this condition, contacts A1 complete the 50 volts a.c. supply to the heater element, R5, and also cause a green indicator lamp, 2, on the front panel of the unit to be illuminated. Upon the temperature of the oven reaching 60°C, TH1 opens and releases Rel.1. Should the oven temperature rise to 80°C, due to a failure of TH1, thermostat TH2 opens and results in a white indicator lamp, 1, being illuminated and the oven heating being reduced. The oven temperature will then remain at a level of about 80°C until taken out for servicing.

The oscillator output is taken to a conventional frequency-doubler stage, V2, which, in turn, feeds an amplifier, V3, and also supplies a low impedance output at the beating frequency (6.9 to 24.9 Mc/s), for use in the demodulator circuits of a monitor receiver, such as the type A.1407B, or use in a local demodulator unit (109-LRU.8A) for the first conversion back to a frequency of 3.1 Mc/s.

All stages of the oscillator unit operate into circuits the inductors of which are ganged and tuned by a single control. Trimmers provide for initial alignment at the upper and lower frequency ends of the band. The tuning mechanism also operates a tuning scale calibrated in Transmitter output frequency.

The amplifier V3, referred to above, supplies two low-impedance balanced outputs (at the beating frequency) to the input stage of the Exciter Unit, and also feeds a following demodulator V4.

Tuning of both the amplifier and doubler stages is by ganged rotary inductors of the type used in the oscillator.

Turning to the negative-feedback section of the unit, it has been already mentioned that a mixer, V4, in this section, receives a 6.9 - 24.9 Mc/s input from V3. This input is applied to the control grid of V4 simultaneously with the application to the cathode of an r.f. signal from the output stage of the transmitter. The difference frequency components, centred around 3.1 Mc/s and occurring at the anode of V4, are selected by a tuned circuit, 400-LU.47D, for application to a following buffer stage V6.

At the same time, a 3.1 Mc/s signal input from the drive unit is applied, via a feedback on/off switch, S3, and a gain control R70, to an amplifier, V5, whose anode is common to the tuned circuit 400-LU.47D. Thus the tuned circuit receives the 3.1 Mc/s outputs from V4 and V5 out of phase and thereby controls the input to V6 (and hence the 3.1 Mc/s drive to the transmitter). The tuned circuit is given a high Q to remove risk of instability which might otherwise be caused by a positive feedback of components of cross-modulation lying outside the band 3.1 Mc/s $\pm$ 6 kc/s.

The combined drive and feedback signals are amplified by V6 and delivered via a phase-changing network (L35, R89) and low-impedance line to the input socket of the R.F. Exciter Unit. Inductor L37 and condenser C85 form a rejector circuit for the second harmonic, i.e. 6.2 Mc/s.

With regard to general metering, M1 in association with selector S2, enables cathode currents of V1-V6 to be checked. The meter may also be switched to monitor the input level to the control grid of V4 and the output level of V6, the necessary rectification being obtained by half-wave rectifiers X7 and X8, respectively.

To reduce the level of harmonic radiations, filters are fitted to the input and output circuits of V3.

In the input circuit, a composite 3.45 Mc/s and 6.2 Mc/s filter is fitted comprising L13/C30 and L14/C31 respectively.

In the balanced output, a 3.45 Mc/s filter is fitted in each lead. The filter in the orange lead (P8) is L16/C33 and in the blue lead (P9) is L17/C34.

In the anode lead of V6, an anode stopper assembly (comprising L38 and R79) is also fitted.

2.2.3 The R.F. Exciter Unit, Code No. 181-LU.13E

(The circuit diagram is given in Fig. 5 and the unit is illustrated in Plates IX, X, Xl.)

The r.f. equipment of the DS.13 incorporates five radio-frequency stages, four of which are constructed to form a single removable exciter unit. This unit contains a frequency-converter stage and three stages of class A amplification. Frequency coverage is in three bands as follows:-

Band 1 4 to 5.5 Mc/s
Band 2 5.5 to 12 Mc/s
Band 3 12 to 28 Mc/s

Band switching of all stages is by means of a single control on the truck, ganged with the final r.f. amplifier. As in the Oscillator and Negative Feedback Unit, tuning is carried out by means of ganged rotating coils. In the third amplifier stage, pi-networks are used on all three bands and, in the remaining two stages, pi-networks are used on the highest frequency band and parallel tuning on the two lower bands. The tuned circuits are arranged to have a Q approximately proportional to frequency so that the gain through the system is constant regardless of frequency.

Dealing with the frequency conversion stage, the 3.1 Mc/s output from the Oscillator and Negative Feedback Unit is applied, via a gain control, RV1A/B and an Alford-type circuit, to the control grids of V1, V2. The Alford circuit causes the input to V1 to be in anti-phase to that applied to V2. Simultaneously, the heterodyne frequency from the Oscillator and Negative Feedback Unit is applied, also in anti-phase, to the cathodes of V1 and V2, hence balanced mixing is effected.

The tuned anode circuit of the converter selects the required band of frequencies and feeds them to a following amplifier V3. A rejector circuit, L7 and capacitors C13A and B, serves to filter out any remaining 3.1 Mc/s signal.

From V3 the output is fed, at radiation frequency, via V4 and V5, connected in parallel, to the penultimate amplifier V6.

The anode circuit of V6 is tuned by inductors L22 to L24, brought into circuit by sections D and E of the ganged waveband selector, S1. A small hand-controlled tuning capacitor, C35, permits final trimming of the stage. Anode supplies are choke fed from the 1500 volt line. A tapping in the output circuit of V6 permits a small portion of the r.f. voltage to be fed directly to an external monitor receiver, if required. Alternatively, it may be fed to a monitor demodulator incorporated in the r.f. truck and then to an external monitor.

Circuit Description

Output from the R.F. Exciter Unit is coupled, by way of C36, and a laminated spring contact to the power amplifier stage.

Cathode currents are metered by means of M1, in association with selector S1.

2.2.4 The Power Amplifier Stage

(Circuit diagrams - Figs. 4 and 5; Illustrations: Plates VI, XIX)

The power amplifier uses an air-blast cooled pentode valve, V1, normally operating in Class AB. A phase protecting circuit (TH.U1), ensures that the main blower, B1, will shut down in the event of a failure in the 3-phase supply and thus prevent excessive current from flowing through the motor windings. To improve the efficiency when the transmitter is used for C.W. or high-level modulated d.s.b. working, however, arrangements are made for increasing the bias for Class C operation. This change is effected via a switch S7, on the front panel of the r.f. truck. The switch simultaneously changes the bias to the penultimate amplifier, V6, in the R.F. Exciter Unit, in such a manner that it thereby functions in Class C.

The anode circuit of V1 is tuned by a pi-network of which the rotating inductor, L5, forms the continuously variable element. Band selection is effected by switching capacitor banks in the input and output arms of the network. Similarly, choke sections L4 A-C, in the anode feed circuit of the valve, are brought into operation according to the band used.

For neutralising purposes on the highest frequencies, a small amount of feedback takes place from the anode of V1 to V6, in the R.F. Exciter Unit. The feedback is via capacitors C11, C12, and a small adjustable plate, C47, fixed near the anode of V6.

A line tuning reactor L6, and an Alford circuit (which enables the transmitter to operate into balanced lines) complete the main portion of the output circuit. The Alford circuit comprises variable inductor L7 and capacitors C35 to C42, the latter being switched according to the waveband required. In the circuit diagram it will be observed that there are a series of links associated with the Alford circuit. One of these serves to disconnect tuning coil L5 from line reactor L6, while a second shorts out the coaxial connection to the Alford circuit when the Truck is being used to drive the R.F. OUTPUT Amplifier.

With regard to the remaining links they are necessary to change the transmitter from balanced to unbalanced operating conditions. In the unbalanced condition L8 is short-circuited by strapping a link across it, and the lower feeder is earthed by a further link between C2 and chassis. Also L7 and capacitors C35 to C42 are disconnected from circuit by the opening of a link between C35 and the upper feeder line.

Further, a link assembly on the roof of the cabinet is rearranged to permit the unbalanced output to be fed into Uni-Radio 131 cable.

Individual cathode, grid and screen current metering of V1 is provided and a small portion of the output of the stage is applied, via coaxial line, to the Oscillator and Negative Feedback Unit for feedback purposes. A further small portion is tapped off potentiometer R9, R10 and may be fed to Demodulator, 109-LRU.8A, in the truck, according to the setting of a Monitor U-link.

2.2.5 The Demodulator Unit. Code No. 109-LRU.8A

(Circuit diagram - Fig. 33)

According to the setting of the Monitor U-link on the r.f. truck, the Demodulator Unit accepts a small portion of r.f. output (at radiation frequency) from one of 3 pick-up points in the transmitter chain. It converts these signals to 3.1 Mc/s for application to the separate monitoring equipment type A.1407B.

The r.f. pick-up points, referred to above, are at the output of the penultimate amplifier V6 in the R.F. Exciter Unit, at the output of the final amplifier (V1) in the r.f. truck and the output of the R.F. Output Amplifier.

Upon arrival in the demodulator unit, the r.f. signal is applied to the control grid of a pentode valve V1. Simultaneously a beating frequency, within the range 6.9 to 24.9 Mc/s and derived from the Oscillator and Negative Feedback Unit, is injected into the valve cathode circuit.

A band of frequencies, centred around 3.1 Mc/s and resulting from the two inputs, is selected by a pi-network L1, C3, C4 and fed via low-impedance line to the separate monitoring equipment (type A.1407B).

A link is provided in the unit whereby the demodulator may be by-passed, if required. Under these circumstances R.F. would be fed to the monitoring equipment and demodulation to 3.1 Mc/s would take place therein.

2.2.6 The Monitor Unit, Code No. 171-LU.30A

(Circuit diagram - Figs. 7 and 8)

The monitor unit, comprises a small assembly containing a double-diode rectifier, V1, with its anodes suitably connected across the balanced feeder lines. It gives meter indications at the local or remote points of the relative output of the transmitter. Local metering is effected by M4, M5. and a jack point, J1, gives facilities for aural or other monitoring when the remote indicating position is not used.

2.2.7 The Power Supply Circuits

(Circuit diagram - Fig. 11; Plate XIV)

All power supplies for the r.f. trucks are derived from the Exciter Power Supply Unit, excluding 50 volts a.c. required for oven heating certain 50V d.c. switching supplies and 24V a.c. lighting supplies. The supplies are routed to various circuits via a hand-operated isolator switch located in the base of each truck. The isolator is designed to earth h.t. circuits of the truck when in the "off" position and thereby discharge miscellaneous capacitors etc.

Upon the closing of the isolator (and upon the assumption that supplies are switched on at the power cabinets) 3-phase a.c. is fed to one side of contactor Rel.3 in the truck. The contactor closes, a blower motor, B1, starts up and a.c. supplies are extended to T1. Transformer T1 supplies 6.3 volts to valve heaters in the R.F. Exciter Unit, the Oscillator and Negative Feedback Unit and the Monitor Unit. It also supplies 230 volts a.c. to the blower in the R.F. Exciter Unit. It will be observed, however, that the supplies to R2 and T3 (which feed the penultimate and final r.f. stages) are withheld until the Local/Remote switch, S2, is suitably placed for local or remote operation.

In explanation of the above, to reduce the number of heavy contactors and so obtain simplicity of construction and economy of maintenance, anode voltages can be applied to the penultimate amplifier valve V6 and the final amplifier valve V1 whether filament voltages are on or off. This is the reverse of normal practice and is rendered possible by the use of bias and by a delay relay in the screen circuit of final amplifier valve V1.

Dealing with the switching in more detail, when S2 is placed to LOCAL, the circuit of d.c. operated relay, Rel.1, is completed to earth. Contacts of Rel.1 extend the a.c. supply through to transformers T2 and T3, and close the 500V d.c. line to the R.F. Exciter Unit and to the Oscillator and Negative Feedback Unit. (The 500, 1500 and 6000 volt supplies may or may not be present at the isolator switch depending upon the switching conditions at the power cabinets.) After a period of 5 seconds they also complete the circuit of relay Rel.2, which closes the 1500 volt h.t. line to the screen of the final amplifier V1.

During the process of changing the frequency band upon which the truck is operating, the circuit of Rel.1 is broken by S3, ganged with the band switch. It is restored when the new band is selected. Similarly the circuit of Rel.1 is broken if a thermal switch, VPD1, protecting the final amplifier valve, opens. The thermal switch is attached to the valve cooling fins and functions in the event of the valve overheating, due to over-running or failure of the blower. Further switching details are given in Section 4.0.

3.0 R.F. OUTPUT AMPLIFIER

S.T.C. Code No. 28-LU.295A
Schematic Reference: Fig. 6
Plate Nos. 1 & XX

The R.F. Output Amplifier stage employs two air blast cooled grounded grid triode valves, connected in parallel, in an inverted amplifier circuit. The valves are driven by output from the penultimate amplifier applied between cathode and ground. Anode circuit tuning is accomplished by a single-ended circuit in which the inductive element L1 is variable. A coil with rotating contacts is employed. Parallel vacuum-type capacitors C14A, B, C and D and C13A and B can be switched in parallel on the two lower frequency ranges.

NOTE:

On Range 1. C14A, B, C, D and C13A, B are switched in.
On Range 2. C14A, B, C and D are switched in.
On Range 3. The stray capacitance is sufficient for tuning.

Coupling to the aerial is provided by a balanced output circuit consisting of a variable inductor L2, inductively coupled to the anode circuit coil, and mica-stacked capacitors C17, C18 (plus the capacitors C19, C20, C21, C22 on the lower frequency ranges) are connected in series-parallel with their centre points connected to ground. The degree of coupling is governed by the movement of the coupling coil relative to the anode coil.

The control grids are maintained at high d.c. and zero r.f. potential to ground by built-in mica capacitors C1A - C1L surrounding the grids and arranged to facilitate removal of the valves. Fixed grid bias for Class B operation is obtained from an adjustable h.c.m.v. rectifier unit in the Exciter Power Supply Equipment and is applied to the grids through a choke-resistor impedance, CH3, R8. Potentiometer P1 in the Grid bias supply provides a fine bias adjustment.

In series with the grid bias feed are resistors R7A and B across which is developed auto bias for Class C operation on C.W. The resistor is shorted by a switch S10 on the front panel when the amplifier is to be operated under Class B conditions.

Cathodes of the output valves are maintained at high r.f. potential to ground by means of tuned input circuits comprising L6, C4 and L7, C5. L6 and L7 are ganged and brought out to a handwheel control (Input Tuning Plate I), thus coupling between the penultimate and final amplifier stages is obtained. L6 and L7 also provide a d.c. return path to earth.

The r.f. input voltage is applied to the cathodes of valves V1 and V2 through capacitors C2 and C3. The paths to the two valves are unequal in length; to prevent unbalanced drive at higher frequencies, therefore, the shorter path is electrically lengthened by means of an inductive strip connection.

A loop of coaxial cable permits a small portion of the r.f. output voltage to be fed to the demodulator in the r.f. truck for monitoring purposes.

D.C. at 7.5 to 10.5 kilovolts is supplied from the E.H.T. Supply Equipment to the anodes via choke-resistor impedances CH4A, R9A and CH4B, R9B, and large ceramic capacitors C15A, B and C16A, B are fitted to by-pass r.f. components to ground.

Air cooling for the anode and coupling coils is derived from louvres in the ducting carrying the air supply to the valves.

All meters are assembled in line on the front panel of the R.F. Amplifier Unit. These meters indicate (from left to right):-

(a) R.F. Input (relative amplitude). A milliameter indicating rectified d.c. output from the monitor unit connected in the input drive circuit.

(b) Grid current, a centre-zero meter in the common grid lead.

(c) Cathode current of left-hand valve.

(d) Cathode current of right-hand valve.

(e) R.F. Output (relative amplitude), and

(f) R.F. Output (relative amplitude), - two meters connected one in each side of a monitor unit similar to that used for (a) above.

Tuning and variation of coupling between coils is controlled by handwheels. Switching of capacitors is accomplished by large brake magnets in the case of the anode tuning capacitors whilst a smaller type of contactor is employed for switching the capacitors in the output coupling circuit and the line discharge chokes. (CH5, 6, 7, 8).

To avoid the use of hand-controlled switches for band changing, the operation of the above mentioned contactors is effected by means of relays REL.10, 11 and 12, coupled to the band change switch in the Exciter Unit. Selenium rectifiers are shunted across the relay contacts for spark suppression.

Two overload relays, mounted on the relay panel and connected one in each cathode circuit, are arranged to break the e.h.t. supply.

To protect valves and output circuit in the event of low air flow, a butterfly flap is mounted in the air stream. This operates a mercury switch to cut off the e.h.t. and filament supplies when the air flow falls below a safe value.

The valve cathodes are supplied from a Scott-connected group of transformers T1, T2, which deliver 2-phase A.C. in quadrature from a 3-phase 400 volts regulated supply. The secondary windings, delivering 84 amps each at 10 volts, are insulated and screened and their capacitance to ground becomes part of the coupling impedance to the drive unit.

A circuit is provided for 50 Mc/s parasitic oscillation suppression.

The circuit comprises a pick-up plate C30, a coil L10 and capacitors C28 and C29, together with a damping resistor R41.

On Bands 1 and 2 the circuit is switched in by the auxiliary contact of relay 3.

On Band 3, some of the unused turns of anode coil L1 are short-circuited by relay 8.

4.0 POWER SUPPLIES

4.1 Mains Distribution Unit (E)

Code No. 196-LE.4F
Plates: II, and XVIII
Schematic Reference: Fig. 9

Three-phase A.C. at 380-415 volts is brought into the unit from the supply mains and distributed to the power supply units, motors, lighting circuits and oven heating circuits through appropriate switches (hand or contactor-operated) and fuses.

A supply is taken from the input side of the oil-filled circuit breaker for oven heating, thus ensuring that the ovens remain at a steady temperature ready for immediate use.

Meters M1, M2 and M3 are provided for indication of current in each phase, power consumption and voltage between phases respectively. M4 records the number of hours service. Lamps 1 to 3 indicate the presence of each phase supply.

Transformer T1 steps down the regulated 400 volt supply to 110 volts for the filament heating circuits of the e.h.t. h.c.m.v. rectifiers.

A transformer T3 and 3-phase full-wave selenium rectifier, Rect. 1 are built into the unit to supply D.C. at 50 volts for operation of relays Supplies of A.C. at 50 volts are taken from T2 for operation of contactors.

Two changeover switches S3 and S4 enable the voltage regulator to be put into or taken out of operation as required.

4.2 Exciter Power Supply Unit (K)

S.T.C. Code No. 94-LU.156B
Schematic Reference: Fig. XI.
Plate No. XIV.

(a) 500 Volt D.C. Supply Units

S.T.C. Code (KB) 22-LU.75A.

Schematic Reference: Fig. 12.
Plate No. XXI.
S.T.C. Code (KC) 94-LU.161B.
Schematic Reference: Fig. 34.
Plate No. XV.
S.T.C. Code (KD) 14-LRU.129A
Schematic Reference: Fig. 35.
Plate No. XVI.

Three units each supply d.c. output at 500V. (KD) and (KC) are used for h.t. and grid bias respectively for the R.F. Trucks. The third unit (KB) supplies grid bias to the R.F. Output Amplifier.

Units (KC) and (KD) employ three-phase full-wave selenium rectifiers and have a current capacity of 0.75 amp and lamp respectively. Choke input filters reduce output ripple to 40 db below the d.c. level. An overload breaker (Rel.5) is located in the 500 volt h.t. circuit and a fuse and under-voltage relay in the 500 volt negative bias output circuit. Output voltages are indicated by meters M2 and M4.

The rectifiers are fed from fuse-protected transformers; these in turn receive their supplies through contactors from the main feeders.

Grid bias unit (KB) employs two h.c.m.v. valves in a full-wave rectifier circuit, with a current rating of 2 amps. A third valve is included as a spare ready to be put into immediate use. Single-phase A.C. is supplied from the main feeder, via a contactor, to the transformer T1, whose centre-tapped secondary supplies the two rectifying valves. An under voltage relay across the output trips the e.h.t. contactor if the bias voltage is low.

D.c. output voltage is indicated by Meter M3.

(b) The 1500 Volt D.C. Supply

This supply consists of a three phase half-wave rectifier assembly using three h.c.m.v. valves, V1-V3, and having a current rating of 0.75 amp. Smoothing is accomplished in a choke-input filter and the equipment is protected against overload by a relay Rel.6 in the output circuit. Output voltage is indicated by M5.

The transformer T2 supplying the rectifying valves is supplied from the main feeder through contactors, a hand-operated isolator S4 and fuses.

(c) The 6000 Volt H.T. Supply Equipment

The 6000 volt h.t. d.c. supply is obtained by means of six h.c.m.v. valves, V4 - V9, connected as full-wave rectifiers. By means of S6, auto-transformer T8 may be switched to reduce the input voltage to the rectifier. A resulting reduced output voltage of 4600V is used when high level modulation is applied.

The assembly has a current rating of 1.25 amps at 6000V to 1.8 amps at 4600V and is provided with a choke input filter.

A.c. is supplied from the main feeders through a hand-operated isolator switch S1, contactor Rel.8, miniature circuit breakers M.C.B. 1, 2 & 3 and anti-surge chokes, CH2. The latter are shorted out by a relay, Rel.9, a suitable time-delay being provided by Relays 15 & 16. Output voltage is indicated by the meter M6. Protection from overload is effected by the overload relay, Rel. 7.

H.c.m.v. rectifier filament transformers are supplied from the 400 volt regulated supply.

4.3 E.H.T. Rectifier Unit (G)

S.T.C. Code No. 22 LE.18B
Schematic Reference: Fig.13
Plate: V

4.3.1 General

This unit employs six grid-controlled hot-cathode mercury vapour valves in a three-phase full-wave rectifier circuit to provide an e.h.t. d.c. supply at 7.5 to 10.5 kilovolts.

At 10 kV the current rating is 6.45 amps continuous.

The use of grid control gives the following advantages:-

(a) Adjustment of the output over a wide range, including starting at any predetermined voltage.

(b) High speed overload protection.

(c) Automatic re-application after overload interruption and progressive increase of rectified voltage from an initial low value to a pre-determined working value within 350 milliseconds.

(d) Maintenance of constant output voltage on varying loads.

The principle of grid control is basically one of controlling the starting of conduction in the valve by varying the point of the a.c. voltage wave at which 'firing' is permitted. In practice, a grid is introduced into the normal h.c.m.v. valve and the amplitude of the potentials and phase on this grid, relative to the anode, will determine the point on the a.c. voltage wave at which conduction between anode and cathode will take place. Once the valve has 'fired' the grid can exercise no further control and the discharge can only be stopped by reducing the anode potential below the ionization voltage and maintaining it at this value sufficiently long for mercury vapour to become de-ionized.

Since the point on the a.c. wave at which conduction takes place can be varied, the output voltage of the rectifier can also be varied. (See also Appendix 2).

4.3.2 H.C.M. V. Valve Units

S.T.C. Code (GC) 22 LU.76A
S.T.C. Code (CD) 22 LU.76B
Schematic Reference: Figs. 17 and 18

The e.h.t. rectifier equipment is divided into two assemblies (designated GC and GD on the circuit diagrams) and upon each are mounted three valves.

The valves are mounted with their holders supported on insulators attached to individual units containing transformers for filament and grid excitation. Behind each valve is its grid circuit unit.

The filaments are heated by A.C. at 5 volts obtained from the oil-filled transformers mentioned above. Alternative tappings give a secondary output voltage of 5.2. The primary windings are supplied from the 3-phase 110 volt feeder. Filament voltages are indicated by meters M1 to M6, visible from the front of the transmitter.

An air-cooling system provides ventilation which ensures that mercury condensation occurs only at the base of the valves, thus reducing the causes of flashover.

A 3-phase auto switch similar to the one used in the R.F. Amplifier, is included in the blower circuit.

4.3.3 Grid Control Equipment

(1) Transformer Unit

Each rectifier valve requires two supplies to the grid, a permanent negative d.c. bias and a peaked wave supply of variable phase. Both these supplies are obtained from the grid excitation transformer, the d.c. supply being obtained from a full-wave selenium rectifier. The supplies are conveyed to the grid through the Grid Circuit Unit.

The grid excitation transformers comprise a peak wave transformer, a single-phase transformer, and a smoothing choke; all mounted in an oil-filled tank with the filament transformer.

The peak-wave transformer, which provides the variable phase peak wave that fires the valve, carries the following windings:-

(a) A.C. Excitation Winding, which is the primary winding connected to one phase of the a.c. supply to the main unit. The winding is tapped for 220 volts, 50 c/s.

(b) D.C. Excitation Winding, through which flows the controlling current which provides for $\pm$ 45° shift of the phase of the peak wave relative to the anode voltage of the valve. This winding requires a maximum of 250 mA d.c. in each direction.

(c) Compounding Winding, through which flows a portion of the rectified load current of the main rectifier (3.5A D.C.) in such a direction as to vary the flux produced by the d.c. excitation winding and to produce a resultant constant-voltage output from the main rectifier. In this case only the positive direction of current, and therefore phase shift is used.

(d) Peak Wave Winding. This winding forms the secondary winding of the transformer and on no load has a peak output voltage of about 300V developed across it. The secondary feeds into a half-wave selenium rectifier which removes the negative peak wave.

One of the single-phase transformers in the tank is designed to deliver a centre-tapped output of about 160 volts R.M.S. for feeding the selenium rectifier used to supply permanent grid bias to the main rectifier valves. A 30 Henry choke is connected in series with the centre tap.

(2) The Grid Circuit Unit (Code No. 282-LU.6A) is an intermediate unit between the grid excitation transformer and the rectifying valve. The functions of the unit are:-

(a) Elimination of the negative peak wave by means of rectifier Rect. 1.

(b) Broadening of the base of the peak wave by means of capacitor C1 connected across load resistor R1.

(c) Provision of the standing bias for the rectifier valve from selenium rectifier Rect. 2. Smoothing is effected by C2 and the bias of approx. 60V is developed across R2.

(d) Protection of the rectifier valves against excessive grid current or grid voltage. The former is effected by means of a series resistor R3 which functions as a current limiter, while a neon tube gives voltage protection.

These units, which are at high d.c. potential to earth during operation of the rectifier, are mounted on insulators.

(3) Contactor Unit (GA)

S.T.C. Code No. 183-LU.13A
Schematic Reference: Fig. 14

This unit consists of a hinged panel on which are mounted the following relays and circuit breakers for the sequential control of E.H.T.

(a) 0-15 minute adjustable time delay relay REL.11 to prevent application of E.H.T. to the e.h.t. h.c.m.v. rectifier valves until the filaments have been adequately heated.

(b) Under-current relays REL.9 in the filament supply to the e.h.t. h.c.m.v. rectifier valves.

(c) Surge limiting resistors R1-R3 are provided in the filament circuit of the e.h.t. h.c.m.v. rectifier valves. These are shorted out by relay REL.8 after a maximum delay of 5 seconds.

(d) Time and current RELS. 1 and 3 and instantaneous relays Rels. 2 and 4 for protection against a.c. overloads in the e.h.t. transformer primary supply.

(e) E.h.t. starting and final contactors RELS. 6 and 5.

(4) Grid Control Unit (GB)

S.T.C. Code No. 1-LU.90A
Schematic Reference: Fig. 15

This unit consists of an assembly of relays, circuit breakers etc. to provide:-

(a) A.c. and d.c. excitation, T3 and Rect.2, respectively, for the grid excitation transformers including relays to control these supplies and to provide automatic re-application after overloads.

(b) "Raise" and "Lower" control of the rectifier output voltage by means of a motor driven potentiometer, R3. The direction of rotation of the motor is determined by field windings energised via switch S1.

(c) Automatic control of the output voltage when the rectifier is started and after an overload has been removed. The output requires approximately 350 milliseconds to reach its full value due to the time constant of CH1, R6 and C2 across the d.c. excitation supply.

(d) High speed overload protection by means of relays operating into the grid excitation supply. On the occurrence of a d.c. or a.c. overload, the e.h.t. supply is immediately suppressed and automatically re-applied two seconds later. If the overload persists after three successive attempts at reclosing, the control trips the e.h.t. contactor.

(e) Remote signalling of circuit conditions by means of relays. A description of the control and resetting circuits is given in Section 8.3 of this chapter.

(f) A full-wave selenium rectifier unit, 246-LU.3738A, supplies 50V D.C. for relay operation.

(g) D.c. overload protection is provided by the shunt R1, in the e.h.t. negative lead in conjunction with the d.c. O/L multiplier, R4.

(h) Shunt R2, supplies the compounding current to the peak wave transformers to maintain a constant rectifier output voltage.

4.3.4 Reverse Current Indicators

S.T.C. Code No. 248-LU.6A and B
Schematic Reference: Fig. 38

Each valve of the e.h.t. rectifier unit is provided with a reverse current indicator for counting the number of arc-backs (i.e. conduction on reverse half-cycle), and giving a visual indication, by means of a signal lamp, of the faulty valve.

An "Indicate-Record" switch is provided on these units. In the "Indicate" position the unit locks up on operation and the lamp stays alight until the supply is cut off or the indication cancelled by switching to "Record". In the "Record" position the register counts up the number of flashovers and the lamp flashes for the duration of operation only.

The indicator units are connected in the anode circuits of the "phase" valves V1 to V3 and in the cathode circuits of the "conjugate" valves V4 to V6.

The principle of operation is as follows:-

Normal anode current flows through the resistor R1, or R2, etc., and there is no flow through relay B due to the presence of rectifier, Rect. 1. When an arc-back occurs, the reverse current operates the high speed relay B, contact B1 closes and completes the circuit of relay, A/2 from RECT. 2. This circuit includes relay B and the latter remains energised so long as contact D1 or switch S1 are closed.

Relay A/2 closes A1 and the message register D/1 now operates, advancing the counter one digit and opening contact D1. Contact A2 also closes and completes the lamp circuit. If the lamp is to remain ON the manual switch S1 is left closed, thus shorting out the D1 contact.

The d.c. supply for the relays is obtained from a selenium bridge-connected rectifier, Rect. 2, supplied from the transformer

T1 whose primary is connected across the filament supply of the associated "conjugate" valve.

4.3.5 Anode Supply

Three-phase A.C. is supplied to the valve anodes from the h.t. transformer which stands as a separate unit within the enclosure. The primary supply to the transformer is controlled by the contactor unit housed behind the valve unit.

To eliminate any possibility of oscillation being set up by rectifier commutation in the secondary windings of the h.t. transformer, a damping circuit consisting of a capacitor in series with a resistor is included between each phase and neutral.

4.3.6 Smoothing

Smoothing is carried out by means of a circuit comprising the components detailed in Chapter 3, 6.2.

5.0 CONTROL CIRCUITS

5.1 General

The control circuits are designed for ease of operation and complete protection of the transmitter equipment against damage due to the operation of controls in incorrect sequence.

5.2 Starting Sequence

Schematic Reference: Figs. 24 and 25.

(a) Switch on the Relay Resetting Circuit (set to either "AUTO" or "MANUAL".)

Close the oil circuit breaker. Air blowers start up in E.H.T. Rect. cabinet and meter lighting comes on. The e.h.t. rectifier valve filament transformers are now supplied with 110V 3-phase a.c. via resistors GA.R1, 2 and 3. GA. Rel.7, closes and after a time delay of 5 secs. GA. Rel.8 closes and short circuits the three resistors GA.R1, 2 and 3. GA.Rel.9 closes, operates GA. Rel.10 and prepares the e.h.t. time delay circuit (GA.Rel.11).

GA.Rel.8 energises GA.Rel.11, the main e.h.t. time delay, which, after a delay of up to 15 mins., prepares the E.H.T. ON circuit. (See fig. 25 (control ccts.)

(b) The "Exciter Filaments ON" button (K1) is operated. (Fig. 25.) Contactor K.Rel.1 closes, switches on exciter filament supplies and completes K. Rel.3 circuit. K.Rel.3 closes and completes the circuit to the exciter grid bias supplies. K1 signal lamp lights indicating that the sequence is completed.

(c) The R.F. Amplifier Air and Filaments ON button (K3) is operated. Contactor E.Rel.2 (Fig.9) closes and switches on the main blower motor. Contacts on the air flow switch open and release E.Rel.4. The time-delayed relay E.Rel.1 closes and completes E.Rel.3 circuit. E.Rel.3 closes and switches on the R.F. Amplifier filament supply. K3 signal lamp lights.

(d) The Main Isolator is closed switching on the grid bias supply to the R.F. Trucks and K.Rel.11 and 12 operate. When the time-delayed relay K.Rel.10, protecting the h.c.m.v. valves has closed, the bias supply to the R.F. Amplifier valves is applied and K.Rel.14 and 13 operate. The Exciter H.T. ON button K2 can now be operated. Contactor K.Rel.4 closes and switches on the 500V and 1500V h.t. supplies. K.Rel.8 then closes and switches on the reduced 6 kV h.t. supply. Finally, K.Rel.9 closes, shorts out the anti-surge chokes and completes the K2 signal lamp circuit.

(e) The E.H.T. ON button (K4) is operated.

GA.Rel.6 closes, and completes GA.Rel.5 circuits. GA.Rel.5 closes and applies e.h.t. a.c. to the grid-controlled h.c.m.v. rectifying valves. K4 signal lamp lights.

5.2.1 Exciter Stages

H.T. cannot be applied to the R.F. Truck until:-

(a) The transmitter enclosure door is closed.

(b) The isolator is closed.

(c) The Exciter Filaments ON button has been operated and 30 to 60 seconds have elapsed since the oil circuit breaker has been closed.

(d) Grid bias is at its normal value.

(e) The isolator switch at the bottom of the R.F. Truck has been closed.

5.2.2 R.F. Output Amplifier

E.H.T. cannot be applied until the following operations have been completed:-

(a) The isolator is closed.
(b) Air flow is correct.
(c) Filaments and grid bias are on and at the normal working voltages.
(d) The time delay relay protecting the h.c.m.v. valves has operated.
(e) The resetting circuit is prepared.

5.3 Rectifier Automatic Resetting Circuit

5.3.1 General

Schematic Reference: Fig. 19.

Circuits are provided to protect the rectifier against overloads, either on the input or output sides.

Operation of the a.c. or d.c. overload relay results initially in removal of the a.c. excitation from the peak-wave transformers. What happens then depends on one of the two following conditions existing:-

(a) If the overload lasts less than 2 seconds the excitation will be restored and normal operation will continue. The restoration sequence can deal with three transient overloads within 6 seconds, but if a fourth occurrs within 10 seconds the rectifier circuit breaker will be tripped.

(b) If any overload lasts longer than 2 seconds the circuit breaker will be tripped and not reclosed automatically. The reclosing sequence is shown diagrammatically on Fig. 25.

If desired, the automatic relay sequence can be switched out of circuit and an overload will then trip the rectifier circuit breaker immediately. (See Fig. 20.)

When an overload occurs, the appropriate overload lamp will light and the alarm bell will ring for the period during which the transmitter is without E.H.T.

If the overload results in the tripping of the e.h.t. contactor the alarm bell will continue to ring until the E.H.T. "ON" button is pressed, or the oil circuit breaker on the Mains Distribution Unit is opened.

On a light sustained a.c. overload (200% or more) such as would occur if the secondary winding of the E.H.T. Transformer was accidentally short-circuited, contacts of relay PB would open and trip the e.h.t. contactor instantly. With an instantaneous a.c. overload of 400% or more, such as would occur with an "arc-back", relays FGL will operate, releasing relay CC and CCA and thus removing the a.c. excitation and switching the d.c. excitation to the maximum negative value, resulting in the e.h.t. d.c. being cut off in less than 1 cycle of the a.c. input. This sequence is similar for d.c. overloads.

Referring to paragraph (a) above, an overload which lasts for 2 seconds can only be one which persists after removal of grid excitation and in this case the e.h.t. contactor will be tripped after 2 seconds.

5.3.2 Manual Operation

Schematic Reference: Fig. 20

2(a) E.H.T. Circuit Preparation

When the Oil Circuit Breaker is closed and the AUTO-MANUAL switch is placed to MANUAL, JC is operated from positive supplied via a back contact of CP. JC locks-in, remaining operated under control of AD. JC operates CP which locks-in until the Oil Circuit Breaker is opened. JC also operates BD. BD operates relays AC and T which prepares the main e.h.t. breaker operating circuit. AC operates AD to release JC.

2(b) E.H.T. Application

The E.H.T. "ON" button is pressed to close the circuit of auxiliary breaker Rel.6(GA) which closes the main e.h.t. breaker Rel.5 (GA), Rel.6 (GA) operate CC and CCA and CCB. CC completes the grid peak-wave excitation already prepared by BD. CCB raises the d.c. excitation to a pre-determined level. CC and CCA and CCB remain locked whilst the main breaker is closed.

2(c) D.C. Overload

A d.c. overload produces a voltage across the D.C. Shunt sufficient to operate DU. DU releases BD quickly and removes grid peak excitation to the thyratrons, and DU releases. BD releasing operates DC which lights the appropriate lamp and rings the alarm bell; and AD releases. BD releases T to open the e.h.t. breakers Rels. GA5 and GA6, and release CC CCB and CCA.

Re-preparation after overload

After the main e.h.t. breaker has tripped on fault, the overload relay (FG-L, PB or DU) will restore, and with AD, CC CCA and CCB open, BD will be re-operated, (if it had released on d.c. overload). T will operate to prepare main breaker closing circuit. The alarm bell and lamp will remain in action till the Oil Circuit Breaker is opened or the e.h.t. circuit is reclosed as described below.

2(d) & (e) A.C. Overloads

An a.c. overload fault causes the operation of FG-L or PB. (Surge overloads of 400% and over, actuate relay FG-L, and lighter overloads of 200% which are prolonged for 2 seconds will operate PB.) Operation of FG-L and PB releases AC and T. AC releasing lights the a.c overload lamp and rings the alarm bell, and AD releases. T releasing causes a shut down of the main breaker which in turn releases CC CCA and CCB removing a.c. and d.c. excitation as described in para. (b). When FG L operates the relay T, CC CCA and CCB are released simultaneously, but for PB the sequence is as described above. PB operates C which breaks the coil circuit of AC and T, and CC CCB and CCA simultaneously whereas FG-L short-circuits relays AC and T through series resistor YAC. Relay T releases main breaker B which releases CC CCB and CCA.

2(f) E.H.T. Restoration

The E.H.T. "ON" button is pressed to close the circuit of the e.h.t. breaker. An auxiliary contact on the breaker closes JC via the manual switch and back contacts of AD. JC locks-in under control of AD. JC operates AC (if released) and releases DC (if operated) to stop the alarm, and operates AD. AD reduces the flux of BD (allowing for very rapid release of BD in case of a fault). AD also releases JC. JC operates CC CCA and CCB. The position now is as described in para. (b).

2(g) E.H.T. Switch off

Pressing the E.H.T. "OFF" button releases the main e.h.t. breaker. An auxiliary contact of the breaker releases CC CCB and CCA. The circuit is then in the condition described in para. 2(a).

5.3.3 Auto Operation

Schematic Reference: Fig. 21

3(a.1) Circuit Preparation

When the Oil Circuit Breaker is closed, AR operates via a back contact of CP and the AUTO-MANUAL switch in the AUTO position. AR operates JC. JC locks-in under control of AD. JC operates CP which locks-in until the Oil Circuit Breaker is opened. CP releases AR JC also operates BD and AC. BD operates relay T which prepares the main e.h.t. breaker switching circuit. AC operates AD to release JC.

3(a.2) Switch On

The E.H.T. "ON" button is pressed to close the circuit of the auxiliary breaker GA Rel.6 which closes the main e.h.t. breaker GA Rel.5. An auxiliary contact on the breaker GA Rel.5 operates CC CCA and CCB and AR. CC completes the grid peak-wave excitation already prepared by BD. CCB raises the d.c. excitation to a pre-determined level. CC, CCA and CCB remain locked while the main e.h.t. breaker is closed.

3(b.1) If D.C. Fault Occurs

DU operates and releases BD quickly to cut off a.c. excitation. BD releases T and operates DC to give the alarm. DC releases AD. AD releases CC, CCB and CCA. BU falls back when the excitation is removed. BD operates via the back contacts of AD and CC. BD operates T.

3(b.2) 2 secs. Time Delay Before Re-excitation

Release of AD, CCB and CCA sets the timing circuit in operation. The supply to this delay circuit is derived from a 110V single-phase a.c. supply and rectifiers MRA-MRB. The output voltage is controlled by varying the load across reservoir capacitor QR by resistor YVS. When AD is operated, the timing capacitor QT, is held discharged via a front contact of AD and a break contact of BC.

Release of AD, CCB and CCA allows QT to be charged via resistor YC. When QT attains the potential required to ionise the control gap of V, JA operates and locks-in under control of AD, and extinguishes V. JA operates JB which discharges QT.

3(b.3) Re-excitation

When relay T operated, the e.h.t. breaker remains closed. JB operates JC and counting circuit relay A. JC releases DC to stop the alarm. AD operates to release JA which releases JB and JC. JC going back, operates CC, CCA and CCB to reapply grid excitation. JB releasing operates counting relays B and BC. BC takes off the short circuit on QT and allows it to become charged via resistor YR; after one second QT acquires the potential to ionise the control gap of V. If the fault has been cleared JA operates and locks-in under the control of AD and extinguishes V. JA operates JB which discharges QT. JB operates JC.

3(b.4) Re-setting

JA releases B and A, and B releases BC. BC releases JA. JA releases JB. JB releases JC, and the resetting unit is in the normal working condition as described in para. 3(a).

3(c) If Fault Persists after 1st Trial

If the fault has not been cleared as described in para. 3(b.3) after the first trial with the operation of CC, CCA and CCB - DU operates to release BD to suppress a.c. excitation. BD releases T and operates DC to give the alarm. DC releases AD, and DU falls off again when the excitation has been removed.

NOTE: The operation of DU, BD, DC and AD all takes place in less than the one second delay which was timed from the operation of BC mentioned in para. 3(b.3) and thus the resetting described in 3(b.4) does not occur.

Release of AD causes a 2 second delay as described in 3(b.2) and re-excitation takes place as described in 3(b.3) except that operation of JB releases counting relay A, and release of JB operates counting relay C.

If the fault has cleared at this stage the resetting sequence of para. 3(b.4) takes place, except that JA releases B and C.

3(d) If Fault Persists after 2nd Trial

The sequence of operations are as described for the first and second trials except that operation of JB releases B and operates A and release of JB operates B.

If the fault has cleared at this stage the resetting sequence of para. 3(b.4) takes place, except that JA releases A, B and C.

3(e) If Fault Persists after 3rd Trial

DU releases BD which suppresses rectifier output. BD releases T and operates DC to give the alarm. DC releases AD. AD releases CC, CCB and CCA. CC operates BD, but T cannot reoperate as A and C are operated. Release of AD causes QT to charge via YB in 100 milliseconds. When QT attains the potential to ionise the control gap of V, JA operates and operates JB. JB releases auxiliary e.h.t. breaker GA Rel.6 which releases main e.h.t. breaker GA Rel.5.

Release of GA Rel.5 causes the following sequences:-

Release of A which operates T
Release of B
Release of C
Release of AR which releases JA and JB

At this point, the alarm bell continues to ring and the signal lamp remains alight until the Oil Circuit Breaker is opened or the E.H.T. "ON" button is pressed.

If the fault has cleared, relay AR operates and removes the short circuit on QT which becomes charged sufficiently to ionise the gap of V and the sequence of operations continue as described in para. 3(b.3) and 3(b.4).

3(f) E.H.T. Switch Off

This is exactly as described in para. 2 (g).

3(h) If A.C. Surge Fault Occurs

On surge overloads of 400% and over the relay FG-L operates to release AC and T by short-circuiting their coils. Relay AC gives the alarm and releases AD. AD releases CC, CCB and CCA to remove a.c. and d.c. excitation. Whereupon FG-L restores and operates T.

