AIR PUBLICATION

**2877U**

**VOLUME 1**

# TRANSMITTER TYPE SWB 8X

## (TRANSMITTERS TYPE T.1975, T.1976, T.2000 AND T.7095)

## GENERAL AND TECHNICAL INFORMATION

Prepared by direction of
the Minister of Aviation

Promulgated by Command
of the Air Council


AIR MINISTRY

*(A.L.12, Oct. 59)*

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## LIST OF ASSOCIATED PUBLICATIONS

| | A.P. |
|---|---|
| *Transmitter Type SWB11X* | *2877V* |
| *Drive unit (radio) Type 7* | *2877W* |
| *Drive unit (radio) Type 4* | *2883Q* |

# LAYOUT OF A.P.2877U

## TRANSMITTER TYPE SWB 8X

*Heavy type indicates books being issued under this A.P. number; when issued they will be listed in A.P.113 and A.P.2463*


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| **Part 2** | **Testing and servicing** |
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| VOLUME 4 | PLANNED SERVICING SCHEDULES (*application to be decided later*) |
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# Chapter 1

# INTRODUCTION

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**1.** Transmitter Type SWB 8X is a medium-power HF transmitter having an overall frequency range of 2 to 27 Mc/s and a maximum RF power output of 4kW. There are four Service variants of the transmitter (transmitters Type T.1975, T.1976, T.2000 and T.7095) which provide the following types of emission:—

(1) CW on-off telegraphy

(2) FSK telegraphy

(3) SSB telephony

(4) Class C anode-modulated telephony.

### TRANSMITTER TYPE T.1975

**2.** Transmitter Type T.1975 (*Stores Ref.* 10D/18478) provides CW on-off and FSK telegraphy services over a frequency range of 2 to 27 Mc/s. The RF power output varies from 4kW at 2 Mc/s to 3kW at 22·2 Mc/s, and falls to 2kW over the range 22·2 to 27 Mc/s. The maximum keying speed is 200 words per minute. The total input power is 9·6kW. A block diagram of the transmitter is shown in fig. 1.

**3.** The transmitter consists of the following units:—

(1) Drive unit (radio) Type 4 (*Stores Ref.* 10D/18480)

(2) Transmitter unit Type 89 (*Stores Ref.* 10R/93)

(3) Power unit Type 811 (*Stores Ref.* 10K/17203).

**Drive unit (radio) Type 4** (*A.P.2883Q*)

**4.** The drive unit consists of a crystal-controlled oscillator and FSK equipment. The oscillator delivers output on ten selected frequencies, five of which are used for CW and five for FSK telegraphy. The RF output is 1 volt across an impedance of 80 ohms.

*CW service*

**5.** When CW on-off telegraphy is employed the RF output of the oscillator is applied as drive directly to the harmonic amplifier stages in the transmitter unit (*para.* 8). The output frequencies of the oscillator are in the range of 1·0 to 1·5 Mc/s; the range of frequency multiplication in the transmitter unit is 2 to 18, therefore the final radiated frequency is in the range 2 to 27 Mc/s.

**6.** As an anti-fading facility, the unit includes a a reactance modulator which permits phase modulation of the crystal oscillator. A 400 c/s voltage for operation of the phase modulator is derived from an audio-frequency oscillator in the transmitter unit.

*FSK service*

**7.** In this application a "fixed" frequency FSK source is mixed with a suitable harmonic from the crystal oscillator unit to provide the drive for the transmitter. The "fixed" frequency is obtained from a 2·15Mc/s crystal oscillator which is frequency-modulated for mark and space conditions by a reactance modulator. This results in five output frequencies in the range 1·15 to 2·73 Mc/s, which with a multiplication of between 2 and 18 in the transmitter unit, gives a final radiated frequency in the range 2·3 to 27Mc/s.

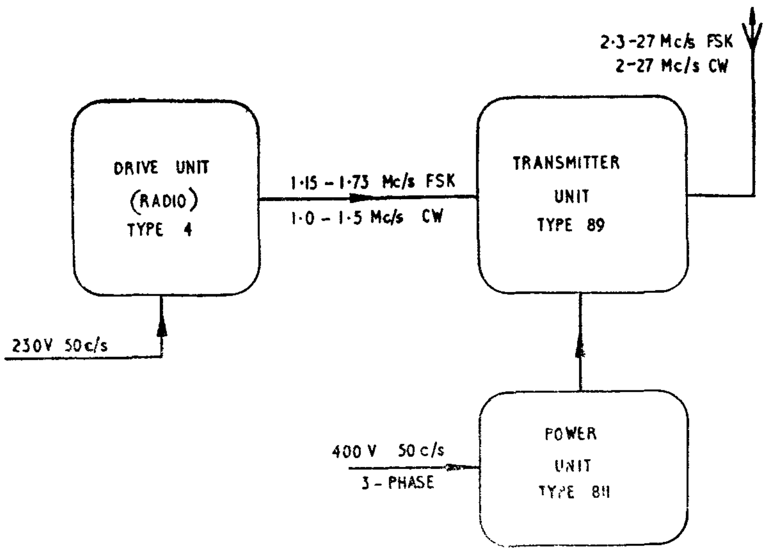


**Fig. 1. Transmitter Type T.1975**

**8.** A frequency deviation control ensures a constant shift of final radiated frequency from mark to space irrespective of the amount of frequency multiplication in the transmitter harmonic generators. The shift at the final frequency may be adjusted to between 200 and 1,000kc/s; where the transmitter overall multiplication is 18 it may be necessary to restrict the range of frequency shift to 400 to 1,000c/s.

**Transmitter unit Type 89**

**9.** Transmitter unit Type 89 consists essentially of four frequency-multiplying stages (harmonic amplifiers), followed by a buffer amplifier and push-pull power amplifier. The frequency multiplying stages are normally driven from the output of the external crystal oscillator (*para.* 4); alternatively, when transmitting CW telegraphy, a Franklin master oscillator which is housed in the transmitter unit may be used to provide the drive; the master oscillator has a frequency stability of 1 part in 20,000.

**10.** The four harmonic amplifier stages provide the necessary multiplication to obtain the final radiated frequency from the drive frequency, together with part of the overall power amplification necessary. Stages 1, 2 and 3 may be used either as amplifiers or frequency multipliers but stage 4 is used solely as an amplifier.

**11.** The two power amplifiers (stages 5 and 6) operate under Class C conditions in the present application of the transmitter unit, and employ forced-air-cooled valves. The RF output from the push-pull final amplifier is fed to the aerial via an output unit which enables either coaxial or parallel-wire feeders having impedances of 77 and 600 ohms respectively to be used; alternatively, the coupling unit may be adjusted to match into other impedances when, due to emergency conditions, the correct impedances may not be obtained.

**Power unit Type 811**

**12.** The power unit operates from a 400-volt, 3-phase, 4-wire input supply and delivers the following output voltages to the transmitter unit:—

(1) 240V DC stabilized HT supply to the Franklin master oscillator

(2) 6·3V and 18V AC valve heater and filament supply

(3) 400V negative grid bias supply

(4) 5,000 to 6,000V main HT supply.

**13.** Provision is made in the power unit for conditioning two spare mercury vapour rectifier valves used to supply the main HT voltage.

**TRANSMITTER TYPE T.1976**

**14.** Transmitter Type T.1976 (*Stores Ref.* 10D/18479) provides either CW on-off telegraphy or single-sideband telephony transmissions. A block diagram of the transmitter is shown in fig. 2.