Release of AD, CCB and CCA sets the 2 second time circuit in operation as described in 3(b.2) and the sequence of events continue as described in 3(b.3) and 3(b.4) except that AC operates instead of DC.

3(j) If Faults Persist after 1st. 2nd and 3rd Trial

The succeeding trials continue as described in paras. 3(c), 3(d) and 3(e) with the following differences:-

(1) FG-L operates instead of DU.
(2) AC operates instead of DC.
(3) BD does not operate.

3(k) If Sustained A.C. Overload Occurs

Overloads of 200% which are prolonged for 2 seconds will operate the PB relays releasing AC, AR and T.

Release of AC gives the alarm and releases AD.
Release of AR releases CC, CCB and CCA.
Release of T opens the auxiliary e.h.t. contactor GA, Rel.6 which releases main e.h.t. contactor GA.Rel.5. PB restores.
Release of CCB, CCA and PB operates T.

The alarm continues until the interlocks are broken or E.H.T. "ON" button is pressed.

5.4 Signal Lamps

Signal lamps on the Main Control Unit (L) are used to indicate the following conditions:-

(a) Oil Circuit Breaker Made (green)
(b) H.C.M.V. Filament Heating Commenced (green)
(c) H.C.M.V. Filament Heating Completed (green)
(d) Exciter Filaments ON (green)
(e) Exciter H.T. On (red)
(f) R.F. Amplifier Filaments On and Air Flow Normal (green)
(g) E.H.T. Prepared (green)
(h) E.H.T. On (red)

Red signal lamps indicate d.c. or a.c. overloads on the final stage and remain alight until the anode voltage is re-applied automatically or manually.

CHAPTER 5

INSTALLATION

1.0 PREPARATION OF SITE

The building used for housing the equipment should preferably be constructed from brick or concrete both to ensure adequate protection from weather and freedom from vibration. Excessive humidity and general dampness should be avoided and precautions taken to prevent ingress of rodents and destructive insects.

A low resistance earth is essential and, if no really "positive" earth point exists in the immediate vicinity of the building, it can be provided by the burial of a metal plate.

The plate should be constructed from sheet copper or heavily galvanised iron and should be at least 3 feet square and not less than one-eighth of an inch thick. Heavy gauge copper multi-strand cable, of suitable length for connection between plate and equipment, should be splayed at one end and soldered at various points to the plate. The soldered joints should be painted with bitumen compound to prevent corrosion. The plate should be buried on edge, with the upper edge at least three feet below ground level, at a point in the immediate vicinity of the building and, in dry areas, provision must be made for keeping the soil moist.

2.0 SHIPPING SPECIFICATION

The Shipping Specification is a booklet listing, in classified form, all items into which equipment is broken down for shipment. It will vary according to method of transport and project and is not, therefore, supplied as part of this manual. Two copies are packed with the equipment and one is despatched by mail.

The specification comprises four parts as follows :-

(a) Cover.
(b) Sheet of explanatory notes.
(c) Sheet giving summarised breakdown of equipment.
(d) A series of sheets giving detailed breakdown.

The first two sheets (a) and (b) require no comment. The third or "Classification Sheet" is an index showing principal sections into which the equipment has been divided as considered from a shipping and re-erection point of view. It contains four columns, the first two of which refer to manufacturing codes and tables of main parts. The third column shows arbitrary designation letters corresponding to "Classification Letters" on top right hand side of each detailed "Breakdown" sheet. The fourth column shows number of detailed sheets which should be present.

The detailed "breakdown" sheets list every item which forms a separate entity or package. Each sheet contains eleven columns titled as follows :-

(1) Unit Reference

This is a letter corresponding with that marked on layout drawings. It indicates part of floor on which item will stand. The unit reference letter should not be confused with the Classification Letter, which is purely a shipping "breakdown" indication.

(2) Specification)
) for manufacturers use only.
(3) Item No.   )

(4) Remarks — Notes for assembly and installation.

(5) M.S.T. — Job M.S.T. number and serial number of equipment shipped.

(6) and (7) Class and Item No.

The letter S denotes that article is a shipping item; the following letter is the Section Classification Letter as given in the Classification Sheet. The Item Number is shipping item number under above classification.

(8) Case No.

Shows number of case in which item will be found. This number is stencilled on outside of case.

(9), (10) and (11) Quantity, Code, Description

Describes articles, and states how many make up each package or item.

How to use Shipping Specification

(a) Decide which part of erection is to be done first, by studying information given in this chapter.

(b) From the third, or "Classification Sheet", of Shipping Specification, find Section Classification Letter of apparatus required.

(c) Turn to detailed breakdown sheets bearing the appropriate classification letter, and find case number for items wanted.

(d) Unpack items and identify by means of labels on them.

(e) Note, from "Unit Reference", on detailed "breakdown" sheets and layout drawings, where items should go on floor or wall.

(f) Check, from detailed "breakdown" sheets, that nothing is missing.

(g) Proceed with erection and assembly.

3.0 ERECTING THE TRANSMITTER

3.1 General

Before the installation of the Transmitter is undertaken, it is essential to have at hand the complete Shipping Specification, as repeated references are made to it in the following instructions. When the Transmitter is packed for shipment at the factory, it is necessary to remove some of the units from the frameworks for safety reasons, and to add certain "shipping details" which are painted yellow. These are added to, or take the place of, some part of the assemblies to strengthen and protect these units against vibration or shock experienced during shipment. Most of the mains contactors are tied down and some of the relay contacts are wedged before shipment to protect the mechanism or movements from damage.

It is advisable to congregate the cases of equipment as near as possible to the transmitter site; to read the following instructions, and then to open the cases in the correct sequence to facilitate the overall assembly.

3.2 Detailed Instructions for Procedure During Installation

3.2.1 Mark out the enclosure dimensions and prepare the trench for the air ducting. Mark out the positions and make the holes for the fixing bolts of the air blast cooling plant (refer to fig.39). The blower motor and filter assembly is fitted and bolted to the floor through the anti-vibration mountings at a later stage, the inlet air ducts are laid in the trench and connected from the R.F.Amplifier to the blower by means of flexible couplings. The assembly of this ducting is shown in fig.40. The pipes are cemented at the joints when assembly is complete. Details of the parts required for this assembly will be found in Section Q of the Shipping Specification.

3.2.2 The plinths and cable ducts must now be assembled in position, starting with the plinth for the R.F. Amplifier which has a centre line marked to coincide with the centre of the front of the enclosure. Continue with the plinth to left and right of it, followed by the plinths for the sides and back. There is a bracket detail (L.93886 Detail 521 - Section H) which is added to the base of the back plinths and serves to complete the assembly of the rear partitions. It should be noted that one section of the plinth on the left-hand side looking from the front can be removed whenever needed, to move in or out units from the interior of the enclosure.

Important Note:- Before proceeding further with the work of installation, it is most important to be sure that the plinths are absolutely level all round.

3.2.3 Assemble the copper earthing strips into the plinth ducts; they will be connected to the frameworks by bolts at a later stage. See paragraph 4.

At this stage it is advisable to remove all the shipping details which have been included for the safety of the equipments. These shipping details are to be found on the following units :-

Unit	H	R.F. Amplifier
"	JB)	R.F. Trucks
"	JC)	
"	K	Exciter Supplies
"	E	Mains Distribution

Replace components such as ceramic rods, resistances, condensers, chokes, transformers, etc., which have been removed for shipment, with the exception of transformers on Unit E as follows; T1 (RL.7008.419), T2, T4, T5 which are mounted on det.239. Close reference should be made to the Shipping Specification and photographs and schematics in the Handbook, in order that all the components may be found and assembled in their correct positions. It is important to note that in the case of the ceramic rod, certain marks and letters are painted on the rods and on the frameworks to which they assemble; these marks and letters must coincide when the ceramic rods are pushed into place. The reason for this is because the ceramic rods are not always truly straight. The steel tubes are partially withdrawn and the ceramic rods are then pushed in to take the place of the steel tubes.

3.2.4 The following unit frameworks are now put into position on their plinths, ready for bolting to the plinths and the other framework. The unit frameworks are placed in position in this order :-

Unit	H	R.F. Amplifier
"	JB	R.F. Exciter
"	K	Exciter Power Supply Unit
"	JC	R.F. Exciter
"	GC	Valve Unit
"	GD	Valve Unit
"	E	Mains Distribution Unit

When fitting the R.F. Amplifier, the datum line marked on the base of the R.F. Amplifier framework must be placed to coincide with the datum line marked on the centre plinth. This establishes the centre of the front of the Transmitter.

It may become apparent that the various bolt holes do not completely align with one another between unit frameworks and between unit frameworks and plinths. Two jigs are supplied, (4.LE.100 detail 1236 and detail 1237) to ensure that the enclosure posts will line up with the unit frameworks. Before bolting any unit frameworks to the plinths or to each other, the jigs must be used. The jig is placed along the front face of the frameworks so that the holes on the frameworks coincide with the holes on the jig. This alignment should be carried out at the bottom front and the top front of the framework.

Assemble framework detail (4-LE.100 detail 10) between the R.F. Exciter (JB) and the Exciter Power Supply Unit (K). This framework detail must be assembled with its spacers (4-LE.100 detail 2) loosely to allow for adjustment. The assembly is completed in paragraph 7 below.

Fill the oil circuit breaker on the mains distribution unit E with oil by removing the panel which masks the Distribution Unit and pouring the oil through the filler hole in top front of the oil circuit breaker, and check that all the other oil-filled units such as transformers, chokes, etc., are correctly filled to the level indication on the unit. The level of oil in the Oil Circuit Breaker is judged by inserting a dipstick into the hole through which the oil is poured. Remove all blanking pieces from breathers and air vents.

All contactors and other moving parts which have been tied down or fixed for shipping should be released.

Connect the earthstip to the various unit frameworks by bolting them together at the points supplied.

3.2.5 Remove the left-hand section of the plinth (refer to paragraph 2) and move the following units of equipment into their approximate final position :-

Unit B	Automatic Voltage Regulator
" C	H.T. Smoothing Unit
" D	E.H.T. Transformer
" GA	Contactor Unit
" GB	Control Unit
RL.7008-273	Transformer 6000V Supply
RL.7008-275	Transformer 1500V Supply
RL.7009-183	E.H.T. Smoothing Choke

The units B, C, and D will be put into their final positions during the course of the assembly. The units GA and GB can be assembled to the valve units GC and GD respectively.

3.2.6 The two back partitions slide into one another and are each connected to the side framework by three brackets. It is at this stage that the brackets L.93886 detail 521 referred to in 3.2.2 are assembled.

3.2.7 The enclosure framework is shipped in fairly large assemblies, for instance, the front part of the enclosure is broken into 2 frameworks and a centre door assembly, the sides of the enclosure are shipped as complete assemblies, and the rear partitions of the enclosure are in two pieces. The sequence of the enclosure assembly should be as follows :-

(a) The two front frameworks and the centre door but excluding the box above the door (L.93886 detail 387). The box is assembled later (3.2.8).

(b) The two side frameworks.

(c) Assemble the two front corner post sections of the framework (L.93886 detail 221) to the framework of the units K and GD respectively. Make final adjustment to 4-LE-100 detail 10 (3.2.4).

The cabletrays should be screwed to the back partitions, and the earth strip fixed in position.

At this stage the various cableforms can be fed in under the frameworks which have been assembled on the plinths as described above. The cableforms are numbered and the Shipping Specification gives a list of them together with units between which they are laid. The following is the sequence of procedure :-

(i) Run in and connect FORM 1A.
(ii) Run in the lead covered meter shunt.
(iii) Run in and connect FORM 2.
(iv) Tie in temporarily the above cables to the cable rack which is mounted on the back partitions.
(v) Run in FORM 4 and connect.
(vi) Dress and cleat this form at unit GD only.
(vii) Run in FORM 1C and connect at unit GC only.
(viii) Run in FORM 1B and connect at unit H only.
(ix) Run in FORM 5 and connect at unit F only.
(x) Run in FORM 3 and connect at GD only.
(xi) Place the E.H.T. Transformer DS8.1.86 into its correct final position and make off the cables which connect to it.
(xii) Run in and connect FORM 24.
(xiii) Dress and cleat all cables which run on the cable rack mounted on the rear partitions, that is to say, FORMS 1A, 2, 4, 1C, 1B, 5 and 3, which have so far only been connected at one end.

(xiv) Run in and connect earth leads from :-

(a) Auto Voltage Regulator RL.7018.9
(b) E.H.T. Smoothing Choke RL.7009.183
(c) E.H.T. Transformer DS8.1.86 and unit F.

All these earth leads are made off to the copper earth bar.

(xv) Run in and connect FORM 15.
(xvi) Run in and connect FORM 21.
(xvii) Earth all the armoured cables to the main copper earth bar in 5 positions by using the clamps prepared for the purpose. These clamps are made up ready for each position and can be identified quite readily. The 5 positions are as follows:-

(a) Cabletray on rear partition.
(b) Entrance door at side of main isolator
(c) At centre of E.H.T. Rectifier unit.
(d) Under R.F. Truck No.1.
(e) Next to R.F. Truck No.2.

(xviii) Run in and connect the following forms in the order given:- 7, 13, 11, 12, 6, 8, 9, 10, 14, 16, 17, 18, 19, 20, 22, and 23.

Move the following units into their final positions:-

Unit B Automatic Voltage Regulator
Unit C H.T. Smoothing Unit

Wheel the transformers RL.7008-273 and RL.7008-275 into their respective positions in unit K, and connect them up.

Make all cable connections from the cableforms to their respective terminals internally on the Transmitter. The terminal lugs are clearly marked with the number of the terminal to which they are connected.

3.2.8 The exhaust air ducts which are assembled above the transmitter framework are put together in the following manner:-

(i) Screw the aerial change-over switch base to the top of the R.F. Amplifier and fit insulator 26-4002A (Section G of Shipping Specification) on to the bracket provided on the front of the switch base.

(ii) Place the portion of the exhaust duct assembly which fits over the 2 - R.F. Trucks and final R.F. Amplifier (4.LE.100 detail 126) over the insulator mentioned above. Bolt this duct assembly into position on top of the framework.

(iii) Fit the blanking details 59 to the curved cornice.

(iv) Fit the box L.93886 detail 387 to the top centre of the enclosure.

(v) Assemble the aerial-change-over switch by referring to Section G of the Shipping Specification and to the photographs supplied.

(vi) Fit the remainder of the top ducting and blanking details 140, 142, 146, 148, remembering to assemble the E.H.T. tubular connections and the air ducting for the cooling of the H.C.M.V. Valves between the 2 Valve units of the E.H.T. Rectifier, before assembling the top part of the ducting. If this exhaust ducting is to be extended to the outside of the building it should be done at this stage to any special drawings that may have been prepared for this site, either in the supplier's factory or locally by the customer.

3.2.9 Assemble the Isolator switch (F) and its interlock mechanism (4-LE.100 Sheet 3.11) and replace the resistors which have been removed from the sub-assembly mounted on this Isolator switch.

3.2.10 Connect up the transmission lines from the R.F. Trucks and the R.F. Amplifier to the aerial change-over switch.

3.2.11 Assemble the Suppressor Unit 242-LU.5A above the E.H.T. Transformer DS8-1-86 and assemble the resistances associated with it. Make all copper tubular connections between the Suppressor Unit and E.H.T. Transformer.

3.2.12 On the E.H.T, Smoothing Unit (C) wheel the Smoothing Choke RL.7009-183 into position and assemble the resistance mats, refer to Plate lV. Make all tubular copper connections on this unit.

3.2.13 Make all external mains supply and drive connections to the terminals supplied on the mains distribution unit's lead.

NOTE: It will be necessary to remove side panels when making the connections described in paragraph 13.

LINING UP THE TRANSMITTER

1.0 GENERAL

It is assumed that the transmitter has been erected, the air cooling system installed and connected, all cabling installed and connected, packing pieces removed from the equipment and loose components fitted.

WARNING: (If applicable): The door in front of vacant truck position must be firmly bolted to prevent accidental contact with high voltages.

2.0 CONNECTIONS

All connections should be checked with the aid of the Inter-Unit Wiring Diagram, Fig. 23 and a continuity tester such as a buzzer and battery. Before checking, however, take care to disconnect any cable offering parallel paths and to remake the connections when testing is complete. Verify that links have been inserted, where required, between pairs of terminals on the same unit.

3.0 FUSES

Check that fuses fitted in the transmitter are correct according to Table 2 Appendix 1.

4.0 TRANSFORMERS

The tappings of transformers should now be checked and if necessary adjusted according to the following tables. It is important to operate the transmitter at the recommended voltages and the additional information is for reference purposes only.

4.1 Mains Distribution Unit (E)

(a) Transformer T1:

Primary voltage is regulated at 400V.
Primary tapped at 340, 360, 380, 400, 415, 440, 460
Secondary output 110V A.C.

(b) Transformer T2:

Primary tapped at 5, 0, 100, 110V
Primary voltage normally 110V
Secondary output voltage is rated at 50 volts.

(c) Transformer T3:

Primary 110V tapped at ± 5%, ± 10% of nominal secondary voltage. Secondary output voltage is rated at 44V

(d) Transformer T4:

T4 Primary 10 - 0 - 200 - 220 - 240 set to nearest supply line voltage.

Secondary 50 volt

(e) Transformer T5:

T5 Primary 0 - 415 unregulated
Secondary 0 - 24

4.2 Exciter Power Supply Unit (K)

(a) H.T. Transformer (T2) and Filament Transformer (T3) (mounted in same tank)

These transformers have no voltage tappings and no adjustments are necessary. Connections are indicated on the terminal panel.

(b) H.T. Transformer T4 and Filament Transformers T5, T6 and T7 (mounted in same tank)

See note for T2, T3 above.

(c) Auto Transformer T8

This transformer is provided with tappings to cover mains voltages of 380, 400 and 415 R.M.S. Adjust to tapping nearest to that of the supply voltage.

It provides reduced input voltages to the primaries of transformer T4 when high level modulation is applied.

4.2.1 Grid Bias Rectifier (22-LU.75A) (KB)

H.T. Transformer T1

See information on fig. 12.
Input voltage regulated at 400V
Normal sec. tappings 9- 11 - 13

Filament Transformer T2

See information on Fig. 12.
Set to tapping giving 4.0 to 4.1V at the rectifier filaments.

4.2.2 Grid Bias Unit (-ve) (94-LU.161B) (KC)

Input Transformer T1

Voltages are indicated on the terminal panel. Input voltage is regulated at 400V.

4.2.3 500V H.T. Supply Unit (+ve) (14-LRU.129A) (KD)

Input Transformer T1:

Voltages are indicated on the terminal panel. Input voltage is regulated at 400V.

4.3 E.H.T. Power Supply Unit (G)

4.3.1 Main E.H.T. Transformer (DS8-1-86)

Primary (L.V. winding)

Suitable for supply voltages 342V, 361V, 380V, 395V or 415V, 435V, 453V. Delta connected.
Adjust to the tapping nearest to that of the supply voltage.

Secondary (H.V. winding)

Normal voltage between phase and neutral: 4820 R.M.S. (tap 4) (at no load).

Normal phase current: 4.6 R.M.S.

Tappings provided to give 4030V, 3780V 4370V and 5200V R.M.S. (at no load) for same output power i.e. corresponding to phase currents of approximately 5.5, 5.85, 5.1 and 4.2A R.M.S.
Star-connected, Neutral brought out.

A schematic diagram of windings and connections to terminals is attached to the tank.

4.3.2 Grid Control Unit (GB) 1-LU.90A

(a) Transformers, T1 and T2

Secondary terminals are marked 5-0-125-135-145V
Input is 110V.

(b) Phase-Shift Transformer, T3:

Primary			Secondary		
Input Volts	Connect to	Links	Volts	Connect to	Phase Shift
400	a1,b1,c1	a1 - b3) b1 - b3) c1 - a3)	230	A1, B1, C1	0
400	a1,b1,c1	a1 - b2) b1 - b2)* c1 - c2)	338 230 230	A1, B1, C1 *A2, B2, C2 A3, B3, C3	0 15° advance 15° retard

* Normal tappings

(c) Transformer in Rectifier Unit 246-LU.3738A

Primary not tapped
Secondary tapped 2-1-0-1-38-42V
Secondary terminals are marked and connections are normally made to terminals marked 0 to 42.

(d) Transformer T1 in Reverse Current Indicators 248-LU.6A and 6B

Primary not tapped, terminals marked 1 and 2
Secondary terminals, numbered 3-4-5-6 volts 0-26-28-30
Normal connections are to terminals 3 and 4

4.4 R.F. Truck 389-LE.2M

(a) Transformer T1:

Input:	10-0-10-380-400-415V	) Primaries regulated
Secondary:	No.1: 6.3V 9.0A	) at 400V A.C.
Secondary	No.2: 230V, 0.25A	)

(b) Transformer T2:

Input: 0-10-380-400-415V)
Secondary: 2.75-0-2.75V, 27A)

(c) Transformer T3:)

Input: 0-10-380-400-415V) Primaries regulated at 400V A.C.

Secondary: 5-0-5V, 30A)

4.5 R.F. Output Amplifier Unit 28-LU.295A

(a) Filament Transformers T1 and T2 are Scott-connected Primaries tapped at 380, 400, 415V with further tappings to provide sec. V adj. of ± 2½% and ± 5%. Input regulated at 400V A.C.

Set to tappings giving nearest to 9.5V at valve filaments. When adjustments are made, the associated chokes (L3, 4, 5) must be adjusted in steps with the transformers.

(b) Filament Transformer T3:

Primary

Voltage	Terminal No.
0	1
10	2
380	3
400	4
415	5

Input regulated at 400V A.C.

Secondary

Voltage	Terminal No.
0	6
3.15	7
6.3	8

5.0 OVERLOAD RELAY SETTINGS

Check that protection relays in the transmitter are correct to the following information.

5.1 Mains Distribution Unit (E)

Oil Circuit Breaker OCB1 Overload coils
Current setting: 250 Amps.
Time setting: Max.

5.2 Contactor Unit (GA)

(1) Instantaneous A.C. overload relays REL.2 and REL.4
Plug setting multiplier: 400%

(2) Time and current A.C. overload REL.1 and REL.3
Plug setting: 100%
Time setting multiplier: 0.4

(3) Filament undercurrent relay REL.9

(4) E.H.T. Time delay relay REL.11
Initial testing: 15 mins.
Normal running

Ambient temp.	15° - 20°C	15 mins.
" "	20°C and above	5 mins.

5.3 Grid Control Unit (GB)

(1) D.C. overload shunt R1
5.0 Amps.

(2) Compounding shunt R2
6.0 Amps.

(3) D.C. overload multiplier R4
Set link to 20%

5.4 R.F. Output Amplifier (H)

Cathode current overload relays OL/1 and OL/2
Set links to 20%

5.5 Exciter Power Supply (K)

(1) 500V overload relay REL.5
Set link to 20%

(2) 1500V overload relay REL.6
Set link to 20%

(3) 6000V overload relay REL.7
Set link to 20%

(4) F.T. time delay relay REL.2
Set dial to 15 mins.
or 5 mins. if ambient temperature is above 20°C.

6.0 SPARK GAPS

Spark gaps in the transmitter should be adjusted as follows:-

E.H.T. Transformer .... 0.5 inch (1.27 cm)		(3)
E.H.T. Smoothing Choke .... 0.5 inch (1.27 cm)		
R.F. Output Amplifier ..... 0.1 inch (0.254 cm)		(2)

7.0 OIL FILLED COMPONENTS **Check the level of all oil - filled components and top up if necessary with Grade "B" transformer oil (B.S.148) during installation. Oil circuit breaker dashpots should not have oil in them".**

8.0 AIR COOLING PLANT

(a) Check that the remote control link on the starter switch has been removed.

(b) Fill the starter switch tank up to the level indicator with grade B transformer oil.

(c) Adjust the tension on the belt drive by means of the two horizontal adjusting screws under the motor. The tension should be such that about ½ inch of play is obtainable at the mid point of the slack side.

(d) Check that the two grease nipples on the motor are charged.

(e) Check that sufficient lubricating oil is present in the bearings at either end of the fan driving shaft. If not remove the four filler screws and add oil until a drop appears at the two exhaust nipples below the bearings.

9.0 METERS

Set all meters to zero by means of the screw in the middle of the cover.

10.0 R.F. OUTPUT AMPLIFIER

Side screens on the Output Amplifier must be in place before power is applied to ensure that correct ventilation conditions are obtained.

CHAPTER 7

TESTING AND PUTTING INTO SERVICE

1.0 OUTLINE OF PROCEDURE

In the transmitter all valves are fitted except those of the R.F. Output Amplifier. A.C. supplies to the filament transformers are switched on in sequence at the Mains Distribution Board and checks made at the appropriate points in the equipment to ensure that the voltages are correct and that the contactors and blowers operate correctly. Adjustments to transformers are made where necessary, to give the correct voltage on filaments.

The R.F. Output Amplifier valves are now fitted, the operation of the air blast cooler checked. R.F. amplifier valve filament voltages are checked.

Filament supplies to the h.c.m.v. valves are switched on and the valves conditioned. As a precaution against possible damage to the R.F. Output Amplifier valves due to the application of e.h.t. before the amplifier is tuned, the lead from the e.h.t. supply is disconnected.

The E.H.T. Rectifier is now put into service. A low voltage transformer (see Section 2.0 paragraph 28 of this chapter) is temporarily substituted for the e.h.t. transformer and a check is made of phasing of the grid peak wave relative to the anode voltage wave. The Re-setting Relay Unit and various protective devices are checked for satisfactory operation.

Tests are made next on the R.F. Trucks. Grid bias voltages are adjusted. Trucks (JB, JC) are individually tuned to the setting-up frequencies of 4 and 28 Mc/s. One truck is selected and connected to the R.F. Output Amplifier which is then tuned and tested.

Compounding in the E.H.T. Rectifier and the setting of the travel limiting switch of the Raise/Lower control are adjusted to suit the operating conditions of the Output Amplifier.

If desired, the power output can be measured at this stage.

After tuning to the required frequency of radiation, the transmitter is ready for operation on telegraphy with frequency shift keying.

For single sideband working minor additional adjustments must be made to bias in the R.F. Output Amplifier and Truck Final Amplifier and to phasing in the Oscillator and Negative Feedback Unit.

2.0 TESTING PROCEDURE

NOTE: During the following preliminary tests, all h.c.m.v. valves should be given their initial "conditioning" period of 30 minutes. In addition valves for the E.H.T. Rectifier should have been conditioned in the Valve Conditioning Unit (See Appendix 4). Valves should subsequently be maintained in an upright position if moved or stored. Conditioning of spare valves for the E.H.T. Rectifier can be accomplished in the Valve Conditioning Unit (See Appendix 4).

(1) Open all ironclad switches on Mains Distribution Unit (E) and isolators on the R.F. Trucks (J.B.) and (J.C.) If Remote Off button is not used, link terminals E62, 63.

(2) Connect the Artificial Load to the Antenna output terminals.

(3) Fit all the valves and lamps in the transmitter with the exception of valves in the R.F. Output Amplifier. Open the knife switches in the e.h.t. leads to the hot cathode mercury vapour rectifying valves. Check that all fuses are fitted in accordance with Table 2, Appendix 1.

(4) Close the isolator switch external to the equipment. Crystal ovens on the r.f. trucks should begin to heat. The indicator lamps show whether they are operating correctly. If the "overheat" lamp should light, the circuit must be checked immediately.

(5) On the Mains Distribution Unit (E) remove the fuse carrier from the e.h.t. rectifier switch-fuse S.F.1. Remove fuses F4, 5, 6 and 7.

(6) Close S.F.3 and close the oil circuit breaker. Check that front panel lighting comes on. Phase indicator lamps E1, 2, 3 should light up. Check the mains voltage on all phases. Check the phase rotation of incoming supply. Check that the no-volt trip on the circuit breaker operates if the incoming mains supply is switched off. Set the overload trips to minimum current and time settings.

NOTE: A simple phase-rotation indicator can be produced using two, 230 volt 60W, lamps and a 1000V 1 µF capacitor. The method is as follows:-

Connect the lamps in series between Red and Blue phases.

Connect the 1 µF capacitor between the yellow phase and a point between the lamps.

If the phase rotation is correct the lamp now connected between the capacitor and blue phase will glow more brightly than the other.

(7) Set switches S3 and S4 to "IN". Set mains switch on the Automatic Voltage Regulator to "ON" and remove the locking screw on the Astatic Voltage Relay. Close switch-fuse E.SF2. Check that the voltage between terminals E50, 51 and 52 is 400V A.C. ± 1%. If not, adjust the tappings on the Automatic Voltage Regulator.

(8) Close SF7 and measure the voltage between terminals E.37, 38 and 39. This should be 110V A.C. ± 5%. Check that filament undercurrent relay G.A. Rel. 9 has operated and the filament voltmeters G. M1 - M6 indicate approximately 5.0V. If low, adjustment can be made by connecting to the 5.2V tap on transformers T1 - T6. Check the filament voltage of rectifier valves in grid bias unit KB. This should be 4 volts ± 2½% A.C. If incorrect adjust tapping switch on KB.

(9) Open SF7 and replace fuses E.F4, F5, and F6. Reclose S.F7. Check that the voltage between terminals E21, 20 is 50V A.C. ± 5%.

(10) Replace fuse E.F7, and check that voltage between terminals E7(-) and E8(+) is 50V D.C. ± 5%. Lamps "OCB made" and "H.C.M.V. Fils. Heating Commenced" should light on the Control Unit.

(11) Close ESF4. Clamp the "Start" buttons and press the Reset button on the blower motor protection switches in the E.H.T. Rectifier Unit (GC) S1, and the R.F. Trucks (JB) and (JC) TH.U.1. Air blowers should start up in the E.H.T. Rectifier but not in the R.F. Trucks. Check the blower rotation and correct if necessary by reversing two of the leads to the blower motor.

(12) Close SF5. Clamp the "start" button and press "reset" buttons on the Air Blast Cooler thus ensuring that contacts are not tripped.

Operate R.F. Amp Fils. & Air button on the Transmitter Control Unit. The Air Blast cooler motor should start. Check the rotation and, if wrong, reverse any two supply leads to the motor.

(13) Switch off the R.F. Amp Fils & Air button, and insert the two valves in the R.F. Output Amplifier. Care should be taken in fitting these valves and the instructions given below should be followed closely.

The valve mountings are located immediately behind the upper front door of the R.F. Output Amplifier unit.

(a) Remove dust plates from anode sockets.

(b) Release and raise the grid contact platform on its hinges until it engages the retaining clip.

(c) Replace existing fixed type carrying handles with detachable type (see paras. (f) (g) (h) (i), and by means of these handles lower the valves carefully into position (anode downwards) so that the handles are parallel with the front panel of the transmitter.

(d) After slackening the knurled screw on handles and slipping them off, stow the handles on the bushes provided on the inside of the front acess door of the 40 kw amplifier.

(e) New valves must be made ready for use as replacements by having the detachable type handles substituted for the fixed type in the manner described in paras. (f) (g) (h) (i).

(f) Loosen the 6 screws which secure the two halves of the fixed type handle-band and remove the handle-band complete with handles.

(g) Using six 2 BA screws (which must be of brass material) fit the two half-collars on to the valve anode in the position previously occupied by the handle-band. Set the studs so that the handles, when attached, will come in line with the filament pins of the valve.

(h) Fit the handles on to the studs and lift the handles to ensure that the studs lock the handles behind their shouldered portion, and tighten the knurled screw on each handle sufficiently to maintain this position.

(i) Do not discard the existing fixed type handle-bands, as these must be refitted to the valves, before return, when their useful life has ended.

(j) Lower the grid contact plate into position and secure it.

(k) Connect up the filament connectors to the two insulated pins on each of the valve bases.

.4) Close E.SF9 and operate the R.F. Amplifier Fils & Air button. The filament contactors should now have closed and R.F. Amplifier valve filaments should be lit. Check voltages across filament pins using a sub-standard voltmeter; it should be 9.5V ± 2%. If necessary, adjust the primary connections of the Scott-connected transformers T1, T2 and the associated chokes L3, L4, L5 to give this voltage. The taps on the chokes must be set to the same settings as those on the transformers. Switch off the "R.F. Amp. Fils. & Air" button.

(15) Open switches K.S1, S2, S3 and S4. Remove fuses K.F4, 5, 6, 7. Close E.SF8. Measure the voltage on terminals K.11, 12 and 13. This should be 400V A.C. ± 1% 3 phase.

(16) Close switch K.S2. Operate the Exciter Filaments On Key. Measure the voltage on terminals K.30, 31 and 32. This should be 400V A.C. ± 1%, 3-phase. Open E.SF8 and replace fuses KF4, F5, F6, F7, then close E.SF8 again.

(17) Check the filament voltage of the rectifier valves V1, 2 and 3 on the 1500 volt h.t. rectifier and of V4 to V9 on the 6000 volt rectifier. This should be 4V ± 2½% a.c. Adjust, if necessary, the tappings on the associated transformers.

(18) Close the transmitter door and main isolator switch (F).

(19) The a.c. voltmeter K.M1 should indicate 400V A.C. on each phase. The Exciter grid bias meter K.M2 should give an indication. With the main isolator closed check that relays K.Rel.11 and Rel.12 are energised. If not, adjust bias resistor K.R32 to give an indication of 380V on meter K.M2. Hold Rel.12 open and adjust R14 until Rel.11 just closes. Hold Rel.12 closed and adjust R17 until Rel.11 just opens. Close the isolator switches on both R.F. Trucks. Adjust resistor K.R32 to give -350V on meter KM2 with the bias switch JB S7 set to "350V". Open the R.F. Truck isolators.

(20) When the time delay relay KA Rel.2 has closed, the R.F. Output Amplifier grid bias supply meter K.M3 should give an indication. With the main isolator closed, check that relays K.Rel.18 and Rel.13 are energised. If not, adjust bias resistors K.BR2 and H.P1 for an indication of 180V on meter K.M3. Hold Rel.13 open and adjust R21 until Rel.18 just closes. Hold Rel.13 closed and adjust R18 until Rel.18 just opens. Set bias control on the R.F. Output Amplifier H.P1 to 75 and adjust the grid bias supply to 270V by means of potentiometer K.B.R2. If required, additional adjustment is available by means of a tapped resistance mat K.R27 in the top of the Exciter Power Supply Unit.

(21) Open the main isolator. Set the adjustable links above K.Rels. 5, 6 and 7 to 20%.

(22) Close switch K.S3 and the main isolator. Turn the Exciter H.T. ON button, meter K.M4 should read approximately 600V. Switch off H.T. and open the isolator.

(23) Close switch KA.S4 and the main isolator. Operate the Exciter H.T. ON key, meter K.M5 should indicate approximately 2000V. Switch off H.T. and open the isolator.

(24) Close switch KA.S1, switch-fuse E.SF10 and the isolator. Turn the Exciter H.T. ON button, meter K.M6 should indicate approximately 7000V with switch K.S6 in the "C.W." position. Check that the "MOD" position gives an indication of about 5500V. Switch off H.T. and open the isolator.

(25) The E.H.T. Rectifier can now be tested and put into operation. If the rectifier is to operate efficiently the following phasing conditions should exist:-

(a) The firing point on the grid peak wave must be approximately 15° in advance of the peak of the anode voltage wave for each valve, with zero d.c. excitation flowing through the peak wave transformers.

(b) The filament and anode voltages must be in quadrature for each valve position.

The rectifier has been set up and tested at the works to satisfy the above conditions and provided the adjustments have not been disturbed and inter-unit cabling is correct, no difficulty should be experienced in putting it into commission on site. For the sake of completeness, however, full instructions for carrying out the phasing are given in the following paragraphs.

(26) It is assumed that the control circuits are functioning correctly and that the following test apparatus is available:-

(a) Double Beam Cathode Ray Oscilloscope.

(b) Multi-range A.C./D.C. Test Set (e.g. Avo Model 7).

(c) A 3-phase step-down transformer, 400 volt delta-connected primary and star-connected secondary giving about 100 volts output. The kVA rating is unimportant. Connections must be to British Standard Specification 171, Vector Group 41. Dy. 11.

(d) Four 500,000 ohm 1-watt resistors.

(e) Phase rotation indicator.

(27) Disconnect the e.h.t. transformer and connect in its place the step-down transformer of (c) above, taking care to connect the primary (delta) and secondary (star) phases to the correct input and output phases. Disconnect the R.F. Output Amplifier from the Filter Unit at terminal C - R.F. Amplifier. Remove the connections to the shunt winding of the compounding resistor G B.R2 and open the knife switch in the anode connection to each valve. Set the mains switch on the 50V D.C. Supply Unit (GB) to "on".

(28) Connect the phase rotation indicator across the primary of the substitute e.h.t. transformer. Switch off ironclad switches, E.SF10, SF8, SF4. Replace fuses in E.SF1 and close the switch. Short-circuit terminals H36 and 37 on the R.F. Output Amplifier and open circuit E9 on the Mains Distribution Unit.

(29) To carry out the following tests two people will be required, one inside the enclosure and an assistant to operate the controls and isolator switch.

Close the main isolator and switch on e.h.t. Check the phase rotation and switch off e.h.t. The phase rotation should be such that Phase A is wired to the anode of V1, phase B to V2 anode and Phase C to V3 anode. The anode knife switches should be left open. Open the isolator and oil-filled circuit breaker.

(30) Connect the X plates of the oscillograph via the internal amplifier to the filament terminals. Connect the four 500,000 ohm resistors in series between neutral and the live side of the anode switch in the case of V1, V2 and V3, and connect the common cathode connection to neutral. For V4, V5 and V6 the potential divider should be connected between neutral and filament and the common side of the anode switches should be connected to neutral. Connect the oscillograph Y plates (either Y1 or Y2) across the resistor which is electrically nearest to the filament.

(31) Close the oil circuit breaker and the isolator and switch on E.H.T. Observe the oscillograph pattern. When the anode and filament voltages are in quadrature the pattern should be a circle or an ellipse. It may be necessary to adjust the amplifier gain controls to produce a suitable pattern but the important point is to ensure that this is not a straight line. If it is a straight line then the wiring of the rectifier must be checked.

Check each of the six valve positions for correct phasing. Switch off E.H.T.

(32) Re-connect E9, and switch on R.F. Output Amplifier filaments. This supply also feeds the primary of the phase shifting transformer T3 in the Grid Control Unit which in turn supplies A.C. for excitation of the peak wave transformers. Verify that approximately 60 volts d.c. standing bias is present between the grid and filament of each rectifying valve. The pattern of the peak wave can be displayed by connecting one of the sets of oscillograph Y-plates between grid and filament of each valve in turn and using the internal linear time base on the X plates.

The pattern on the oscillograph screen will be the summation of the positive peak wave and the permanent d.c. negative bias voltages.

(33) To determine the relative phasing of the peak wave with respect to the anode voltage wave, the second pair of Y-plates should be connected as before across the appropriate resistor of the potential divider.

NOTE: Due to the arrangement of plates in the Cossor oscillograph type 339 the trace sign will change according to which voltage is applied to a given pair of Y-plates. Although this is not important, as it is the angle between them which matters, it should be noted that it will cause grid and anode waveforms to appear 180° out of phase when they are actually in phase. (No reversal occurs on Cossor model 1035.)

The correct phase adjustment should be such that the point at which the front of the grid peak wave cuts the zero base line must be 15 degrees in advance of the peak of the anode voltage wave, with zero d.c. excitation, i.e. with the motor controlled rheostat set in the central position.

(34) Check the shift of the peak wave with varying d.c. excitation. Set the C.R.O. so that it displays the grid peak wave and the relative anode voltage wave. Check that turning the Raise/Lower Volts switch in a clockwise direction drives the slider to the positive end of the rheostat and advances the peak wave. Anti-clockwise movement of the switch should produce the reverse effect. With the maximum of ± 250 mA d.c. flowing through the d.c. excitation winding of the peak wave transformer the phase of the grid wave shifts by ± 45 degrees from the zero excitation position.

The phasing tests are now complete. Open the isolator and oil circuit breaker. Remove the oscillograph and associated apparatus. Remove the short-circuit between terminals 36 and 37 on terminal strip H.

(35) A low voltage functional test should now be made. The low voltage transformer is left in circuit and the knife switch above each rectifying valve is closed, and compounding resistor G.B.R2 reconnected.

IMPORTANT: It is important that the valves should have undergone their preliminary conditioning.

Close the oil circuit breaker. The filaments of the e.h.t. rectifying valves should heat up, and the lamp "Filament Heating Commenced" on the Control Unit should be illuminated.

NOTE: Air is blown in fine jets on the lower part of each h.c.m.v. valve to produce a ring of condensed mercury about $\frac{1}{4}$ inch above the base ring.

(36) After ensuring that everything is working correctly, close the main door and isolator. After about 15 minutes (for filament heating) - the time depends on the setting of the time-delayed relay GA.Rel.11 - the latter closes and lights the "Filament Heating Completed" lamp on the Control Unit. Operate the "R.F. Amplifier Filaments and Air" switch. If the e.h.t. preparing circuit is complete, the E.H.T. Prepared" lamp will also light.

(37) Operate the "E.H.T. ON" switch. The d.c. voltage indicated on the meter should be approximately the same as the secondary voltage of the substitute e.h.t. transformer. Operate the "Raise/Lower Volts" switch and check that output varies accordingly. The theoretical maximum d.c. voltage is given by

$$E_{D.C.}\ \text{Max.} = \frac{E_{A.C.}\ \text{(phase to neutral)}}{0.428}$$

(38) With the rectifier operating, the filament undercurrent relay GA.Rel.9 should be checked by removing any one of the three fuses GA.F3, 4 or 5. The relay should trip the e.h.t. control circuit but not the filament circuit.

(39) Make the following tests with the E.H.T. supply disconnected, i.e. by opening switch E.SF1.

Check that the e.h.t. contactor is tripped by:-

(a) Switching off the air blower to R.F. Output Amplifier.
(b) Removing the R.F. output amplifier grid bias supply (remove fuse K.F12).
(c) Opening the isolator.

(40) Check the relay sequence in the Relay Resetting Unit performing the various operations with care. Before making any of the following tests the rectifier should be operating normally.

(a) On the Grid Control Unit (GB) set the Manual/Auto switch to "Manual".

(b) Remove the cover of the a.c. overload relay GA.Rel.1 and operate the armature by hand. The e.h.t. circuit should trip, the alarm bell ring and a.c. overload lamp light. Re-set GA.Rel.1 by means of the rotary switch on top of the relay housing.

(c) Close the e.h.t. circuit. The lamp should go out and the bell cease to ring.

(d) Repeat (b) and (c) with a.c. overload relays GA.Rel.2, 3 and 4 and the three d.c. overload relays, DU in the Relay Resetting Unit, and OL.1, OL.2 in the R.F. Output Amplifier.

(e) Switch to "Auto". Momentarily operate GA.Rel.2 armature. The rectifier output should be immediately suppressed, by removal of the a.c. excitation and then automatically reconnected.

(f) Repeat (e) with GA.Rel.4, GB.DU, H.OL1 and H.OL2.

(g) Operate the time and current a.c. overload relay GA.Rel.1. The e.h.t. contactor should trip.

(h) Repeat (g) with GA.Rel.3.

(k) To simulate the condition corresponding to a series of overloads such as would occur when a rectifying valve "arcs back" repeatedly, remove the cover from the Relay Resetting Unit and watch relays CC and CCA. Operate GA.Rel.2 to represent the first overload. Relays CC and CCA should release. When they reclose, immediately operate GA.Rel.2 (second overload). Repeat the sequence. On the fourth "overload" the e.h.t. contactor should be released and alarm bell ring until E.H.T. ON switch is operated or oil circuit breaker opened.

(l) Repeat (k) with GA.Rel.4, GB.DU, H.OL1 and H.OL2.

(41) Make a final check of the h.c.m.v. valve filament voltages to ensure that they are as near to 5.0 volts as possible. If low set link at rear of peak wave transformers to 5.2V. By means of the Raise/Lower control, bring E.H.T. down to its lowest value. Switch off E.H.T., disconnect the low voltage transformer and reconnect the e.h.t. transformer. Set the e.h.t. transformer secondary tapping switch for minimum output voltage (position 1).

WARNING: From this stage no person should be allowed inside the rectifier enclosure whilst the equipment is in operation and whenever an e.h.t. point is approached it should first be proved "safe" by testing with an earthing stick.

(42) Leave the R.F. Output Amplifier disconnected and carry out "arc-back" tests.

(43) Close the oil circuit breaker and main isolator switch, and Exc. Fils ON. Operate the R.F. Amplifier Filaments and Air Switch and then the E.H.T. ON switch after the necessary time delay. Check that conditions are normal. Operate the Raise/Lower Voltage control and check that the actual maximum d.c. voltage is substantially the same as the theoretical maximum. Set the rectifier for various voltages and operate the E.H.T. ON/OFF control twelve times for each voltage to test the rectifying valves for freedom from "arc-back". If any valve does show a tendency to arc-back, a further period of conditioning will probably cure it. If the "arc-back" tests are satisfactory the rectifier is ready for full load tests with the amplifier, made after the transmitter has been tuned. Re-connect e.h.t. cable to the R.F. Output Amplifier.

(44) Set the Aerial Changeover switch to connect the R.F. Truck (J.B.) to the artificial aerial load. Set the reactances on the latter to the correct value for the frequency of alignment (4 Mc/s). (See Fig. 32). Set switch H.S12 to "LOW POWER".

(45) Withdraw the R.F. Truck to the full extent of its runners. Close the link between the output side of L5 and input of L6, and open the links across C28-C31 and across the input of the coaxial feeder to the Alford circuit.

(46) Close the Isolator switch at the bottom of the Truck and operate the Exciter Filaments ON control. Heaters of all valves in the Oscillator Unit and of valves V1 to V5 in the Exciter Unit (fig. 5) should light. At the same time the blowers should start up causing a strong blast through the valves. If the airflow is low, reverse two of the incoming (400) volt lines to change the phase sequence and re-test.

(47) Set the Local-Remote Control Switch to "Local". Relays 1 and 2 (5 sec. delay) should operate and the filaments of V6 in the Exciter Unit (fig. 5) and V1, (see fig. 4 Truck Final Amplifier), should light up.

(48) Measure the heater voltages at the following points. (Indications should be within the limits given):-

Filament pins V1 (Truck Final Amplifier (fig.4))	9V ± 2½%	(A.C.)
Filament pins V6 (Exciter Unit (fig.5))	5V ± 2½%	(A.C.)
Heater pins V1, V2 Exciter Unit (fig. 5)	6.3V ± 5%	(A.C.)
Heater pins V1 (Oscillator Unit (fig. 3)	6.3V ± 5%	(A.C.)
Heater pins V3 (Oscillator Unit (fig. 3)	6.3V ± 5%	(A.C.)

Voltages should be measured with valves in position. Adjust voltages, if necessary, by means of the primary taps on transformers T1, T2 and T3 (see fig. 4). T1 affects the last three valves. Switch to -350V Bias on front of Truck.

(49) Set the key switch on the Oscillator Unit to the "Feedback OFF" position and Drive Level to zero. Operate the Exciter H.T. ON control switch. Check that the voltages are approximately correct. The Truck Final amplifier (V1) (fig. 4) and V6 (fig. 5) cathode currents should each be 250 mA ± 10 mA. If the currents are outside these limits the bias, ~~tappings on R1~~ POTENTIOMETERS RLA TO RIB (fig. 4) should be adjusted for V1 and V6.

(50) Set the switch S1 on the Oscillator Unit to Int. Osc. and measure cathode currents of V1 to V6 and also, in the Exciter Unit, (fig. 5) V1 to V6. These readings should correspond approximately to those given in the test sheets.

(51) Set the Oscillator Tuning to 4 Mc/s on the scale (actual oscillator frequency before doubling will be 3.55 Mc/s). Put the "Waveband Selector" switch to "Band 1" and set the Exciter (fig. 5) and Truck Final Amplifier (V1, fig. 4) tuning controls to indicate 4 Mc/s on their respective scales. Set the Exciter Feedback Control (RV1 A/B fig. 5) to mid-position. Switch on the external drive unit to apply a 3.1 Mc/s signal to the Oscillator Unit. Tune the Exciter for maximum Truck Final Amplifier (V1, fig. 4) cathode current, (it may be necessary to increase the Drive Level (R70, fig. 3) slightly to enable a clear indication of resonance to be obtained). Tune the Truck Final Amplifier (fig. 4) for minimum cathode current. Adjust the Line Balance Control for equal readings on Line Current meters (M4, M5). Check that a spurious point is not selected by decreasing turns. No other balance point should be found. Increase drive and adjust coupling (i.e. Line Reactance Control) retuning after each step until 1.2A and 50 mA is obtained on cathode and screen current meters. The calibration of the equipment should be used to obtain approximate settings for all controls before tuning. Switch off exciter

h.t. supply and repeat above tuning procedure at frequency of 28 Mc/s (Band 3). Turn exciter output control towards maximum and adjust "Line Reactance" and "Drive Level" controls to produce half-scale deflection (approximately) of cathode and screen current meters on Truck Final Amplifier, (V1, fig. 4) (i.e. 0.8 and 100 mA respectively).

Swing Truck Final Amplifier (V1, Fig.4) anode tuning control slowly through resonance. Anode and screen currents should change in anti-phase, and maximum screen current should coincide with minimum anode current at resonance. If incorrect, adjust neutralising capacitor C47, on Exciter Unit, until correct condition is obtained. Lock capacitor plate. Switch off and re-set truck to frequency of 4 Mc/s.

(52) Turn the Feedback Control (RV1 A/B fig 5) slowly towards maximum and at the same time adjust the Line Reactance and Drive Level controls to produce Truck Final Amplifier (fig.4) meter indications of 1.2 amp cathode current and 50 mA screen current, re-tuning Truck Final Amplifier anode circuit as required.

(53) Set the key switch on the Oscillator Unit to "Feedback ON". Turn the "Phase Adjust" control to bring cathode current of the Truck Final Amplifier V1 (fig 4) to a minimum.

(54) Return the key switch to "Feedback OFF". Check the tuning. Set the Exciter Feedback Control RV1 A/B to maximum and adjust the Drive Input control to produce Truck Final Amplifier (fig.4) meter indications of 1.2 amp cathode current and 50 mA screen current. Check the setting of the Drive Input control, it should be approximately the same as that shown on the test sheets providing the same drive service is in use.

(55) Turn the Feedback and Drive Level controls to minimum. Move the Feedback ON/OFF switch to ON. Should a violent rise in the Truck Final Amplifier cathode current occur, indicating self oscillation, switch off the feedback, re-position the Phase Adjust control and apply feedback again. Adjust the Drive Level control for a small rise in Truck Final Amplifier cathode current, then reduce this indication to a minimum by adjustment of the Phase Adjust control.

Increase the Drive Level control for a Truck Final Amplifier Cathode Current of 0.75 amp. If this cannot be attained, leave the control at maximum. Switch off the feedback and adjust the feedback control for a cathode current of 0.75 amp., or the maximum value previously obtained; the Phase Adjust control may require re-adjustment for minimum cathode current. Switch on the feedback and re-set the

Drive Level control for 0.75A cathode current. Switch the feedback off and re-adjust the feedback control for 0.75A cathode current. Continue this procedure until there is no difference in cathode current indication with feedback on or off. Finally, leave the Feedback ON. Increase the Drive Level control to produce the original readings on the Truck Final Amplifier.

(56) It is not necessary during alignment to carry out two-tone tests for s.s.b. working, but these can be made at any time, when desired, using the Drive Unit type A.1406B and Monitor Unit A.1407B.

(57) Repeat the tests given in paragraphs (41) to (56) for the 2nd R.F. Truck (J.C.).

Finally set up truck JB on 10 Mc/s Band 3 for CW conditions, i.e. Bias switch to 500V and Feedback OFF.

(58) The R.F. Output Amplifier can now be aligned. Switch off all supplies and open the circuit breaker. Open the link between L5 and L6, and close links across C28-31 and across input of coaxial line to Alford circuit (fig.4). Replace the Truck. Check that the spark gaps in the aerial feeders of the Output Amplifier are set at 0.1 inches.

(59) To check the operation of the waveband contactors :-

(a) Set Switch H.S12 and truck changeover lever to "L.H.TRUCK".

(b) Set the band-switch on R.F. Truck first to Band 3. All contactors in the base of the Output Amplifier Cabinet should be open but the contactor Rel.1 at the rear of the cabinet should be closed. Check that micro-switch S1 is closed bringing economy resistor R16 in series with the coil of Rel.1.

(c) Set the band-switch to Band 2. The contactor at the rear should be open and Rel.3 on the right of the Amplifier Unit closed to introduce four capacitors into circuit. In addition the front contactors Rels. 4 and 5 on the lower deck close.

(d) Set the band-switch to Band 1. The contactor at the rear should be open and all contactors behind the panel should be closed. Check that micro-switches S2-S7 are operated.

(e) Set switch H.S12 and truck changeover lever to "R.H. TRUCK". The contactor positions on Bands 3, 2 and 1 should be the same as in (b), (c) and (d) respectively.

(60) The bias to the output valves must now be checked at the valve grids.

(a) Open the Main Isolator and remove the key to open the small door at the front of the R.F. Output Amplifier.

Connect the negative lead to grid contact springs and positive lead to ground. Set the meter to the 500V d.c. range.

(b) Lock the door of the Output Amplifier and close the main isolator. Operate the Exciter Filaments and R.F. Amplifier Filaments ON switch. After a delay the grid bias supply should come on.

(c) Check that rotation of the bias potentiometer in Unit KB and the bias RAISE/LOWER control on unit H vary the bias. The former will involve opening the main isolator and entering the enclosure each time an adjustment is made to the potentiometer. Finally set the bias to 270V with potentiometer H.P1 on the front of the R.F. Output Amplifier at 75.

(d) Remove the meter leads, and set switch H.S12 to "L.H. TRUCK".

(e) Turn the E.H.T. RAISE/LOWER control to "LOWER" for about 10 seconds.

(f) Set E.H.T. transformer secondary tap to Position 4.

(g) With all filament supplies switched ON and Exciter H.T. supply OFF, operate the "E.H.T. ON" switch.

(h) By means of the "Raise-Lower" switch, raise the E.H.T. to 10.5 kV. The output valves should now take 0.5 amp each and the bias should be adjusted by means of the bias control on the R.F. Output Amplifier to produce this indication.

(i) Switch OFF e.h.t. and open the main isolator to discharge the smoothing capacitors.

(61) The R.F. Output Amplifier can now be tuned.

(a) Put the aerial switch to the full output position. Make sure that the artificial load is connected and that the reactances are still adjusted to the correct value for the frequency of alignment, 10 Mc/s. (See fig. 32)

(b) On the R.F. Truck set the Drive Input control to zero, Feedback Switch to OFF, Bias switch to 500V and Oscillator Selector to INT. OSC.

(c) On the Output Amplifier adjust the "Input Tuning", "Anode Tuning" and "Line Tuning" and "Coupling" (L1, L2 Fig.6) controls to the settings for this frequency given in Test Report. Put the "SSB/CW" switch to "CW".

(d) Switch on the external Drive Unit then switch on Exciter H.T. supplies and watch the cathode current meter of the Truck Final Amplifier (V1, fig.4).

(e) Increase the drive input (by means of the Drive Input control) until the cathode current tends to rise. Adjust the Exciter Tuning control for maximum Truck Final Amplifier, (V1, fig.4) cathode current.

<u>WARNING:</u> If cathode currents tend to rise above 0.7 amp. reduce the drive input.

(f) Tune the Truck Final Amplifier (V1, fig. 4) for maximum Output Amplifier grid current (M2, fig. 6). If the grid current tends to rise above 1 amp, reduce the drive input. Adjust the Exciter output trimmer (C35, Fig. 5) to produce maximum grid current.

<u>N.B.</u> Tuning point of Truck Final Amplifier (fig. 4) will be off calibration due to different circuit loading.

(g) On the Output Amplifier tune the Anode Tuning control to the resonant point, indicated by a variation in grid current. Leave the control set to this point. Set Line Tuning control to the same approximate setting as anode tuning control.

(h) Turn the E.H.T. Raise/Lower control to "Lower" then operate the E.H.T. ON switch. By means of the E.H.T. Raise/Lower control, adjust the E.H.T. to between 5 and 6 kV. Output Amplifier cathode current should increase and grid current decrease.

(k) Adjust Anode Tuning for minimum cathode current on V1, V2 (fig. 6). If necessary increase the Feedback control and the Drive Level control for greater drive but on no account must the screen and cathode meters on the Truck Final Amplifier rise above mid scale.

(l) Adjust the Line Tuning Control for maximum indication on the Output Mon. meters.

Readjust the Anode Tuning Control for minimum cathode current.

(m) Raise E.H.T. to 10.0 kV, re-adjust Feedback control RV1/AB (fig.5) to make cathode current of V1 and V2 about 2.2 amps each. Re-check the tuning. With adjustment of the Anode control it may become apparent that the setting for minimum cathode current does not coincide with maximum indication on the Output Monitor meters. A setting should be chosen about midway between these two conditions. Grid current should be from 400 to 600 mA and cathode currents between 2.1 and 2.3 amps. E.h.t. supply current should be from 3.6 to 4.0 amps.

To change the output coupling, (e.g. if cathode current is less than 2.2 amps when the grid current is 500 mA the coupling is too loose) adjust the Coupling control (anti-clockwise for tighter coupling) and retune the Anode and Line controls. Repeat as necessary until the correct valve currents are obtained.

(n) Adjust the Feedback Control until the Truck Final Amplifier cathode current is 1.0 amp. Screen current should read 45 mA. To change the coupling from this stage (.e.g. if screen current is higher than 45 mA when cathode current is 1.0 amp coupling is too loose) adjust the Input Tuning Control on the R.F. Output Amplifier and retune the Truck Final Amplifier tuning. Repeat as necessary until the correct valve currents are obtained.

Adjust the Feedback control for the original value of cathode current (2.2 amps) on the R.F. Output Amplifier.

(o) If required, the power output can be checked by measuring the rate of flow and temperature rise of the cooling water in the artificial aerial load and substituting in the formula :-

$$P = 0.0698\, Q_1(T_2 - T_1) = 0.317\, Q_2\, (T_2 - T_1)$$

where Q_1 = flow in litres/minute.
Q_2 = flow in (Imperial) gallons/minute.
T_2 & T_1 = outlet and inlet temperature in ^{o}C.
P = Power in kilowatts
Power output should be 25 kW or more.

NOTE: If E.H.T. regulation is poor check compounding of e.h.t. rectifier. Refer to Chapter II section 6.0.

(62) Repeat the tests given in paragraph (61) using the 2nd R.F.Truck at a frequency of 10 Mc/s.

N.B. This completes the testing for 25 kW F.S.K. or C.W. operation. Tune the transmitter to the working frequency and it is ready for service.

For frequencies above 22 Mc/s the E.H.T. is adjusted to 9 kV giving an output of 15 kW.

For S.S.B. 40 kW peak envelope power operation, continue as follows :-

(63) Set switch H.S12 to "L.H. TRUCK" and set up the R.F. Truck for 10 Mc/s on Band 2. Set truck Bias switch to 350V. On the R.F. Output Amplifier set the S.S.B./C.W. switch to "S.S.B.". Set the secondary tap of the E.H.T. transformer to Tap 4.

(64) Leaving the Exciter H.T. switched OFF, switch on E.H.T. and raise to 10.5 kV. Adjust bias to the R.F. Output Amplifier to give 0.5 amp cathode current in each valve.

(65) Switch on the Exciter H.T. and from the S.S.B. Drive and Monitor Equipment A.1406B and A.1407B apply two tones of 1100 c/s and 1775 c/s respectively to one sideband input. (See Handbook on A.1406B).

(66) Increase the coupling in the R.F. Output Amplifier and readjust the anode and line tuning controls to make cathode current 1.85 amps per valve and grid current 350 mA. With adjustment of the Anode control it may become apparent that the setting for minimum cathode current does not coincide with maximum indication on the Output Monitor meters. A setting should be chosen about midway between these two conditions.

(67) Increase the coupling between the R.F. Truck and R.F. Output Amplifier, i.e. adjust Input Tuning to make Truck Final Amplifier cathode and screen currents approximately 0.9 amp and 25 mA respectively.

(68) Turn the Feedback and Drive Level controls to minimum. Move the Feedback ON/OFF switch to ON. Shouls a violent rise in the Truck Final Amplifier cathode current occur, indicating self oscillation, switch off the feedback, re-position the Phase Adjust control and apply feedback again. Adjust the Drive Level control for a small rise in Truck Final Amplifier cathode current, then reduce this indication to a minimum by adjustment of the Phase Adjust control.

Increase the Drive Level control for a Truck Final Amplifier Cathode Current of 0.75 amp. If this cannot be attained, leave the control at maximum. Switch off the feedback and adjust the Feedback control for a cathode current of 0.75 amp., or the maximum value previously obtained; the Phase Adjust control may required re-adjustment for minimum cathode current. Switch on the feedback and re-set the Drive Level control for 0.75A cathode current. Switch the feedback off and re-adjust the feedback control for 0.75A cathode current. Continue this procedure until there is no difference in cathode current indication with feedback on or off.

Leave the feedback on and increase the Drive Level control to produce the original conditions of current in the R.F. Output Amplifier. Do not attempt to retune any part of the Transmitter with feedback ON.

(69) Power output should be 20 kW or more. For s.s.b. operation this is the R.M.S. power of the two-tone test envelope, the peak envelope power being 40 kW.

(70) The transmitter is now ready for service and may be tuned to the required working frequency.

N.B. For frequencies higher than 22 Mc/s adjust E.H.T. to 8.5 kV for the reduced peak envelope power of 30 kW. (See Appendix 1 Table 3). The tapping of the E.H.T. Transformer secondary must be re-set to tap 3, i.e. 4370V.

CHAPTER 8

OPERATING INSTRUCTIONS

1.0 SELECTION OF SERVICE REQUIRED

1.1 Set up the drive equipment A1406 for DSB, SSB, or ISB as required (Refer to AP.2883NB).

or

1.2 Set up the drive equipment A1401 or A1410 for CW or FSK operation as required (Refer to AP.2883NE).

1.3 Connect the drive unit output to the R.F. truck to be used.

1.4 Close truck isolators.

1.5 Close the enclosure door, turn door interlock to CLOSED and isolator switch to ALIVE.

1.6 Close the oil circuit breaker. Lamps "OCB MADE" and "FILS HEATING COMMENCED" should light on the control unit (Unit L).

2.0 LOW POWER OPERATION (4kW)

2.1 Setting Up

2.1.1 Set the Aerial change-over switch to connect aerial feeder to the appropriate R.F. truck.

2.1.2 Set the SERVICE switch located on the right of the 40kW Amplifier compartment to the appropriate position.

2.1.3 Set the Truck Selector switch on the left of the 40kW Amplifier compartment to Low Power.

2.1.4 Set the U link Monitor Selector on the R.F. truck to 4kW.

2.1.5 Set the Bias Selector on the R.F. Truck to either -350 Volts for DSB, SSB or ISB or to -500 Volts for CW or FSK operation.

2.1.6 Withdraw the R.F. Truck after opening the isolator and set links as follows:-

(a) Close link between L5 and L6 (situated below C31).

(b) Open link between L6 (transmission line) and frame.

(c) Close link between L5 and C30/C31 (situated above C30).

Replace R.F. Truck and set the truck Isolator Switch to ON, Check that the truck isolator on the other truck is set to OFF.

2.1.7 (i) On the Oscillator and Negative Feedback Unit, set the OSCILLATOR SELECTOR to either:

(a) Appropriate crystal
(b) External drive
or (c) Internal (test purposes only)

as appropriate.

(ii) Set DRIVE LEVEL control to zero.
(iii) Set FEEDBACK ON/OFF switch to OFF.
(iv) Set Oscillator Tuning control to the frequency required.

2.1.8 Set Exciter and truck final amplifier tuning controls to the frequency required and the Feedback Control to the centre of its travel.

2.1.9 Set Line Reactance and Line Balance controls to the calibration settings as quoted in the calibration chart or test report.

2.1.10 Set Waveband Selector to the appropriate band.

2.2 <u>Setting Up the Drive Equipment</u>

2.2.1 For SSB or ISB
Apply one tone to one sideband of the A1406 drive unit. Set tone level to -6 dB on zero line up level. (If TOP.10 or TOP.12 terminating equipment is to be used refer to Appendix 7).

2.2.2 For DSB set the A1406 drive unit for DSB carrier only.

2.2.3 For CW and FSK
Set the drive equipment to give 3.1 Mc/s drive.

3.0 <u>TUNING THE TRANSMITTER</u>

3.1 Switch on EXCITER FILS (by turning the control button and releasing).

3.2 Switch on EXCITER H.T.
When supplies are on, the lamp lights in the control button.

3.3 Place the Local/Remote switch to LOCAL. Wait 10 seconds.

3.3.1 On the Oscillator and Negative Feedback unit, adjust Oscillator Tuning as follows.

(a) Crystal Operation

Set Meter Switch to check V1 cathode current. Turn control slowly in the direction of increasing frequency until oscillation commences, as indicated by a sharp drop in the reading of M1, continue adjustment in the same direction until the cathode current has risen by one division (200 μA x 10) on the meter.

(b) External Drive

Set Meter Switch to MON.1 Adjust Oscillator Tuning for maximum reading.

(c) Internal

Set scale to frequency required.

3.3.2 Adjust Drive Level Control for a slight increase in drive as indicated either by meter M1 set to MON.2 or for an increase in final amplifier cathode current.

3.3.3 Adjust final amplifier tuning for maximum indication on line current meters.

3.3.4 Check Exciter tuning and adjust Exciter Output trimmer for maximum output.

3.3.5 If unequal currents are indicated by the line current meters adjust the Line Balance Control until equality is reached. Check that the adjustment is correct by setting the Test/Normal switch to TEST. If the setting is correct, no indication should be obtained on the line current meter. Re-set Test/Normal switch to NORMAL.

3.3.6 Increase the drive level until a final amplifier cathode current of 1.1 amp and screen current of 30 mA is obtained. (The line reactance settings are for a 600 ohm load and the control may have to be adjusted to suit the impedance presented by the aerial). To tighten the coupling decrease turns on the line reactance control and vice versa. Re-check Final Amplifier tuning if the line reactance is adjusted.

3.3.7 ISB, SSB, DSB ONLY (For CW and FSK see para.4.0)

Reduce the drive level until the final amplifier cathode current falls to 0.75 amps. Set the feedback switch to ON with one hand and immediately vary the phase adjust control with the other hand to obtain minimum final amplifier cathode current. Note the value of cathode current.

3.3.8 Turn Feedback OFF and adjust the feedback control on the Exciter to obtain the same value of cathode current. Reset Drive Level for a cathode current of 0.75 amps. Repeat this operation until there is no change in cathode current with feedback on or off.

Note The phase adjust control may require slight adjustment if the feedback control has had to be moved very much for the first setting.

3.3.9 SSB or ISB Use

For testing the intermodulation product (third order harmonic distortion) arrange for two tones, both at -6dB on zero dB line up level, to be applied to the same sideband. Adjust the drive level for 0.9 amp. cathode current in the final amplifier valve. Measure the resultant intermodulation product with the type A1407 Monitoring Equipment. Measure the output power of the transmitter in Kilowatts R.M.S., double the figure to arrive at peak envelope power and check that the result is not less than 4kW for -28dB intermodulation. The drive level may be varied to obtain 4kW if required, but with a final amplifier cathode current of 0.9 amps. an output of more than 4kW should be obtainable.

3.3.10 DSB USE

With feedback applied, reduce the drive level for a transmitter output of 1kW (the final amplifier cathode current will be approximately 0.65 amp. for this condition). Apply modulation signals to input "A" (U.S.B.) of the type A1406 Drive Unit, as required.

4.0 OPERATING CONDITIONS FOR CW AND FSK

4.1 Proceed as described in paragraphs 3.3.1 to 3.3.6 inclusive and continue as para.4.1.1 below.

4.1.1 Increase drive level to give a final amplifier cathode current of between 1.1 and 1.3 amps, and screen current of between 75 and 125 mA. The exact figures should be chosen to give an output of 4kW.
The drive unit may now be connected to the line for traffic .

NOTE: See Appendix No.1 Table 3 (Page 157) for typical meter readings.

5.0 FULL POWER OPERATION (30-40 kW)

5.1 Setting Up

5.1.1 Set Aerial changeover switch to connect Aerial feeders to the Final Amplifier.

5.1.2 Set the SERVICE switch located on the right of the 40kW amplifier compartment to the appropriate position.

5.1.3 Set the truck selector switch on the final amplifier to the appropriate truck.

5.1.4 Set the U link monitor selector to 40 kW.

5.1.5 Set the Bias Selector on the R.F. Truck to either -350 volts for DSB, SSB or ISB or to -500 volts for CW or FSK operation. Set SSB/CW switch on Final Amplifier to the service required. (Use SSB position for SSB, ISB and DSB).

5.1.6 Withdraw the R.F. Truck after opening the isolator, and set links as follows:-

(a) Open link between L5 and L6 (situated below C31).
(b) Close link between L6 (transmission line) and frame.
(c) Open link between L5 and C30/C31 (situated above C30).

Replace the R.F. Truck and close the isolator. Check that the truck isolator on the other truck is set to OFF.

5.1.7 Turn the EXciter Fils ON/OFF button to ON. The lamp (green) in the button will light.

5.1.8 Turn the R.F. Amplifier Fils and Air ON/OFF button to ON.

5.1.9 (i) On the Oscillator and Negative Feedback unit, set the OSCILLATOR SELECTOR to:-

(a) Appropriate crystal
(b) External drive
(c) Internal (test purposes only)

as appropriate.

(ii) Set DRIVE LEVEL control to zero.
(iii) Set FEEDBACK ON/OFF switch to OFF.
(iv) Set Oscillator Tuning control to the frequency required.

5.1.10 Set Exciter and truck final amplifier tuning controls to the frequency required, and the Feedback Control to the centre of its travel.

5.1.11 Set waveband selector to the appropriate band.

5.1.12 Set Input Tuning, Line Tuning, Anode Tuning and Coupling controls of the Final Amplifier to the settings as given in the calibration or test report.

5.2 Setting up the drive equipment.

5.2.1 For SSB or ISB
Apply two tones to one sideband of the A1406 drive unit. Set tone level to -6dB on zero line up level. (If TOP.10 or TOP.12 terminating equipment is to be used refer to Appendix 7).

5.2.2 For DSB set the A1406 drive unit for DSB carrier only.

5.2.3 For CW and FSK
Set the drive equipment to give 3.1 Mc/s drive.

6.0 TUNING THE TRANSMITTER

6.1 Place the Local/Remote switch (on the R.F. Truck) to LOCAL and wait 10 seconds.

6.2 Turn the E.H.T. Raise/Lower control to LOWER for about 10 seconds. Turn the E.H.T. ON/OFF button to ON. The lamp in the control will light provided that the filaments have been switched on for about 15 minutes. Raise the E.H.T. to 10.5 kV for operation up to 22 Mc/s and 8.5 kV for operation above 22 Mc/s.

6.3 Turn the Exciter H.T. On/Off button clockwise. The red lamp will light in the control.

6.3.1 On the Oscillator and Negative Feedback unit, adjust Oscillator Tuning as follows:-

(a) Crystal Operation

Set Meter Switch to check V1 cathode current. Turn control slowly in the direction of increasing frequency until oscillation commences, as indicated by a sharp drop in the reading of M1, continue adjustment in the same direction until the cathode current has risen one division (200 μA x 10) on the meter.

(b) External Drive

Set Meter Switch to MON.1. Adjust Oscillator Tuning for maximum reading.

(c) Internal

Set scale to frequency required.

6.3.2 SSB, ISB and DSB OPERATION (For CW and FSK see para.7.0)

(1) Increase the Drive Level control to about midway and increase the Feedback Control until a slight rise is indicated on the Truck Final Amplifier cathode current meter.

(2) Adjust the Exciter Output Trimmer for maximum indication on the Truck Final Amplifier cathode current meter.

(3) Adjust the Truck Final Amplifier stage tuning for maximum indication on the grid current meter on the R.F. Output Amplifier. If the grid current tends to rise above 0.5 amps turn back the Feedback Control.

(4) Adjust the Anode Tuning (R.F. Output Amplifier) for minimum cathode current indication. If necessary slightly increase the Feedback Control to give greater drive but on no account must the meters on the Truck Final Amplifier rise above mid-scale. Adjust the Line Tuning Control for maximum indication on the Output Monitoring meters. Re-adjust the Anode Tuning for minimum cathode current.

(5) Increase the Feedback Control and if necessary the Drive Level control until the meter indications on the R.F. Output Amplifier are approximately as below:-

Freq. Mc/s	Peak Envel-ope Power	Truck Final Amplifier				RF Output Amplifier				EHT kV
		Bias	Ig	Is	Ic	Bias	Ig	Ic_1	Ic_2	
4-22	40	350	5	25	0.9	SSB	350	1.85	1.85	10.6
22-27.5	30	350	-	15	0.75	SSB	350	1.85	1.85	8.5

(6) To change the output coupling (e.g. if the cathode current is less than 1.85 amps when the grid current is 350 mA the coupling is too loose) adjust the Coupling Control (anti-clockwise for tighter coupling) and retune the Line and Anode tuning controls. With adjustment of the anode control it may become apparent that the setting for minimum cathode current does not coincide with maximum indication on the Output Monitor meter. A setting should be chosen about midway between these two conditions. Repeat as necessary until the correct valve currents are obtained on the R.F. Output Amplifier.

(7) Adjust the Feedback Control until the meter indications on the Truck Final Amplifier are approximately the same as in the above table. To change the output coupling of this stage (e.g. if the cathode current is less than 0.8 Amp when the screen current is 20 mA the coupling is too loose). Adjust the Input Tuning control (anti-clockwise for tighter coupling) and readjust the Truck Final Amplifier tuning. Repeat as necessary until the correct screen and cathode current are realised.

N.B. If correct coupling is obtained at two different settings of the input tuning control select the one giving the higher scale reading.

Adjust the Feedback Control to give the correct valve currents on the R.F. Output Amplifier.

(8) Application of Negative Feedback

Turn the Feedback and Drive Level controls to minimum. Move the Feedback ON/OFF switch to ON. Should a violent rise in the Truck Final Amplifier cathode current occur indicating self oscillation, switch off the feedback, re-position the Phase Adjust control and apply Feedback again. Adjust the Drive Level control for a small rise in Truck Final Amplifier Cathode current, then reduce this indication to a minimum by adjustment of the Phase Adjust control.

Increase the Drive Level control for a Truck Final Amplifier Cathode Current of 0.75 amp. If this cannot be attained, leave the control at maximum. Switch off the feedback and adjust the Feedback control for a cathode current of 0.75 amp or the maximum value previously obtained; the phase Adjust control may require re-adjustment for minimum cathode current. Switch on the Feedback and re-set the Drive Level control for 0.75A cathode current. Switch the feedback off and re-adjust the Feedback control for 0.75A cathode current. Continue this procedure until there is no difference in cathode current indication with feedback on or off.

Readjust the Drive Level control to give the original meter readings on the R.F. Output Amplifier. WHILE THE FEEDBACK IS ON DO NOT ATTEMPT TO RETUNE ANY OF THE R.F. STAGES.

(9) To check that the transmitter has been lined up correctly it is advisable to measure the intermodulation distortion at this stage using the Monitor Unit Type A1407B. The level of the 3rd Order (425 c/s) intermodulation product should not be higher than -28dB relative to peak envelope power. Peak envelope power in the two tone conditions is given by twice the R.M.S. output power of the transmitter and should be not less than 40 kW for output frequencies up to 22 Mc/s and not less than 30 kW above 22 Mc/s. The output power can be adjusted by means of the Drive Level Control.

If required the intermodulation distortion at the output of the Truck Final Amplifier and the preceding stage can be checked by putting the Monitor U-link Selector to the 4kW or 300W positions. This completes the transmitter lining up procedure. The final adjustments on the A1406B Drive Unit will vary according to the service required i.e. SSB, ISB or DSB.

6.3.3 S.S.B.

Switch off the two test tones from the A1407BMonitor Unit. Set carrier Re-insert switch on the A1406B to SSB and adjust carrier level. Set meter switch to sideband level. Connect the input terminals of the required sideband amplifier (Input A or Input B) to the station terminal equipment. A reading of Odb on the S.S.B. sideband scale on the A1406B output level meter corresponds to 40kW output from the transmitter. For an approximate setting the A1406B Input Attenuator should be adjusted so that this figure is not exceeded on the peaks of the incoming signal.

6.3.4 I.S.B.

Switch off the two test tones from the A1407B Monitor Unit. Set Carrier Re-insert switch on the A1406B to I.S.B. and adjust carrier level. Set meter switch to I.S.B. and connect the Upper Sideband Amplifier (Input A) to its incoming programme line. A reading of Odb on the S.S.B. sideband scale of the A1406B output level meter corresponds to a transmitter output of 40kW. For an approximate setting the A1406B Input A attenuator should be adjusted so that this figure is not exceeded on the peaks of the incoming signal.

Remove Input A line and connect Input B to its incoming programme line. Adjust Input B attenuator in the same manner as Input A.

Replace the Line to Input B.

If telephone terminating equipments type TOP.10 or TOP.12 are used see Appendix 7.

6.3.5 D.S.B.

Switch off the two test tones from the A1407B Monitor Units. Set all control switches on the A1406B to D.S.B., including the re-inserted carrier. Adjust the carrier level control until the A1406 output level meter indicates OdB on the D.S.B. scale. This corresponds to a carrier power of 10kW from the transmitter. Connect the Upper Sideband Amplifier (Input A) to its incoming programme line. The depth of modulation can be controlled by the Input A attenuator. A reading of OdB on the Input A level Meter (meter switch to DIRECT) corresponds to approximately 80% modulation.

NOTE: See Appendix 1 Tables 1 and 2 (Pages 155 and 156) for typical meter readings.

7.0 CW OR FSK OPERATION

7.1 Set the EHT voltage to 10.0 kV for operation up to 22 Mc/s or 9.0 kV for operation above 22 Mc/s.

7.2 Increase the Drive Level control to about midway and increase the Feedback Control until about 0.2 amp is indicated on the Truck Final Amplifier cathode current meter.

7.3 Adjust the Exciter Output Trimmer for maximum indication on the Truck Final Amplifier cathode current meter.

7.4 Adjust the Truck Final Amplifier anode tuning for maximum grid current on the R.F. Output Amplifier. If the grid current tends to rise above 0.5 amp. turn back the Feedback Control.

7.5 Adjust the Anode Tuning control for minimum cathode current indication. If necessary, slightly increase the Feedback Control to give greater drive but on no account must the meters on the truck Final Amplifier indicate a reading above mid scale. Adjust the Line Tuning Control for maximum indication on the Output Monitoring Meters.
Readjust the Anode Tuning for minimum cathode current.

7.6 Increase the Feedback Control and if necessary the Drive Level control until the meter indication on the R.F. Output Amplifier are approximately the same as below:-

Freq. Mc/s	Power Output R.M.S. kW	Truck Final Amplifier				RF Output Amplifier				EHT kV
		Bias V	Ig mA	Is mA	Ic A	Bias	Ig	Ic_1	Ic_2	
4-22	25	500	15	45	1.0	CW	.5	2.2	2.2	10
22-27.5	15	500	10	30	0.9	CW	.3	1.85	1.85	9

7.7 To change the output coupling (e.g. if the cathode current is less than 2.2 amps. when the grid current is 500 mA the coupling is too loose) adjust the Coupling Control (anti-clockwise for tighter coupling) and retune the Line and Anode Tuning Controls. With adjustment of the Anode control it may become apparent that the setting for minimum cathode current does not coincide with maximum indication on the Output Monitor meters. A setting should be chosen about midway between these two conditions. Repeat as necessary until the correct valve currents are obtained on the R.F. Output Amplifier.

7.8 Adjust the Feedback Control until the meter indications on the Truck Final Amplifier are approximately the same as in the above table. To change the coupling from this stage (e.g. if the cathode current is less than 1.0 amp. when the screen current is 45 mA. the coupling is too loose) alter the Input Tuning Control by a small amount and readjust the Truck Final Amplifier tuning in turn until the correct screen and cathode currents are realised. N.B. If correct coupling is obtained at two different settings of the Input Tuning Control, select the one giving the higher scale reading. Adjust the Feedback Control to give the correct valve currents on the R.F. Output Amplifier.

7.9 On the A1401 Drive Unit set the Service Switch to FS or AM (On/Off Keying) as required and set the keying switch to LINE.

7.10 For F.S.K. working the F.S.K. reversal switch on the R.F. truck must be switched to position in accordance with the radiated frequency.

8.0 DUAL OPERATION

8.1 The types of service available are as follows:-

(a) S.S.B. Telephony
(b) F.S.K. Telegraphy
(c) On-Off Keying Telegraphy
(d) D.S.B. Low Level Modulation Telephony

8.2 Two services may be operated simultaneously, i.e. one at high power using one r.f. truck to drive the R.F. Output Amplifier, and the other at reduced power using the second r.f. truck alone (Table I P.105). Alternatively, the reduced power services are available, the R.F. Output Amplifier being removed from service (Table II P.107).

8.3 The lining up procedure on each service is carried out in the same manner as for single operation. Only one service may be lined up at a time, the other being off or carrying its normal traffic. The service being lined up must not be on full line-up power for more than 5 minutes if the second service is already in operation.

8.4 When the High power service is operating above 22 Mc/s the E.H.T. must be reduced and the output power may be reduced as in the case for single operation.

8.5 Tables I and II give the available output power for combination of the above services along with the maximum valve currents on the Truck Final Amplifier (4kW) Stage. In each case the limiting factor is the cathode current in this stage; the sum of the average cathode currents must on no account exceed 1.25A with 6kV H.T. of 1.8 amp with 4.6kV H.T. For temperate climate this may be increased by not more than 20%.

DS.13 DUAL WORKING
(TROPICAL CONDITION)
TABLE I

		1.	2.*	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
Service	High Power	S.S.B.	F.S.K.	Independent On-Off	Simultaneous on-Off	D.S.B.	S.S.B.	F.S.K.	S.S.B.	On-Off	S.S.B.	D.S.B.	F.S.K.	On-Off
	Low Power	S.S.B.	F.S.K.	Independent On-Off	Simultaneous On-Off	D.S.B.	F.S.K.	S.S.B.	On-Off	S.S.B.	D.S.B.	S.S.B.	On-Off	F.S.K.
Output	HP1	40kW	10kW	25kW	25kW	10kW	40kW	20kW	40kW	25kW	40kW	10kW	15kW	15kW
	HP2	30kW	7.5kW	15kW	15kW	7.5kW	30kW	15kW	30kW	15kW	30kW	7.5kW	10kW	10kW
	LP	4kW	1.5kW	4kW	3kW	800W	2.5kW	4kW	4kW	4kW	1kW	4kW	3kW	3kW
Rating	HP	Int.	Cont.	Int.	Int.	Cont.	Int.	Cont.	Int.	Int.	Int.	Cont.	Cont.	Int.
	LP	Int.	Cont.	Int.	Int.	Cont.	Cont.	Int.	Int.	Int.	Cont.	Int.	Int.	Cont.
Max.Pen. Amp Cathode Current	HP1	1.0 (.5)A	.55A	1.15 (.57)A	1.15 (.57)A	.6A	1.0 (.5)A	.9A	1.0 (.5)A	1.15 (.57)A	1.0 (.5)	.6A	.7A	.7 (.35)A
	HP2	.85	.5A	1.05 (.55)A	1.05 (.55)A	.5A	.85 (.45)A	.8A	.85 (.45)A	1.05 (.55)A	.85 (.45)	.5A	.7A	.7 (.35)A
	LP	.9 (.4)A	.7A	1.15 (.57)A	.9 (.45)A	.63A	.8A	.9 (.4)A	1.15 (.57)A	.9 (.4)A	.63A	.9 (.4)A	.9 (.45)A	.9A
Max.Screen Current	HP	35mA	15mA	60mA	60mA	15mA	35mA	40mA	35mA	60mA	35mA	15mA	30mA	30mA
	LP	30mA	20mA	60mA	50mA	15mA	30mA	30mA	60mA	30mA	15mA	30mA	50mA	50mA
Line Up Time	HP	5 mins	-	5 mins	5 mins	5 mins	5 mins	-	5 mins	5 mins	5 mins	5 mins	-	5 mins
	LP	5 mins	-	5 mins	5 mins	5 mins	-	5 mins	5 mins	5 mins	5 mins	5 mins	5 mins	-
E.H.T.	HP1	10.5kV	10kV	10kV	10kV	10.5kV	10.5kV	10kV	10.5kV	10kV	10.5kV	10.5kV	10kV	10kV
	HP2	8.5kV	9kV	9kV	9kV	8.5kV	8.5kV	9kV	8.5kV	9kV	8.5kV	8.5kV	9kV	9kV
RF Amp.Bias	HP	S.S.B.	C.W.	C.W.	C.W.	S.S.B.	S.S.B.	C.W.	S.S.B.	C.W.	S.S.B.	S.S.B.	C.W.	C.W.
Truck Bias	HP	350V	500V	500V	500V	350V	350V	500V	350V	500V	350V	350V	500V	500V
	LP	350V	500V	500V	500V	350V	500V	350V	500V	350V	350V	350V	500V	500V
Neg. Feedback	HP	On	Off	Off	Off	On	On	Off	On	Off	On	On	Off	Off
	LP	On	Off	Off	Off	On	Off	On	Off	On	On	Ob	Off	Off

NOTES: HP1 and HP2 refer to high power working below and above 22 Mc/s respectively.

For DSB working output figures are carrier power

For SSB working cathode currents refer to the two tone line up condition, and output figures are the corresponding peak envelope power. Cathode current figures in parenthesis give the average current on intermittent services (normal speech on SSB).

NOTES: (Continued) On-Off Keying refers only to services where "key-down" represents "Mark". Where "key-up" represents "mark" the FSK line-up figures must be used.

*In this condition greater efficiency may be realised by dropping the Exciter H.T. to 4.6 kV (by switch K.S6) and the E.H.T. to 7.5 kV with cathode and screen currents of 0.9 amp and 50 mA on each R.F. Truck outputs of 2.4-2.5kW (LP) 16 kW(HP1) and 10 kW (HP2) can be obtained.