**15.** The transmitter consists of the following units:—

(1) Transmitter unit Type 89

(2) Drive unit (radio) Type 5 (*Stores Ref.* 10D/18481)

(3) Drive unit (radio) Type 7 (*Stores Ref.* 10D/19123)

(4) Modulator unit Type 127 (*Stores Ref.* 10D/18482)

(5) Power unit Type 812 (*Stores Ref.* 10K/17204)

(6) Rectifier Type 62 (*Stores Ref.* 10D/17621).

**16.** In this transmitter DC heating of the sub-amplifier and final amplifier valve filaments is employed. The power unit Type 812 supplies HT, GB and LT voltages similar to the Type 811 (*para.* 12), with the exception that an 18-volt filament supply derived from rectifier Type 62 is provided in lieu of the 18-volt AC filament supply.

*CW service*

**17.** Apart from the difference in filament supplies, operation of the transmitter on CW telegraphy is similar to that of transmitter Type T.1975.

*SSB service*

**18.** When operating on SSB telephony, the transmitter covers continuously the frequency range 4 to 27Mc/s and gives a peak envelope power of 4 to 3kW between 4 and 22·2Mc/s, and 1·7kW between 22·2 and 27Mc/s.

**19.** A block diagram of the transmitter when operating on single-sideband is shown in fig. 2. The SSB signals are generated in the first instance by the drive unit (radio) Type 7, the output of which consists of a 3·1Mc/s low-level pilot carrier, and upper and lower sidebands produced by audio signals applied to two independent input channels of the unit. Provision is made in the drive unit for monitoring the signals at all stages in the transmitter chain.

**20.** The 3·1Mc/s output from the SSB drive unit is applied to the modulator unit Type 127, together with a sub-carrier having a frequency 3·1Mc/s higher or lower than the final radiated frequency; the sub-carrier is derived from the crystal drive unit and the first three harmonic amplifier stages in the transmitter unit. The two frequencies are mixed in the modulator unit, and the resultant output consists of a pilot carrier at the final radiated frequency, with upper and lower sidebands due to audio signals applied to the sideband generator.

**21.** The output of the modulator unit is applied to the input of the fourth harmonic generator stage in the transmitter unit. In the SSB application, this stage and also the following stages 5 and 6 are adjusted to operate as Class B linear amplifiers. This is necessary in view of the fact that these stages are now amplifying a modulated waveform, and linear amplifiers operating under Class A or Class B conditions must be used to avoid distortion.

**Drive unit (radio) Type 5** (*A.P.2883Q*)

**22.** The RF drive to the harmonic amplifier stages in the transmitter unit is obtained from the drive unit (radio) Type 5, which consists of the 10-way crystal oscillator Type 7069 mounted on top of a supporting framework.

**Drive unit (radio) Type 7** ~~[illegible]~~ (AP2877W) AL 12

**23.** A block diagram of the SSB drive unit is shown in fig. 3. Two independent audio input channels are provided, channel A and channel B. Considering channel A and an input range of audio frequencies up to 6kc/s, the AF signal is amplified by the line amplifier LA(A), the output level of which is shown on a volume indicator.

**24.** The amplified audio signal is then fed via an attenuator to the differential input of the first balanced modulator M1(A). A 100kc/s carrier voltage derived from a crystal-controlled oscillator 01 is applied, via a hybrid distributing circuit (H) to the parallel input of the modulator. The 100kc/s carrier is balanced out by resistance and capacitance controls and the resultant frequencies in the differential output circuit consist of the upper and lower sidebands only.

**25.** The two sidebands are fed into a band-pass crystal filter F1(A) which suppresses the lower sideband (LSB), and passes the upper sideband frequencies (USB) between 100 and 106 kc/s only.