DS.13 DUAL WORKING
(TROPICAL CONDITION)
TABLE II

		1.	2.*	3.	4.	5.	6.	7.	8.	9.
Service	1	S.S.B.	F.S.K	Independent On-Off	Simultaneous On-Off	D.S.B.	S.S.B.	S.S.B.	S.S.B.	F.S.K
	2	S.S.B.	F.S.K.	Independent On-Off	Simultaneous On-Off	D.S.B.	F.S.K.	On-Off	D.S.B.	On-Off
Output	1	4kW	1kW	4kW	3kW	800W	4kW	4kW	4kW	2.5kW
	2	4kW	1kW	4kW	3kW	800W	2.5kW	4kW	1kW	2.5kW
Rating	1	Int.	Cont.	Int.	Int.	Cont.	Int.	Int.	Int.	Cont.
	2	Int.	Cont.	Int.	Int.	Cont.	Cont.	Int.	Cont.	Int.
Max.Cathode current	1	.9(.4)A	.63A	1.15(.57)A	.9(.45)A	.63A	.9(.4)A	.9(.4)A	.9(.4)A	.8(.4)A
	2	.9(.4)A	.63A	1.15(.57)A	.9(.45)A	.63A	.8A	1.15(.57)A	.7A	.8A
Max.Screen current	1	30mA	20mA	60mA	50mA	20mA	30mA	30mA	30mA	30mA
	2	30mA	20mA	60mA	50mA	20mA	30mA	60mA	20mA	30mA
Line-up Time	1	5 mins	-	5 mins	5 mins	5 mins	5 mins	5 mins	5 mins	-
	2	5 mins	-	5 mins	5 mins	5 mins	-	5 mins	5 mins	5 mins
Bias	1	350V	500V	500V	500V	350V	350V	350V	350V	350V
	2	350V	500V	500V	500V	350V	500V	500V	350V	500V
Neg. Feedback	1	On	Off	Off	Off	On	On	On	On	Off
	2	On	Off	Off	Off	On	Off	Off	On	Off

NOTES: For DSB Working output figures are carrier power.
For SSB Working valve currents refer to the two tone line-up condition, and output figures are the corresponding peak envelope power.
Cathode current figures in parenthesis give the average currents on intermittent services (normal speech on SSB).
On-Off keying refers only to service where "key-down" represents "Mark".
Where "key-up" represents "mark" the FSK line-up figures must be used.
*In this condition greater efficiency may be realised by dropping the H.T. to 4.6kV (by switch K.S6). With cathode and screen currents of 0.9 amp and 50 mA respectively two outputs each of 2.4-2.5 kW can be obtained.

CHAPTER 9

MAINTENANCE

1.0 PREVENTATIVE MAINTENANCE - ROUTINE CHECKS

Regular attention will go a long way to prevent faults developing. The organisation and timing of this routine can best be decided upon by the operator to fit in with transmission schedules. The following suggestions, therefore, are offered as a guide. It must be emphasized, however, that a regular routine will reduce the loss of transmission time to a minimum.

N.B. No contactor or relay should be touched unless all safety isolators are switched off. Failure to take this precaution may result in serious damage to the equipment.

2.0 GENERAL POINTS

By keeping a daily record of meter readings against valve life, any falling off in emission will be detected and the valve may be replaced before it becomes quite useless, thus avoiding a possible break in transmission. For these records to serve a useful purpose, it is important that the conditions of measurement remain constant in respect to supply voltage and transmission frequency.

2.1 Cleaning

All parts of the transmitter, inside and out, should be kept perfectly clean and free from dust. Particular attention should be paid to all high voltage components - insulators, valve envelopes and oil-filled capacitor caps. Should a flashover occur across the glass envelope of a valve, due to dirt, it will almost certainly ruin the valve. The presence of quantities of dust on the valve envelopes is also likely to result in the formation of hot spots. A soft cloth moistened in methylated spirit may be used for cleaning valves. The operation should be carried out when valves are cold and water should never be substituted for spirit.

The air filters in the air cooling systems should be lifted out of their slots and cleaned. This can best be done by blowing air through in the reverse direction.

Any marks on spark gap horns should be cleaned off with fine emery cloth and the horns repolished. Check that the settings are correct, viz:-

E.H.T. transformer: 0.5 inch (1.27 cms) (3 gaps)
E.H.T. smoothing choke: 0.5 inch (1.27 cms)
R.F. Output Amplifier: ~~0.05 inch (0.127 cms)~~ 0.1 inch (0.25 cm) (2 gaps)

2.2 Contactors and Relays

All contactors should be regularly inspected for pitted contacts and appropriate action taken.

Contacts on telephone type relays should be cleaned very gently with the Cleaning Tool 4258. Contact springs should only be adjusted when absolutely necessary. Use only the Spring Bender Tool 4294A and take great care to avoid overbending. Adjustment and test figures for the various relays used in the transmitter are given in the following table: the actual methods used being described in Appendix 5 - "Maintenance of Telephone Type Relays".

Relay Code	Coil Resistance	Contact Pressure Grams	Residual Gap in 1/1000 of inch	Minimum Saturation Current mA	Operate Current mA
4672 AEE	2000	16 - 20	12	20	6
4662 MAA	120	30 minimum	4	100	54 - 55
4662 MCG	6250	16 - 20	12	12	3.4
4664 MEY	2000	16 - 20	4	21	10
4666 MAM	1950	16 - 20	4	21	10
4666 MT	1950	16 - 20	4	21	12
4666 MBX	2000	16 - 20	4	21	11
4666 MAZ	2000	16 - 20	12	21	12
4666 MCA	2000	16 - 20	4	21	12
4666 MBZ	1000	16 - 20	4	29	16
4666 MCE	200	16 - 20	4	21	14
4666 MBY	2000	16 - 20	4	21	12
4664 MCP	1950	16 - 20	12	21	9
4661 MAB	120	30 minimum	12	100	44 - 45
4632 ACJ	1100	16 - 20	4	29	7.5
4185 AC	1000	15 - 21	-	41.2	18.2
4181 CR	800	11 - 15	-	44	26
4662 MCT	2000	16 - 20	4	36	10

No instructions are given for adjusting the Midget Relay type 4181 CR in the Oscillator and Negative Feedback Unit, 28-LU.234G, as it is considered beyond the scope of normal station maintenance. In the unlikely event of troubles being experienced with this relay it should be removed from the unit and replaced by the spare provided which will be either a type 4181 CR or a type 4189 GE.

2.3 Coils and Chokes

Ensure that the windings on all coils and chokes are fixed rigidly. If they become loose during service, short-circuited turns may result.

The pressure by the contact wheels on coils L2, L11, L21 (Oscillator and Negative Feedback Unit 28-LU.234G) should be of the order of 600 gms.

2.4 Lubrication

All variable capacitor bearings, mechanical interlocks and other moving parts should be lubricated with small quantities of oil, any surplus oil being carefully removed.

The gearing mechanism associated with the coils in the R.F. Exciter Unit (181-LU.13E) should be oiled periodically.

A faint smear of petroleum jelly should be applied to the switch blades of isolators, etc.

Ensure that the waveband switch has complete freedom of movement. Any stiffness may lead to indeterminate location causing flashover. All bearings should therefore be oiled.

Part of the stiffness of the waveband switch may be due to friction between two lugs on the back of the R.F. Exciter and the clutch plate on the Truck.

2.5 Oil Levels

Oil levels in all oil-filled components such as transformers, capacitors, chokes etc., should be checked and, if necessary, "topped up" with Grade 'B' transformer oil.

After a period of a few years, samples of the oil from the open breather type of transformer, smoothing choke, feed reactor, regulator etc. should be analysed in accordance with the British Standard Specification BS.148 by a competent body. If means are not available for complete analysis, the procedures under Appendix VII of the above specification entitled "Electric Strength" and under Appendix XI - "Crackle Test" (moisture content) should be carried out.

2.6 Filament Voltages

These should be checked from time to time with a voltmeter of high accuracy. Adjustments, if necessary, can be made as indicated in Chapter 5 Sections 4.4 and 4.5.

2.7 Selenium Rectifiers

The voltages of all selenium rectifiers should be checked from time to time as it may be that up to 10,000 hours there will be a falling off of output voltage due to "ageing" of the rectifiers. This is because, over a long period of time, there is a gradual increase in the forward resistance of selenium rectifier discs. Tappings are provided on all supply transformers by means of which this change of output can be compensated. Further ageing is extremely unlikely after 10,000 hours, but should this happen, suitable adjustment can again be made.

2.8 Conditioning H.C.M.V. Valves

After replacing any h.c.m.v. rectifier valve (4049D or 4078CA) allow 30 minutes with the filament switched on only before applying h.t. This waiting period is only necessary when the equipment is first put into service or when one of the rectifier valves has been replaced. Normally the automatic delay will be sufficient, but the first time h.c.m.v. valves are used after being handled or shaken, mercury may be lodged on the electrodes and cause flashback if h.t. is switched on. However, 30 minutes heating time will settle the mercury and protect the valve.

2.9 Automatic Voltage Regulator

The regulator is self-contained and together with its operating mechanism, completely oil-immersed. As rubbing contacts are eliminated no periodical maintenance is required.

The Astatic relay does not require regular attention since there is no wear or arcing of open contacts and the mercury switch is capable of an unlimited number of operations.

The regulator should be given the routine examination following the standard practice for ordinary static transformers. Satisfactory operation may be checked by changing the voltage 1% or more, by hand operation. The automatic gear should then function and correct the voltage to its original value.

3.0 AIR COOLING SYSTEM

Check motor and fan bearings for cool running and lubricate as in Chapter 6 section 8.0.

The air filters should be cleaned at least once a fortnight. To do this the filters should be removed and immersed in a solvent such as washing soda. After cleaning remove the filters and allow to dry, then recharge them in the oiling tank with Shell Carnia No. 69 Filter oil. If this is not available, grade A transformer oil may be used.

4.0 VALVE CHANGING PROCEDURE

4.1 R.F. Output Amplifier Valves, Type 3J/260E

(1) Remove the filament connections.

(2) Undo the two thumbscrews and swing the grid platform backward on its hinges until it engages the retaining clip. The valve may now be lifted clear.

(3) Replace the valve carefully, having regard for the glass insulators on which it stands.

4.2 Truck Final Amplifier Valve, Type 5J/180E

(a) Pull R.F. Truck out on runners.
(b) Open side panel giving access to valve.
(c) Remove valve connections and replace valves

N.B. When handling the above valve types, care should be taken to keep them upright. Under no circumstances should crated valves be stored on their sides.

5.0 METHOD OF ADJUSTING THERMAL SWITCH IN TRUCK FINAL AMPLIFIER

In the event of this switch failing to open at 100°C carry out following procedure:-

(1) Remove switch and immerse the end, containing bi-metal strips, into noiling water.

M.I (2) Allow ~~sufficient time~~ 2 MINUTES for switch to attain temperature of 100°C (i.e. temperature of boiling water).

(3) Loosen locking grub screws. Adjust knurled knob until switch opens and tighten locking screw.

(4) Take care to dry switch thoroughly and then replace.

CHAPTER 10

FAULT LOCATION

1.0 GENERAL

The transmitter is amply provided with meters, signal lamps and alarm systems. It is possible, therefore, to locate very quickly the section of the circuit in which the fault has occurred and the probable nature of the fault.

An additional advantage is that the control circuits are divided, generally speaking, into two systems. There is the forward system which initiates a change in circuit conditions (closing of contactors etc.), and the signalling back system, which is connected across the circuit experiencing the change. The two are, therefore, independent and the signalling back system gives a true indication of what has actually happened in the main circuit.

It is possible, though unlikely, that the fault may have occurred in the initiating control circuit. This can soon be confirmed by visual and other inspection, and reference to the control circuit diagrams Figs. 20, 21, 24 and 25. It is important, however, before attempting to locate an apparent fault in a control circuit to check that all operations have been performed correctly in accordance with the sequence outlined in Chapter 7.

To facilitate speedy correction of any fault, both operators and maintenance personnel should make themselves as familiar as possible with the contents of this Handbook.

2.0 FAULTS DUE TO VALVE FAILURE

Premature filament failure is of rare occurrence in the valve types used in this transmitter. Failure will occur due to gradual loss of emission as the valve approaches the end of its useful life.

By keeping a daily record of meter readings against valve life, any falling off in emission will be detected and the valve may be replaced before it becomes quite useless, thus avoiding a possible break in transmission.

3.0 FAULTS DUE TO CIRCUIT COMPONENTS

In the event of a fault occurring due to the complete failure of a circuit component it is relatively easy to locate the particular component, but any circuit involving a series of contacts such as a control circuit may fail to function properly due to the presence of dirt on a contact or due to the accidental omission to close a switch.

When locating such a fault operators may find it helpful to trace the circuit from point to point with the aid of the drawings supplied with this Handbook.

4.0 AUTOMATIC VOLTAGE REGULATOR

4.1 Fault Analysis

Faults may be diagnosed by the effect they produce in the operation of the regulator. There are four effects, as follows:-

4.1.1 The astatic relay does not operate, due to:-

(a) Relay supply cut-off.
(b) Relay fuses blown.
(c) Open circuit in the relay tapping board flexible link.
(d) Open circuit in the relay coil.

4.1.2 The motor does not operate, due to:-

(a) Motor supply cut off.
(b) Motor fuses blown.
(c) Motor connections at fault.
(d) Motor capacitor broken down.
(e) Seizure of mechanism.
(f) Motor running but not moving coil.

4.1.3 The gear runs one way or runs to one end, due to:-

(a) Supply voltage outside the range of the regulator.
(b) Defective relay mercury switch or movement.
(c) Relay sticking.
(d) Short circuit in the relay winding.
(e) Motor connections at fault.

4.1.4 "Hunting" due to:-

(a) Relay sticking.

4.2 Fault Testing

4.2.1 Relay does not Operate

Check that the regulator is energised; and if so, connect a voltmeter to read the voltage across terminals 1 and 2 in the control cubicle. If no indication is obtained look for a broken connection between the regulator terminals and the control panels.

If an indication is obtained across Terminals 1 and 2, the voltmeter should then be connected across the relay coil terminals which are located at the top left-hand corner of the panel.

The relay switch should be in the ON position. If no indication is obtained, there will be an open circuit in the connections from the fuses to the relay coil, or from terminals 1 and 2 to the fuses. The fuses should be examined to see that they are intact, and if not, rewired with 36 S.W.G. copper wire. If the open circuit is in the panel connections the panel should be removed and the connections and resistors examined.

If an indication is obtained across the relay terminals and the relay does not function, an open circuit in the relay coil connections or the flexible tapping link is indicated. The insulating ferrules on the link plugs should be unscrewed and the connection between the flexible cable and the plug examined.

4.2.2 Motor does not Operate

The motor is operated from one phase of the supply via the mercury relay, capacitors being used to obtain split-phase operation. If the motor does not run when the mercury switch makes contact, tests should be made to verify that the supply is through to the cubicle. Examine the fuses and if necessary re-wire the holders with 34 S.W.G. copper wire.

If the supply is present and the motor does not run, runs very slowly or runs in the "raise" direction only, the phase-splitting capacitors may be defective. These may be tested as follows:-

Connect the capacitor in series with a 60 watt 230-volt lamp and connect the combination across a 230 volt 50 c/s supply. Short circuit the capacitor, and if the lamp increases in brightness the capacitor may be assumed to be satisfactory.

If the capacitors are in good order and the motor does not run, an ammeter should be inserted in the lead connected to the centre contact of the mercury switch. The current should be between 0.42 and 1.68 amperes (depending on motor size). If no indication is given an open circuit exists in the motor or its associated wiring.

4.2.3 Seizure of Mechanism

This may be checked by the hand operating crank. This gear is designed for operation without undue effort by an average person and it is unnecessary to utilise levers, etc., to effect operation. External levers or undue force should not be used.

4.2.4 Motor Running but not moving Coil

This is a mechanical defect, and either the gear wheel teeth have been stripped, or one of the pins which secure the gears to the shaft may have sheared through. This can be checked visually.

4.2.5 Gear only Runs one Way or Tuns to one End

This fault can be due to a number of causes, listed below:-

(a) Supply Voltage Outside the Range of the Regulator

If the variation in the supply voltage is greater than the range of the regulator, the regulator will operate to an end position. The relay will hold the mercury switch in the "contact" position, the motor will be energised and will operate the regulator to the end position in an endeavour to correct the output voltage to its normal value.

(b) Defective Mercury Switch and/or Movement

This can be checked visually. The relay movement should be examined to see that it is free on its pivot, and that the stream of mercury will make in each direction when the switch tilts over. If necessary the mercury switch movement can be removed from the relay and replaced by a new movement. It will be necessary to remove the complete relay from the cubicle in order to do this. When removing the switch movement from the relay the nuts securing the hook to the spindle must not be removed.

(c) Relay Sticking in "Raise" or "Lower" Position

The plunger and movement should operate in a smooth, even manner. The operation of the relay may be checked by varying the supply to the relay and watching the movement tilt over in one direction and then the other when the voltage is altered from the normal by approximately ± 1%.

"Sticking" may also occur if the relay plunger has become damaged, or the bearings have become worn so that movement is jerky and uneven. This condition is usually accompanied by considerable noise and vibration.

If the plunger moves too far with the supply voltage high, the cam-shaped bakelite stop situated on the top left-hand screw of the movement support should be examined, and if necessary adjusted and locked. The cam washer can be adjusted to the right or left to stop the movement sooner or later in its travel. The switch should be permitted to contact with ½" clearance between the stop and the weight on the movement.

(d) Short Circuit in Relay Winding

If a short circuit should occur, the voltage which will then maintain the movement in the neutral position will not correspond with the voltage indicated on the terminal board. The new balanced-position voltage may possibly be such that the regular output voltage range will not normally maintain the relay in the neutral position and the regulator will then run to the end position. It will be necessary to return the complete core and coil for repair, or a new core and coil can be supplied.

4.2.6 "Hunting"

If, under normal operating conditions, the relay is observed to be operating continuously, with the mercury switch contacting from one side to the other, even when the input voltage and the load are constant, or, if the relay operates a number of times in this manner after correcting a voltage change, the relay is said to be "Hunting".

The "Hunting" effect can be stopped by making the relay less sensitive, i.e. by the addition of loading weights to the switch movement below the spindle.

"Hunting" may occur if the relay plunger has become damaged, or the bearings have become worn, so that the movement is jerky and uneven. This condition is usually accompanied by considerable noise and vibration.

5.0 TYPICAL FAULT TRACING PROCEDURE

In this section typical fault tracing procedure is given and it is assumed, for the purpose of description, that the transmitter is undergoing initial alignment in the manner described in Chapter 6. It is also assumed that a fault has arisen in the r.f. system which prevents the cathode current in the truck final amplifier stage from rising when the Exciter Output Control is turned in a clockwise direction. The problem is dealt with broadly and should prove of value when tracing any general faults in the r.f. circuits.

5.1 Symptom

Cathode current of valve V1, (fig. 4) in Truck Final Amplifier in R.F. Truck does not rise when DRIVE LEVEL control on Oscillator and Negative Feedback Unit is turned from minimum to maximum.

5.2 Action

(1) Switch off at once and turn Drive Level control in a fully anti-clockwise direction.

(2) Check all setting-up operations including those essential to the functioning of the S.S.B. Drive Unit and the Oscillator and Negative Feedback Unit. Note especially that the Exciter Output control is at normal setting.

(3) Switch on equipment again and turn Drive Level control in clockwise direction, noting if there is any indication of current in the grid circuit of the Penultimate R.F. Amplifier valve V1 (Fig. 4). If current is indicated there should also be a deflection of the pointer on the TRUCK FINAL AMPLIFIER CATHODE CURRENT meter but should deflection be small and equal in value to grid current, it may be assumed that the 1500 volt supply is not available at screen of V1. This is possibly due to one of the following causes:-

   (a) Connections on h.t. terminal in base of exciter power supply unit incorrectly made.
   (b) Failure of Relay Unit (82-LRA.1C) in R.F. Truck.
   (c) Disconnection (wiring or contacts) in 1500 volt supply line to screen of V1 (fig. 4).

(4) If symptoms described in (3) are not applicable, again switch on and, with Drive Level control turned for very low drive, check current indicated by meter in screen circuit of V1. If exceptionally high it is most probable that h.t. supplies are available at anode of V1. Check voltage indicated by h.t. voltmeter (on Exciter Power Supply Unit, K) and, if indication at that point is correct, the fault must be due to disconnection of the circuit (cables or contacts) between h.t. supply and anode of V1.

(5) If, when transmitter is operated, no current is indicated by meter in grid circuit of the Truck Final Amplifier V1 check cathode current of V6 (R.F. Exciter Unit fig. 5). Observe if current rises as Drive Level control is turned in clockwise direction. If so, anode circuit of stage may be defective. Defect may be due to one of the following causes:-

(a) Faulty tuning capacitor.
(b) Break in connection between anode of V6 (fig. 5) and grid of V1 (fig. 4).
(c) Contact wheel off variable inductor.

(6) If cathode current of valve V6 (fig. 5) does not rise at all when checked in manner described in (5) it should be assumed that a fault has developed either in the earlier stages of the exciter, in the Drive Unit, or in the Oscillator and Negative Feedback Unit.

(7) Failure of either the 3.1 Mc/s drive or the beat frequency will result in failure of the Exciter to tune in accordance with calibration settings. In this case it is advisable to check both outputs and meter indications of the Oscillator and Negative Feedback Unit.

(8) In the event of failure of the beat frequency oscillator referred to in (7) both crystal and auto operation should be checked (if available an external oscillator can be tried). The valves (V1, V2 and V3) should be inspected together with the rotating inductors.

(9) The 3.1 Mc/s signal originates in the separate Drive Unit. If this unit is normal but no 3.1 Mc/s input appears at the Exciter, valves V4, V5 and V6 in the Oscillator and Negative Feedback Unit should be checked and associated circuits examined.

(<u>Note</u>: If a receiver is not available, input to each stage must be checked with a valve voltmeter located between grid pin of appropriate valve and chassis.)

(10) If during operations, detailed above, it is found that a stage is faulty the following circuit checks should be made:-

Check for faulty valve, shorted connection in anode circuit, defective components in tuned circuit, disconnection of wiring in tuned circuit, and for bad contacts in band-switch.
Finally, it is essential that, if during checking operations any change is made to tuned circuits, it should be followed by realignment in accordance with instructions given later. However, it is most unwise to upset circuit adjustments unless necessary and, if possible, this course should be avoided.

6.0 ORDERING A SPARE PART

If, in the course of repair or maintenance work, a component is required which is not among the spares provided, it should be obtained through Standard Telephones and Cables Limited (Radio Division) Oakleigh Road, New Southgate, London, N.11, England. Quote:-

(a) The unit letter (given in Chapter 3) for the unit concerned.

(b) The appropriate drawing number, e.g. "Fig. 5 R.F. Truck Schematic" as given in the list of drawings in the front of this Handbook.

(c) Component identification as shown on the drawing, e.g. "resistor R6" plus any additional information given in the component lists in Appendix 1.

(d) All data which may appear on a label fixed to an item not made by Standard Telephones and Cables Ltd.

(e) Type and serial number of the transmitter. The type is "DS.13", the serial number will be found on the test report.

(f) Full shipping instructions.

7.0 FAULT INDICATION

Cause	Effect	Indication	Action (after clearing fault)
Mains input overload	Oil circuit breaker trips	Transmitter off	Repeat switching on procedure
D.C. Overload on 6 kV, 1.5 kV or 500V H.T. Rectifiers	Exciter H.T. removed	Exciter H.T.on/off lamp, off	Reduce Drive Level control. Close Exciter HT on/off button. Restore Drive Level control
Low bias voltage to RFA	EHT breaker opens	EHT on/off lamp off	Close EHT on/off button
Low bias voltage to RF Truck	Exciter HT removed	Exciter HT on/off lamp, off	Reduce Drive Level control. Close Exciter HT on/off button. Restore Drive Level control
Low current to EHT Rectifier Filaments	EHT breaker opens	EHT on/off lamp off, EHT prepared lamp off. HCMV Fils. Heating Commenced lamp ON. HCMV Fils Heating Completed, lamp OFF.	When fault is cleared, "HCMV Fils Heating Completed" and "EHT. Prepared" lamps light after a delay of 15 mins. Close the EHT on/off button.
Low RFA air flow	RFA valves filaments off. EHT breaker opens	RFA Fils. and Air lamp off. EHT on/off lamp off	Close RF Amp Fils. and Air on/off button. If fault is cleared the lamp lights after 10 secs. delay. Close EHT on/off button.
Truck Final Amplifier valve overheating	Filament supply removed from the valve		Filament supply resets itself when valve has cooled down.

Fault Location

E.H.T. OVERLOADS

(Resetting Relay Unit on MANUAL operation)

Cause	Effect	Indication	Action
Instantaneous AC O/L (Rel. FGL).	AC excitation removed. EHT breaker opens.	"AC Overload" lamp lights and alarm bell rings until EHT is re-applied.	Circuit resets when O/L is cleared. Close EHT On/Off button.
Sustained AC O/L (Rel.PB)	AC excitation removed. EHT breaker opens.	"AC Overload" lamp lights and alarm bell rings until EHT is re-applied.	Circuit resets when O/L is cleared. Close EHT On/Off button.
DC O/L or excess cathode current on RF amp valves	AC excitation removed. EHT breaker opens.	"DC overload" lamp lights and alarm bell rings until EHT is reapplied	Circuit resets when O/L is cleared. Close EHT On/Off button.

(Resetting Relay Unot on AUTO operation)

Cause	Effect	Indication	Action
Instantaneous AC O/L (Rel. FGL).	(1) AC and DC excitation removed.	AC lamp and alarm bell operate until circuit resets.	Circuit resets automatically.
If the O/L persists the excitation is removed and the circuit resets itself 3 times. O/L persists after 3rd trial	(2) EHT breaker opens.	AC lamp and alarm bell operate until EHT is re-applied	Close EHT on/off button.
Sustained AC O/L (Rel.PB)	EHT breaker opens	AC lamp and alarm bell operate until EHT is re-applied.	Close EHT on/off button.

Fault Location

Cause	Effect	Indication	Action
DC O/L or excess cathode current on RF Amp. valves.	(1) AC and DC excitation removed.	DC lamp and alarm Bell operate until circuit resets.	Circuit resets automatically.
If O/L persists the excitation is removed and the circuit resets itself 3 times. O/L persists after 3rd trial.	(2) EHT breaker opens.	DC lamp and alarm bell operate until EHT is re-applied.	Close EHT on/off button.

CHAPTER 11

RE-ALIGNMENT

1.0 GENERAL

Should it become necessary, at any time, to replace components in the various units of the equipment or should normal fault tracing procedure fail to disclose causes of unsatisfactory performance it may be necessary to carry out re-alignment. For this eventuality a series of re-alignment instructions are given in following sections of this chapter. It should, however, be clearly understood that re-alignment is not a routine procedure and should only be carried out in cases of absolute necessity. Further, the work should only be undertaken by skilled radio engineers.

2.0 RE-ALIGNMENT THE OSCILLATOR AND NEGATIVE FEEDBACK UNIT

2.1 Test equipment required

2 - Valve voltmeters 0.25 to 150 volt range. Fitted with r.f. probes.
1 - Crystal-controlled wavemeter such as the type B.C. 221.
1 - Multi-range voltmeter and milliameter. (An Avometer Model 7 is suitable.)
1 - Signal generator, with an output of 1 volt into 75 ohms (at 6.2 Mc/s).
1 - Trimming Tool, Code No. 73/4215 AG.
Crystals as normally used in the unit.

2.2 Mechanical checks

A thorough mechanical check should be made, with the unit out of the r.f. truck, in the following manner:-

2.2.1 Turn the Oscillator Tuning control in a clockwise direction until it reaches the stop position. Check that the contact wheels or brushes are set one third of a turn from the top of all the coils.

2.2.2 Check that the four screws which secure the tuning unit to the main chassis are well tightened.

2.2.3 Check that there is no excessive end-play on the coils in the tuning unit.

2.2.4 Turn each tuning coil against the gear-tensioning spring and check that each returns satisfactorily to its normal position upon being released. This is particularly important when dealing with the oscillator coil.

2.2.5 Check that all fixing screws on the coil cans are well tightened.

2.2.6 Check that the line-up marks on the tuning scroll are correct (i.e. to ensure that no disengagement of gearing has occurred since the initial alignment at the factory).

2.3 Electrical re-alignment

2.3.1 General checks

(a) Open the lower right-hand side door of the r.f. truck, with the master key.

(b) Obtain a small box or similar support, position it close to the right-hand side of the truck and lay the Oscillator and Negative Feedback Unit upon it. Position the unit on its side, with valves V4 and V6 uppermost and with plug terminations facing towards the truck. Connect up P6 (power plug), P7 (red plug), P8 (orange plug), P9 (blue plug) and P10 (white plug) to relevant cables in the truck. Connect up P11 (black plug) with a pair of wires. (This arrangement enables the unit to function outside the truck without the necessity of providing an assortment of extention leads.)

(c) Switch the 6,000V isolator (S1) on the Exciter Power Supply Unit, to OFF, and remove lamps 2 and 3 from the screen circuit of the final amplifier valve V1, in the r.f. truck. Switch on the power equipment and the r.f. truck in the normal manner. Check that the 500 volt supply is correct. (It will be assumed that the H.T. will be switched on or off, as required, by the engineer during the remainder of the tests on this unit.)

(d) Set the Feedback On/Off switch, on the Oscillator and Negative Feedback Unit to ON and turn the Oscillator Selector to a position where no crystal is fitted. Using the Avometer Model 7 (or equivalent meter) check the filament and anode voltages of V1 to V6 and the voltage at the junction of L3, R11. Check the cathode currents of the valves. Compare the figures obtained with those quoted in the typical test sheet.

(e) Check the operation of the thermostatically controlled heating elements in the crystal oven. For this purpose switch off the equipment and remove the cover from the crystal oven and fit a Langite sheet (or a sheet of some other heat-insulating material) as a temporary cover in its place. The sheet should be drilled in the centre and a thermometer fitted through the hole in order that temperature variations may be observed from time to time. Switch on the equipment again and allow at least two hours for the oven temperature to reach a stable temperature. Check that the temperature reached is 60°C ± 2°. If the temperature is incorrect adjust thermostat TH1 as necessary. For this purpose it will be necessary to remove the lower cover plate (nearest V1) at the rear of the oven, to obtain access to the thermostat. After each adjustment allow at least 20 minutes for conditions to re-stabilise. Short circuit oven terminals numbers 2 and 3 and allow the oven to continue heating. Check that when a temperature of approximately 80°C is reached the white indicator lamp on the front panel of the unit is illuminated and the temperature ceases to rise. Remove the short circuit and replace the oven cover.

NOTE: The 80°C thermostat is enclosed by a small cover and is situated immediately above the 60° thermostat.

2.3.2 Re-aligning the beat-frequency oscillator

(a) Set the Crystal Selector to INT OSC. and set the Oscillator Tuning control to 10 Mc/s as indicated on the black scale. If the equipment has just been switched on allow a period of at least 30 minutes for the oscillator to stop initial drift then, using the precision wavemeter, check the frequency. This should be 6.9 Mc/s at the anode of V3. If it differs by more than 20 kc/s adjust condenser C8 to obtain the correct frequency. (Note: It is possible that one of the padding elements of C7 has been removed at the Factory to enable C8 to tune.)

(b) Tune the anode circuits of V2, V3 by adjusting trimmer condensers C23 and C43, respectively, for minimum cathode currents. Check the adjustment of C45 for equal indications by valve voltmeters connected across plugs P8 and P9. Each time C45 is adjusted retune trimmer condenser C43. (Note: It is important to tune for dip where stated.)

(c) Turn the Oscillator Tuning control to 28 Mc/s as indicated by the scale. Using the wavemeter check that the frequency at the anode circuit of V3 is 24.9 Mc/s. If it differs by more than 50 kc/s unlock and adjust L1 to obtain the correct frequency, then unlock and adjust L10 and L20 for minimum anode currents of V2 and V3, respectively. If a dip in anode current of V2 is not apparent adjust L10 (with the trimming tool) for maximum cathode current of V3.

(d) Repeat the operations detailed in (a) to (c) until satisfied that the stages are accurately aligned at both ends of the frequency band.

(e) Disconnect coaxial connection from P10 (white plug).
Connect one of the valve voltmeters terminated with a 68 ohm 5% resistor across P10 (white plug) and turn the Oscillator Tuning control through the range 10 to 28 Mc/s, checking meanwhile that the valve voltmeter indication does not fall below 5.5 volts peak.

(f) Set main tuning of the unit to 24.9 mc/s.

(g) Connect 68 ohm 5% resistor across P8.
Connect valve voltmeter across P8.

(h) Connect signal generator (5 volts RMS output) to other side of C33/L16. Set frequency to 3.45 mc/s exactly (use a heterodyne wavemeter.)

(i) Adjust L16. for minimum reading on valve voltmeter.

(j) Transfer 68 ohm resistor and valve voltmeter to P9.
Transfer signal generator to other side of C34/L17.
Adjust L17 for a minimum.

(k) Transfer signal generator to junction of C40 and L13/C30.
Remove 68 ohm resistor from P9.
Connect valve voltmeter across stand off insulator (between V2 & V3) and chassis.
Adjust C32 and then L13 for a minimum indication.

(l) Set signal generator to 6.2 mc/s exactly.
Adjust L14 for minimum indication.

(m) Reset signal generator to 3.45 mc/s exactly and check adjustment of C32 and L13.
Remove valve voltmeter and signal generator.

(n) Re-connect the valve voltmeters across plugs P8 (orange plug) and P9 (blue plug) and again turn the Oscillator Tuning control through the range 10 to 28 Mc/s. Check that, throughout the frequency range, the valve voltmeter indications do not fall below 9 volts peak and also remain reasonably equal. If these results are not obtained it may be necessary to make re-adjustments of C43, C45 and L20 towards the top end of the band (i.e. at a frequency of approximately 20 Mc/s). Re-lock the trimmers.

(o) Connect a valve voltmeter across resistor R61, in the grid circuit of V4. Turn the Oscillator Tuning control through the frequency range of 10 to 28 Mc/s and check that the valve voltmeter indication does not fall below 9 volts peak. Check that, with the Meter Multiplier on the unit switched to MON. 1, a current of between 170 and 300 mA is obtained throughout the range.

(p) Check that, when the Oscillator Selector is turned to bring into circuit each of the various crystals previously inserted in the oven and the unit is appropriately tuned, the current indicated by meter M1 (with the Meter Multiplier set to MON. 1) is between 200 and 330 mA.

(q) Check that, after pulling with loading condenser C5, the tolerances of the oscillator under crystal control are not less than .003%. The frequency comparison gear for these measurements must have an accuracy of at least .001%.

(r) Connect a valve voltmeter across P10 (white plug) and check that the output obtained, as each crystal is switched in (and the unit appropriately tuned) is not less than 5.5 volts peak. Transfer the voltmeter to P9 (blue plug) and repeat the check, noting that an output of not less than 9 volts peak is obtained.

2.3.3 Re-aligning the Negative-Feedback Stages

(a) Set the Feedback On/Off switch to OFF and set the Drive Level control, R70, to the fully-anticlockwise minimum position.

(b) Connect a valve voltmeter across P7 (red plug) and set the Feedback control on the R.F. Exciter Unit to 2.5.

(c) With the type A.1406B or type A.1401 Drive Unit switched on and applying a 3.1 Mc/s signal to P11 adjust the Drive Level control for approximately 1 volt as indicated by the valve voltmeter.

(d) Unlock and tune condenser C68 for maximum output as indicated by the valve voltmeter. (NOTE: The spindle of C68 is 500 volts positive with respect to earth.) Check that the capacitor is tuning satisfactorily by observing that the tuning points for maximum output are not 180° apart. Re-lock C68 in the tuned position. Switch off the drive unit to P11.

(e) Set the signal generator for a frequency of 6.2 Mc/s ± 500 c/s and connect it to the junction of R80, R81. Turn the Phase Adjust control to 10. With the generator level appropriately controlled, unlock and adjust L37 for minimum output as indicated by the valve voltmeter located across P7. Set the generator to a level of 1 volt and check that the indication given by the valve voltmeter accords with that quoted in the typical test sheets. Re-lock L37 then remove the signal generator.

(f) Switch on the type A.1406B Drive Unit and adjust the Drive Level control, R70, for an output of 3.0 volts as indicated by the valve voltmeter across P7. Using the other valve voltmeter, measure the input to the grid of V5 for this condition. Set the Feedback On/Off switch to ON and check that the voltage at the grid of V5 rises by 12 dB.

(g) Rotate the Phase Adjust Control in a fully-clockwise direction and note the voltage indicated across P7. Turn the Phase Adjust control fully anti-clockwise, then adjust the trimming slug of L35 to restore the voltage across P7 to the figure previously noted. Rotate the Phase Adjust control through its complete range and observe that the voltage level across P7 does not vary by more than 10%.

(h) Disconnect the coaxial cable supplying the 3.1 Mc/s drive input to P11 and connect the signal generator, set to a frequency of 3.1 Mc/s, in its place. Adjust the generator output level and the Drive Level control, as necessary, for an output of 1 volt across P7. Adjust the generator frequency above and below 3.1 Mc/s for indications of 0.7 volts across P7. Observe the indicated frequencies of the generator for these conditions and compare with figures quoted in the accompanying typical test sheets.

Re-alignment

(i) Connect a valve voltmeter to the grid of V5. Set the generator to a frequency of 3.1 Mc/s and adjust its output for a level of 0.25 volts at the grid of V5. Note the output level at P7 for this condition and compare the results obtained with the figures quoted in the accompanying typical test sheets.

(j) Transfer the signal generator input from P11 to P13 (yellow plug). Adjust the generator (set to 3.1 Mc/s) for an output of 1 volt as indicated by the valve voltmeter across P7. Check that the input voltage for this condition is as quoted in the accompanying typical test sheets.

(k) If an external v.f.o. oscillator such as the type A.1408 is used, connect it to P12 by inserting the green plug or by connecting across with two short wires. Set the v.f.o. unit to 3.45 Mc/s and turn the Oscillator Selector to EXT. OSC. Turn the Meter Multiplier to MON.1. Adjust the Oscillator Tuning control, at 10 Mc/s (black scale) for maximum indication as given by M1. The indication given by M1 should be within 20% of that obtained when the Oscillator Selector is switched to INT OSC. Repeat the test with v.f.o. inputs of 6.9, 4.225 and 6.225 Mc/s. The Oscillator Tuning control settings for these frequencies should be 16.9, 20.0 and 28.0 Mc/s, respectively on the black scale.

(l) The above operation completes the re-alignment of the Oscillator and Negative Feedback Unit. All test gear should therefore be removed, lamps 2 and 3 re-fitted in the screen circuit of final amplifier valve V1 and the unit re-connected in its normal position.

2.4 Typical Test Sheet for the Oscillator & Negative Feedback Unit

Valve	Heater Voltage (a.c.)	Anode Voltage (d.c.)	Quiescent Current (mA)	Voltage at Junction of R11, L3 (d.c.)	Crystal Oven Mean Stable Temp.	Oven Supply Voltage (a.c.)	H.T. Supply Voltage (d.c.)	Min Output at P.10	Min Output at P.9	Mon. 1 Indication	Variation of level over range Phase control
V1	6.3 volts	155	25	150	60°C	50	500	6.0V a.c. Peak at 24.6 Mc/s	10.0V a.c. Peak at 24.9 Mc/s	300 at 16.7 Mc/s	2%
V2		414	12								
V3		427	30								
V4		500	32								
V5		500	29								
V6		467	40								

Pad Attenuation	Bandwidth (Sig. Gen. Input Level of 1 volt to P11 at Frequency of 3.1 Mc/s)					Output at P7 for Input of 0.25V at Grid of V5	Input Voltage for Output of 1 volt at P7
Ratio	Output of 0.7 Volt at Frequencies of:		Difference High Side	Difference Low Side	Band-Width		
13 db	3.1066 Mc/s	3.0933 Mc/s	6.6 kc/s	6.7 kc/s	13.3 kc/s	2.0 - 2.5V	1.05 - 1.2V

References in Text:

H.T. Supply Voltage	2.3.1 (c)	Mon. 1 Indication	2.3.2 (g)
Heater Voltages	2.3.1 (d)	Variation of Phase Control	2.3.3 (g)
Anode Voltages	2.3.1 (d)	Pad Attenuation	2.3.3 (f)
Voltage at R11, L3	2.3.1 (d)	Bandwidth	2.3.3 (h)
Quiescent Currents	2.3.1 (d)	Output at P7 for 0.25V Input at Grid of V5	2.3.3 (i)
Crystal Oven Temp.	2.3.1 (e)	Input Voltage for Output of 1 volt at P7	2.3.3 (j)
Min. Output at P10	2.3.2 (e)		
Min. Output at P9	2.3.2 (f)		

3.0 RE-ALIGNING THE R.F. EXCITER UNIT

3.1 Test equipment required

2 - Valve voltmeters with a range 0.25 to 150 volts, and having a 10:1 multiplier
1 - Trimming Tool, Code No. LP.182219. (This will be found fitted inside the lower door of the r.f. truck.)
1 - Multi-range test meter (an Avometer Model 7 is suitable).

3.2 Mechanical Checks

3.2.1 Remove the base plate.

3.2.2 Check that the blower-motor fan rotates freely and that the air-ducting is clear.

3.2.3 Turn the main tuning control to the fully clockwise position and check that all brushes are at the top starting points on their respective variable inductances.

3.2.4 Check that there is very slight end play on all the coils.

3.2.5 Check wiring and connectors in the anode circuit of V6. Wires carrying 1500 volt h.t. should be clear of earth by at least 3/16" and clear of other h.t. wires by at least ⅛". The coaxial cable to P15 should be clear of r.f. leads and moving parts.

3.2.6 Check that condenser C35 is at position of minimum capacity when Output Trimmer Control is set to zero.

3.2.7 Check that the screws securing the coil unit to the main chassis are tight and that the coil can fixings are also right.

3.3 Electrical re-alignment

3.3.1 General checks

(a) Remove lamps 2 and 3 from the screen circuit of final amplifier, V1, in the r.f. truck. Disconnect heater lead between C3 and final amplifier valve. (Suspend clear from earth.)

(b) Mount the R.F. Exciter on a box or table, adjacent to its normal position in the truck. The front panel of the R.F. Exciter should be facing away from the truck. Connect power supply plugs P14, P16 and P17 from the truck to the exciter.

(c) Switch the 500V (S3), 1500V (S4) and 6000V (S1) isolators to OFF.

(d) Switch on the l.t. supplies, close the truck isolator and place the Local/Remote switch, on the truck to LOCAL.

(e) Check that the blower motor, B1 in the R.F. Exciter Unit, is running freely and that there are no indications of faulty bearings.

(f) Check that the scroll lamps 1, 2 are equally illuminated and, using the multi-range meter, check the voltages across pins 7, 8, 9 and 10, on plug P17. (NOTE: If the accuracy of the multi-range meter is doubtful a sub-standard meter should be used).

(g) Press the H.T. ON button, on the power cabinets, and check that the bias voltage applied to the control grid of V6 is between 60 and 80 volts negative with respect to earth. If necessary the voltage may be corrected by adjustment of the potentiometer R1B in the r.f. truck.

(h) Set the waveband switch to the 12 to 28 Mc/s band by turning the dog clutch, at the rear of the unit, fully anti-clockwise as viewed from the rear.

(i) Switch off the h.t. supply and place the 500V (S3) and 1500V (S4) isolators in Exciter Power Supply unit to ON. Switch on the h.t. supply and check the cathode current of V6, in the r.f. Exciter Unit. This should be 250 mA. If it is incorrect adjust the potentiometer R1B in the r.f. truck, appropriately.

(NOTE: The 500 and 1500 volt h.t. supplies should be correct when R1B is adjusted.)

(j) Using the multi-range test meter (set to the 1000 volt range) measure the anode and screen voltages of V1 to V5, in the R.F. Exciter. Check the valve cathode currents. Switch off the 500V (S3) and 1500V (S4) isolators and re-check the bias voltage at the grid of V6.