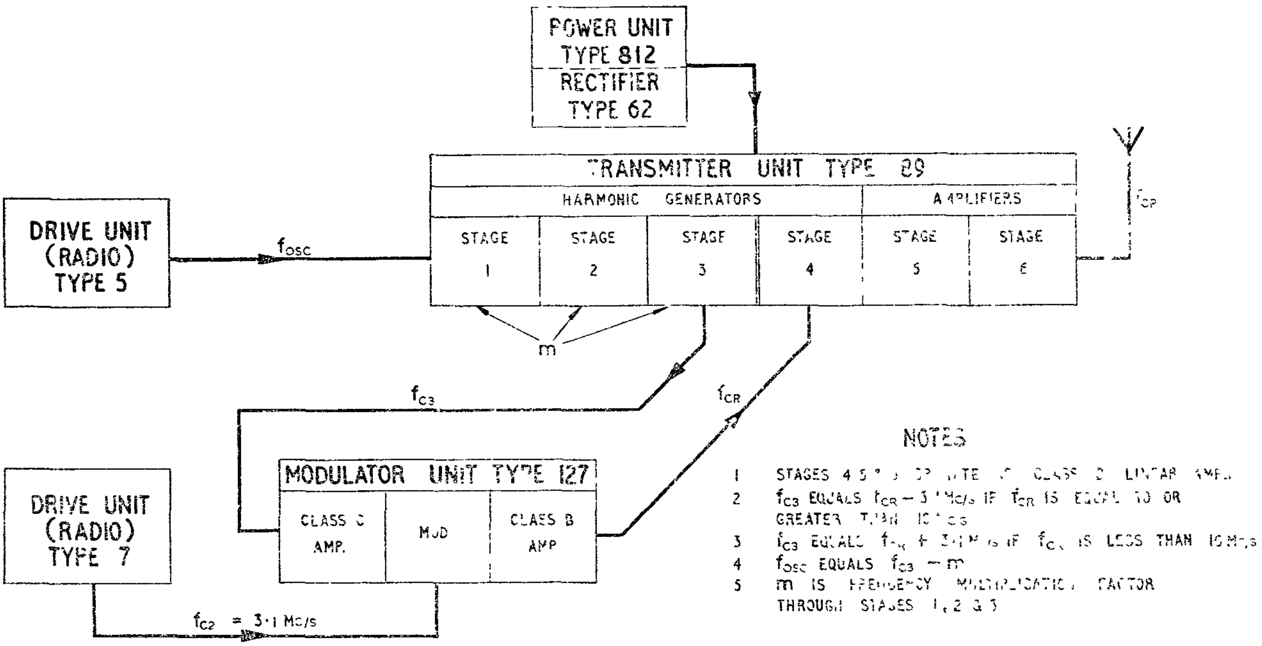


**Fig. 2. Transmitter Type T.1976—SSB service**

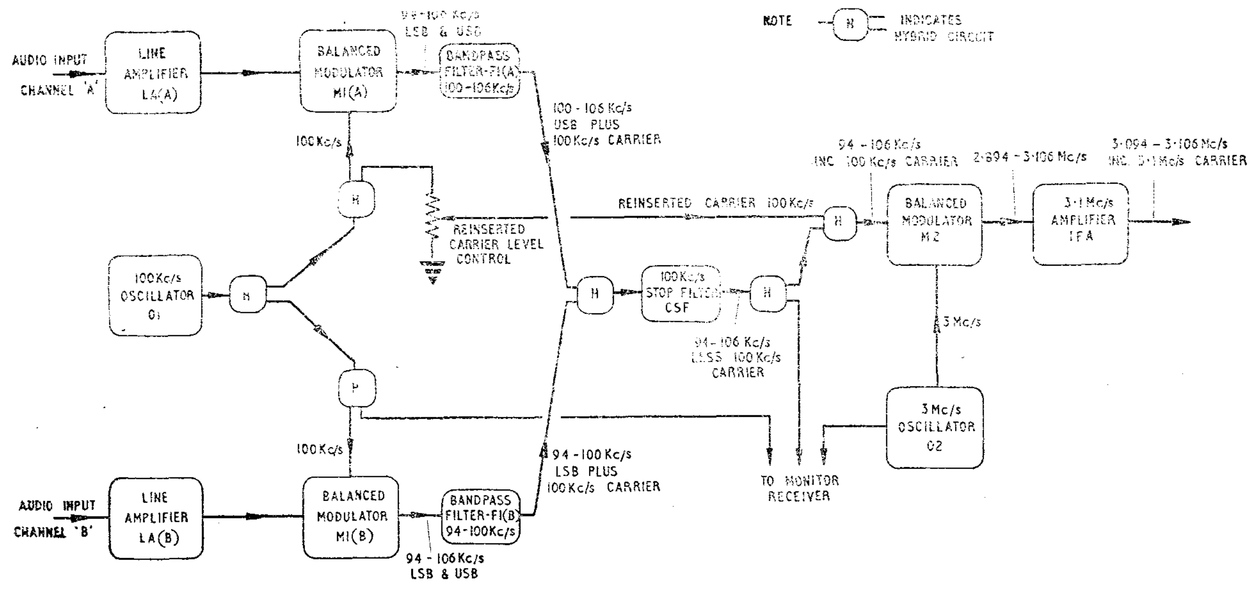


**Fig. 3. Drive unit (radio) Type 7—functional diagram**

**26.** The audio signals applied to channel B pass through a similar chain, except that in this instance the upper sideband is suppressed by the filter F1(B), and the lower sideband, between 94 and 106kc/s only is passed. The selected USB and LSB from channels A and B respectively are then combined in a hybrid network and passed through a narrow-band crystal filter, the carrier stop filter (CSF). The function of the CSF is to remove any 100kc/s residual carrier component that may be present due to out-of-balance in M1(A) and M1(B).

**27.** The two independent sideband signals are applied to another hybrid circuit where they are combined with a controlled low-level 100kc/s carrier obtained from 01. The combination of the USB, LSB and the 100kc/s pilot carrier is applied to the differential input of the second balanced modulator M2, into the parallel input circuit of which is injected voltage at a frequency of 3Mc/s; this frequency is derived from a second crystal-controlled oscillator 02. The 3Mc/s carrier component is balanced out in M2, and the resultant sideband frequencies in the differential output circuit are fed to a tuned amplifier (IFA) which selects the upper sideband of 3·094 to 3·106Mc/s. This upper sideband is composed of the following frequencies:—

(1) A mid-band frequency of 3·1Mc/s which forms the controlled low-level pilot carrier; this frequency is due to the re-inserted 100kc/s carrier.

(2) An upper sideband of 3·1 to 3·106Mc/s. This is due to the audio signal applied to channel 1.

(3) A lower sideband of 3·1 to 3·094Mc/s. This is due to the audio signal applied to channel B.

**28.** Each sideband has a maximum RF power output of —6dB relative to 0·25 watt; the total sideband peak output power is therefore 0·25 watt. The level of the 3·1Mc/s pilot carrier is adjusted to be —16dB relative to 0·25 watt for single channel working (that is, audio input applied to channel A only) and —26dB relative to 0·25 watt for two channel working. The frequency error of the pilot carrier is less than 1 part in $10^5$.

**29.** Provision is made for generating a double-sideband amplitude-modulated signal, which may be necessary in an emergency. In this condition channel A only is used; the audio signal is amplified by LA(A) and then passed to M1(A). The DSB signal is developed by unbalancing the modulator by resistance and capacitance controls (other than those used to obtain balance on SSB) to give the correct ratio and phase between carrier and sidebands. The channel filter F1(A) is removed from circuit to allow both sidebands to pass to the second modulator, whilst the 100kc/s carrier stop filter CSF is by-passed in order to pass the carrier. The subsequent conversion of the 3·1Mc/s DSB signal to the final radiated frequency is identical to that employed in SSB service.

**30.** The drive unit incorporates a monitor receiver and associated circuits which enable the SSB signal to be monitored and distortion to be measured. The signal is monitored at the following stages in the transmitter chain:—

(1) The output of the channel modulators M1(A) and M1(B) at frequencies between 94 and 106kc/s.

(2) The output of the IFA at a centre frequency of 3·1Mc/s.

(3) The 3rd modulator (*para.* 31), stages 4, 5 and 6 in the transmitter unit. This monitoring is carried out at the final radiated frequency.

#### Modulator unit Type 127

**31.** The output of the 3·1Mc/s amplifier is fed to a third modulator (modulator unit Type 127) where it is converted to the final radiated frequency. The third modulator consists essentially of three stages:—

(1) A Class C amplifier, which amplifies the sub-carrier obtained from the third harmonic generator in the transmitter unit ; input to the harmonic generator stages is derived initially from the crystal drive unit on the Franklin master oscillator.

(2) A modulator stage, which mixes the sub-carrier from the Class C amplifier and the output of the SSB drive unit to provide SSB signals at the final radiated frequency.

(3) A Class A amplifier which amplifies the SSB signals at the final radiated frequency.

**32.** The 3·1 Mc/s pilot carrier frequency (fc2) and sub-carrier frequency (fc1) are combined either by addition or subtraction to produce the final radiated frequency (fcr), according to whether fcr is higher or lower than 10Mc/s. When fcr is higher than 10Mc/s, fc3 = fcr — 3·1Mc/s. and when fcr is lower than 10Mc/s, fc3 = fcr + 3·1Mc/s. For example, if the radiated frequency is 15Mc/s, then fc3 = 11·9Mc/s, and if fcr = 7Mc/s, then fc3 = 10·1Mc/s.

### TRANSMITTER TYPE T.2000

**33.** Transmitter Type T.2000 (*Stores Ref.* 10D/19142) provides CW on-off telegraphy and amplitude-modulated telephony services over a frequency range of 2 to 27Mc/s. The CW telegraphy conditions are identical to those of the transmitter Type T.1975 (*para.* 2). On telephony the transmitter delivers a power output of 2·5 to 2kW over the range 2 to 22·2Mc/s, and 1·0 to 0·7kW over the range 22·2 to 27Mc/s ; under these conditions the total power input is 11·1kW.

**34.** The transmitter (*fig.* 4) consists of the following units :—

(1) Drive unit (radio) Type 5 (*para.* 22).

(2) Transmitter unit Type 89.

(3) Power unit Type 811

(4) Modulator unit Type 7436

(5) Amplifiers, Type A.7488 (10U/16882)

(6) Microphone assemblies Type 72 (10AH/1505) with associated smoothing units Type 22 (10AE/1583).

**35.** RF drive to the transmitter unit is derived from either the oscillator unit Type 7069, which forms part of the drive unit (radio) Type 5, or the internal Franklin master oscillator. When transmitting CW telegraphy, optional anti-fading phase or frequency modulation can be applied to the crystal or master oscillator.

*Telephony service*

**36.** When operated as a telephony transmitter the final RF amplifier (stage 6) functions as an anode-modulated Class C amplifier. Change-over from telegraphy to telephony is by a switch on the modulator unit.

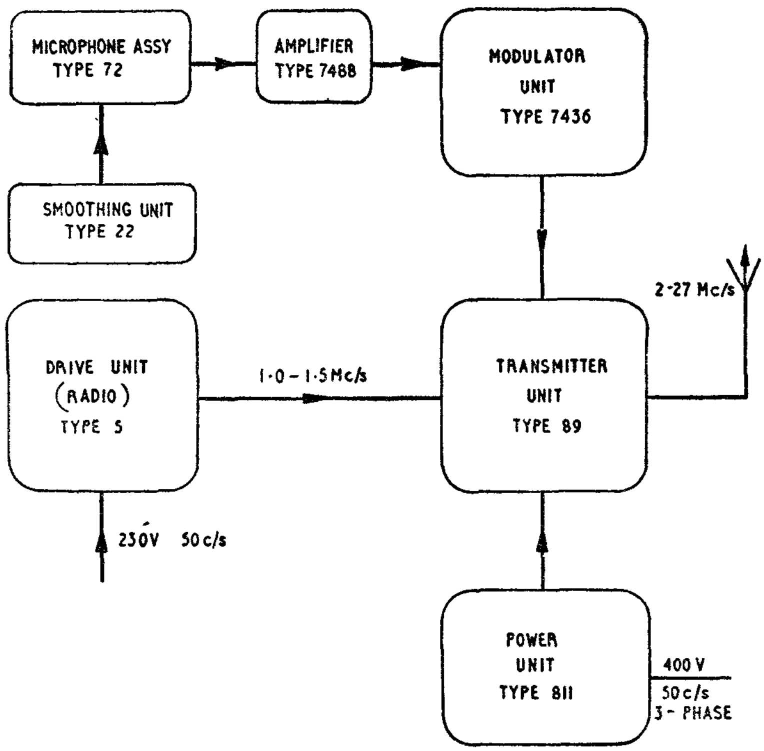


**Fig. 4 Transmitter Type T.2000**

#### Modulator unit Type 7436, (Class B modulater)

**37.** The modulator unit (*Stores Ref.* 10D/19430) consists of three push-pull stages, namely, a line amplifier, cathode-follower and Class B main modulator. The main modulator employs forced-air-cooled valves ; the output of this stage is coupled via a reactor and transformer to the transmitter unit to modulate the HT supply to the final RF amplifier.

**38.** All power supplies for the modulator unit are derived from the power unit Type 811 ; AC heater and filament supplies are used in both transmitter and modulator units.

#### Amplifier Type 7488

**39.** Amplifier Type 7488 (*Stores Ref.* 10U/16882) is provided to match the input circuit of the line amplifier to lines having input impedances of 100 or 600 ohms and, where necessary, to increase the input level to the transmitter. An input signal level of approximately 1 milliwatt is required to give 100 per cent modulation of the transmitter.

### TRANSMITTER TYPE T.7095

**40.** Transmitter Type T.7095 (*Stores Ref.* 10D/19188) provides CW on-off telegraphy transmission only. The transmitter, a block diagram of which is shown in fig. 5, consists of the following units :—

(1) Oscillator unit Type 7069 (*Stores Ref.* 10V/16228)

(2) Transmitter unit Type 89

(3) Power unit Type 811.

**41.** The transmitter functions in a manner identical with that of the transmitter Type T.1975 when operating on CW telegraphy (*para.* 5).

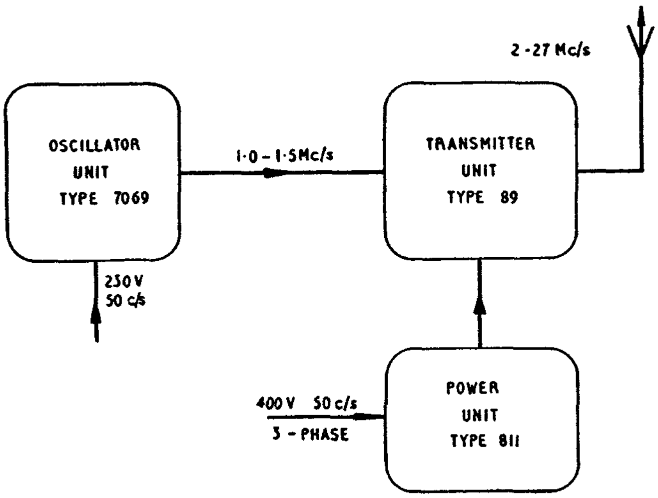


**Fig. 5 Transmitter Type T·7095**

# Chapter 2

## INSTALLING

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**Layout and foundations**

**1.** Typical layouts for the transmitters Types T.1975, T.7095, T.1976 and T.2000 are shown in fig. 3, 5 and 7. Some departure from the layouts shown is permissible, but sufficient space must be left round all units. A space of not less than 3 ft. 6 in. must be allowed between the back of the power unit and the wall to allow removal of the main rectifier transformer.

**2.** The concrete plinth is optional, but is an advantage in that it affords protection to the transmitter. Dimensions and constructional details of a typical plinth are shown in fig. 9.

**3.** Cable ducts must be provided under the main units in the positions shown to carry interconnecting cables and air pipes. External ducts may be modified, if necessary, to suit the location of the 3-phase AC supply point and the position decided upon for installing the air blower.

**4.** Main ducts should be drained to the outside of the building or constructed with a slight fall to prevent water accumulating.

**Ventilation**

**5.** Considerable heat is generated in the transmitter unit and auxiliary apparatus, and the room in which the transmitter is installed must be well ventilated to allow heated air to escape. Where the ambient air temperature exceeds 20 deg. C. or accommodation space is restricted, it is recommended that a 24 in. slow speed exhaust fan, capable of displacing 3,000 cu. ft. of air per minute, should be fitted to the transmitter room.

**Air-cooling system**

**6.** Fig. 10 shows the arrangement of the air cooling system. To reduce noise the air blower should be installed in a room adjacent to the transmitter, or in an external weather-proofed cupboard, suitably louvred at the sides for the air intake.

**Equipment earth**

**7.** The transmitter must be earthed through short, direct lengths of copper strip laid in parallel to form a low-impedance connection. The main strips must be laid before the transmitter is installed, and extended over the position where the units of the transmitter are to be located. The outside strips and earth stakes are to be buried in moist virgin soil, clear of all footings. An illustration of a typical earthing system is shown in fig. 11.

**8.** The frames of all electrical equipment excluding RF units are to be bonded to the nearest earth continuity conductor by copper strip or wire. All joints should be soldered, wiped to remove traces of flux, and painted to prevent electrolytic action.

**Installation cabling**

**9.** Inter-unit cabling of the transmitters Types T.1975, T.1976, T.2000 and T.7095 are shown in fig. 2, 4, 6 and 8 respectively. Size and grade of the cables are given in Table 1.

**TABLE 1**

**Cable details**

| Ref. | Size | No. of Cores | Grade | Remarks |
|---|---|---|---|---|
| A | 7/·036 | 4 | 250V | V.I.R.L.C. |
| B | 1/·044 | 3 | 250V | V.I.R.L.C. |
| C | 1/·044 | 2 | 250V | V.I.R.L.C. |
| D | 1/·044 | 1 | 250V | V.I.R.L.C. |
| E | 1/·044 | 1 | 660V | V.I.R.L.C. |
| F | 7/·064 | 1 | 6600V | Varnished Cambric Insulated L.C. |
| G | 19/·064 | 1 | 250V | V.I.R.L.C. |
| H | 7/·029 | 1 | 250V | V.I.R.L.C. |
| J | H.F. Co-axial Cable Type PT. 1 L. | | | Lead sheathed |

**10.** To reduce the possibility of pick-up of RF energy on the sheaths of cables, the sheaths should be bonded at the end of each run, and connected to the nearest earth continuity conductor. Where possible, grid bias heads should be run apart from 50 c/s AC leads to reduce the possibility of AC modulation.