3.3.2. Re-alignment

(a) Switch off the supplies and the truck isolator. Remove the connections to P14, 16 and 17 on the R.F. Exciter and turn the unit in such a manner as to enable the coaxial cables to P18, P19 and P20 to be connected up and access left to L1A. Connect up these cables and also connect the two valve voltmeters to the respective control grids of V1, V2. Set the Feedback control to zero position. Turn the Drive Level Control, on the Oscillator and Negative Feedback Unit to zero, the Phase Adjust control to 10 and the Oscillator Selector to an unused crystal position. Switch on the type A.1406B Drive Unit and set it for d.s.b. operation (carrier only). Alternatively if type A.1401 Drive Unit is used set it to A.M. and MARK. Switch the 1500 volt isolator, (S4) to OFF and switch on the l.t. supplies. Switch on the truck isolator and the h.t. supplies. Increase the drive level until the valve voltmeters, connected to the control grids of V1, V2 in the R.F. Exciter Unit, indicate approximately 1 volt. Check that the indications are equal. If not, unlock the slug on Inductor L1A and adjust to obtain a balanced condition. Re-lock L1A, re-set the Drive Level control for a level of 1 volt, as indicated by the valve voltmeters. Disconnect the meters and use one of them to check the voltage level across P7, on the Oscillator and Negative Feedback Unit. Compare the results obtained with figures quoted in the typical test sheets. Switch off the power supplies and the truck isolator. Disconnect the coaxial cables linking the R.F. Exciter to the truck. Re-fit the base on the exciter and replace the unit in its normal position to the truck. Reconnect all cables to the exciter. The waveband switch should be in position 3 to receive the exciter on refitting.

(b) Switch the 1500V isolator (S4 to ON). Turn the Tuning control, on the R.F. Exciter Unit, to one end of the scale and then to the other, checking that the initial line-up marks are correct (i.e. that there has been no disengagement of gearing while in service). Set the Tuning control to 12 Mc/s as indicated by its associated scale on the top rider. Set the Oscillator Tuning control, on the Oscillator and Negative Feedback Unit to 12 Mc/s as indicated by its associated scale. Turn the Oscillator Selector to INT. OSC. Connect a valve voltmeter with its multiplier, to the control grid of final amplifier valve V1, in the r.f. truck. Switch on the l.t. supplies, the truck isolator and the h.t. supplies. Adjust the Drive Level control on the Oscillator and Negative Feedback Unit, and the Feedback control, on the R.F. Exciter Unit, for a voltage indication by the valve voltmeter connected to the control grid of amplifier valve V1. (The indication should not be allowed to exceed 200 volts at this stage.) Vary the Output Trimmer control and check that it tunes for maximum output between 3 and 8 on its associated engraved scale. The setting will probably be higher than normal due to the valve voltmeter capacity. Adjust trimmer capacitors C11, C18 and C26, in that order, for maximum output as indicated by the valve voltmeter. (Control the drive level so that the indication does not exceed 200 volts.)

(c) Switch off the h.t. supplies and set the Oscillator Tuning control, on the Oscillator and Negative Feedback Unit, and the Tuning control on the R.F. Exciter Unit to a frequency of 28 Mc/s.

Switch on the h.t. supplies again and vary the Output Trimmer control. Check, as before, that it tunes between 3 and 8 on its associated engraved scale.

Trim L6, L11 and L17, on the R.F. Exciter Unit, for maximum output as indicated by the valve voltmeter.

Repeat the capacitive and inductive trimming operations for the lower and upper ends, respectively, of the frequency band until satisfied that the alignment is correct. Switch off the h.t. supplies and re-lock the capacitor trimmers.

(d) Turn the Oscillator Tuning control, on the Oscillator and Negative Feedback Unit and the Tuning control, on the R.F. Exciter Unit to 5.5 Mc/s. Place the Waveband Selector to Band 2.

Switch on the h.t. supplies and adjust the Drive Level control, if necessary, for an output level not exceeding 200 volts as indicated by the valve voltmeter connected to the grid of final amplifier valve V1.

Check that the Output Trimmer control tunes for maximum output between 3 and 8 on its associated scale then adjust trimmer capacitors C10B, C12A and C29, in that order, for maximum output as indicated by the valve voltmeter. Maintain the level within 200 volts by adjusting the Drive Level control.

(e) Switch off the h.t. supplies and set the Oscillator Tuning control on the Oscillator and Negative Feedback Unit, and the Tuning control on the R.F. Exciter Unit, to 12 Mc/s. Check tuning of the Output Trimmer as previously detailed then trim L5, L12 and L18, for maximum output as indicated by the valve voltmeter. Repeat the capacitive and inductive trimming operations, at the lower and upper ends of the frequency range until satisfied that the alignment is correct. Switch off the h.t. supplies and lock the trimmer condensers.

(f) Turn the Waveband Selector to Band 1 and set the Oscillator tuning control on the Oscillator and Negative Feedback Unit and the Tuning control, on the R.F. Exciter Unit, to 4 Mc/s. Switch on the h.t. supplies and check the tuning of the Output Trimmer in the manner previously detailed. Adjust capacitors C9B, C19A and C28, in that order, for maximum output as indicated by the valve voltmeter. Maintain the level within 200 volts by adjustment of the Drive Level control. Switch off the h.t. supply.

(g) Set the Oscillator Tuning control, on the Oscillator and Negative Feedback Unit and the Tuning control, on the R.F. Exciter Unit to 5.5 Mc/s. Switch on the h.t. supplies, check the Tuning of the Output Trimmer and then trim L4, L13 and L19, for maximum output as indicated by the valve voltmeter. Repeat the capacitive and inductive trimming operations at the lower and upper end of the frequency range respectively until satisfied that the alignment is correct. Switch off the h.t. supplies and lock the trimmer capacitors and coils.

(h) Connect the valve voltmeter to the control grid of V6, in the R.F. Exciter Unit. Switch on the h.t. supplies and adjust the Feedback control, on the exciter, to the maximum position. Turn the Oscillator Selector to an unused crystal position. Adjust the Drive Level control, on the Oscillator and Negative Feedback Unit, for a convenient level as indicated by the valve voltmeter connected to the control grid of V6. Unlock and tune inductor L7 (the 3.1 Mc/s rejector circuit) for minimum output as indicated by the valve voltmeter. Re-lock inductor L7 and switch off the h.t. supplies.

(i) Connect a valve voltmeter across P7 (if necessary using a short link for this purpose), on the Oscillator and Negative Feedback Unit and reconnect the valve voltmeter with the 10:1 multiplier to the control grid of final amplifier valve V1. Place the

Oscillator Selector, on the Oscillator and Negative Feedback Unit to INT. OSC. Switch on the h.t. supplies and, keeping the voltage indicated by the voltmeter located across P7 constant at 0.5 volt (by means of the Drive Level control on the R.F. Exciter Unit) and with the feedback level control at 10 check the output voltages at the following frequencies. Compare the results obtained with those quoted in the typical test sheets.

	Band 1	Band 2	Band 3
Frequency in Mc/s	4, 4.5, 5.5	5.5, 7.6, 10,12	12,15,19,23,25, 28

(j) Switch off the h.t. supplies and set the Oscillator Tuning control, on the Oscillator and Negative Feedback Unit, and the Tuning control on the R.F. Exciter Unit to 19 Mc/s. Increase the drive level to obtain an output of one volt r.m.s. as indicated by the valve voltmeter located across P7. Adjust the Feedback control for an output of 300 volts r.m.s., as indicated by the valve voltmeter connected to the control grid of final amplifier valve V1. Reduce the drive level by one quarter, a half and then three quarters of the original input and compare the outputs obtained with those quoted in the typical test sheets. Re-set the Feedback control to the maximum position.

(k) Adjust the Drive Level control for an output of 200 volts. Turn the Feedback control to minimum and observe the output voltage indicated. There should be a reduction of between 10 and 18 db. Switch off the power supplies and the truck isolator.

(l) This concludes re-alignment of the R.F. Exciter Unit. The filament connection of final amplifier valve V1 should be re-fitted and lamps 2 and 3 re-inserted in the screen circuit of V1.

3.4 Typical Test Sheet for R.F. Exciter Unit

Valve	Filament Voltage (+2½%)	Cathode Current	Screen Voltage (D.C.)	Anode Voltage (D.C.)	Bias Voltage (-D.C.)	Supply Current		Supply Voltage	
						Low H.T.	High H.T.	Low H.T.	High H.T.
V1	6.3 a.c.	17 mA	154V	144V					
V2	6.3 a.c.	16 mA	154V	144V					
V3	6.3 a.c.	35 mA	277V	470V		200mA	236mA	500V	1500V
V4	6.3 a.c.	100 mA	273V	482V					
V5	6.3 a.c.								
V6	5.0 a.c.	252 mA	500V	1500V	70.2V				

Linearity		Drive Voltage at 3.1 Mc/s for 1 volt at grids of V1, V2	Band	Frequency Response													Range of Feed-back Control		
Input Voltage	Output Voltage (R.M.S)			1			2				3						Max	Min	Ratio
1.0	300	2.2	Freq. (Mc/s)	4	4.5	5.5	5.5	7.5	10	12	12	15	19	23	25	28	200V	44V	13db
0.75	230		Gain	567	630	653	1020	1330	707	660	667	720	760	713	727	720			
0.5	148																		
0.25	79																		

References in Text:

Filament Supply Voltage	3.3.1 (f)	Linearity	3.3.2 (j)
Bias Voltage (V6)	3.3.1 (g)	Range of Feedback Control	3.3.2 (k)
Cathode Currents	3.3.1 (j)		
Anode & Screen Voltages	3.3.1 (j)		
Voltage at P7 for 1 volt to V1, V2	3.3.2 (a)		
Frequency Response	3.3.2 (i)		

4.0 ADJUSTING NEUTRALISING CAPACITOR IN R.F. TRUCK

(1) Apply 3.1 Mc/s signal from Drive Unit, and place Feedback ON/OFF switch on the Oscillator and Negative Feedback Unit to OFF.

(2) Set up transmitter for frequency of 27 Mc/s on (JB) or (JC) and adjust coupling and drive for a truck final amplifier screen current of 100 mA and cathode current of 800 mA.

(3) Adjust neutralising plate C47 (next to V6 in Exciter Unit) in such a manner that the cathode current is minimum when the screen current is maximum, as the tank circuit is detuned on either side of resonance. Fix plate firmly at conclusion of operation

5.0 RE-ALIGNING THE DEMODULATOR UNIT

4.1 Test equipment required

1 - Signal generator covering the range 3.1 to 28 Mc/s and having an output of 0.5 volts into 75 ohms.
2 - Valve Voltmeters.
1 - Resistor, 75 ohms 1 watt, carbon.
1 - Multi-range test meter (an Avometer Model 7 is suitable)
2 - Sockets S.T.C. Code 219-4003A.
1 - 0-20 mA d.c. meter.

4.2 Re-alignment

4.2.1 Remove the two red-ringed screws, holding down the demodulator, and remove the side panel from the demodulator. Leave the lower right-hand door of the r.f. truck open.

4.2.2 Connect a type 219-4003A socket to the signal generator termination and fit the socket into P24, on the demodulator.

4.2.3 Connect P28, on the demodulator unit to P10 on the Oscillator and Negative Feedback Unit, by means of the white coaxial lead.

4.2.4 Connect the 75 ohm resistor across the other type 219-4003A socket and fit into P25 on the demodulator unit.

4.2.5 Connect one valve voltmeter across the 75 ohm resistor and the other across plug P24.

4.2.6 Disconnect resistor R4, in the demodulator, from earth and insert the 20 mA d.c. meter in series between the resistor and earth.

4.2.7 Remove lamps 2 and 3 from the screen circuit of final amplifier V1, in the r.f. truck. Place the 6000 volt isolator switch in power cabinet No. 1 to OFF.

4.2.8 With all other units in position on the r.f. truck switch on the power supplies and the truck isolator. Place the Local/ Remote switch to LOCAL and place the Oscillator Selector switch, on the Oscillator and Negative Feedback Unit to an unused crystal position. Do not switch on the signal generator at this stage.

4.2.9 Using the multi-range test meter, measure the anode and screen voltages of V1, in the demodulator unit. Observe the cathode current of V1, as indicated by the 0-20 mA d.c. meter. Compare the results obtained with figures quoted in the typical test sheets.

4.2.10 Set the signal generator to a frequency of 3.1 Mc/s ± 500 c/s and for a level of approximately 0.5 volt. Adjust L1, in the demodulator unit, for maximum output as indicated by the valve voltmeter located across the 75 ohm carbon resistor. Check that L1 is correctly tuned by swinging the generator frequency control slightly to both sides of 3.1 Mc/s and noting that a fall in the output indicated by the valve voltmeter occurs.

4.2.11 Set the signal generator to a frequency of 4 Mc/s and for an output of 0.5 volt. Set the Oscillator Tuning control, on the Oscillator and Negative Feedback Unit to 4 Mc/s and place the Oscillator Selector to INT. OSC. Measure the output of the demodulator, as indicated by the valve voltmeter located across the 75 ohm load resistor, adjusting the signal generator tuning slightly, if necessary, to obtain optimum level.

4.2.12 Detune the signal generator on both sides of 4 Mc/s until the output indicated by the valve voltmeter is reduced to 0.7 of its maximum value. Observe the generator frequencies on either side of 4 Mc/s at which this figure is reached and calculate the differences in kc/s. Compare with the typical test sheets.

4.2.13 Re-lock the trimmer on L1, remove the test equipment, re-fit the demodulator in its normal position and reconnect the normal coaxial cables. Replace lamps 2 and 3 in the screen circuit of final amplifier valve V1.

4.3 Typical Test Sheet for Demodulator Unit

Valve V1					Output Across load for 4 Mc/s Input	Output across load for 10 Mc/s Input	Output Across load for 28 Mc/s Input	Frequency Difference for 0.7 of Output on High Side	Frequency Difference for 0.7 of output on low Side
Heater Voltage (a.c.)	Screen Voltage (d.c.)	Anode Voltage (d.c.)	Cathode Current (mA)	H.T.Supply Current (mA)					
6.3	243	227	14.5	19.8	0.29 volts	0.27 volts	0.21 volts	57 kc/s	62 kc/s

References in Text:

Screen & Anode Voltages and Cathode Current 4.2.9

Output Across Load for 4 Mc/s Input 4.2.11

Frequency Difference for 0.7 of Output 4.2.12

5.0 RE-SETTING UP THE R.F. TRUCK

5.1 General

Following re-alignment of major units in the r.f. truck it will be necessary to repeat the setting-up operations detailed in the relevant parts of Section 2.0, Chapter 8 to ensure that the overall assembly is functioning correctly.

The accompanying test sheets should be referred to when checking the performance.

6.0 COMPOUNDING OF E.H.T. RECTIFIER VOLTAGE

The d.c. excitation circuit is compounded accurately during manufacture and, in normal conditions, should not require further adjustment. Circumstances may arise however, when re-adjustment is necessary, and for this purpose the method is included here.

(1) Switch off the Transmitter and disconnect the lead between e.h.t. filter and R.F. Output Amplifier.

(2) Switch on the Transmitter and by means of the Raise/Lower control adjust e.h.t. volts to 11 kV. Switch off and set the travel-limiting switch on the motor potentiometer to this position. Adjust the compounding resistance GB.R2 to the tapping corresponding to the full load current or nearest higher value (6 amp). Reconnect the e.h.t. filter to the R.F. Output Amplifier.

(3) Switch on and adjust E.H.T. to 10.5 kV. Switch off and if necessary re-adjust the maximum setting of the travel-limiting switch on the motor potentiometer, this corrects for the tolerance in the compounding shunt.

TABLE I

VALVE COMPLEMENT

R.F. TRUCK - 389-LE.2M

Location	Valve	CV No.	Type	Function
R.F. Exciter 181-LU.13E	V1	136	6AM5)	Push-pull mixer
	V2	136	6AM5)	
	V3	124	5B/250A	1st Amplifier
	V4	124	5B/250A)	2nd Amplifier
	V5	124	5B/250A)	push-pull
	V6	1883	4H/180E	3rd Amplifier
Oscillator and Negative Feed-back Unit 28-LU.234G	V1	18	40-4A	Oscillator
	V2	124	5B/250A	Frequency doubler
	V3	124	5B/250A	Amplifier
	V4	124	5B/250A	Mixer
	V5	124	5B/250A	3.1 Mc/s 1st Amplifier
	V6	124	5B/250A	3.1 Mc/s 2nd Amplifier
Truck Final Amplifier Stage	V1	445	5J/180E	Amplifier
Demodulator Unit 109-LRU.8A	V1	136	6AM5	
Monitor Unit 171-LU.30A	V1	1054	EB34	R.F. Level Indicator
Beat Frequency Oscillator	N1	395	G180/2M	Neon Stabiliser

R.F. OUTPUT AMPLIFIER 28-LU.295A

Location	Valve	CV No.	Type	Function
R.F. Output Amplifier	V1) V2)	2908	3J/260E	Power Amplifiers
Grid Monitoring Unit 171-LU.30B	V1	1054	EB34	Rectifier
Line Monitoring Unit 171-LU.30A	V1	1054	EB34	Rectifier

VALVE COMPLEMENT (Contd.)

POWER SUPPLIES

Location	CV No.	Qty.	Type	Function
10,000 volts E.H.T. Supply	447	6	4078GA	Grid-Controlled H.C.M.V. Rectifiers
6,000 volts E.H.T. Supply	5	6	4049D	H.C.M.V. Rectifiers
1,500 volts H.T. Supply	5	3	4049D	H.C.M.V. Rectifiers
500 volts G.B. Supply	5	3 (including one spare)	4049D	H.C.M.V. Rectifiers
Relay Resetting Unit	75	1	4313C	Trigger Valve

Total No. of Valves:- 55

TABLE 2

FUSES

MAINS DISTRIBUTION UNIT (E) - 196-LE.4F

Number	Circuit	Rating
Ironclad Switch-fuse SF1	E.H.T. Supply, 10 kV	150 amp (16 SWG Tinned Copper Wire)
" " " SF2	Regulated Supplies	30 amp
" " " SF3	Unregulated Supplies	30 amp
" " " SF4	Air Blowers	15 amp
" " " SF5	Cooler fan motor	15 amp
" " " SF6	Not used	
" " " SF7	110V Supply (Regulated)	15 amp
" " " SF8	Exciter Filament & Low Voltage H.T. Supplies	15 amp
" " " SF9	Filament Supply R.F. Amplifier	15 amp
" " " SF10	E.H.T. Supply, 6 kV	30 amp
Fuses F1, F2, F3	Mains Voltmeter	0.5 amp Siemens type Z.4220
Fuse F4	50V D.C. & A.C. Supplies	4.0 amp Siemens type Z.4222
Fuse F5, F6.	" "	6.0 amp Z.4223
Fuse F7	50V D.C. Supply	6.0 amp Siemens type Z.4223
Fuses F8		Siemens 10A
Fuses F9, F10, F11		Slydlok 5 amp type 1531
Fuses F12, F13	Lighting Supply	Slydlok 5 amp type 1531
Fuses F14, F15	No-volt coil supply	0.5A Siemens type Z.4220
Fuses F16 to H/10793 Fuse T.39	Oven supply	1.0A Siemens type Z.4220A.

G. E.H.T. SUPPLY EQUIPMENT - 22-LE.18B

GA. Contactor Unit - 183-LU.13A

Number	Circuit	Rating amps	Type
F1, F2	110V A.C. Supply to Contactors	10	Siemens Z.4204
F3, F4, F5	110V A.C. Supply to rectifier filaments	20	Siemens Z.4226

TABLE 2 (Cont'd)

Fuses (Cont'd)

GB. Control Unit - 1-LU.90A

Number	Circuit	Rating Amps	Type
F1, F2	A.C. supply to "Raise/Lower E.H.T." potentiometer supply	4	Siemens Z.4202
F3, F4	A.C. supply to "Raise/Lower E.H.T." motor supply	2	Siemens Z.4201
F5, F6, F7	400V A.C. supply to phase-shift transformer	2	Siemens Z.4201
F1, F2, F3 in Re-setting Relay Power Unit 246-LU.3738A	A.C. supply leads	5	Slydlok type 324SF

GC.
GD. Grid Circuit Unit - 282-LU.6A

Number	Circuit	Rating Amps	Type
F1, F2	Filament circuit to e.h.t. rectifier valves	5	Slydlok No. 534 type F.W.

R.F. OUTPUT AMPLIFIER - 28-LU.295A

Number	Circuit	Rating Amps	Type
F1, F2, F3	400V regulated a.c. input to filament transformers	10	Siemens Z.4224
F7, F8, F6		10	Siemens Z.4224
F4, F5	400V regulated a.c. input to filament transformers T3 (for Monitor Unit)	0.5	Siemens Z.4220

TABLE 2 (Cont'd)

Fuses (Cont'd)

J. R.F. TRUCK - 389-LE.2M

Number	Circuit	Rating Amps	Type
F1, F2, F3	415V unregulated a.c. input to blower motor	10	Siemens Z.4224

K. EXCITER POWER SUPPLY UNIT - 94-LU.156B

Number	Circuit	Rating Amps	Type
F4, F5, F6	400V regulated a.c. input to filament transformers, (6000V h.t. supply)	2	Siemens Z.4221
F7	400V regulated a.c. input to filament transformers, (1500V h.t. supply)	2	Siemens Z.4221
F8, F9, F10	400V regulated a.c. input to 500V G.B. Unit, KC	4	Siemens Z.4222
F11	D.c. output from 500V G.B. Unit KC	2	Siemens Z.4221
F12	400V regulated a.c. input	10	Siemens Z.4224
F13,F14,F15	400V regulated a.c. input to 1500V H.T. Supply Unit	4	Siemens Z.4222
F16,F17,F18		10	Siemens Z.4224

TABLE 2 (Cont'd)

Fuses (Cont'd

KB. Grid Bias Rectifier - 22-LU.75A

Number	Circuit	Rating Amps	Type
F1, F2, F3 F4	Smoothing circuit of 500V grid bias supply	4	Siemens Z.4222
F5	500V d.c. output of grid bias rectifier	2	Siemens Z.4221

L. TRANSMITTER CONTROL UNIT - 1-LU.89C

Number	Circuit	Rating Amps	Type
F1	50V d.c. input	1	Belling Lee L.1055/1

TABLE 3
DS.13 TYPICAL METER READINGS

1. High Power Working (4-22 Mc/s)

Service	Drive	Power Output	Truck Final Amp *				R.F. Output Amp				EHT	Remarks
			Bias	I_g	I_s	I_c	Bias	I_g	I_{C_1}	I_{C_2}		
SSB/ISB/DSB	-	-	350V	-	-	0.25mA	SSB	-	0.5A	0.5A	10.5kV	
"	Single tone	10 kW	"	-	10	0.6	"	-	1.3	1.3	"	DSB carrier condition and -6 db line up level
"	Single tone	20 kW	"	-	15	0.8	"	50	1.8	1.8	"	
"	Two tones	40 kW P.E.P.	"	5	25	0.85	"	350	1.85	1.85	"	Two tone test condition
CW/FSK	Space	-	500V	-	-	-	CW	-			10 kV	
"	Mark	10 kW	"	-	8	0.55	"	100	1.3	1.3	"	
"	"	15 kW	"	-	10	0.65	"	150	1.5	1.5	"	
"	"	20 kW	"	5	20	0.8	"	250	1.8	1.8	"	
"	"	25 kW	"	15	45	1.0	"	500	2.2	2.2	"	Normal operation

2. High Power Working (22-27.5 Mc/s)

Service	Drive	Power Output	Truck Final Amp *				R.F. Output Amp				EHT	Remarks
			Bias	I_g	I_s	I_c	Bias	I_g	I_{C_1}	I_{C_2}		
SSB/ISB DSB	-	-	350V	-	-	0.25mA	SSB	-	0.5A	0.5A	8.5kV	
"	Single tone	7.5kW	"				"				"	DSB Carrier condition and -6 db line up level
"	Single tone	15kW	"				"				"	
"	Two tones	30kW P.E.P.	"	-	15	0.75	"	350	1.85	1.85	"	Two-tone test condition
CW/FSK	Space	-	500V	-	-	-	CW	-			9kV	
"	Mark	7.5kW	"	-	8	0.5	"	100	1.2	1.2	"	
"	"	10kW	"	-	10	0.65	"	150	1.5	1.5	"	
"	"	15kW	"	10	30	0.9	"	300	1.85	1.85	"	Normal operation

3. Reduced Power Working (4-28 Mc/s)

Service	Drive	Power Output	Truck Final Amp Bias	Ig	Is	Ic	Remarks
SSB/ISB/DSB	-	-	350V	-	-	0.25	
"	Single tone	1 kW	"	-	10	0.6	DSB carrier condition and -6 db line up level
"	Single tone	2 kW	"	-	15	0.8	
"	Two tones	4 kW P.E.P.	"	5	25	0.85	Two tone test condition
CW/FSK	Space	-	500V	-	-	-	
"	Mark	1.5 kW	"	-	20	0.65	
"	"	2.5 kW	"	5	35	0.8	
"	"	3 kW	"	10	40	0.9	
"	"	4 kW	"	30	60	1.1	Normal operation

* These figures for the truck final amplifier represent the correct relationship between cathode and screen currents. Their absolute values however may vary somewhat due to the different loading presented by the R.F Output Amplifier at various frequencies.

APPENDIX 2

GRID-CONTROLLED H.C.M.V. VALVE RECTIFIER EQUIPMENT

(to be read in conjunction with Figs. 101 and 102)

The purpose of this section is to present a few notes on thyratrons and to briefly outline the method of grid control.

The thyratrons used are in triode form which permits control of the arc current by means of a grid element. Because of the low arc drop and the high emission efficiency of the cathodes, particularly the indirectly heated, heat-shielded type, the power losses in thyratrons are small. In the larger sizes, efficiencies of 1 to 1.25 amperes of peak emission per watt of cathode heating power are obtainable, and cathodes rated at 600 amperes peak emission (100 amperes average) are in use. Valves having a peak emission of 1,000 amperes have been made, but for practical purposes 200 amperes is considered a reasonable limit. For normal operation of valves designed for high inverse potentials, the maximum peak inverse voltage varies from 30 kilovolts to 15 kilovolts for valves rated at 5 amperes and 150 amperes peak emission respectively.

EFFECTIVENESS OF THE GRID

Before ionisation sets in, operation is similar to that of a high vacuum valve; the more negative the grid potential, the greater may be the anode potential before current begins to flow. The ratio between the anode and grid potentials, for the point at which anode current (in discharge form) commences to flow, is termed the "control ratio" and, except for low values of voltage, is practically constant for a given vapour temperature. In distinction to a vacuum valve, where the amplification factor represents a rate of change, in the gas-filled valve the corresponding coefficient (the control ratio) is the ratio of two quantities only, i.e.:-

$$M = \left(\frac{E_a}{E_g}\right) i_a = 0$$

Once the arc has been initiated, however, the grid loses effectiveness and cannot be used to control the arc current or to extinguish it even though made highly negative. The value of the current depends only on the anode load impedance and the applied voltage, and the arc can be extinguished only by reducing the anode voltage below the ionisation potential or by making it negative.

When the grid is made negative, positive ions are attracted to it and form a positive-ion sheath around the grid. This neutralizes its control effect in the arc space, a greater negative potential on the grid merely increasing the thickness of the sheath. In some special tubes, however, with very close-mesh grids it has been possible to extinguish the arc by an increase in negative grid potential, but, as this does not apply to the normal type of valve capable of passing large currents, it will not be discussed further.

With a direct current anode supply, the arc current can thus only be stopped either by disconnecting the supply, allowing the anode potential to drop below the ionisation potential, or by giving a negative impulse to the anode of sufficient duration to ensure that de-ionisation of the space shall have occurred before the potential again rises to the striking value. On an alternating current supply, the potential automatically falls below the requisite value at the end of each positive half-cycle, and the grid may therefore regain control, provided the negative half cycle of the alternating voltage is of sufficient duration to permit de-ionisation.

TEMPERATURE EFFECTS

In mercury-vapour-filled valves, the vapour pressure depends markedly on the temperature of the coolest part of the valve, i.e., where the mercury condenses. The effects of temperature (by virtue of its influence on the vapour pressure) are twofold. Firstly, increase of temperature reduces the voltage drop under normal working conditions; secondly, it decreases the inverse voltage that the valve will support because of the greater time needed for de-ionisation. This increased time results from a slower diffusion process for more collisions occur with the greater molecular velocity.

Some control of the condensed-mercury temperature is necessary for thyratrons used at high voltage. For the valve types used in this transmitter a system continuously blowing air at ambient temperature against the base of the valve is used. It is considered preferable, however, to operate the largest valves at a constant temperature; the air-blowing system is always in operation and a heater keeps the air within about 2 degrees of the optimum operating temperature of 35 degrees centigrade.

ARCBACKS

For most practical applications of thyratrons, the time taken to set up ionisation can be neglected as it is of small duration, but a definite lag does occur, depending on the vapour pressure, electrode potentials, and geometry. Experiments conducted on several different type of valves indicate that, in general, the time lag varies between about 1 and 8 microseconds. A decrease in vapour pressure not only lengthens the starting time but also makes it more erratic; a negative bias increases the lag, as would be expected. Indications are that a steep wave front of the applied controlling voltage also gives somewhat shorter times of ionisation.

More recent experiments indicate that the lag seems to be made up of two distinct stages, a definite "delay" period in which no ionisation takes place, followed by a shorter "build-up" period after ionisation has commenced and during which the current builds up to full value.

The time of de-ionisation depends greatly on the geometry of the valve and the potential of the electrodes, and to a certain extent on the circuit. It increases with the vapour pressure and with the arc current that existed prior to the extinction of the discharge. Hence arcbacks may occur in the early part of the reverse cycle as a result of this residual ionisation.

Arcbacks may also occur at points in the reverse cycle other than near the beginning, after the space is virtually freed of ions.

It has been proposed that arcbacks result from small particles of insulating material on the surface of the anode becoming charged and producing local fields strong enough to cause field emission.

Experimental evidence in support of this theory seems to indicate further that, in practical circuits, this charging of small insulating particles is mainly caused by one of two mechanisms, viz. residual ions or glow discharge. If operating conditions favour the former, then arcback will occur at the beginning of the cycle, whilst in the latter case, it will most often occur at the middle of the reverse cycle when the voltage is at its maximum.

METHODS OF CONTROL

Since the grid can only initiate the passage of current between cathode and anode and has no further control once this has occurred, different methods of control, both as regards initiation and cessation, will depend on whether the anode supply is direct or alternating current. In the former case, the anode potential must be brought below the ionisation potential before extinction can occur, whilst in the latter case such conditions occur automatically at the end of each positive half cycle. The definition of alternating current in this case should be taken in its broadest sense to include waves of all shapes occurring at other than zero frequency, e.g. capacitor discharge voltage waves.

ON/OFF CONTROL OF ANODE CURRENT

Initiation of the discharge by reducing the grid bias below the critical value is well known, and is applicable equally when the anode supply is alternating or direct voltage. The same principles apply when the grid voltage is alternating or direct for either case of anode voltage.

Another method of controlling the arc for full on/off conditions when an alternating anode supply is used, is illustrated in Sketch (a). It consists in retarding the phase of an alternating bias from the position of antiphase with respect to the anode voltage. It will be noticed that the arc is first struck at the start of each positive cycle and current continues to flow until the anode voltage becomes zero. Variation of the phase of the grid voltage in this sense thus gives a sudden change from zero to full current conduction.

In Sketches (a) to (g) the absissae represent time or electrical degrees, and the ordinates represent voltage or current. The anode current and voltage are drawn of equal value for convenience, the shaded area indicating the time when anode current is flowing. E_a, E_g, E_c represent anode voltage, grid voltage and critical grid voltage, respectively, and I_a represents the anode current.

CONTROL OF THE MEAN VALUE OF ANODE CURRENT

Control of the mean value of anode current, when an alternating anode voltage is employed, was originally devised by Toulon and consists in advancing the phase of an alternating grid voltage from the antiphase position. Conduction then commences from a point towards the end of the anode alternating voltage wave and continues to the point of zero anode voltage. As the phase is further advanced, the angle over which the current flows is increased. Conversely, retarding the phase of the grid voltage from the inphase position will give gradual decrease of mean current.

Other methods of controlling the mean value of anode current have also been devised, and a summary is given below and illustrated in Sketches (b) to (g).

Sketch (b) Advance the phase of an alternating grid bias from the position of antiphase with respect to the anode voltage. This gives smooth control from zero to full half-cycle conduction.

Sketch (c) Raise the direct-current bias suddenly to a value below the critical bias, at regular intervals synchronised with the anode alternating current frequency, and advance the phase with respect to the anode voltage, commencing at the end of the alternating current wave. This gives smooth control from zero to full half-cycle conduction.

Sketch (d) Raise the direct-current bias, on which is superimposed an alternating-current bias of fixed magnitude and fixed phase of 90 degrees in advance of the antiphase position, with respect to the anode voltage, from a negative value greater than the sum of the peak of the alternating-current bias, and the critical bias. This gives smooth control from zero to full half-cycle conduction.

Sketch (e) Decrease the magnitude of an alternating current bias, which is advanced in phase with respect to the anode voltage from antiphase position by a fixed amount, e.g. 30 degrees. This gives smooth control between approximately 1/6th cycle (corresponding to the 30 degrees) and full half-cycle conduction, but it cannot reduce the current to zero.

Sketch (f) Raise the direct-current bias from a value greater than the critical bias for the peak of the alternating anode voltage to a value below the critical bias corresponding to the ionisation potential. This gives a sudden change of conduction from zero to $\frac{1}{4}$ cycle and thence smooth control up to full half-cycle conduction.

Sketch (g) Increase the gradient of an asymmetrical bias voltage so that the point of intersection with the critical bias is advanced with respect to the end of the anode voltage wave. This gives control from approximately zero to full half-cycle conduction.

OUTLINE OF THE PRINCIPLE AND OPERATION OF GRID CONTROL AS USED IN THIS TRANSMITTER

The principle of grid control employed in this transmitter is basically one of controlling the starting of conduction in a rectifier valve when the circuit conditions are such as would normally result in conduction taking place.

Triode h.c.m.v. rectifier valves are used, the grid potential of which will determine the point at which conduction between anode and cathode will take place. Once conduction has begun, the grid can exercise no further control and it is only possible to stop conduction by reducing the anode potential of the valve below the ionisation voltage of about 10-20 volts. This condition must be maintained for a period long enough to permit the vapour to become de-ionised for the grids to regain control.

By firing the valves at a known point on the anode voltage wave, the period of conduction can be varied, which in turn varies the output voltage of the rectifier. 90 degrees shift of the firing point is required to give full control of output voltage from zero to maximum.

In the h.c.m.v. valve units, a standing negative bias is applied to the grids of the valves to prevent premature conduction taking place, with a special voltage impulse having a positive amplitude exceeding that of the standing bias fires the valves at a known point on the anode voltage cycle. The firing impulses are referred to as peak waves, and originate from special saturable transformers called Peak Wave Transformers.

These Peak Wave Transformers have been designed to produce peak waves from a sinusoidal input voltage applied to the a.c. excitation winding, while a winding carrying D.C. alters the direct flux level of the transformer core which causes the peak waves to be displaced according to the magnitude and direction of the d.c. current flowing. In practice, the magnitude and direction of the current flowing in these d.c. excitation windings is controlled, so enabling the relative phasing between the anode voltage wave and the grid peak wave to be varied.

In addition to the a.c. and d.c. excitation windings, the core of the peak wave transformer also carries a compounding winding through which the d.c. output load current is circulated. These windings act in the same manner as the d.c. excitation windings, their ampere-turns being added or subtracted from those of the d.c. excitation windings. Thus an increase in rectified load current advances the peak wave with respect to the anode voltage wave, which raises the rectifier output voltage and so compensates for the drop in output voltage which would otherwise occur due to the regulation characteristic of the rectifier.

Sketch (h) shows the profile of the grid peak waves and also indicates their relative positions with respect to the sinusoidal anode voltage wave for various rectifier output voltages. These oscillograms have been obtained with the limiting values of d.c. excitation.

The firing point is determined not by the position of the peak of the grid wave, but by the point on the steep front of this wave at which the voltage on the grid in the respect to the cathode resultant from the positive amplitude of the peak wave opposing the negative d.c. permanent bias, reaches the critical bias value for the particular anode to cathode voltage at that moment.

When the peak waves are applied across the grid and filament of a hot valve their amplitude will fall due to conduction taking place and the resulting wave will be flat-topped. The peak wave amplitude will then only exceed the level of the permanent negative d.c. bias by the ionisation voltage of the valve.

Sketch (j) illustrates the curve relating output voltage of the rectifier to the d.c. excitation and the corresponding peak wave delay angle for a 3-phase full-wave rectifier. The curve itself is a cosine curve and the rectifier output voltage corresponding to any angular position of the peak waves may be obtained from the expression:-

$$E_{output} = E_{max.\ D.C.} \cdot \cos \theta$$

where θ = the angular displacement of the firing point from the maximum output position in degrees.

Also, neglecting the valve arc drop:-

$$E_{max.\ D.C.} = \sqrt{2} \cdot \sqrt{3}\ E_{ph} \frac{n}{\text{"pi"}} \sin \frac{\text{"pi"}}{n}$$

where E_{ph} = transformer secondary phase-neutral voltage.

n = number of valves

For a 3 phase full-wave rectifier the following conditions apply:-

(1) $E_{max}\ D.C. = \dfrac{E_{ph}}{0.428}$

(2) Maximum inverse voltage $= E_{max.\ D.C.} \cdot 1.05$

Thus for full control of d.c. output voltage from maximum to zero the firing point must be retarded 90°, i.e. from a position 60° in advance of the peak of the anode voltage wave to a position 30° retarding the anode voltage peak.

As will be seen from Sketch (h), the positive peak wave produced in the grid peak wave transformer under conditions of a.c. excitation only, occurs at the positive peak of the a.c. excitation voltage wave. If, therefore, this wave is arranged to be in phase with the h.t. voltage wave applied to the anode of the valve, the grid peak wave will be in phase with anode voltage peak for zero d.c. excitation in the grid transformer.

By means of another transformer, the grid phasing transformer, the grid peak wave is shifted 15° in advance of the above condition, from which position an equal shift of 45° advance and retard is therefore required to give the full range of control 90° from maximum to zero d.c. output voltage. This can be done by feeding an equal amount of d.c. excitation current in positive or negative direction through the peak wave transformers.

As shown in the diagram, the addition of positive d.c. excitation in the grid transformer causes the resultant magnetising current wave to cut the zero axis, inducing the peak wave, at points wider apart then in the case of only a.c. magnetising. Conversely, negative d.c. excitation reduces the spacing between peak waves.

In practice, only the positive wave is used; this, therefore, is effectively advanced in phase by positive d.c. excitation and retarded by negative d.c. excitation.

APPENDIX 3

USE OF "PI" CIRCUITS

The purpose of this section is to explain the action of Pi circuits in a simple way; for more complete theoretical treatment reference should be made to a good textbook such as "Communication Engineering" by Everitt.

Fig. 103 sketch (A) shows a Pi circuit. Such a circuit is generally used in transmitters to obtain a certain ratio of E1 to E2, or for impedance matching purposes. Since it is also a low pass filter, it assists in the suppression of harmonics generated by Class C amplifiers.

In Sketch (A) E1 might be the voltage between anode and earth of the following stage. It is desirable that the impedance looking into the terminals AB should be a pure resistance. This means that the inductive current I_2 must balance the capacitive current I_1. Therefore the currents through C1 and C2 are equal and the voltages across these capacitors will be proportional to their reactances, or in other words:-

$$\frac{E_1}{E_2} = \frac{X_1}{X_2} = \frac{C_2}{C_1}$$

Thus it is seen that any desired ratio of $\frac{E_1}{E_2}$ may be obtained by choosing suitable values of C_1 and C_2.

The effect of R_2 is neglected in the above simple explanation, but its effect is negligible provided that X_2 is small compared with R_2.

It can be proved that X_2 must be less than $\sqrt{R_1 R_2}$ where R_1 is the impedance looking into AB. If this is not the case R_1 and R_2 cannot be matched.

Referring to Sketch (B) suppose C_1 represented the capacitance across the final stage filaments and R_1 the resistance looking into the final stage filaments. Since the final stage is an inverted amplifier, R_1 will change with the output coupling. It can be seen that C_2 in the equivalent circuit will change unless certain conditions are observed, which means that the Penultimate R.F. anode circuit will no longer be in tune and the output voltage of that stage will fall. For good operating conditions, therefore, the change in C_2 must be small; this will be the case if X_{C_1} is equal to or less than $\frac{R_1}{4}$.

For example: Suppose $X_{C1} = R_1$ then $X_{C2} = \frac{1}{2} X_{C1}$

but if $X_{C1} = \frac{R_1}{4}$ then $X_{C2} = \frac{16}{17} X_{C1}$

which is a negligible change.

APPENDIX 4

USE OF VALVE CONDITIONING UNIT

S.T.C. Code 103-LU.19C
Schematic Reference .... Fig. 104

1.0 FUNCTION

This unit enables initial conditioning of h.c.m.v. valves to be carried out to ensure the correct distribution of mercury after a valve has been transported or stored in a non-upright position. Often valves which have caused trouble in service by flashing over can be restored to a serviceable condition by treatment on this unit.

2.0 DESCRIPTION

Two transformers on the unit TR.1 (3-phase) and TR.2) (single phase) provide low voltage anode and filament supplies from the 380V, 3-phase input. In series with the primary of the filament transformer (TR.2) are resistors R2, R3, R4 which limit the starting surge to a safe value.

The anode supply is D.C. provided by a 3-phase, full wave, selenium disc bridge rectifier and the transformer TR.1. By means of a 4-position switch S2 the required filament voltage is applied to the valve under test; at the same time this switch automatically selects the correct value of surge-limiting resistance. Another 4-position switch S1 controls the supplies to the filament transformer TR.2; it connects the selected surge-limiting resistance into circuit when in the "START" position and by-passes it when in "TEST" position. In addition it is ensured that the anode supply contactor RS.1 can only be closed when switch S1 is in "TEST" position.

The input circuits are protected against overload by fuses F1 to F5. Resistor R1, brought out to a handle on the front panel, is used to adjust the anode current. Relay RS.2 straps the grid first to anode for "starting" and then to the filament centre point for "running".

3.0 INSTRUCTIONS FOR USE

(a) Remove side panel and adjust tappings on transformer TR1 to suit the type of valve under test. Normal tappings are 11V for 4049D, and 17V or 20V for 4078GA and 4079GA valves.

(b) Set FILAMENT VOLTS switch to valve type number. Insert the valve.

(c) Set FILAMENT START switch to "START" for 5 seconds, then turn it to "TEST". Check filament volts (see (1) in Table below).

(d) If the valve is a new one or one which has been shaken about, allow 30 minutes heating time. In the case of a valve which has been in use, the heating time depends on the ambient temperature:-

Ambient Temp.	10° - 15°C	15° - 20°C	20°C and over
Heating Time	30 minutes	15 minutes	5 minutes

(e) After the filament has been heated for the required time, set INCREASE CURRENT handwheel fully anti-clockwise. Press H.T. ON button.

(f) Adjust INCREASE CURRENT control temporarily until valve is passing 90% of its maximum peak current (see (2) in Table); note the voltage drop across valve (see (3) in table) then reduce the anode current to the mean value (see (4) in Table).

(g) Conditioning should proceed at the mean value of anode current. As conditioning proceeds, the voltage drop decreases and the anode current increases; if necessary, adjust the INCREASE CURRENT control from time to time to keep anode current at its mean value. Repeat (f) periodically to measure the voltage drop; when it remains constant over a period of an hour or more the valve is conditioned. The average conditioning time is about 6 hours but the criterion is the lowering of the voltage drop across the valve.

TABLE OF VALVE DATA

Instruction Reference No.	Meter		Valve Type 4049D	4078GA	4079GA
1	Filament Volts		4V	5V	5V
2	Anode Current	90% of Maximum Peak Anode Current	4.5A	9.0A	18.0A
3	Voltage Drop	Voltage Drop Across Valve; between	9 & 15V	9 & 15V	9 & 15V
4	Anode Current	Mean Value	1.25A	2.5A	7.5A
5	Anode Current	Maximum Peak Anode Current	5A	10A	20A

4.0 TRANSFORMER DETAILS

1. TR.1, H.T. Transformer (RL.7008-591A)

Primary Input: Delta connected 400V, 3-phase, 50 c/s, tapped -5%, -2½%, +2½%, +5%.