**11.** AC voltage to the blower motor is normally supplied from the power unit In instances where more than one transmitter is cooled by a common blower the motor should be connected to an independent source of supply.

**12.** The method of fitting the coaxial plugs and sockets is shown in fig. 1.

**13.** Details of the installation of drive unit (radio) Type 7 and drive unit (radio) Type 4 will be found in A.P.2877W, Vol. 1, and A.P.2883Q, Vol. 1.

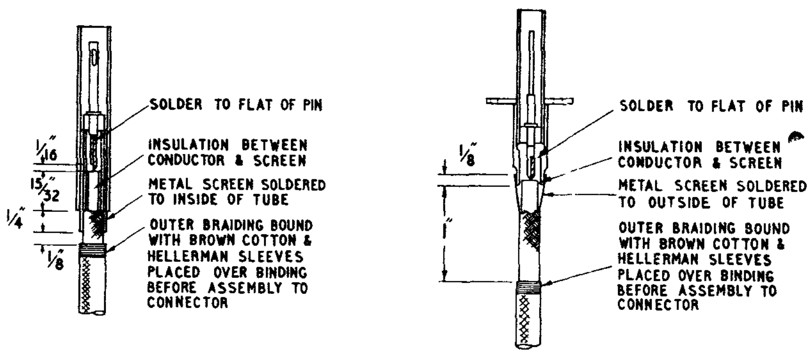


**Fig. 1. Method of fitting coaxial plug and socket**

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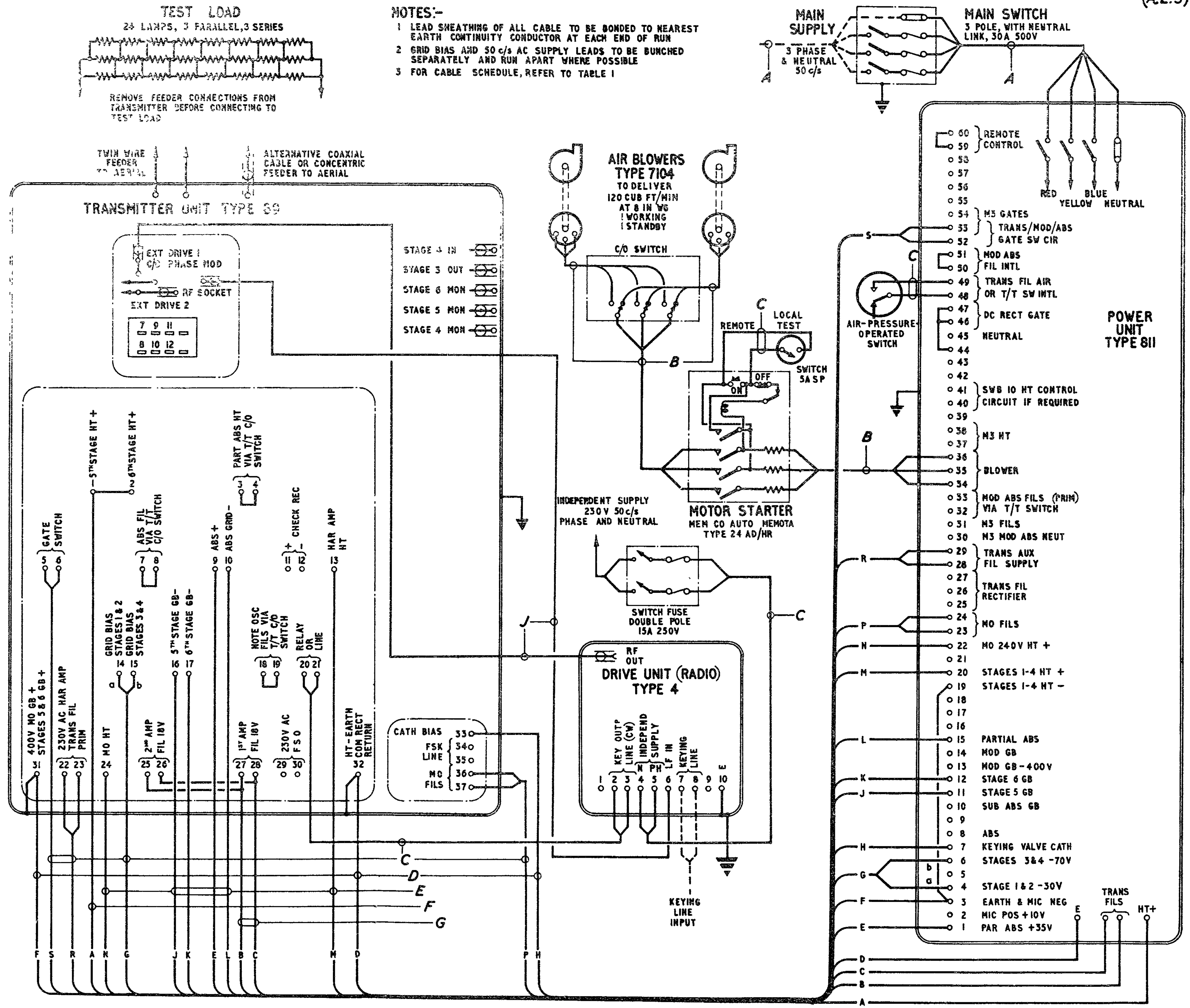
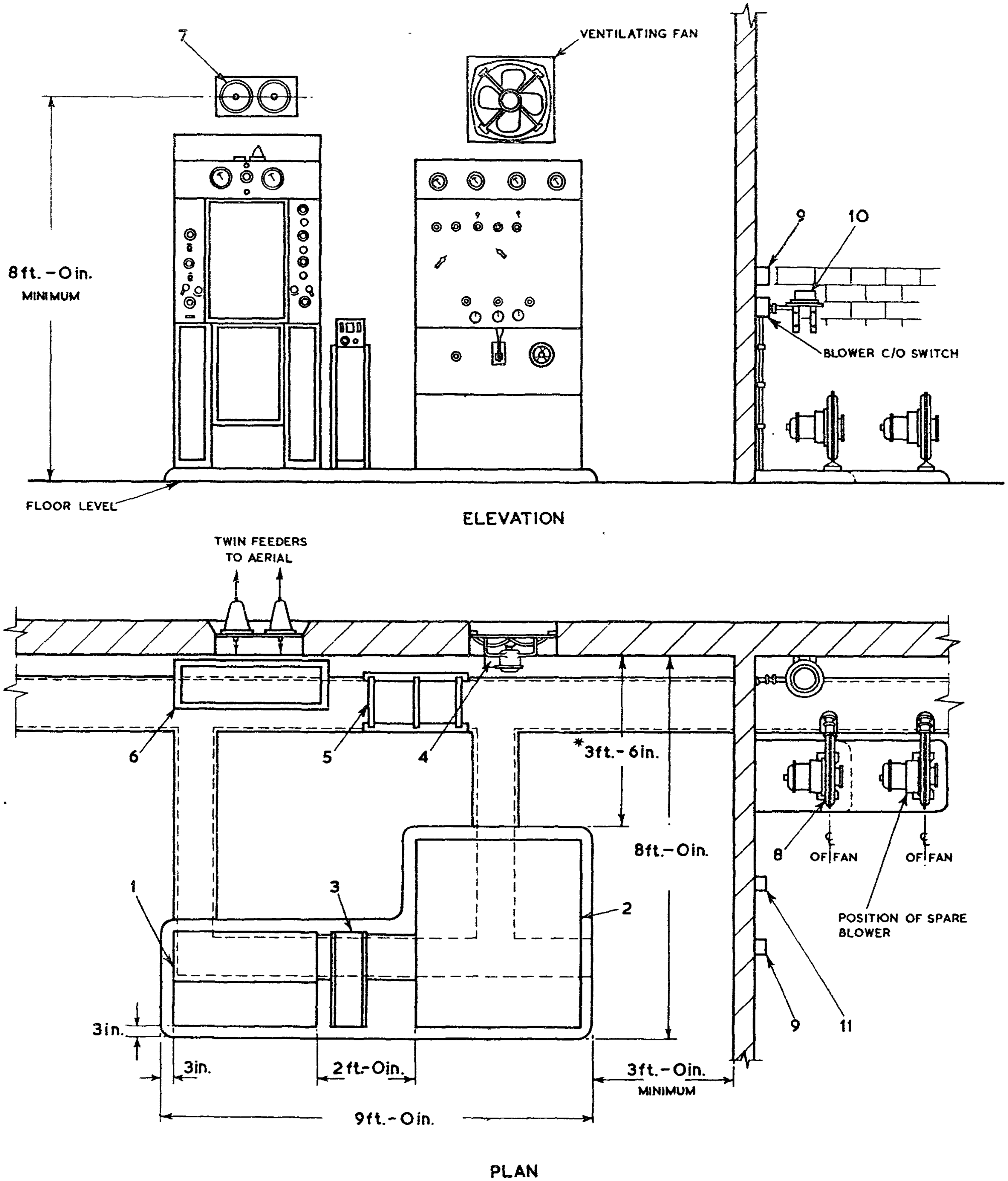