Secondary Output: 20V (phase-phase) 3-phase star-connected 50 c/s tapped for 17V, 14V, 11V, 8V at 16.5 amps line current.

2. TR.2, Filament Transformer (RL.7008-590A)

Primary Input: 400V, single-phase, 50 c/s, tapped -5%, -2½%, +2½%, +5%.

Secondary Output: Alternatively

(a) 4V 11A
(b) 5V 20A
(c) 5V 40A

NOTE: Three primary tappings are provided to give required secondary outputs. These are connected by a 3-way switch.

APPENDIX 6

MAINTENANCE OF TELEPHONE TYPE RELAYS

1.0 DEFINITIONS, NOMENCLATURE AND NOTES

Definitions of the various terms used when describing, testing and adjusting relays are given below.

ARMATURE GAP - The air-gap between the armature and pole-face

Residual (or Operated) Gap - The gap that remains when the relay is fully operated. On some relays this gap is adjustable.

Unoperated Gap - The gap that exists when the relay is fully released.

ARMATURE PRESSURE - The pressure necessary to operate a relay to the point where the lever springs are just about to make (in a 'make' or 'make-before-break' contact unit) or to break (in a 'break' or 'change-over' contact unit). Measurement is made at a point on the armature opposite the pole-face. Pressures are given in grams.

ARMATURE STROKE - The amount of armature movement measured opposite the pole-face.

BLOCK PRESSURE - See CONTACT PRESSURE

BUFFER BLOCK - The part which limits the freedom of the make and break springs, and against which they are tensioned.

CONTACT CLEARANCE - The distance between a pair of associated contacts when they are broken.

CONTACT FOLLOW - See SPRING FOLLOW

CONTACT LIFT - See SPRING LIFT

CONTACT PRESSURE - Either (a) the pressure between a pair of contacts when they are made; or (b) the pressure between the lug of a make or break spring and the buffer-block stop against which it is tensioned, when the contacts are broken (BLOCK PRESSURE). Measured in grams. Whether (a) or (b) is required to be measured is stated in the maintenance instructions for each type of relay.

CONTACT UNIT - Two or three springs in a spring-set which are associated as indicated below. It should be noted that, whereas on schematic drawings all relays are shown unoperated, the nomenclature of the contact units describes what happens when the relays operate.

Break Contact Unit - A break spring and a lever spring. When the lever spring is operated the contacts break, and when it is released they make.

Change-over Contact Unit - A break spring B, a lever spring L and a make spring M. When L is operated contacts L-B break and then contacts L-M make, and when L is released contacts L-M break and then contacts L-B make. Contacts L-M are sometimes known as 'front contacts', and contacts L-B are sometimes called 'back contacts'.

Make Contact Unit - A lever spring and a make spring. When the lever spring is operated the contacts make, and when it is released they break.

Make-before-break-Contact Unit - A break spring B, a lever spring L and a make spring M. When L is operated contacts L-M make and then contacts M-B break, and when L is released contacts L-M break and the contacts M-B make.

X Contact Unit - A contact unit, either a make or break, arranged to operate before the other contact units on the relay, and to release after them.

Y Contact Unit - A contact unit, either a make or a break, arranged to operate after the other contact units on the relay, and to release before them.

CURRENTS - See TEST CURRENTS

GAP - See ARMATURE GAP

MIL - 0.001" (one thousandth of an inch).

POLE-FACE - The part to which the armature is attracted when the relay is energised.

SPRING CLEARANCE - The clearance between those surfaces of springs that are never intended to be in contact.

SPRING-SET - A complete assembly of contact units.

SPRING FOLLOW - The distance travelled by a make spring, measured at the free end, after the lever spring has made contact with it.

SPRING LIFT - The distance travelled by a make spring, measured at the lug which is normally tensioned against the buffer block, after the lever spring has made contact with it. The lug being situated at about three-quarters of the length of the make spring from its fixed end; there is obviously a small difference between LIFT and FOLLOW. Although the word 'lift' suggests vertical movement, in practice the spring lift is horizontal, because the relay is mounted so that the spring-sets are on one side.

TEST CURRENTS - The currents listed below. Unless otherwise stated the currents are applied in the order in which they are listed and in the same direction as in the circuit in which they have to work. If a relay is double-wound, each coil is tested separately unless otherwise stated.

Saturation Current - This is passed through the relay winding to ensure that the magnetic condition of the core will be standard throughout the subsequent tests. The value given is a minimum; the normal working curr ent may be substituted if it is greater.

Holding Current - When the saturation current is reduced to this figure, without disconnecting the circuit, the armature should remain operated.

Releasing Current - When the saturation current is reduced to this figure, without disconnecting the circuit, the armature should release.

Non-operating Current - This current shall not cause the armature to move sufficiently far from its unoperated position to open any break contacts or close any make contacts.

Operating Current - This current shall pull the armature up to the pole-face and holt it there, all break contacts being broken and all make contacts made.

NOTES

ADJUSTMENTS - Where possible, the adjustment of residual screws and armature gaps should take precedence over the adjustment of spring tension.

COVERS - When supplied, relay covers should not be left off for any considerable length of time. These covers prevent the relays from becoming dirty or getting damaged, and in some cases they provide magnetic screening.

2.0 4600 TYPE RELAYS

The Figs. quoted below refer to the sketches on Fig. 106

2.1 General

Usually, the 4600-type Relays are adjusted to mechanical requirements which cover their performance completely, so that, when these requirements are met, the electrical requirements are also met unless the coils are faulty. A certain amount of adjustment within the mechanical limits may, however, be necessary, and on certain forms of these relays spring pressures and residual gaps have to be specially adjusted to meet current or time tests. The maintenance normally required consists of the adjustment of spring pressures.

When necessary, adjustments and tests should be carried out in the order given below.

2.2 Contact Cleaning

The rubbing action of the contacts when operating and releasing renders them almost self-cleaning. However, occasional cleaning may be necessary, the Contact Cleaner No. 2 being provided for this purpose. This tool should be covered when not in use, and cleaned with chemically-pure carbon tetrachloride immediately before use.

2.3 Mechanical Adjustments

2.3.1 Armature Retaining Screw

Check that the armature is securely pivoted about the knife edge by means of the armature retaining screw and coiled spring; and on relays on which the spring-set load is unbalanced, check that there is no tendency for the armature to leave the knife edge on the side where the contact pressure is the smaller. If necessary, tighten the armature retaining screw; use a screwdriver, but do not overtighten.

2.3.2 Residual Gap

The residual air-gap is measured by inserting the holed end of the appropriate 4290A Feeler Gauge between the armature and pole-face, allowing the residual stud or screw to penetrate the hole, and holding the armature firmly in the operated position. The feeler gauge should be selected by reference to the table in Section 2.2 of Chapter 9 of this Handbook. Since it is unlikely that the surfaces of the armature and pole-face will be parallel, the gauge should be held flat against the pole-face.

If the relay is provided with a residual screw, the gap can be adjusted as follows: slacken off the lock nut, slacken off the screw, and pass the armature firmly against the pole-face. Then turn the screw until the required gap is obtained, and lock it in that position, taking care that it does not turn in the process of locking.

2.3.3 Contact Units - General

If any of the contact springs become bent they should be straightened and tensioned, using Spring Adjuster No. 1, to perform as nearly as possible like the undamaged springs. The next four paragraphs give a summary of the sequence of operations: readers who are not familiar with British Post Office-type relays are advised to study the detailed instructions which follow the summary.

When making the adjustments, each contact unit should be dealt with in turn, commencing with the one nearest to the yoke, and working successively to the top unit.

If the relay is fitted with X or Y contact units, see section 2.3.7 below.

(i) Make Contact Unit

(a) Straighten the springs if necessary.
(b) Tension the make spring against the buffer block.
(c) Tension the lever spring against the lifting pin or stud below it.
(d) Check the contact clearance and spring lift, and correct if necessary.

(ii) Break Contact Unit

(a) Straighten the springs if necessary.
(b) Operate the armature, and tension the break spring against the buffer block.
(c) Release the armature, and tension the lever spring so that the break spring leaves the block and, in addition, is tensioned against the lifting pin or stud below it.

(d) Check the contact clearance and spring lift, and correct if necessary.

(iii) Change-over Contact Unit

(a) Straighten the springs if necessary.
(b) Tension the make spring against the buffer block.
(c) Operate the armature, and tension the break spring against the buffer block.
(d) Release the armature, and tension the lever spring so that the break spring leaves the block and, in addition, is tensioned against the lifting pin or stud below it.
(e) Check the contact clearances, sequence of break and make, and spring lift, and correct if necessary.

(iv) Make-before-break Contact Unit

(a) Straighten the springs if necessary.
(b) Operate the armature, and tension the break spring, (the lowest of the three springs) against the buffer block.
(c) Release the armature, and tension the make spring (top spring) against the break springs.
(d) Tension the lever spring (middle spring) against the lifting pin or stud below it.
(e) Check the contact clearances, and correct if necessary by adjusting the tips of the lever spring.

2.3.4 Alignment of Spring Sets

(i) Straightness of Springs

It is a fundamental requirement of this type of relay that every spring, including the lug that rests on the buffer block, shall appear straight and flat when the relay is midway between the operated and unoperated positions; i.e. when all buffered springs are in contact with the buffer block, and all lever springs are midway between the break and make springs. It is difficult to judge exact straightness of springs when assembled on a relay and, therefore, slight banding of the front end of the springs (i.e. in front of the lifting pin or stud) is permissible in order to obtain the necessary clearances. Buffer blocks should never be filed to obtain contact clearances or for any other reason

(ii) Twin-contact Tongues

The springs are provided with independent tongues for each contact point. The twin-contact points should make or break simultaneously, as near as can be judged by the eye. The tongues of the lever springs should be adjusted to lie parallel with each other and with the yoke, when viewed from the front. The tongues of each buffered spring should then be adjusted, using the Spring Adjuster No. 2 so that the twin contacts make or break simultaneously.

(iii) Overlap of Contact Points

Pairs of contact points which make electrical contact one with the other, (one in one spring and the other in the adjacent spring) should not overlap each other by more than one-third of the diameter of a contact Fig. 106:2. This can be judged by eye. If faulty, the spring-set should be changed, but if this is not possible the trouble mey sometimes be cured by loosening the spring-set securing screws, shifting the springs into alignment and then reclamping.

2.3.5 Tensioning of Springs

(i) Principle

The tension of a spring should not be increased by merely giving a bend or set to the back end. If this were done, the pressure at the lifting pin or stud (or at the buffer-block step) would be increased, but the extra pressure would cause the spring to sag and upset the contact clearances. The correct method, therefore, is first to form a uniform hump or bow in the spring by a process known as 'stroking', so that when a set is finally put on the back end of the spring to increase the pressure at the contact point the tendency to sag is counteracted by the hump and the spring remains straight.

(ii) Example

The following example shows details of the method of tensioning contact springs, as applied to the tensioning of a make spring on to the buffer block step. For simplicity, the instructions are given assuming that the relay is mounted with its spring-sets uppermost, but once the principle is understood there should not be any difficulty in carrying out the operation while the relay is mounted on its side, either left-hand or right-hand.

(a) Place the tool over the spring, with the prongs as shown, at the back end of the spring (Fig. 106:3).

(b) Use the tool as a lever to exert a light pressure on the spring as shown, at the same time pressing the tip of the tool upwards (fig. 106:4).

(c) Keeping the spring under pressure, draw the tool gently but firmly along the spring so that a bow is extended towards the buffer block step (Fig. 106:5).

(d) The shape of the spring after this stroking will be as shown, a uniform bow being formed along the length of the spring (Fig. 106:6).

(e) Replace the tool at the back end, and give a set to the spring to increase the pressure on the buffer block step until the spring becomes straight (Fig. 106:7).

The final setting of the spring will apply the necessary increased pressure at the buffer block, and yet the spring will be quite straight at the end of the adjustment. Once the principle of stroking and setting is understood, it can be applied to the increasing or decreasing of tension in any spring without further explanation, the appropriate end of the tool being used (Fig. 106:8).

2.3.6 Spring Set Clearances

(i) Contact clearances and Spring Clearances

The clearances between make contacts when the armature is normal, and between break contacts when the armature is operated, should not be less than 0.01", i.e. half the height of a standard dome-shaped contact when new. The clearance can usually be gauged by eye, and is normally much greater than this. If incorrect, the straightness of the springs, particularly the twin-contact tongues, should be checked and corrected where necessary. Clearances of not less than 0.01" must also exist between those surfaces of springs that are never intended to be in contact.

(ii) Sequence of Contact Operation

Apart from any make-before-break, X or Y contact units, it should be checked that all break contact units break before any make unit makes. Similarly, in a changeover unit, the lever spring should leave the break spring before it makes contact with the make spring. If this requirement is not met, the straightness of the springs should be checked and corrected if necessary, as for incorrect contact clearance. For make-before-break units, the make and break operations will occur in the reverse order to those of a changeover unit.

(iii) Spring Lift

Spring lift, i.e. the movement of the lug away from the buffer block, should be checked by eye, the armature being operated for make contacts and released for break contacts. The nominal value is about 0.005" with a minimum of about 0.002". If the lift is judged to be insufficient, the straightness of the springs, particularly the lugs, should be checked, and corrected where necessary. A contributory cause may be wearing down of the contact points but this will occur only if the contacts are cleaned too vigorously.

(iv) Lifting-pin Clearances

There should be no clearances between lifting pins and studs, except on certain special relays.

2.3.7 Contact Units - X and Y Operation

(i) Adjustment of Spring Set which includes an X Contact Unit

(i)a Adjustment of X Contact Unit

The adjustment of an X contact unit is exactly the same as for ordinary make and break units, the correct sequences of contact operation being ensured in the design of the spring-set.

The X action is obtained by delaying the action of all other contact units both in the spring-set containing the X contact unit and in the spring-set opposite, so that adjustment of the X contact unit may slightly affect that of the others.

(i)b Adjustment of Normal Make or Make-before-break Contact Units on an X Contact Relay.

A normal make or make-before-break contact unit on an X contact relay is adjusted, as regards lever-spring pressure, when the armature is fully released; i.e. at 0.043" travel. Departures from the standard procedure are not necessary, and the lifting-pin clearance that would have occurred if there had been a break spring in the contact unit, is taken up by dropping of the lever spring towards the yoke (Fig. 106:9).

(i)c Adjustment of Normal Break or Changeover Contact Unit on an X Contact Relay

A normal break or changeover contact unit on an X contact relay (Fig. 106:10) is adjusted, as regards lever spring pressure, when the armature is situated 0.031" from the core; i.e. corresponding to the condition that exists on a normal relay with 0.031" travel. This can be effected by inserting a 0.031" gauge between the armature and the core, and operating the armature, electrically if possible. In this way, the extra travel provided for operation of the X contact unit is taken up.

(i)d Final Adjustment of Lowest Normal Break Springs

When all the normal break and changeover units have been adjusted in this manner, the 0.031" gauge should be removed, and the armature allowed to release fully. It is then necessary to ensure that the X contact unit will make or break before any normal break spring is moved. The lowest normal break spring in each set should therefore be given additional upward tension until there is sufficient lifting-pin clearance (Fig. 106:10) to permit this sequence of movement. The lifting-pin clearance, however, should not be so great that the normal lift of the break spring away from the block is less than standard.

If it is desired to check the lever-spring pressures during adjustment operations, this should be done before the final increase in tension of the lowest break spring is carried out; otherwise the extra tension of that spring will cause it to follow the lever-springs when the pressure gauge is applied.

(ii) Adjustment of Y Contact Units

A Y contact unit is adjusted in exactly the same way as an ordinary make or break unit, except that when the Y unit is a break unit (Fig. 106:11) the Y lever spring is not tensioned to meet the value usually specified. The lever spring should be tensioned down until the Y break spring leaves the block step to the extent of the normal spring lift, but a clearance should be left below the Y lever spring as shown in (Fig. 106:11) to ensure that the Y contact unit is the last to be operated.

On a Y make contact unit, the lifting-pin clearance is taken up as a result of the Y lever spring dropping towards the yoke. The contact opening of a Y make unit is therefore slightly wider than normal.

2.4 Electrical Test and Final Adjustments

On applying the correct working voltage, as determined by the particular circuit in which the relay is to work, the relay should operate. Failure to operate may be due to excessive tension on the lever springs. This tension should therefore be reduced, if necessary, care being taken to see that the spring-lift requirements are still satisfied, and this in turn may necessitate reducing the tension on the make and break springs.

With relays of the type under discussion, contact pressure is measured direct only in the case of the make springs of make-before-break contact units: the pressures of all other contacts are measured in terms of block pressure. The latter is measured by applying the Gauge Tension to the tip of the spring in line with the contacts: when the gauge is set to the minimum value the spring should not leave the buffer block, and when it is set to the maximum value, the spring should leave the buffer block. The contact pressure on the make spring of a make-before-break contact unit is measured by applying the tension gauge to the tip of the make spring, with the armature unoperated.

In the absence of a suitable tension gauge, the block pressures of different springs may be compared by lifting each spring off the buffer by means of a light screwdriver. In each case this pressure should be about 16-20 grams or about 2/3 oz.

2.5 Adjusting Tools

A complete list of tools suitable for comprehensive maintenance adjustments is given below. Reasonable field adjustments can however be carried out with the aid of the item marked with an asterisk.

	Tool	Code	Use
	Adjusting Armature No. 2	4291A	Adjusting armature stroke
	Spanners B.A. 4-5	4218	Residual nut
	Contact Cleaner	4258	
	Gauges, Feeler A	4290A	Measuring contact clearance, armature stroke, residual gap.
	Pliers, adjusting No. 1	4231	Tensioning springs
	Screwdriver, Inst. No. 4	4215A	Coil nut
	Screwdriver, Inst. No. 1	4215C	Screws generally
	Spring Bender	4294A	Tensioning springs
	Gauges, Tension A Finger	4270-A-4271C	Measuring contact pressures
*	Adjusters, Spring No. 2	4293A	Bending tongues of springs

3.0 4185 TYPE RELAYS

3.1 Spring, Contact and Armature Assembly

See that armature G fully covers the polefaces and rests flat on the rear edge of the rear poleface C. To adjust, loosen two fixing screws H, align contacts and armature, and retighten screws. Elongated holes permit adjustment of contact spring J.

The tension spring B should line up with the edge of the rear poleface C on the type of relay shown in Fig. 105.

3.2 Residual

Loosen locking screws K and unscrew contact screws L and M using the special tommy bar (Siemens type 204) until clear of contact spring J. Gently press the armature on to front poleface and adjust "Make" contact screw L until it just touches the contact spring. Release armature and advance contact screw L a further one-quarter turn. Lock associated screw K.

NOTE: It is important to use the special tommy bars for adjusting the position of the contact screws to avoid damaging the relay windings.

3.3 Contact Opening

With armature released advance "Break" contact screw M using a tommy bar until it gives a "Make" contact of 0.004 in to 0.0005 in. Lock associated screw K.

3.4 Break Contact Pressure

Adjust pressure screw N until the contact spring rests against the "Break" contact within the pressure limits of 15 to 21 grams. The pressure should be measured with a pressure gauge at the tip of the contact spring. The detent spring P should engage with the knurled edge of pressure screw N.

3.5 Check Adjustment

All adjustments to be checked after final adjustment has been completed.

3.6 Adjusting Tools

A complete list of tools suitable for comprehensive maintenance adjustments is given below.

Tool	Code	Use
Screwdriver	4215C	Screws generally
Feeler gauges	4290A	Measure contact clearance
Pressure gauges	4270	Adjusting contact pressures
Tommy bar	Siemens 204	Adjusting contact screws
Contact cleaners	4258	Cleaning contacts

APPENDIX 7

LINE UP PROCEDURE FOR DS.13 TRANSMITTERS WITH TYPE A.1406B DRIVE EQUIPMENT OPERATED IN CONJUNCTION WITH TELEPHONE TERMINATING EQUIPMENTS TYPE TOP.10 AND TOP.12

1.0 OUTLINE OF SYSTEM

G.P.O. practice requires that, at the point in the terminal equipment transmit path where the speech, RTP is -10 db, the level of the test tone is 1 mW (0 dbm). This test tone is used to load the transmitter to 6 db below Peak Output Power (P.O.P.)

P.O.P. is the maximum rated output power of the transmitter i.e. 40 kW R.M.S. or 4 kW R.M.S. for the DS.13. These powers correspond to ½W at the output of the A.1406B Drive Unit.

In the following instructions the speech signal is referred to in terms of "Speech Level" which is defined as the reading on the RTT Volume Indicator which speech peaks pass, on the average, 3 times in 10 seconds. This reference gives a clearer indication of transmitter loading conditions. Speech Level as read on a Volume Indicator meter is 8 db higher than the corresponding speech R.T.P. and it is accepted that, allowing for the ballistics of this meter, the actual transients rise approximately 8 db above the indicated level.

Thus, in the G.P.O. system, Speech Level is 2 db lower than Test Tone level. In the TOP.10 however, Speech Level and test Tone level are equal, and it is to compensate for this discrepancy that, having lined up the transmitter on Test Tone for P.O.P. -6 db, the input to the Drive Unit must be reduced by 2 db before applying speech.

The reinserted carrier levels obtained from the Drive Unit for SSB and ISB working are respectively -16 db and -26 db relative to P.O.P. (½ W).

The levels of these various components are shown diagramatically below:-

+1 db	TOP.10 or 12 Limiter
0 db	Peak Output Power (and level of speech transients)
-6 db	Test Tone
-8 db	Speech Level
-16 db	SSB Carrier
-26 db	ISB Carrier

2.0 TRANSMITTER SETTING-UP PROCEDURE

2.1 Preliminary Operations

(a) Apply the RTT test tone to one sideband input of the A.1406B equipment.

(b) Adjust the A.1406B Input Attenuator for a reading of -6 dbm on the Input Level meter.

2.2 Full Power Working

Set up the transmitter for 10 kW output power. For convenience, tuning can be carried out at 20 kW or, with two tones applied to the sideband input in place of the RTT test tone at 40 kW peak envelope power. This latter method is recommended if the settings of coupling controls are not known. The correct loading conditions in each case are given below:-

Power Output	4 kW Stage			40 kW Stage	
	Is (mA)	Ic (A)	Ig (mA)	Ic1 (a)	Ic2 (A)
10 kW	10	0.6	-	1.3	1.3
20 kW	15	0.8	50	1.8	1.8
40 kW P.E.P.	25	0.85	350	1.85	1.85

Having tuned by either method, replace the RTT test tone and turn down the transmitter Drive Level control for 10 kW output.

2.3 Reduced Power Working

Set up the transmitter for 1 kW output power. For convenience, tuning can be carried out at 2 kW, or, with two tones applied to the side-band input in place of the RTT test tone, at 4 kW peak envelope power. The latter method is recommended if the setting of the Line Reactance Control is not known. The correct loading conditions in each case are given viz.

Power Output	Is (mA)	Ic (A)
1 kW	10	0.6
2 kW	15	0.8
4 kW P.E.P.	25	0.85

Having tuned by either method, replace the RTT test tone and turn down the transmitter Drive Level Control for 1 kW output.

2.4 Final Operations

(a) Turn back the A.1406B Input Attenuator by 2 db i.e. Input Level meter reads -8 dbm.

(b) Transfer the RTT test tone to the other sideband input and adjust the Input Attenuator for a reading of -8 dbm. on the Input Level meter.

The equipment is now ready to receive speech on one or two sidebands.

(c) Set Reinserted Carrier Switch to SSB or ISB as required.

LIST OF COMPONENTS

FOR Oscillator unit type 345

(See Fig. 3 for circuit diagram)

Schem No.	Value	Tol ±%
C1	0.01 μF	20
C2	0.01 μF	20
C3	50pF	20
C4	220pF	10
C5	3-20pF	
C6	0.01 μF	20
C7	135pF	
C8	3-20pF	
C9	51pF	5
C10	15pF	5
C11	105pF	20
C12	90pF	20
C13	135pF	20
C14	0.01 μF	20
C15	0.01 μF	20
C20	220pF	10
C21	0.01 μF	20
C22	0.01 μF	20
C23	3-20pF	
C24	12pF	10
C25	82pF	10
C26	82pF	10
C27	220pF	10
C28	0.01 μF	20
C30	82pF	2
C31	68pF	2
C32	2-10.5pF	
C33	330pF	2

Schem No.	Value	Tol ±%
C34	330 pF	2
C38	12pF	10
C39	12pF	10
C40	220pF	10
C41	0.01 μF	20
C42	0.01 μF	20
C43	3-20pF	
C44	39pF	10
C45	3-30pF	
C46	12pF	10
C47	150pF	10
C47A	150pF	10
C49	33pF	10
C50	33pF	10
C51	150pF	10
C52	33pF	10
C53	33pF	10
C54	150pF	10
C55	0.01 μF	20
C60	.002 μF	20
C61	0.01 μF	20
C62	0.01 μF	20
C63	0.01 μF	20
C64	0.01 μF	20
C65	0.01 μF	20
C66	.0018 μF	
C67	.0018 μF	
C68	6-100pF	

LIST OF COMPONENTS

FOR Oscillator unit Type 345

(See Fig. 3 for circuit diagram)

Schem No.	Value	Tol ±%
C69	.001 μF	20
C80	0.01 μF	20
C81	0.01 μF	20
C82	0.01 μF	20
C83	.001 μF	20
C84	.002 μF	20
C85	220pF	10
C90	0.01 μF	20
C91	0.01 μF	20
C92	0.01 μF	20

Schem No.	Value	Tol ±%

LIST OF COMPONENTS

FOR Oscillator unit Type 345

(See Fig.3 for circuit diagram)

Schem No.	Value	Tol ±%
R1	180	10
R2	220	10
R3	220	10
R4	220	10
R5	37.7 (70W)	5
R6	390	5
R7	33	10
R8	33	10
R9	47K	10
R10	110	5
R11	9K	5
R12	22K	5
R13	5.6K	10
R20	33	10
R21	100K	10
R22	1K	5
R23	110	5
R24	100	10
R25	470	10
R26	6.8K	5
R40	33	10
R41	22K	10
R42	1K	5
R43	110	5
R44	100	10
R45	68K	5
R46	470	10
R47	2.2K	5

Schem No.	Value	Tol ±%
R60	33	10
R61	75	5
R62	27K	10
R63	75	5
R64	10	10
R65	1K	10
R66	110	5
R67	220K	10
R68	1M	10
R69	91	5
R70	90	5
R71	300	5
R72	82K	5
R73	100	10
R74	100	10
R75	1.3K	5
R76	240K	5
R77	82K	5
R78	10	10
R79	100	10
R80	33	10
R81	560K	10
R82	390	10
R82	110	5
R84	33	10
R85	33K	5
R86	22K	5
R87	470	5

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LIST OF COMPONENTS

FOR OSCILLATOR UNIT TYPE 345.

(See Fig. 3 for circuit diagram)

Schem No.	Value	Tol ±%
R88	470	5
R89	4K + 4K variable ganged	

Schem No.	Value	Tol ±%

LIST OF COMPONENTS

FOR Oscillator unit type 345

(See Fig. 3 for circuit diagram)

Schem No.	Description
	Inductances
L1	0.45-8 /uH
L2	17.3 /uH
L3	1.5mH
L10	0.45-8 /uH
L11	17.3 /uH
L12	0.9mH
L13	STC 20-LRA.93B
L14	STC 20-LRA.93A
L15	STC LP.133284
L16	STC 20-LRA.93C
L17	STC 20-LRA.93C
L20	0.45-8 /uH
L21	17.3 /uH
L22	1.5mH
L29	STC 28-LU.234/60
L30	STC 28-LU.234/57
L31	STC 28-LU.234/57
L32	STC 40CLU. 47D/25
L33	L.5mH
L34	1.5mH
L35	STC 28-LU.234/51
L36	1.5mH
L37	STC 28-LU.234/225
L38	STC 28-LU.234/57

Schem No.	Description
	Valves
V1	CV18
V2	CV124
V3	CV124
V4	CV124
V5	CV124
V6	CV124
	Relays
REL1	STC 4182 EE
	Lamps
1/1	STC 4011C
1/2	STC 4011C
1/3	STC 4011C
1/4	STC 4011C
N1	CY395 Neon
	Meters
M1	0-500/uA
	Rectifiers
Rect 1	STC B18-4-1R

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LIST OF COMPONENTS

FOR OSCILLATOR UNIT TYPE 345

(See Fig. 3 for circuit diagram)

Schem No.	Description
	Switches
S1	S.T.C.RL7016-278A
S2	S.T.C.RL7016-199A
S3	Cutler Hammer 8373-K8
	Thermostats
TH1	B.T.Co. Type MB/A/7
TH2	Sunvic 2 CLV
	Transformers
T1	S.T.C.RL7008-632 A
	Crystal detectors.
X7	B.T.H. CGIC
X8	B.T.H. CGIC

Schem No.	Description

LIST OF COMPONENTS

FOR r.f. truck

(See Fig. 4 for circuit diagram)

Schem No.	Value	Tol ±%
C1	.001 µF	20
C2	10 pF	20
C3	0.01 µF	20
C4	0.01 µF	20
C5	.001 µF	20
C6	.001 µF	20
C7	.001 µF	20
C8	.001 µF	20
C9	.001 µF	20
C10	.001 µF	20
C11	10 pF	20
C12	10 pF	20
C13	10 pF	20
C14	10 pF	20
C15	.001 µF	20
C16	200 pF	5
C17	.001 µF	20
C20	120 pF	20
C21	120 pF	20
C22	120 pF	20
C23	250 pF	20
C24	250 pF	20
C25	120 pF	20
C26	250 pF	20
C27	120 pF	20
C28	120 pF	20
C29	120 pF	20
C30	120 pF	20

Schem No.	Value	Tol ±%
C31	120 pF	20
C32	.001 µF	20
C33	.001 µF	20
C34	250 pF	20
C35	100 pF	20
C36	100 pF	20
C37	15 pF	20
C38	15 pF	20
C39	15 pF	20
C40	15 pF	20
C41	100 pF	20
C42	100 pF	20
C43	0.01 µF	20
C44	0.01 µF	20
C45	0.01 µF	20
C46	0.01 µF	20

LIST OF COMPONENTS

FOR r.f. truck

(See Fig. 4 for circuit diagram)

Schem No.	Value	Tol ±%
R1A	2.5K	10
R1B	2.5K	10
R1C	470	5
R2	200	5
R4	2K	15
R4A	2K	15
R5	50	15
R6	47	10
R7	5K	15
R8	75	5
R9	470	10
R10	68	10
R11	680	10
R12	47	10
R13	47	10
R14	75	5
R15	220	10
R16	220	10

Schem No.	Value	Tol ±%

(A.L.1 Sept. 61)

LIST OF COMPONENTS

FOR r.f. truck

(See Fig.4 for circuit diagram)

Schem No.	Description
	Chokes
L1)	Part of S.T.C.
)	
L1A)	400-LU.50H
L2	389-LE.2 Det. 1081
L3	Part of 400-LU.50C
L4	247-LU.35D
L5	20-LU.144R
L6	20-LU.144K
L7	20-LU.144K
L8	247-LU.42C
L9	1 Section as L8
L10	247-LU.42D
L11	1 Section as L10
	Transformers
T1	STC RL7008/584A
T2	STC U46149/33
T3	STC AE46150/14
	Meters
M1	0-100mA
M2	0-2A
M3	0-300mA
M4	0-5mA
M5	0-5mA

Schem No.	Description
	Relays
REL.1	STC RL.7013/40D
REL2	STC 82-LRA.3A
REL.3	EAC Type U 7619
	Switches
S1F	Part of L4
S1G)	Part of
S1H)	L5
S1J	Part of 276LU22B
S2	STC Type 4641 TFS
S3	Burgess Type C/RRS
S4)	
S5)	Part of L4
S6)	
S7	Santon Type 113A
S8	STC Type 4608 Key
S9	10F/747
	Fuses
F1	15A
F2	15A
F3	15A

(A.L.1. Sept.61)

LIST OF COMPONENTS

FOR r.f. truck

(See Fig. 4 for circuit diagram)

Schem No.	Description
	Jacks
J1	S.T.C. Type 4111A TFG
	Blowers
B1	S.T.C. RL 7060/32A
	Valves
V1	CV 445
	Meter Lamps
ML1B	S.T.C. Type 4011C 50V
Lamp 2	230V. 100W
Lamp 3	230V. 100W
	Thermal overload
TH.U.1	E.A.C. Type U8931C

Schem No.	Description

(A.L.1. Sept. 61)

FOR drive unit, radio Type 6

(See Fig. 5 for circuit diagram)

Schem No.	Value	Tol ±%
C2	33pF	5
C3	68pF	5
C4	0.01 μF	20
C5	0.01 μF	20
C6	68 pF	5
C7	0.01 μF	20
C8	200 pF	20
C9A	39 pF	5
C9B	6-100 pF	
C10A	82pF	5
C10B	6-100 pF	
C11	6-100 pF	
C12A	6-100 pF	
C12B	22 pF	5
C13A	62 pF	5
C13B	91 pF	5
C14	0.01 μF	20
C15	0.01 μF	20
C16	0.01 μF	20
C17	200 pF	20
C18	6-100 pF	
C19A	6-100 pF	
C19B	22 pF	5
C20	0.01 μF	20
C21	0.01 μF	20
C22	0.01 μF	20
C23	0.01 μF	20
C24	0.01 μF	20

Schem No.	Value	Tol ±%
C25	200pF	20
C26	6-100 pF	
C27	0.01 μF	20
C28	6-100 pF	
C29	6-100 pF	
C30	0.01 μF	20
C31A	0.01 μF	20
C31B	0.1 μF	20
C32	0.01 μF	20
C33	0.01 μF	20
C34	.0029 μF	
C35	8-25 pF	
C36	.001 μF	20
C37	3 pF	20
C38	.002 μF	10
C39	.001 μF	20
C40	0.01 μF	20
C41	1.5 μF	20
C42	0.01 μF	20
C43	0.01 μF	20
C44	0.01 μF	20
C45	0.01 μF	20
C46	0.01 μF	20
C47	181-LU.13 dets.327/8	
C48	0.01 μF	20
C49	33 pF	5

LIST OF COMPONENTS

FOR drive unit, radio Type 6

(See Fig. 5 for circuit diagram)

Schem No.	Value	Tol ±%
R1	47	10
R2	47	10
R3	33K	10
R4	33K	10
R5	75	5
R6	75	5
R7A	3.3K	10
R7B	3.3K	10
R8A	2.2K	10
R8B	470	10
R9	270	10
R10	270	10
R11	33K	5
R12	10K	5
R13	470	10
R14A	1K	10
R14B	10K	10
R15A	47	10
R15B	47	10
R16	470	5
R17	100	10
R18	47	10
R19	33K	5
R20	22K	5
R21	470	10
R22	470	5
R.23	3.3K	10
R24	2.2K	10

Schem No.	Value	Tol ±%
R25	47	10
R26A	270	10
R26B	470	10
R26C	470	10
R27	47	10
R28	330	5
R29	56	5
R30	33K	5
R31	22K	5
R32A	10K	10
R32B	47	10
R33	150	5
R34	1K	5
R35	1K	5
R36	47	10
R37	330	5
R38	47	10
R39	33K	5
R40	22K	5
R41	47	10
R42	10	10
R43	220	10
R44	220	10
R45	10	5
R46A	3.3K	10
R46B	3.3K	10
R47	150	10
R48	2.7K	10

(A.L.1. Sept. 61)

LIST OF COMPONENTS

For DRIVE UNIT, RADIO TYPE 6.

(See Fig. 5 for circuit diagram)

Schem No.	Value	Tol ±%
R49	47	10
R50	47	10
R51	3.9K	10
R55	390	
RV1A	4K) ganged	
RV1B	4K)	

Schem No.	Value	Tol ±%

(A.L.1. Sept. 61)

LIST OF COMPONENTS

FOR drive unit, radio Type 6

(See Fig. 5 for circuit diagram)

Schem No.	Description
	Inductances
L1A	STC 20-LU.212C
L1B	STC 247-LU.44B
L2	STC LP.115569
L3	STC 2-LU.20 det.458
L4	STC 20-LU.212D
L5	STC 20-LU.211A
L6	STC 20-LU.211A
L7	STC 20-LU.212A
L8A	3 Turns on R15A
L8B	STC 247-LU.44B
L8C	7 Turns on R15B
L9	STC LP.115569
L10	STC 2-LU.20 det.458
L11	STC 20-LU.211A
L11A	STC 2-LU.20 det.513
L12	STC 20-LU.211A
L13	STC 20-LU.212D
L14A	STC 247-LU.44B
L14B	STC 247-LU.44B
L15	STC LP.115569
L16	STC 2-LU.20 det.458
L17	STC 20-LU.211A
L18	STC 20-LU.211A
L19	STC 20-LU.212D
L20	STC 247-LU.44A
L21	3 Turns on R41
L22	STC 2-LU.20 det.464

Schem No.	Description
L23	STC 2-LU.20 det.470
L24	STC 2-LU.20 det.498
L25	STC 247-LU.43L
L26	STC 247-LU.43H
L27	3 Turns on R25
L28	3 Turns on R36
	Blowers
B1	STC RL.7060/23B
	Meters
M1	0-10 mA

(A.L.1. Sept. 61)

LIST OF COMPONENTS

FOR drive unit radio Type 6

(See Fig. 5 for circuit diagram)

Schem No.	Description
	Switches
S1.A	S.T.C. 112-4022E
S1.B	S.T.C. 112-4022E
S1.C	S.T.C. 112-4022E
S1.D	S.T.C. 112-4013E
S1.E	S.T.C. 112-4013F
S2	S.T.C. RL7016/102D
	Valves
V1	CV 136
V2	CV 136
V3	5B/250A
V4	5B/250A
V5	5B/250A
V6	4H/180E

Schem No.	Description

(A.L.1. Sept. 61)

LIST OF COMPONENTS

FOR R.F. OUTPUT AMPLIFIER

(See Fig. 6 for circuit diagram)

Schem No.	Value	Tol ±%
C1A to) C1L }	Part of Overall assy.	
C2	.002 µF	+40 -0
C3	.002 µF	+40 -0
C4	50 pF	20
C5	50 pF	20
C6	0.01 µF	20
C7	0.01 µF	20
C8	.002 µF	+40 -0
C9	.002 µF	+40 -0
C10	.002 µF	+40 -0
C11	.002 µF	+40 -0
C12	.001 µF	
C13A	50 pF	
C13B	50 pF	
C14A	25 pF	
C14B	25 pF	
C14C	25 pF	
C14D	25 pF	
C15	.001 µF	20
C16A	.002 µF	
C16B	.002 µF	
C17	160 pF	5
C18	160 pF	5

Schem No.	Value	Tol ±%
C19	200 pF	5
C20	200 pF	5
C21	200 pF	5
C22	200 pF	5
C23	25 pF	10
C24	25 pF	10
C25	0.01 µF	20
C26	0.01 µF	20
C27	0.01 µF	20
C28	50.6 pF	
C29	150 pF	20
C30	5 pF part of overall assy.	

LIST OF COMPONENTS

FOR R.F. OUTPUT AMPLIFIER

(See Fig. 6 for circuit diagram)

Schem No.	Value	Tol ±%
R2	2.1	5
R3	5	5
R4	5	5
R5	2.1	5
R6	50	5
R7A	600	5
R7B	600	5
R8	5K	
R9A	5K	
R9B	5K	
R10	10	
R11	10	
R12	10	
R13	10	
R16	220	5
R17A	150	5
R17B	150	5
R18A	150	5
R18B	150	5
R19	220	5
R20	220	5
R21	220	5
R22	220	5
R25	40	
R26	40	
R27	65	
R28	40	
R29	40	

Schem No.	Value	Tol ±%
R30	65	
R33	Metrosil Unit	
R34	2.5	10
R35	2.5	10
R36	50	5
R37	50	5
R38	50	5
R39	100	
R40	100	
R41	500	
R42	220	5
R43	10K	

(A.L.1. Sept. 61)

LIST OF COMPONENTS

FOR R.F. OUTPUT AMPLIFIER

(See Fig. 6 for circuit diagram)

Schem No.	Description
	Chokes
CH.1	STC 28 LU.295 Det.158
CH.2	STC 28 LU.295 Det.158
CH.3	Wound on R8
CH4A	Wound on R9A
CH4B	Wound on R9B
CH5	STC 28 LU.295 Det.399
CH6	STC 28 LU.295 Det.399
CH7	STC 28 LU.295 Det.399
CH8	STC 28 LU.295 Det.399
	Inductances
L1	STC 28 LU.188B
L2	STC 45 LU.30A
L3	STC RL 7009-159A
L4	STC RL 7009-159A
L5	STC RL 7009-159A
L6	12 µH
L7	12 µH
L8	30 µH
L9	30 µH
L10	1 µH

Schem No.	Description
	Fuses
F1	10A
F2	10A
F3	10A
F4	0.5A
F5	0.5A
	Meters
M1	0-5 mA
M2	2-0-2A
M3	0-4A
M4	0-4A
M5	0-5 mA
M6	0-5 mA
	Overload Relays
OL1	STC 4662 MAA
OL2	STC 4662 MAA
	Variable resistors
P1	STC 189 LRA 5A

(A.L.1. Sept. 61)

LIST OF COMPONENTS

FOR R.F. OUTPUT AMPLIFIER

(See Fig. 6 for circuit diagram)

Schem No.	Description
	Valves
V1	3J260E
V2	3J260E
	Relays
REL1	STC 42-4007B
REL2	STC 400 LRU 76C
REL3	STC 400 LRU 76D
REL4	STC 42-4007C
REL5	STC 42-4007C
REL6	STC 42-4007C
REL7	STC 42-4007C
REL8	STC 42-4007E
REL10	STC 4664 MEY
REL11	STC 4664 MEY
REL12	STC 4664 MEY
	Lamps
1/1	24V 6W
1/2	24V 6W
1/3	24V 6W
1/4	24V 6W
1/5	24V 6W
1/6	24V 6W

Schem No.	Description
	Rectifiers
RECT1	STC H45-4-IL
RECT2	STC H45-4-IL
RECT3	STC H45-4-IL
	Transformers
T1	STC RL7008-481A
T2	STC RL7008-481B
T3	STC AS46147/39
	Switches
S1 to)	Burgess micro-switch
S9)	Type BRS
S10	Diamond 'H' 3TP
S11	M.S.M. Type MS58
S12	Santon Type R141/2C

(A.L.1. Sept.61)

LIST OF COMPONENTS

FOR Monitoring units Type 37

(See Fig. 7 for circuit diagram)

Schem No.	Description
	Capacitors
C1	Part of overall assembly
C2	Part of overall assembly
C3	47pF 5% ±
C4	47pF 5% ±
C5	.001/uF 20% ±
C6	.001/uF 20% ±
C7	.001/uF 20% ±
C8	.001/uF 20% ±
C9	.002/uF 20% ±
	Valves
V1	CV 1931

Schem No.	Description
	Resistors
R1	27K 5% ±
R2	27K 5% ±
R3	100 ohms 5% ±
R4	100 ohms 5% ±
	Relays
RLA	STC 4190GG

(A.L.1. Sept. 61)

LIST OF COMPONENTS

FOR Monitoring Unit Type 7205

(See Fig. 8 for circuit diagram)

Schem No.	Description
	Capacitors
C1	Part of overall assembly
C3	47pF ± 5%
C5	.001 µF ± 20%
C6	.001 µF ± 20%
C7	.001 µF ± 20%
C8	.001 µF ± 20%
C9	.002 µF ± 20%
	Resistors
R1	27K ± 5%
R3	100 ohms ± 5%
R4	100 ohms ± 5%
	Valves
V1	CV 1931

Schem No.	Description
	Switches
S1	Cutler Hammer
	8373-K8

(A.L.1. Sept. 61)

LIST OF COMPONENTS

FOR Mains distribution unit 196-LE.4F

(See Fig.9 for circuit diagram)

Schem No.	Description
	Circuit Breakers
CB1	Oil Circuit breaker STC RL7082-2A
	Current Transformers
CT1	Supplied with Ammeter
CT2	Supplied with Ammeter
CT3	Supplied with Ammeter
CT4	Supplied with KWHmeter
CT5	Supplied with KWHmeter
	Meters
M1	0-175A Ammeter
M2	KWH meter
M3	0-500V
M4	Operating hour clock
	Rectifiers
RECT1	3 Units D112-4-3W
	Lamps
L/1	24V 6W
L/2	24V 6W
L/3	24V 6W

Schem No.	Description
	Relays
REL1	Time delay relay EN Bray Type CNY
REL 2	3 Pole contactor EN Bray Type CNY
REL3	3 Pole contactor EN Bray Type CNY
REL4	STC 4672 AEE
REL5	STC 4672 AEE
REL6	STC 4672 AEE
REL7	STC 4672 AEE
	Resistors
R1	Potentiometer for M3
R2	250 ohms
R3	1K 50W
R4	1K 50W
R5	1K 50W
	Switches
S1	Ammeter switch
S2	Voltmeter switch
S3	3 pole c/o
S4	3 Pole c/o

(A.L.1. Sept. 61)

LIST OF COMPONENTS

FOR Mains distribution Unit 196-LE-4F

(See Fig.9 for circuit diagram)

Schem No.	Description
	Transformers
T1	STC RL7008-419
T2	STC RL7008-543B
T3	STC RL7008-493
T4	STC RL7008-544A
T5	STC RL7008-625A
	Switch fuses
SF1	STC 112-LRU-139A
SF2	3 Pole 500V 30A
SF3	3 Pole 500V 30A
SF4	3 Pole 500V 15A
SF5	3 Pole 500V 15A
SF6	3 Pole 500V 15A
SF7	3 Pole 500V 15A
SF8	3 Pole 500V 15A
SF9	3 Pole 500V 15A
SF10	3 Pole 500V 30A

Schem No.	Description
	Fuses
F1	0.5A
F2	0.5A
F3	0.5A
F4	4A
F5	6A
F6	6A
F7	6A
F8	10A
F9	1A
F10	1A
F11	1A
F12	1A Slydlok
F13	1A Slydlok
F14	0.5A
F15	0.5A
F16	1A

(A.L.1. Sept. 61)

LIST OF COMPONENTS

FOR 50V Rectifier for Contactors.