Fig. 2 Transmitter Type T.1975 installation diagram Fig. 2




| REF | DESCRIPTION |
|---|---|
| 1 | TRANSMITTER UNIT TYPE 89 |
| 2 | POWER UNIT TYPE 811 |
| 3 | DRIVE UNIT (RADIO) TYPE 4 (TRANSMITTER TYPE T. 1975) OR DRIVE UNIT (RADIO) TYPE 5 (TRANSMITTER TYPE T. 7095) |
| 4 | MAINS ISOLATING SWITCH |
| 5 | TEST LOAD |
| 6 | COIL RACK |
| 7 | FEEDER LEAD-IN PANEL |
| 8 | AIR BLOWERS TYPE 7104 |
| 9 | STARTER FOR BLOWER MOTORS |
| 10 | AIR PRESSURE OPERATED SWITCH |
| 11 | BLOWER CHANGE-OVER SWITCH |

NOTES:–

1 RECOMMENDED MINIMUM HEIGHT TO CEILING OR HORIZONTAL ROOF TRUSSES 10ft.-0in.

2 MINIMUM CLEARANCE OF DOORWAY TO ADMIT LARGEST UNIT IN CRATE 5ft.-6in. WIDE X 8ft.-0in. HIGH

3 IF ACCOMMODATION SPACE IS UNDULY RESTRICTED OR AMBIENT AIR TEMPERATURE EXCEEDS 70°F. (21°C.) A VENTILATING FAN CAPABLE OF DISPLACING 3000 CU.FT./MIN. (85 CU M/MIN) MUST BE FITTED

4* THIS DIMENSION IS THE MINIMUM ALLOWED FOR WITHDRAWAL OF MAIN POWER TRANSFORMER FROM POWER UNIT TYPE 811

Fig. 3 Transmitters Types T. 1975 and T. 7095 - typical accommodation plan Fig. 3

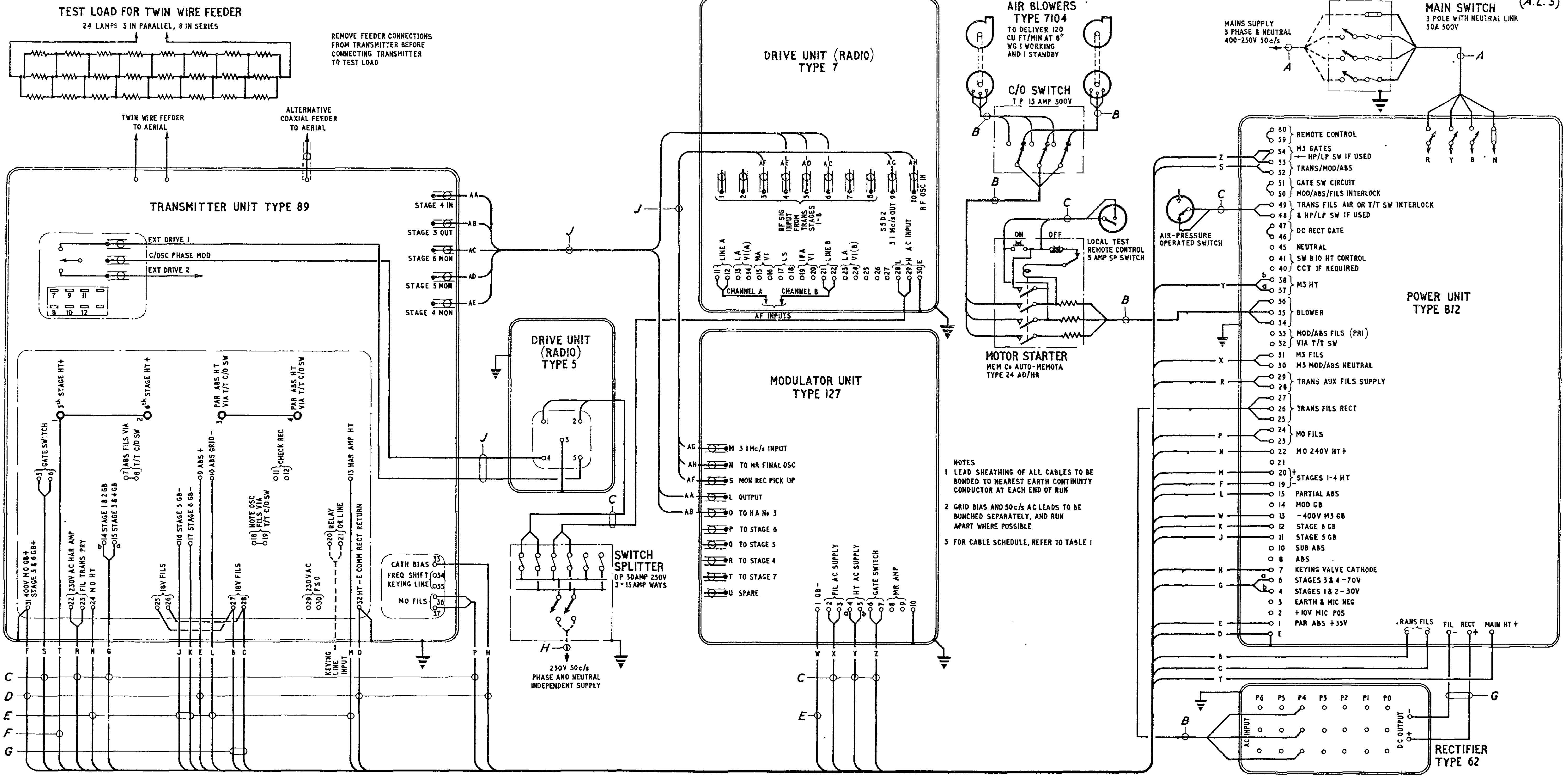
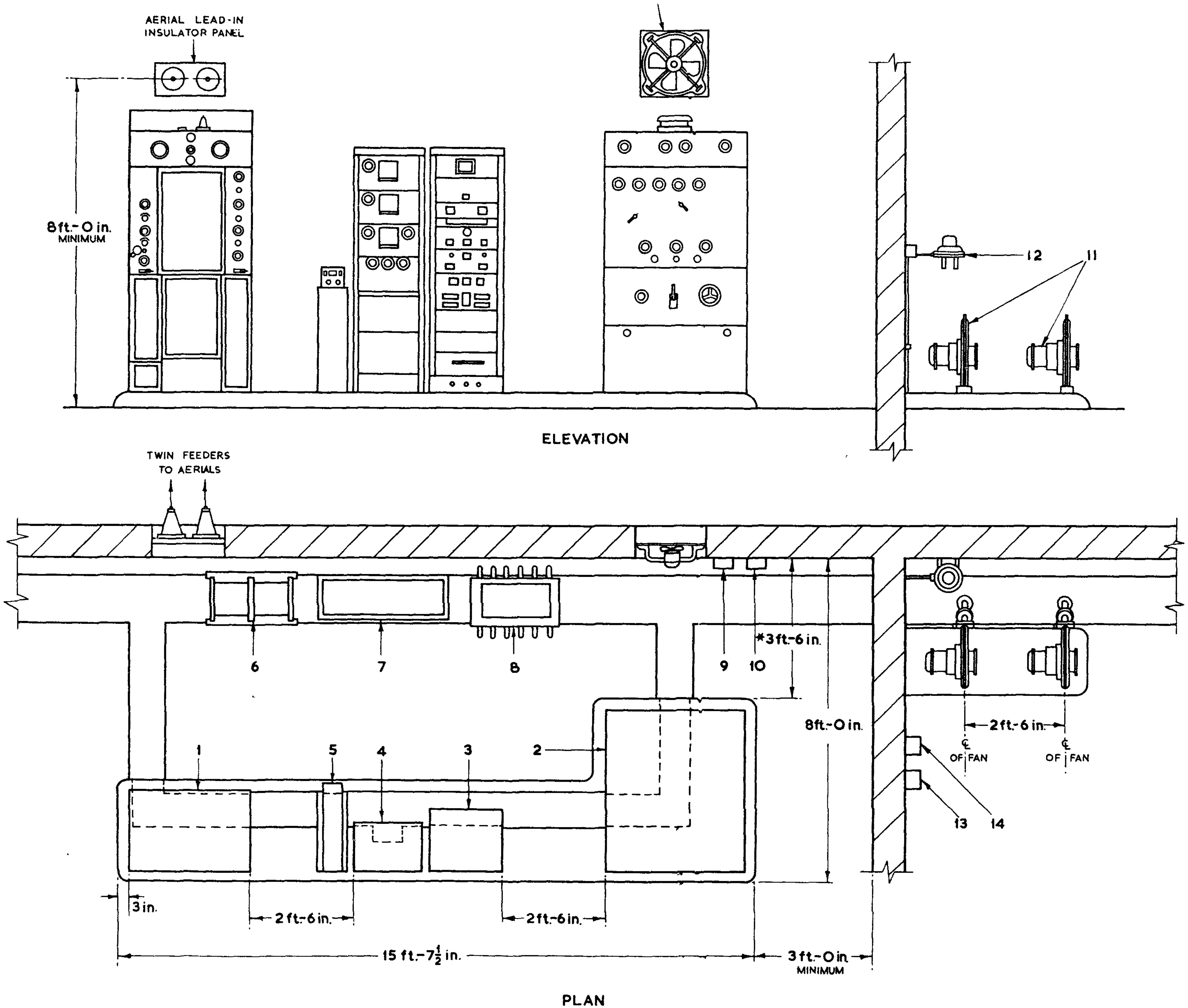