(See Fig. 27 for circuit diagram)

Schem No.	Description
	Transformers
T1	STC RL7008-493A
	Rectifiers
Rect.1	STC D112-4-3L
Rect.2	STC D112-4-3L
Rect.3	STC D112-4-3L

Schem No.	Description

(A.L.1. Sept. 61)

LIST OF COMPONENTS

FOR Mixer Unit Type 25

(See Fig.33 for circuit diagram)

Schen No.	Description	
	Resistors	
R1	75	± 5%
R2	47	± 10%
R3	75	± 5%
R4	1K	± 10%
R5	47	± 10%
R6	3.3K	± 10%
R7	2.2K	± 10%
R8	47K	± 5%
R9	12K	± 5%
	Inductors	
L1	STC 20-LU-212F	

Schen No.	Description	
	Capacitors	
C1	0.01 µF	± 20%
C2	0.01 µF	± 20%
C3	100pF	± 5%
C4	.002 µF	± 10%
C6	0.01 µF	± 20%
C7	0.01 µF	± 20%
	Valves	
V1	CV 136	

(A.L.1. Sept. 61)

LIST OF COMPONENTS

FOR Power Unit Type 818

(See Fig.34 for circuit diagram)

Schem No.	Description
	Capacitors
C1	4 µF ± 10%
C2	4 µF ± 10%
	Chokes
CH1	S.T.C. RL 7009/146
	Transformers
T1	S.T.C. RL 7008/441
	Rectifiers
Rect.1	S.T.C. 280-LU-482D

Schem No.	Description

(A.L.1. Sept. 61)

LIST OF COMPONENTS

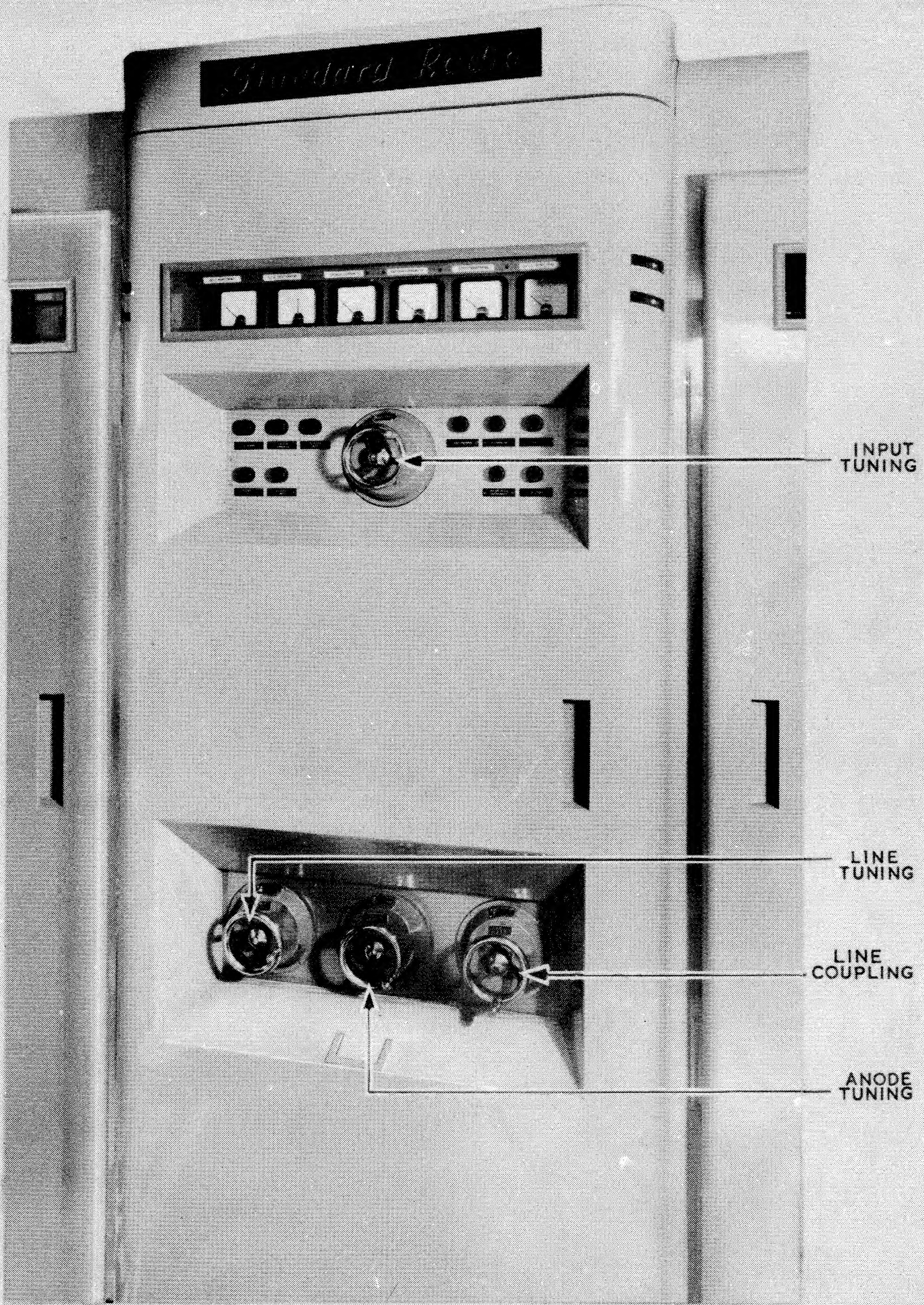
FOR Power Unit Type 828

(See Fig. 35 for circuit diagram)

Schem No.	Description	
	Transformers	
T1	STC RL7008/619A	
	Capacitors	
C1	4 μF	± 20%
C2	4 μF	± 20%
	Chokes	
CH1	STC RL7009/146	
	Rectifiers	
RECT.1	6 - Rectifiers STC 280-LU-413BW	

Schem No.	Description
	Sockets
SKT.2	STC LP.115188
	Plugs
P1	STC LP.115194

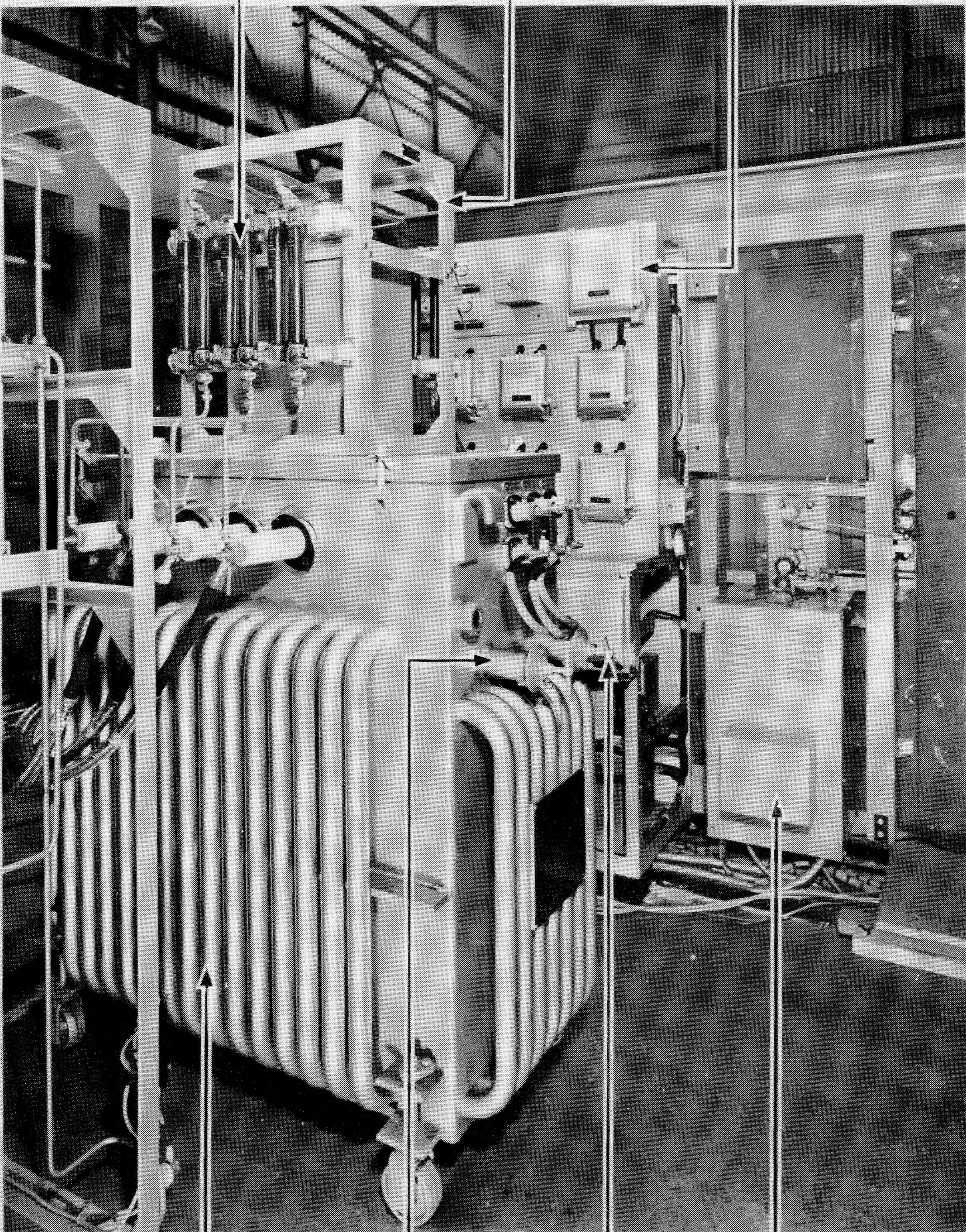
(A.L.1. Sept. 61)



R.F. OUTPUT AMPLIFIER

[TUNING CONTROLS]

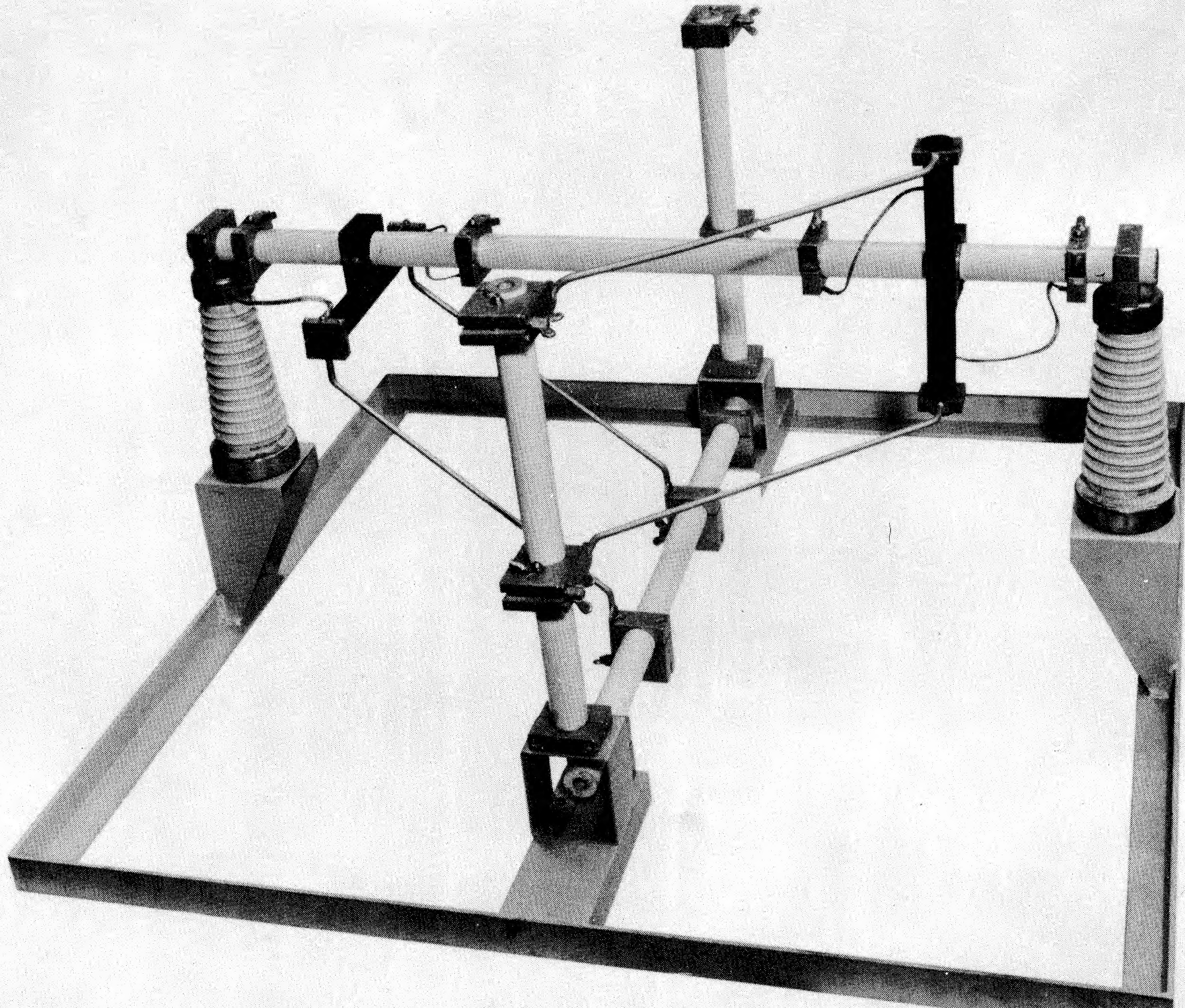
PLATE I



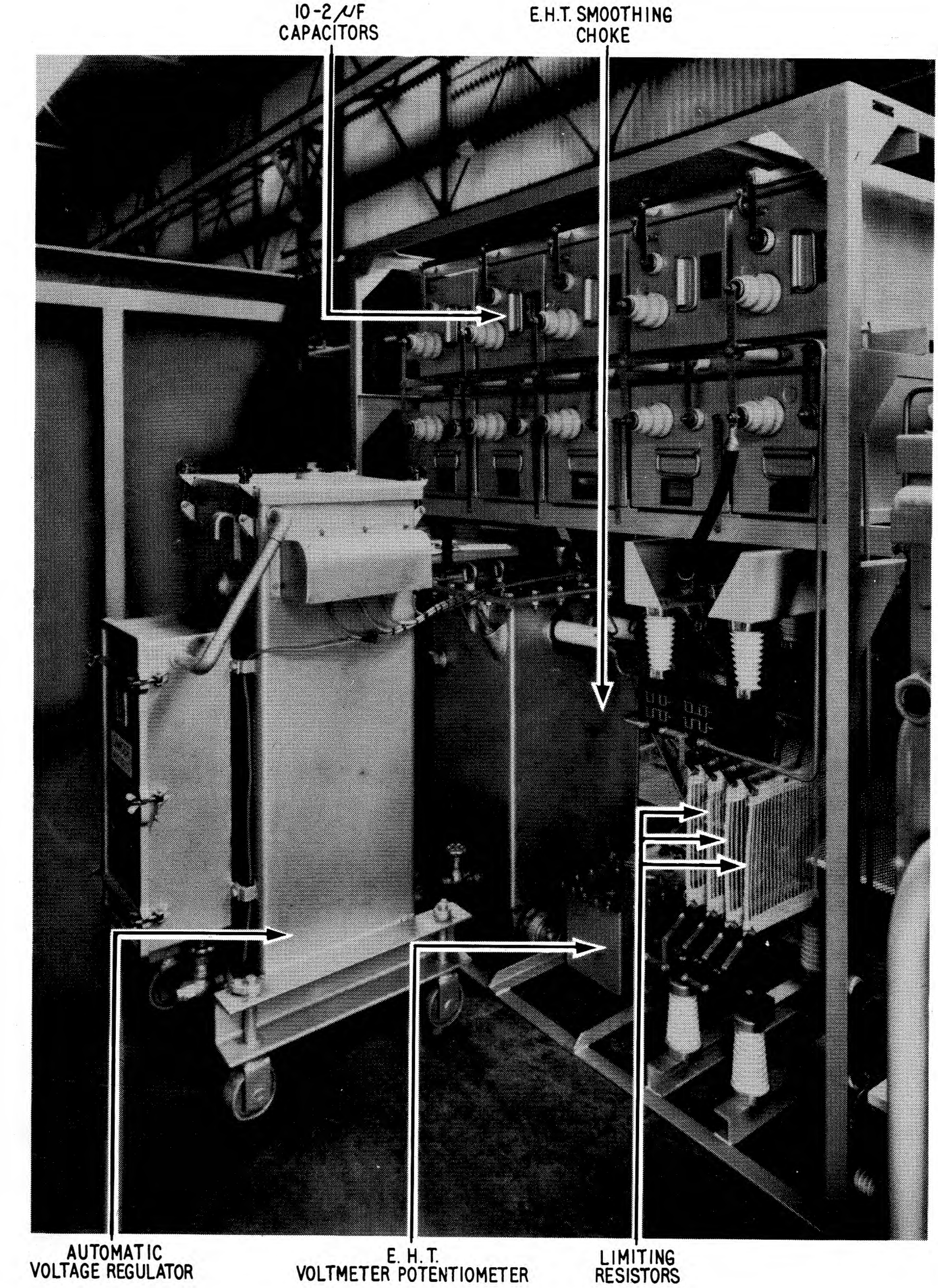
E.H.T. TRANSFORMER, MAINS DISTRIBUTION UNIT & ISOLATOR.

PLATE II

PLATE III

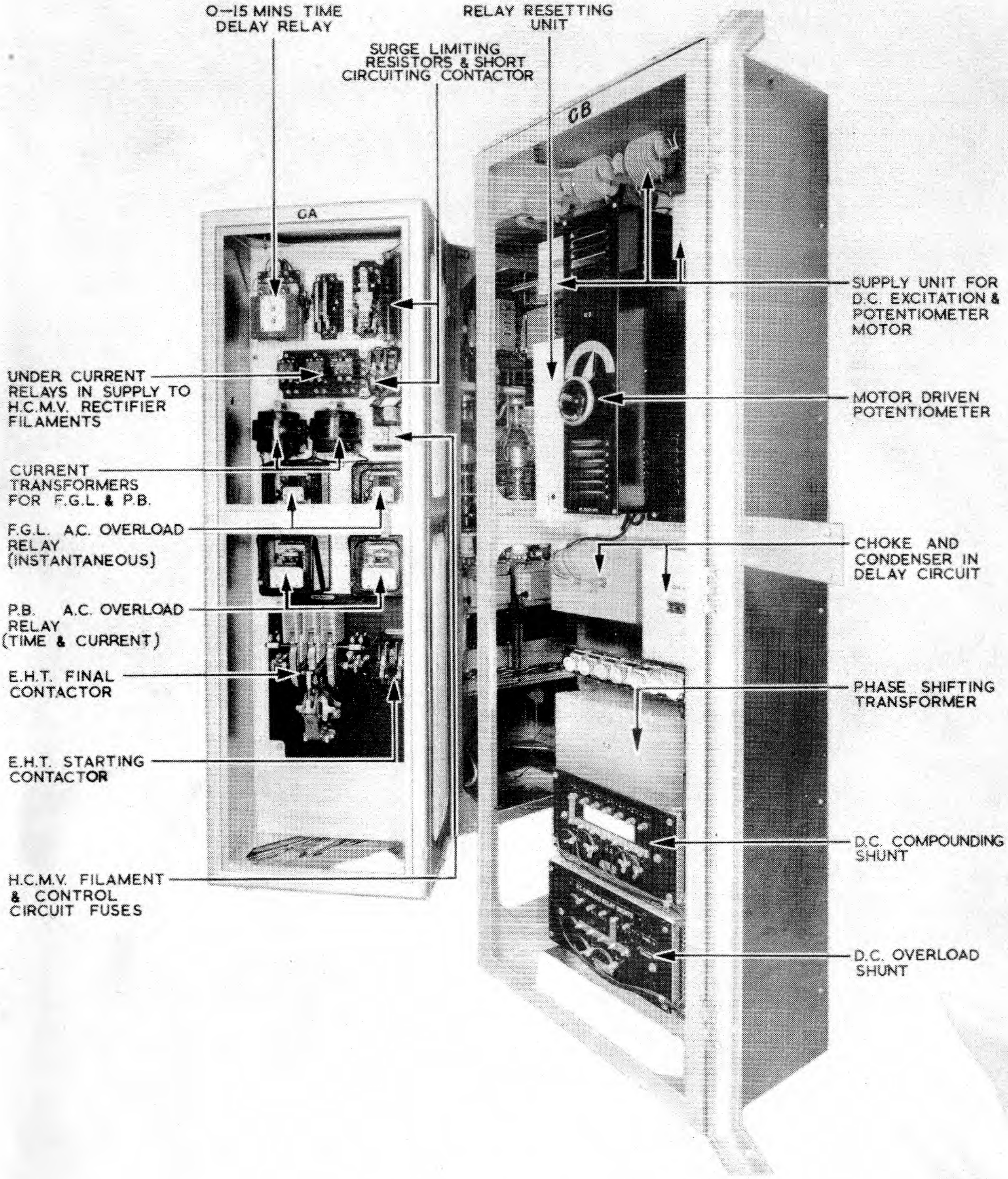


AERIAL CHANGE-OVER SWITCH



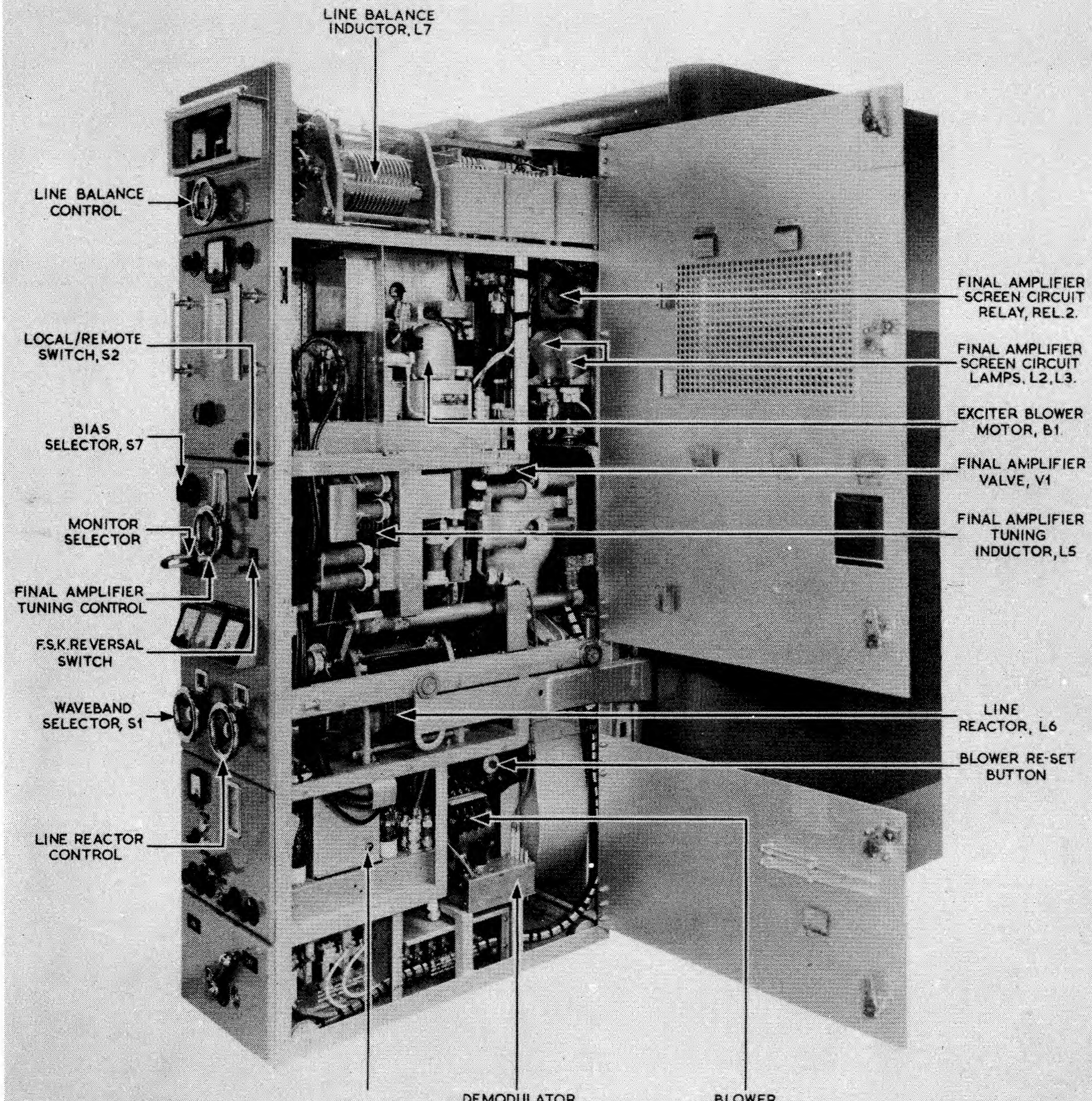
AUTOMATIC VOLTAGE REGULATOR AND E.H.T. SMOOTHING UNIT.

PLATE IV



E.H.T RECTIFIER (G)

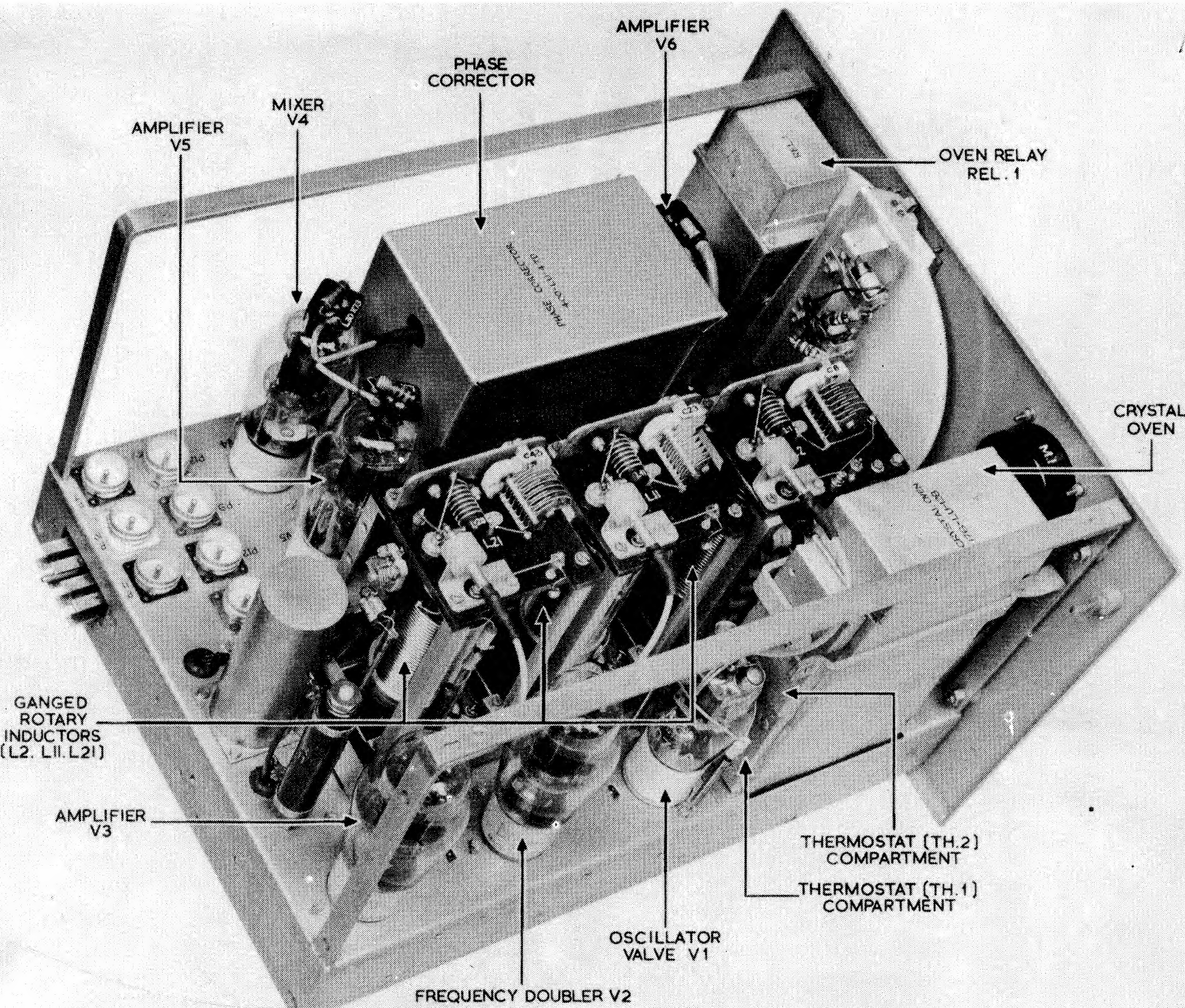
PLATE V



RADIO-FREQUENCY TRUCK. CODE No. 389-LE.2M
(RIGHT HAND VIEW)

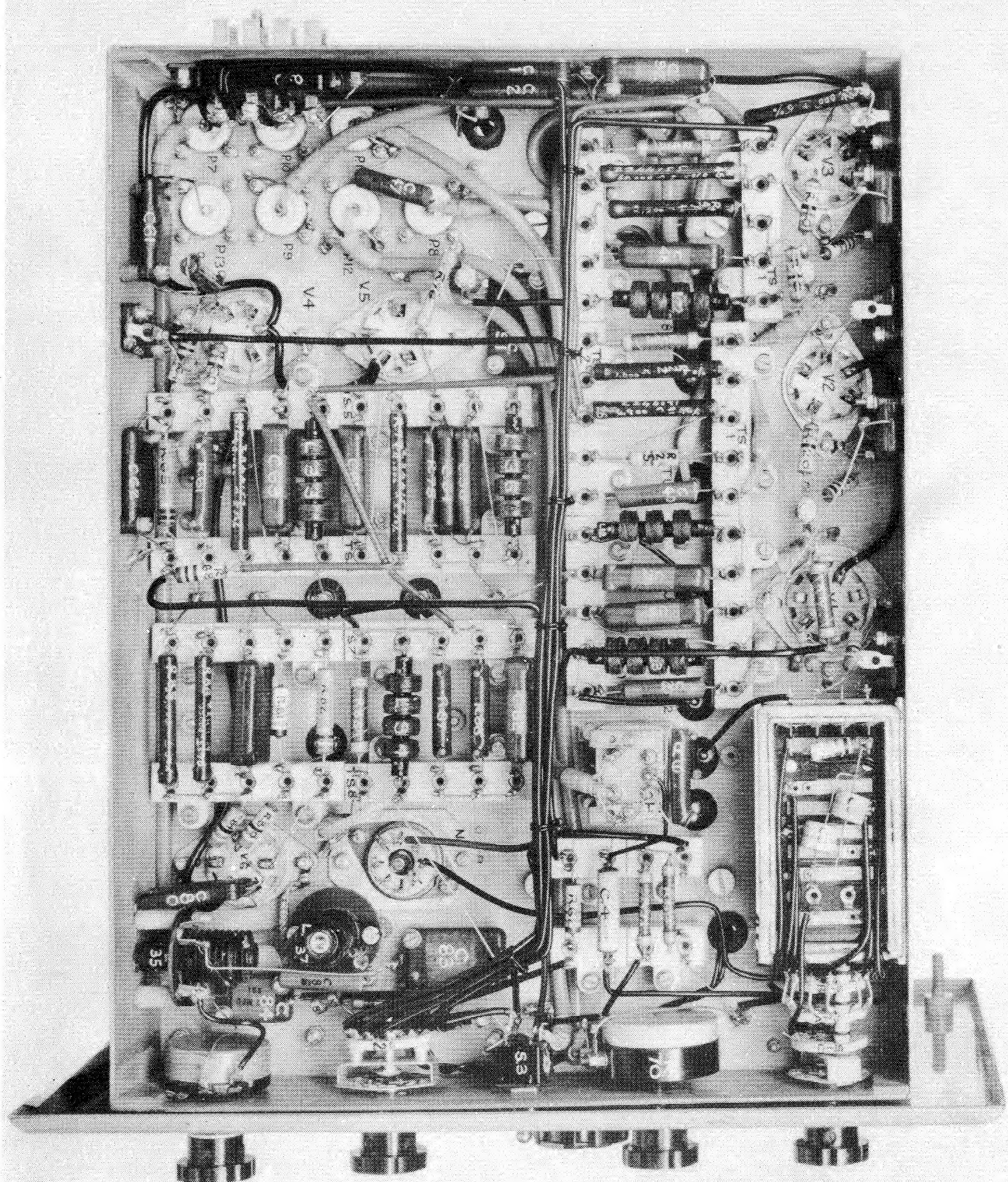
PLATE VI

PLATE VIII



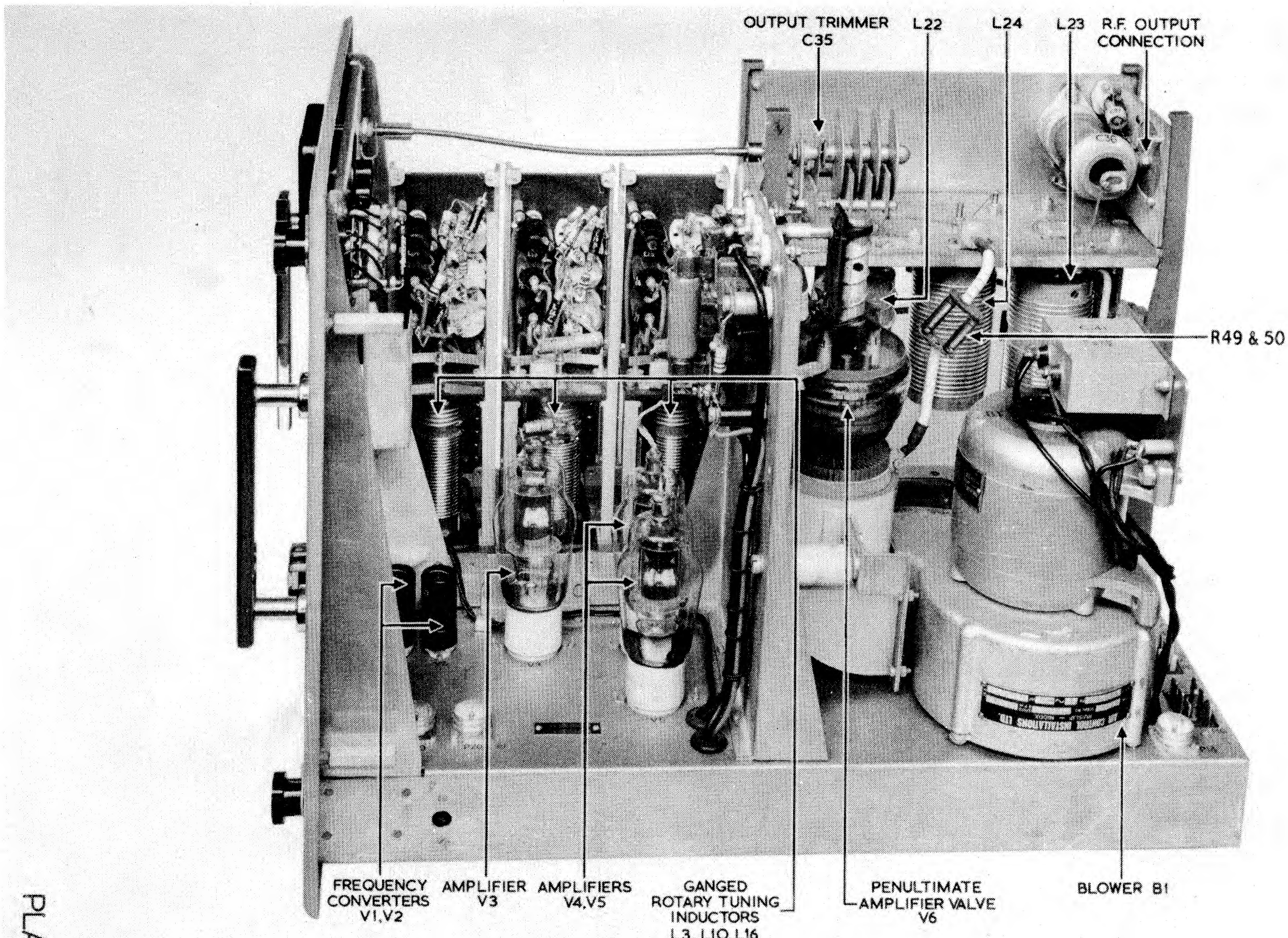
OSCILLATOR & NEGATIVE FEEDBACK UNIT. CODE No. 28-LU. 234G.

(CANS REMOVED FROM TUNED CIRCUITS)



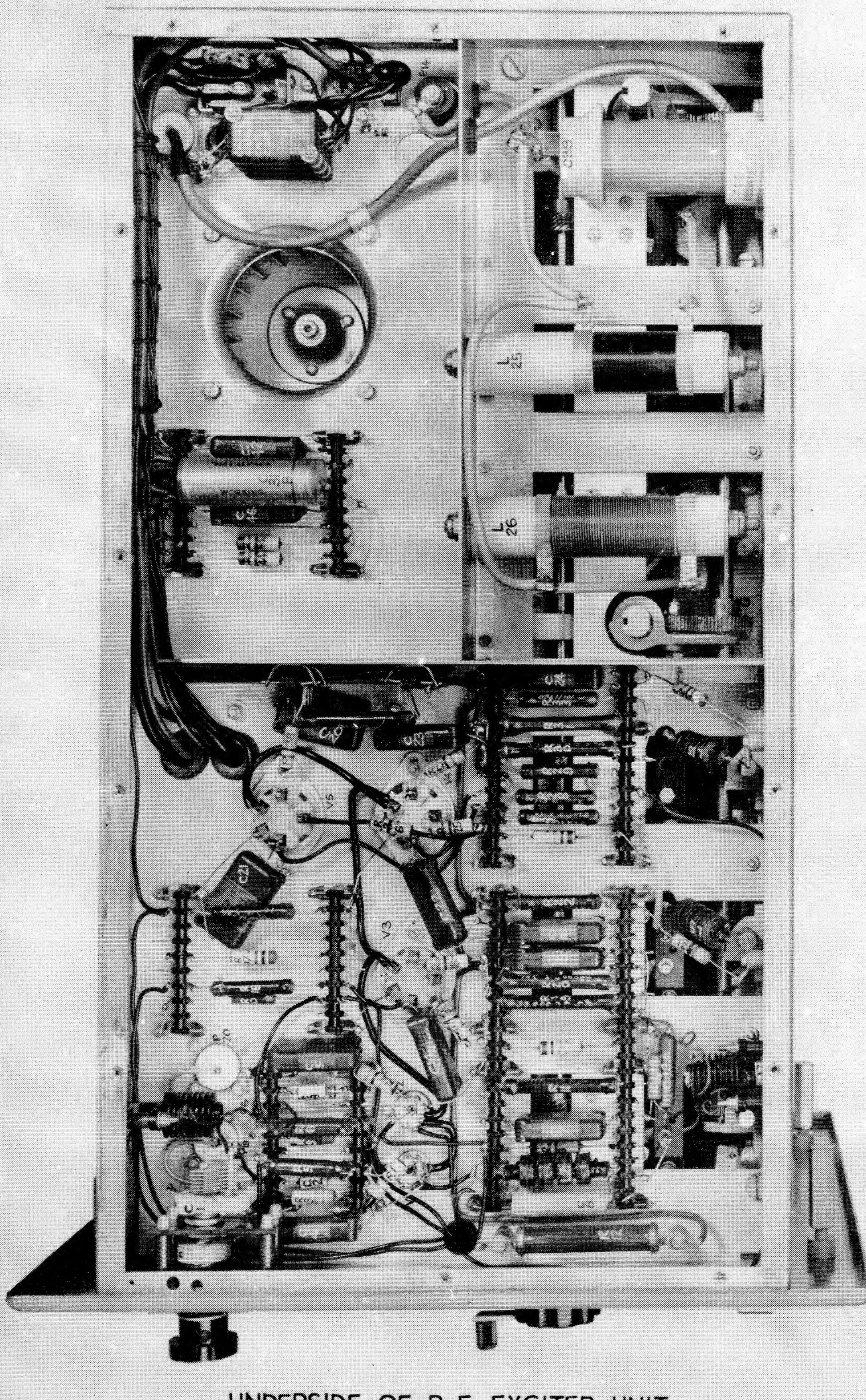
UNDERSIDE VIEW OF OSCILLATOR & NEGATIVE FEEDBACK UNIT.
CODE No. 28-LU.234G.

PLATE VIII



R.F. EXCITER UNIT. CODE No. 181-LU. 13E.
(SCREENING CANS REMOVED)

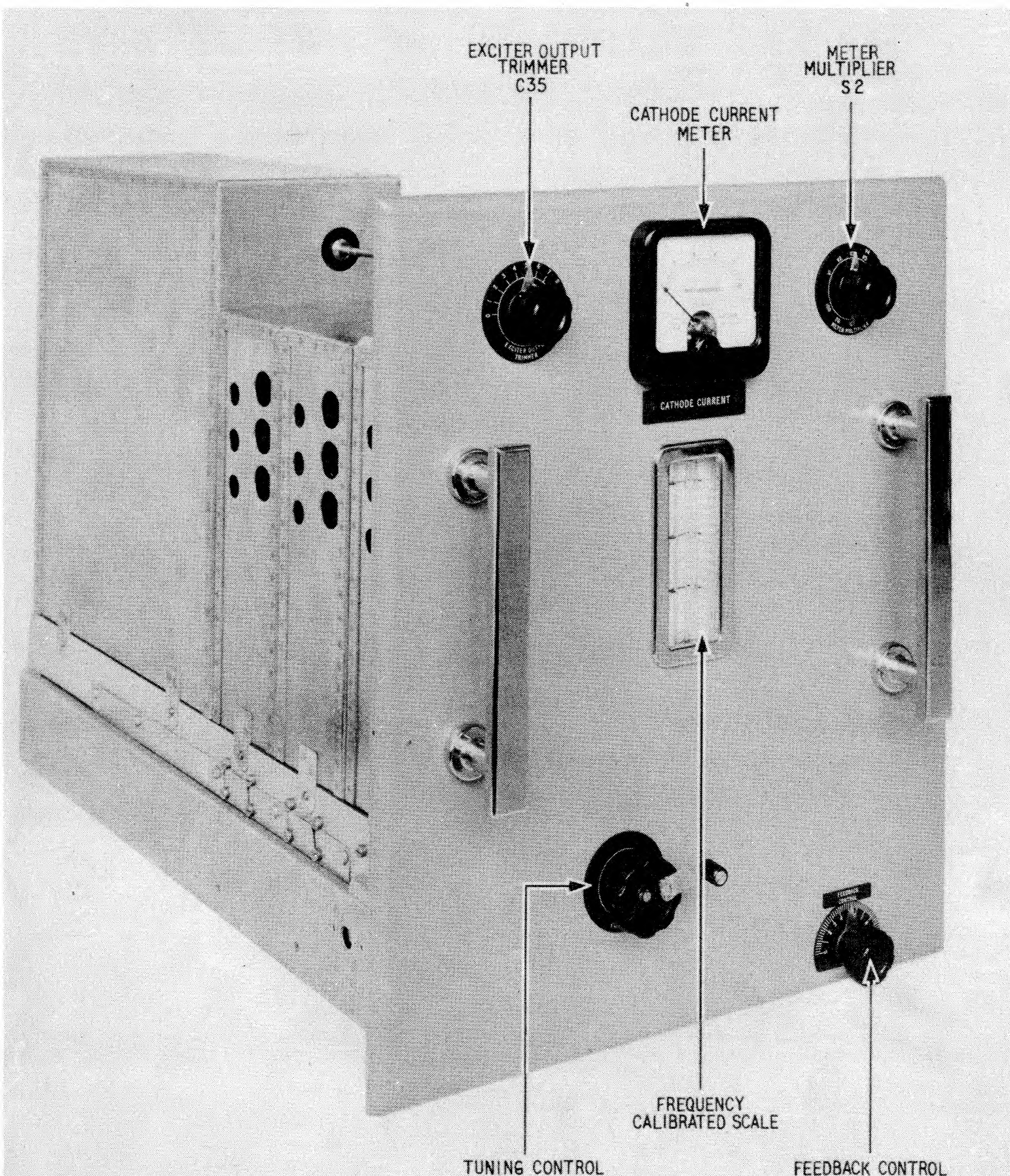
PLATE IX



UNDERSIDE OF R.F. EXCITER UNIT

CODE No. 181-LU.13E

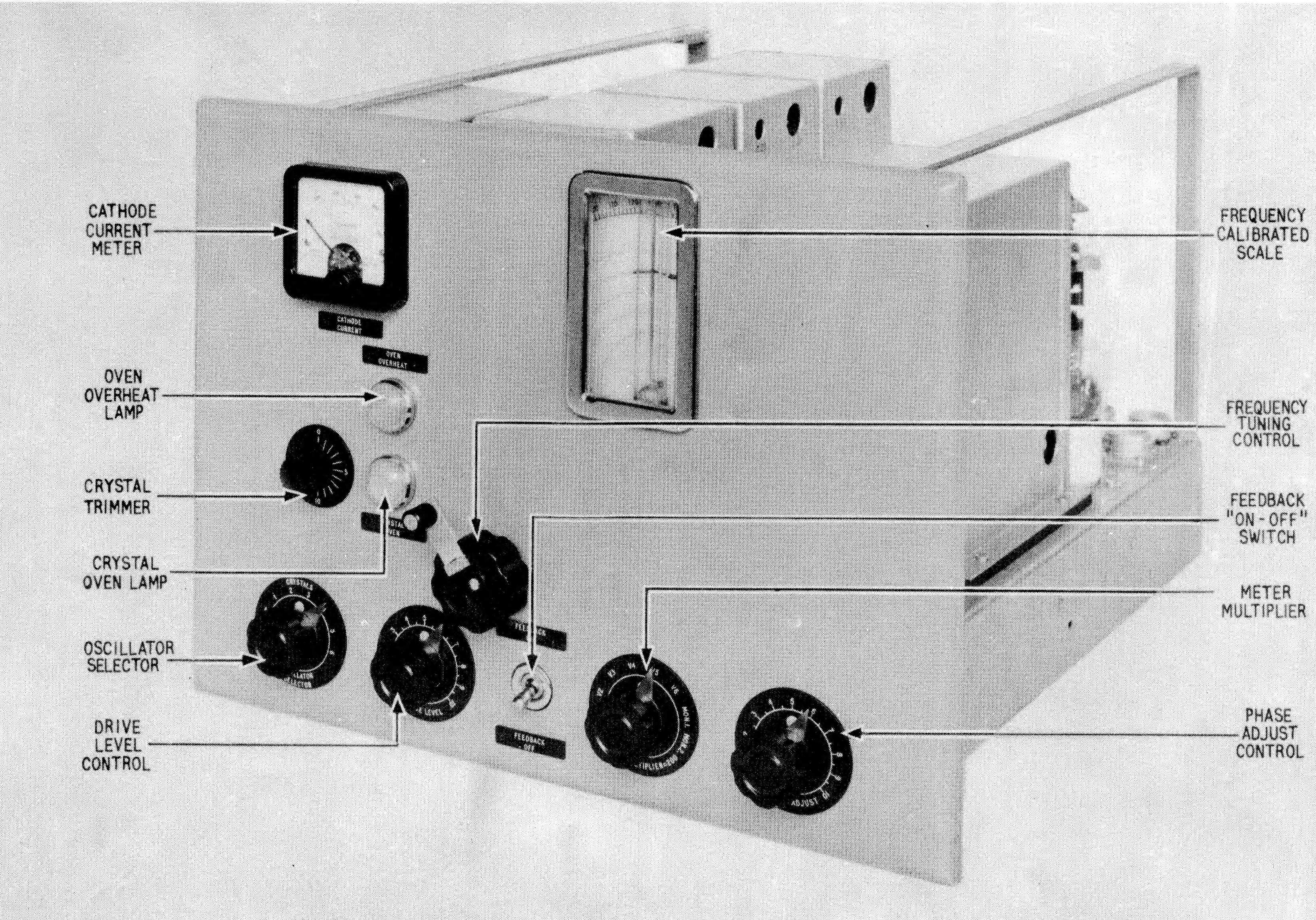
PLATE X



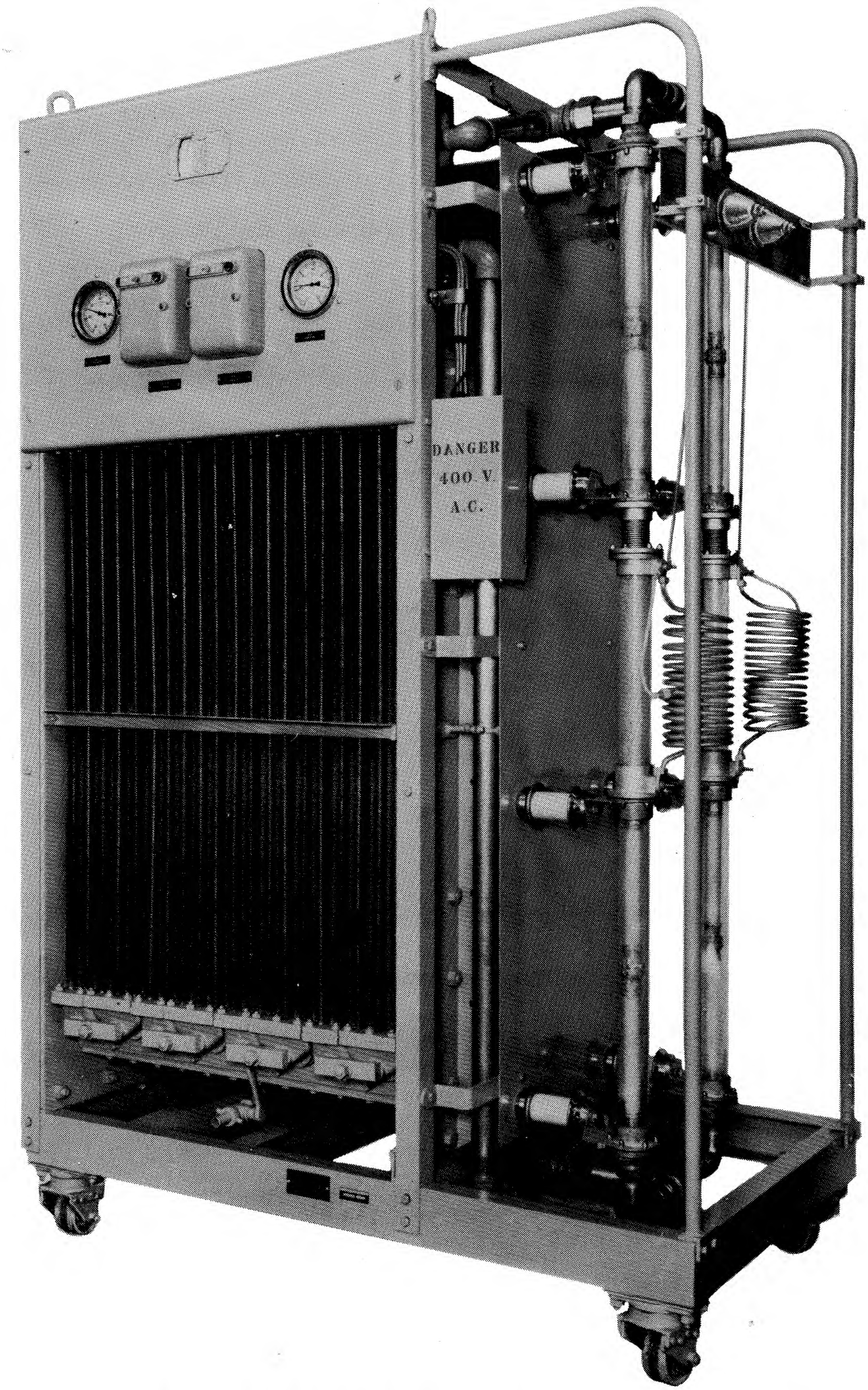
R. F. EXCITER, (181-LU.13E).

PLATE XI

PLATE XII



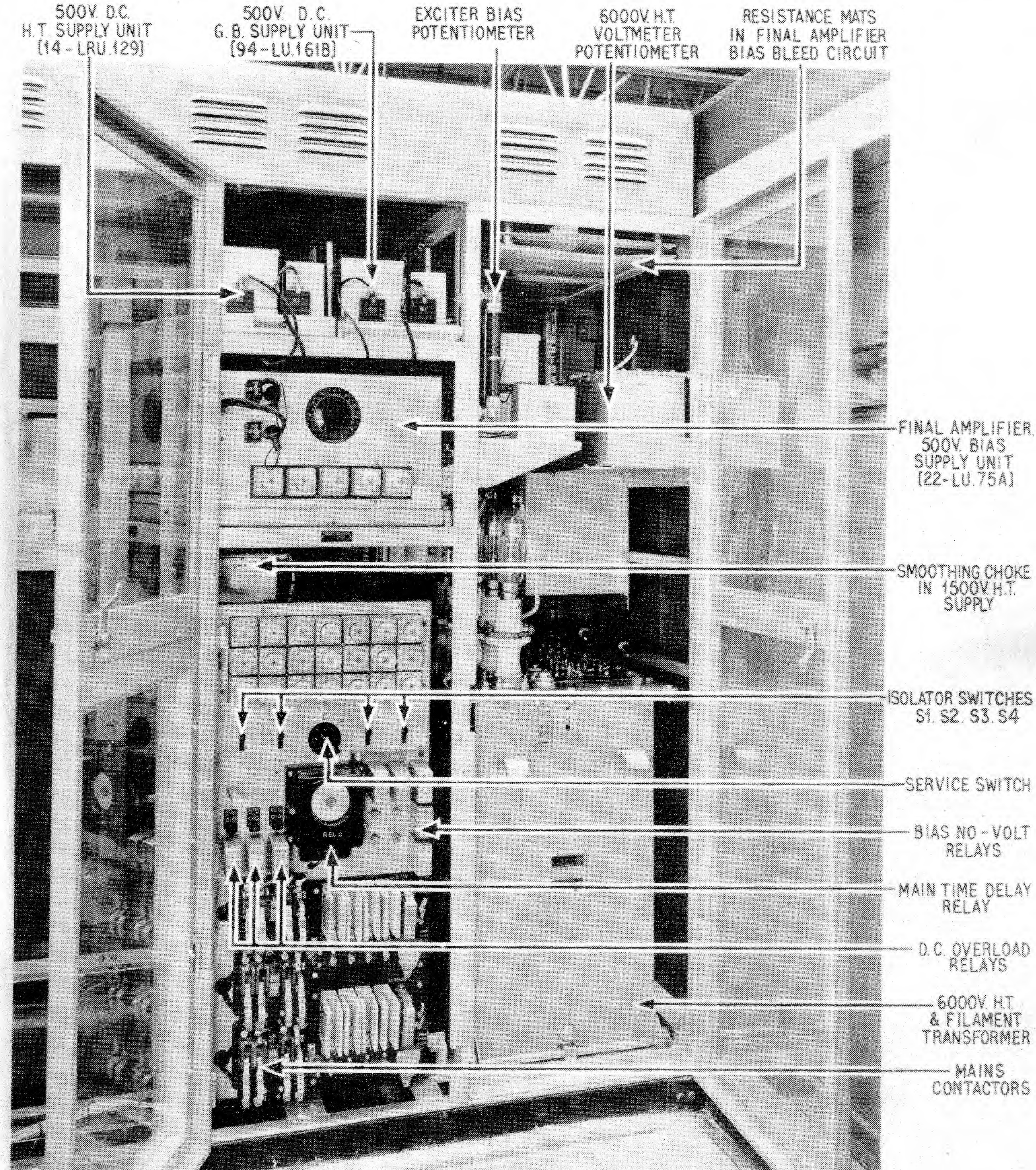
OSCILLATOR AND NEGATIVE FEEDBACK UNIT, (FRONT PANEL).
28-LU.234G



ARTIFICIAL AERIAL LOAD (Screens removed)

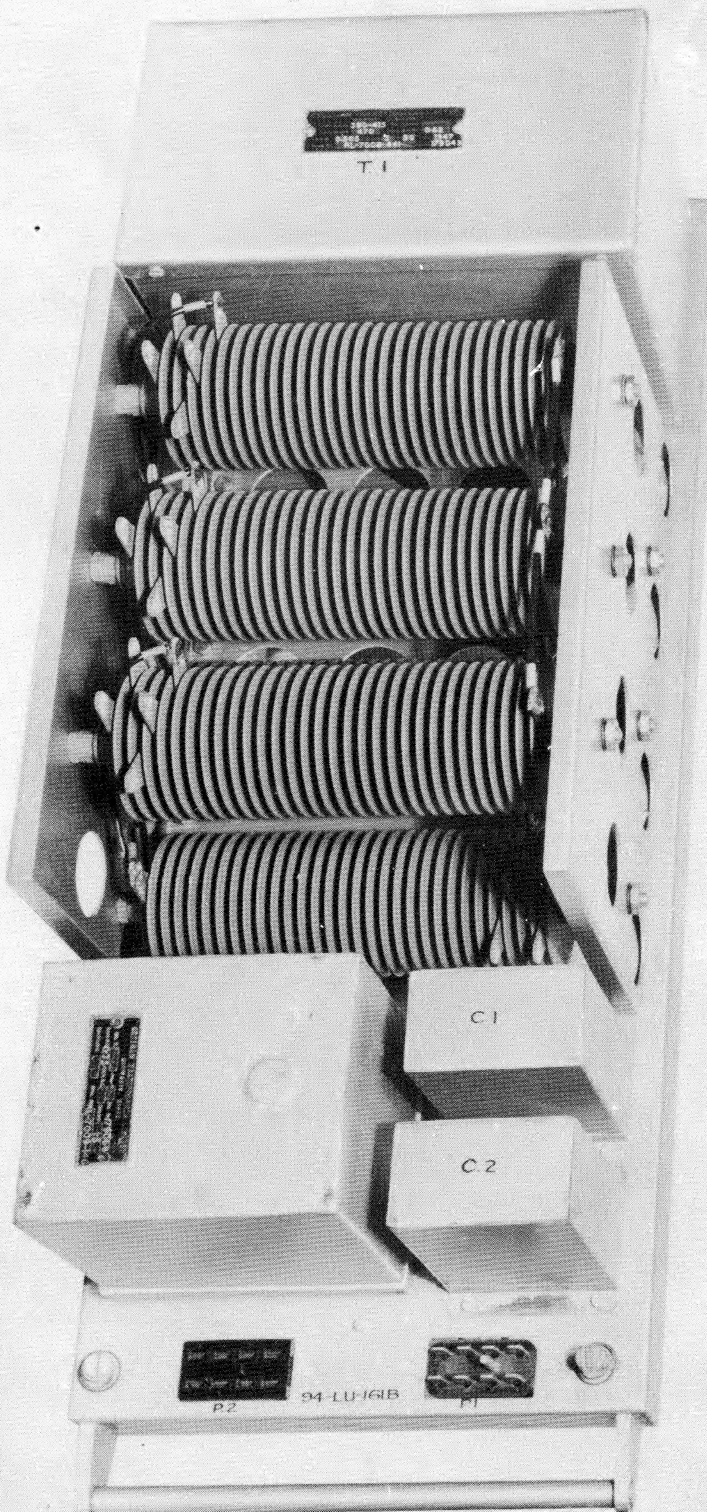
CODE No 140-LRU·55B

PLATE XIII



EXCITER POWER SUPPLY UNIT.

PLATE XIV



-500 VOLT D.C. BIAS SUPPLY UNIT.
CODE No. 94-LU.161B

PLATE XV

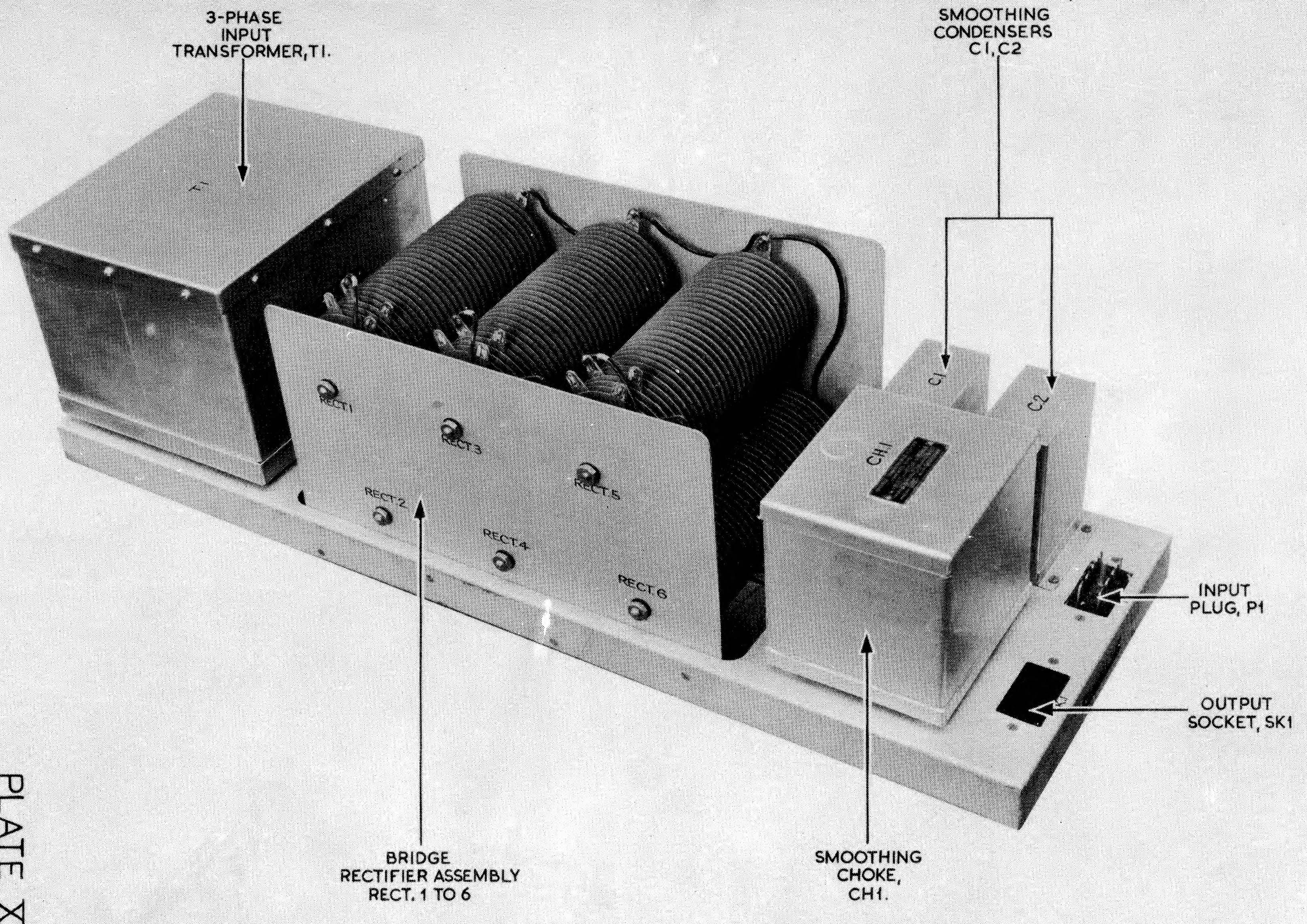
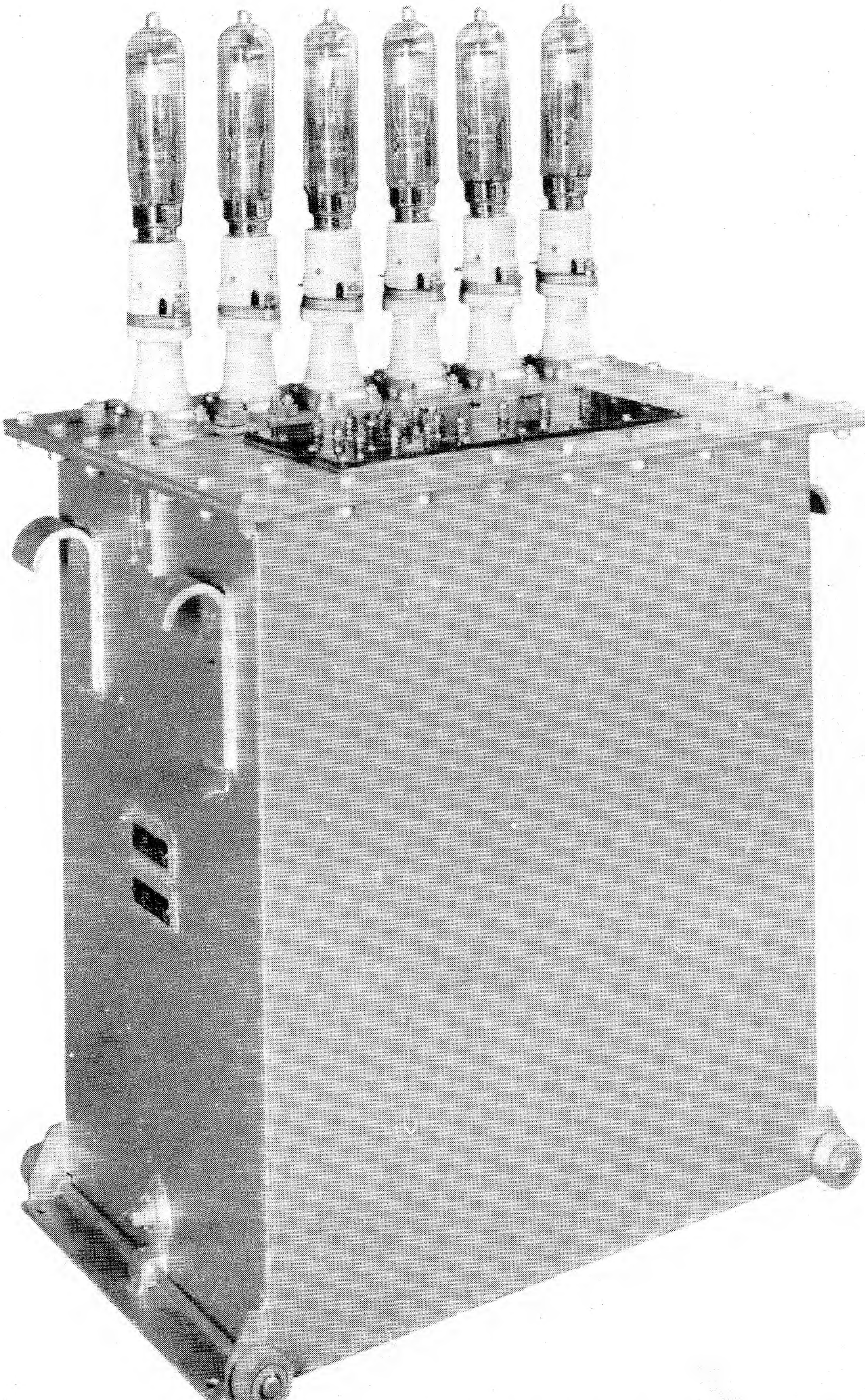


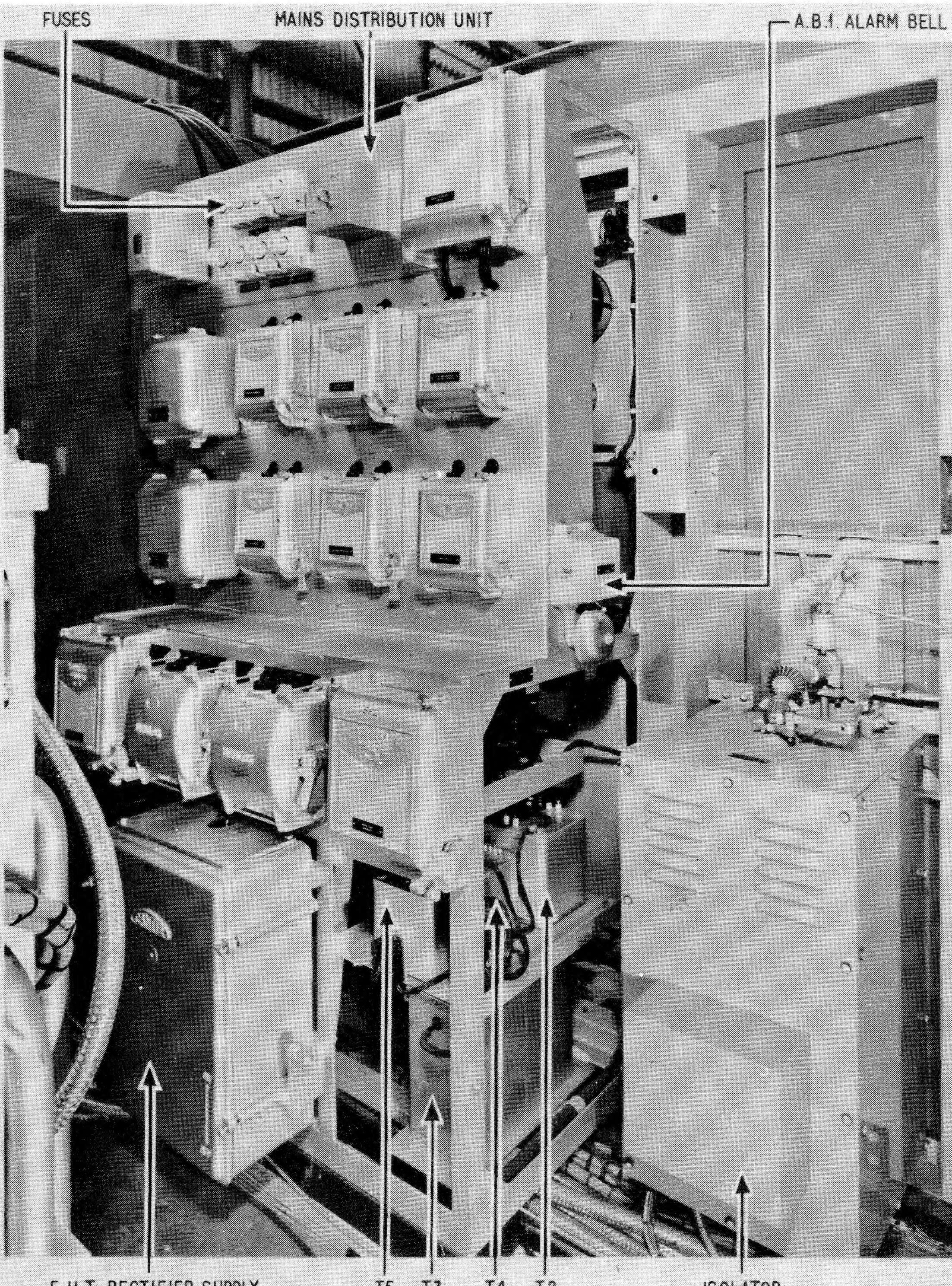
PLATE XVI

500 VOLT H.T. SUPPLY UNIT, CODE No. 14-LRU.129A



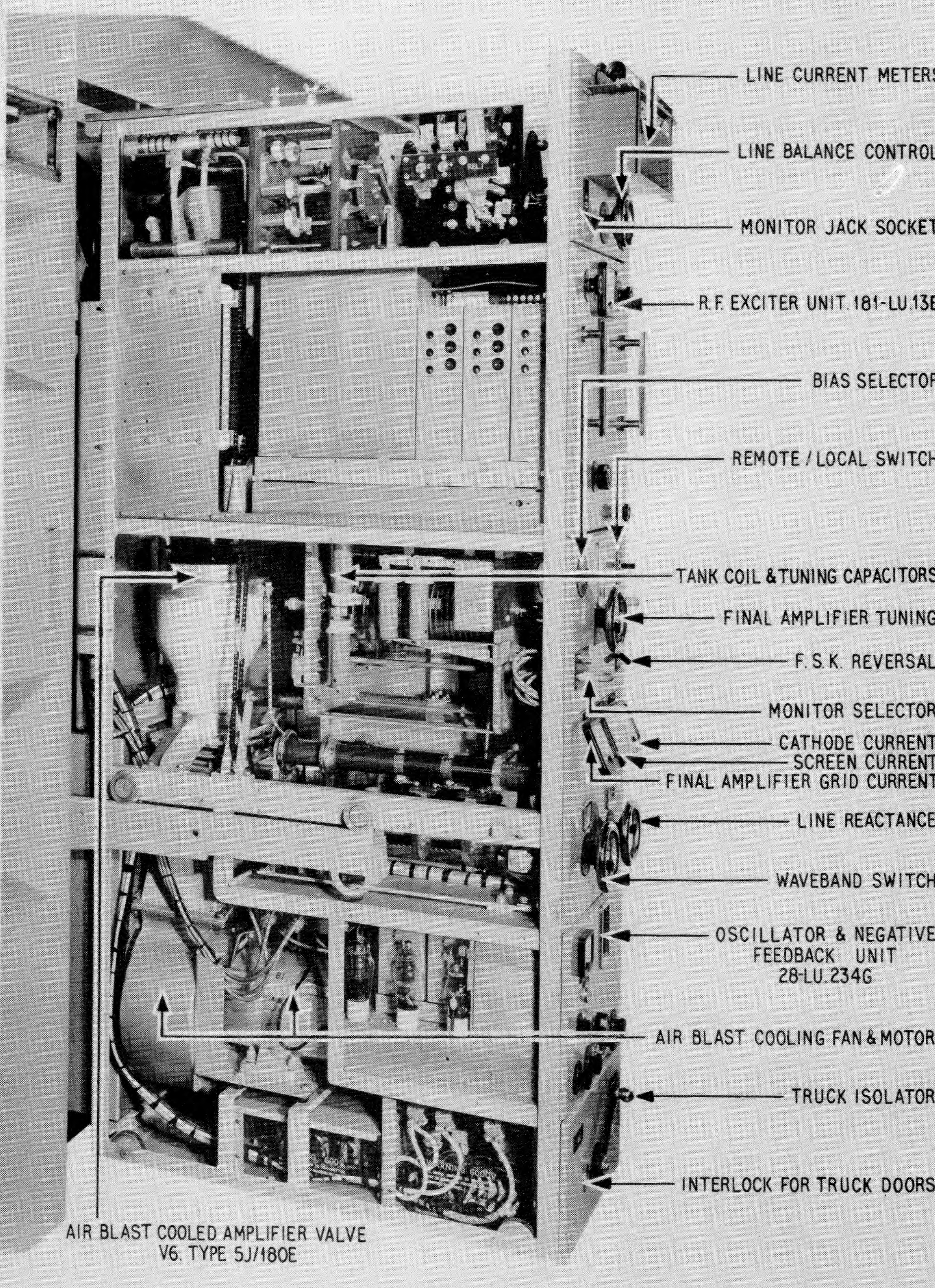
6000 VOLT D.C. SUPPLY EQUIPMENT
(TRANSFORMER & RECTIFIER VALVES)

PLATE XVII



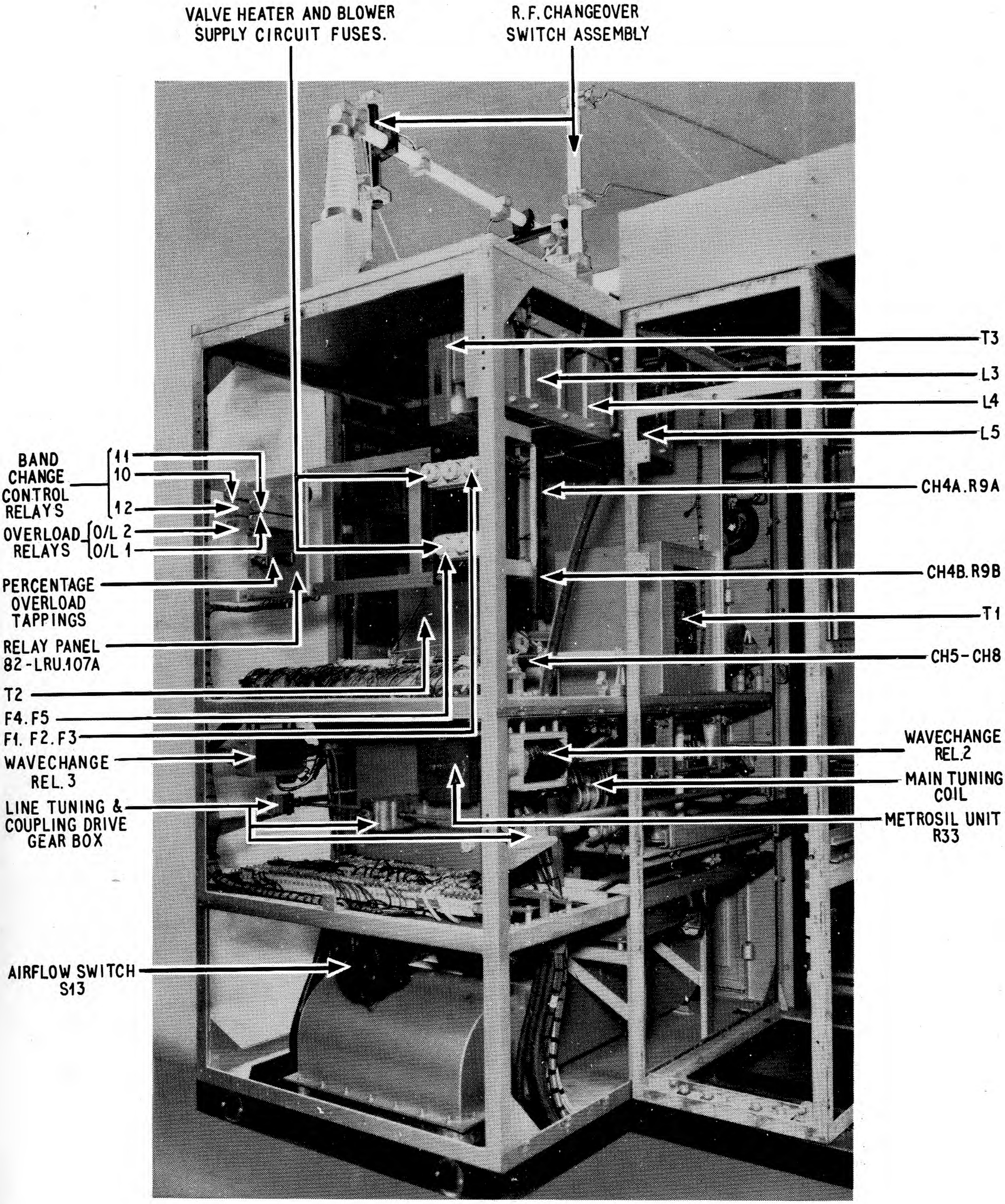
MAINS DISTRIBUTION UNIT AND ISOLATOR.

PLATE XVIII



R.F. TRUCK (J), L.H. VIEW.

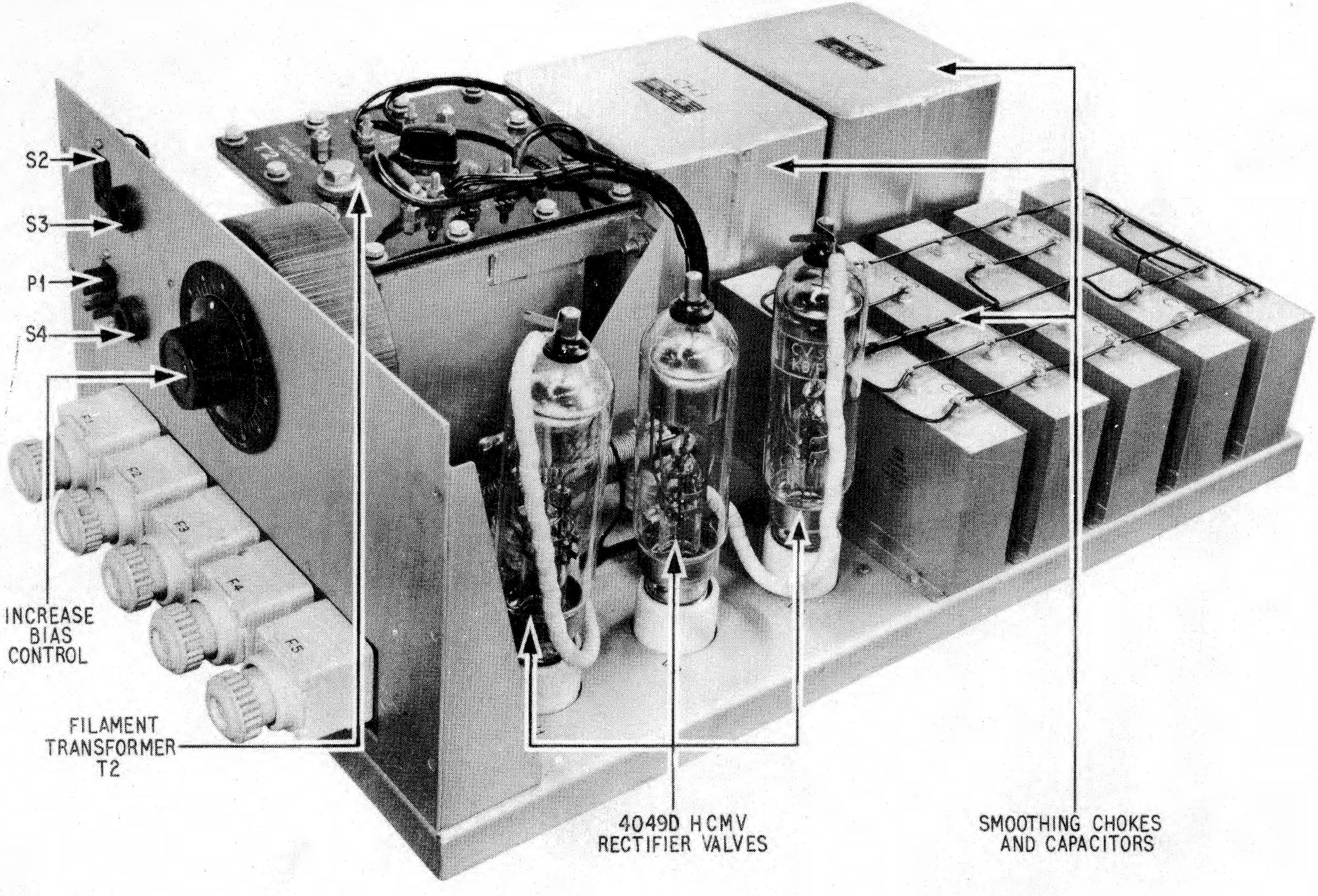
PLATE XIX



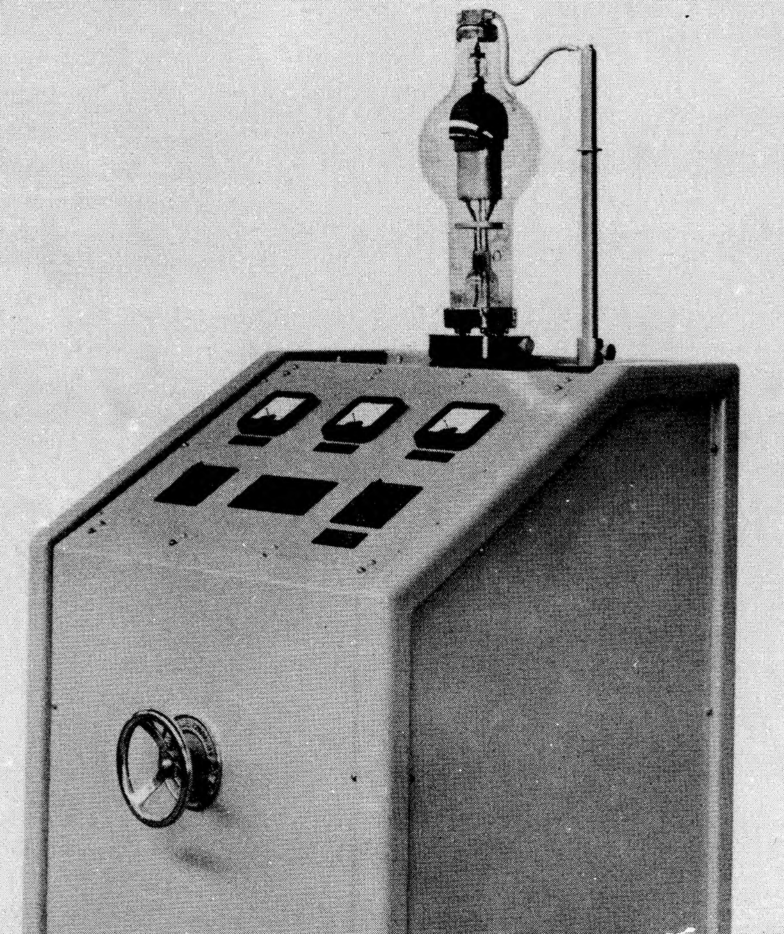
R. F. AMPLIFIER & CHANGEOVER SWITCH.

PLATE XX

PLATE XXI



500 V. G.B. UNIT (22 - LU. 75A)



VALVE CONDITIONING UNIT (103-LU. 19C)

PLATE XXII