Fig. 4 Transmitter Type T.1976 – installation diagram Fig. 4




| REF | DESCRIPTION |
|---|---|
| 1 | TRANSMITTER UNIT TYPE 89 |
| 2 | POWER UNIT TYPE 812 |
| 3 | DRIVE UNIT (RADIO) TYPE 7 |
| 4 | MODULATOR UNIT TYPE 137 |
| 5 | DRIVE UNIT (RADIO) TYPE 5 |
| 6 | TEST LOAD |
| 7 | COIL RACK |
| 8 | RECTIFIER TYPE 62 |
| 9 | MAINS ISOLATING SWITCH |
| 10 | SWITCH SPLITTER |
| 11 | AIR BLOWERS TYPE 7104 |
| 12 | AIR-PRESSURE OPERATED SWITCH |
| 13 | BLOWER MOTOR STARTER |
| 14 | BLOWER MOTOR CHANGE-OVER SWITCH |

NOTES:-

1 RECOMMENDED MINIMUM HEIGHT TO CEILINGS OR HORIZONTAL ROOF TRUSSES 10 ft - 0 in

2 MINIMUM CLEARANCE OF DOORWAY TO ADMIT LARGEST UNIT IN CRATE 5 ft.-6 in WIDE X 8 ft.-0 in HIGH

3 IF ACCOMMODATION SPACE IS UNDULY RESTRICTED OR AMBIENT AIR TEMPERATURE EXCEEDS 70° F. (21° C) A VENTILATING FAN CAPABLE OF DISPLACING 3,000 CU. FT/MIN. (85 CU.M/MIN) MUST BE FITTED

4 * THIS DIMENSION IS THE MINIMUM ALLOWED FOR WITHDRAWAL OF MAIN POWER TRANSFORMER FROM POWER UNIT TYPE 812

Fig.5 Transmitter Type T. 1976-typical accommodation plan Fig.5

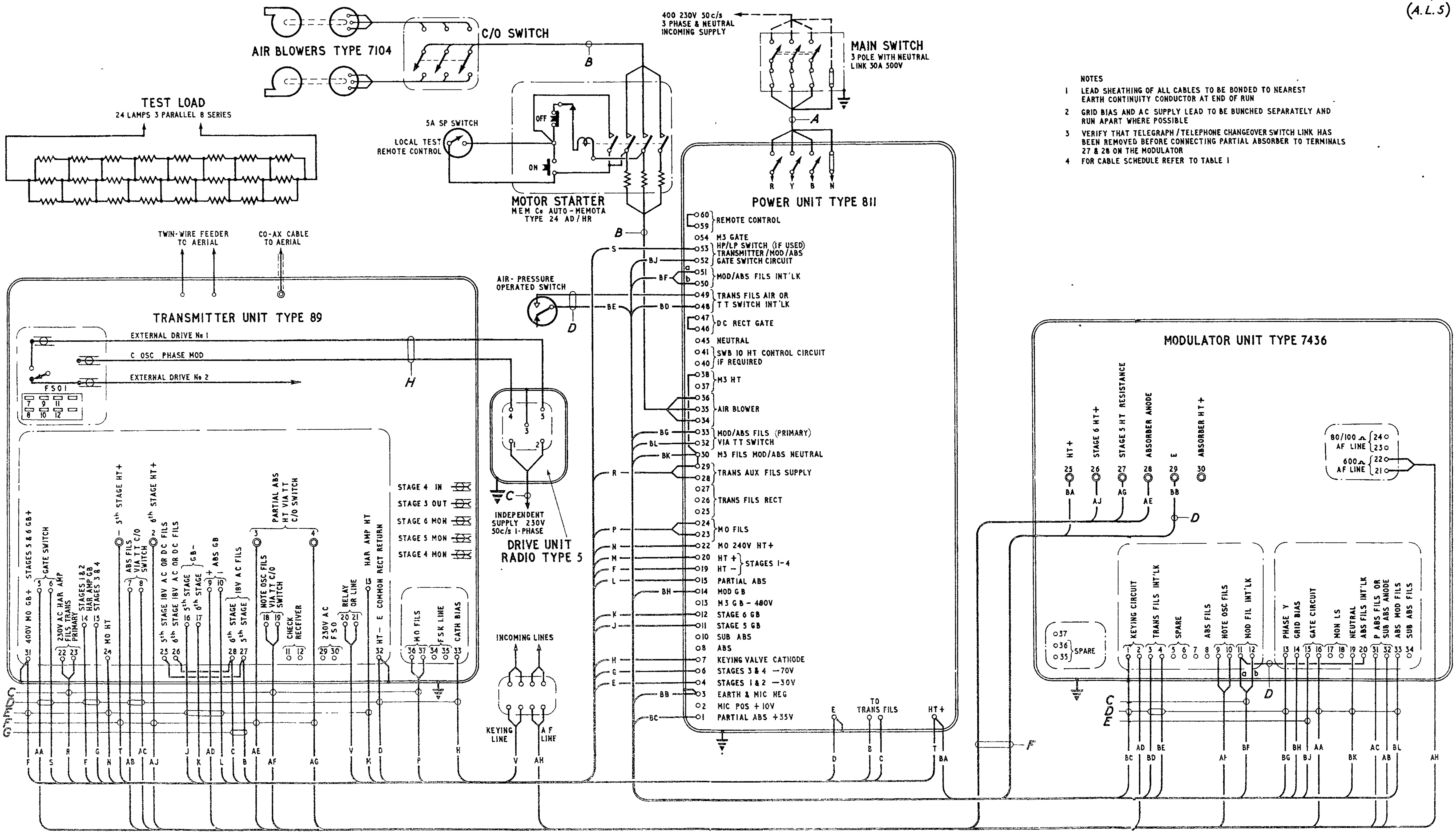
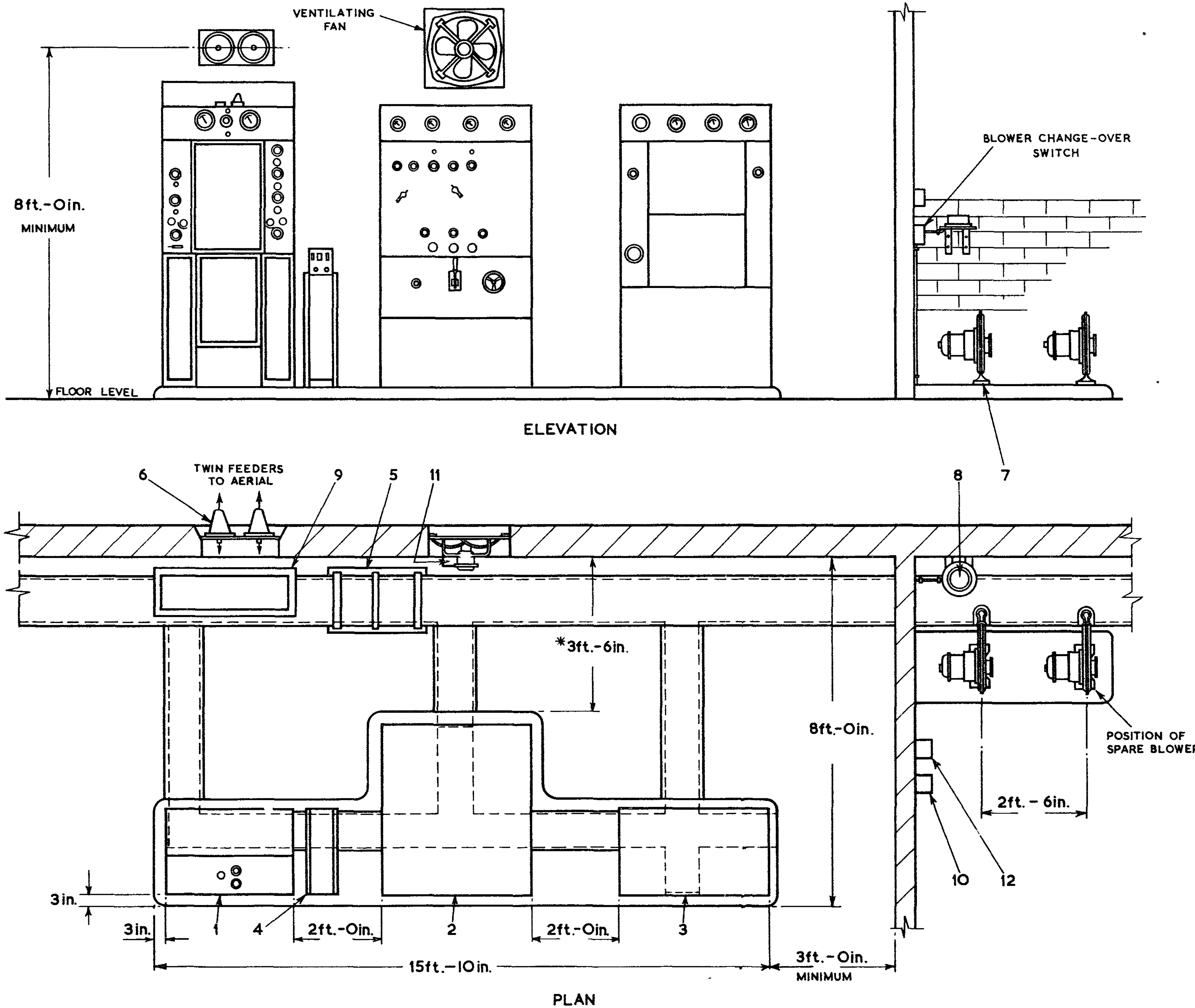



Fig. 6 Transmitter Type T.2000 — installation diagram Fig. 6




| REF | DESCRIPTION |
|---|---|
| 1 | TRANSMITTER UNIT TYPE 89 |
| 2 | POWER UNIT TYPE 811 |
| 3 | MODULATOR UNIT TYPE 7436 |
| 4 | DRIVE UNIT (RADIO) TYPE 5 |
| 5 | TEST LOAD |
| 6 | AERIAL LEAD-IN PANEL |
| 7 | AIR BLOWER TYPE 7104 |
| 8 | AIR-PRESSURE OPERATED SWITCH |
| 9 | COIL RACK |
| 10 | STARTER FOR BLOWER MOTORS |
| 11 | MAINS ISOLATING SWITCH |
| 12 | BLOWER CHANGE-OVER SWITCH |

NOTES:-

1 RECOMMENDED MINIMUM HEIGHT TO CEILING OR HORIZONTAL ROOF TRUSSES 10ft.-0in.

2 MINIMUM CLEARANCE OF DOORWAY TO ADMIT LARGEST UNIT IN CRATE 5ft.-6in. WIDE X 8ft-0in. HIGH

3 IF ACCOMMODATION SPACE IS UNDULY RESTRICTED OR AMBIENT TEMPERATURE EXCEEDS 70°F. (21°C.) A VENTILATING FAN CAPABLE OF DISPLACING 3000CU FT./MIN. (85CU. M/MIN) MUST BE FITTED

*4 THIS DIMENSION IS THE MINIMUM ALLOWED FOR WITHDRAWAL OF MAIN POWER TRANSFORMER FROM POWER UNIT TYPE 811

Fig.7 Transmitter Type T.2000- typical accommodation plan Fig.7

Dmd 7025 459358 375 12/54 AB 979/3 9069

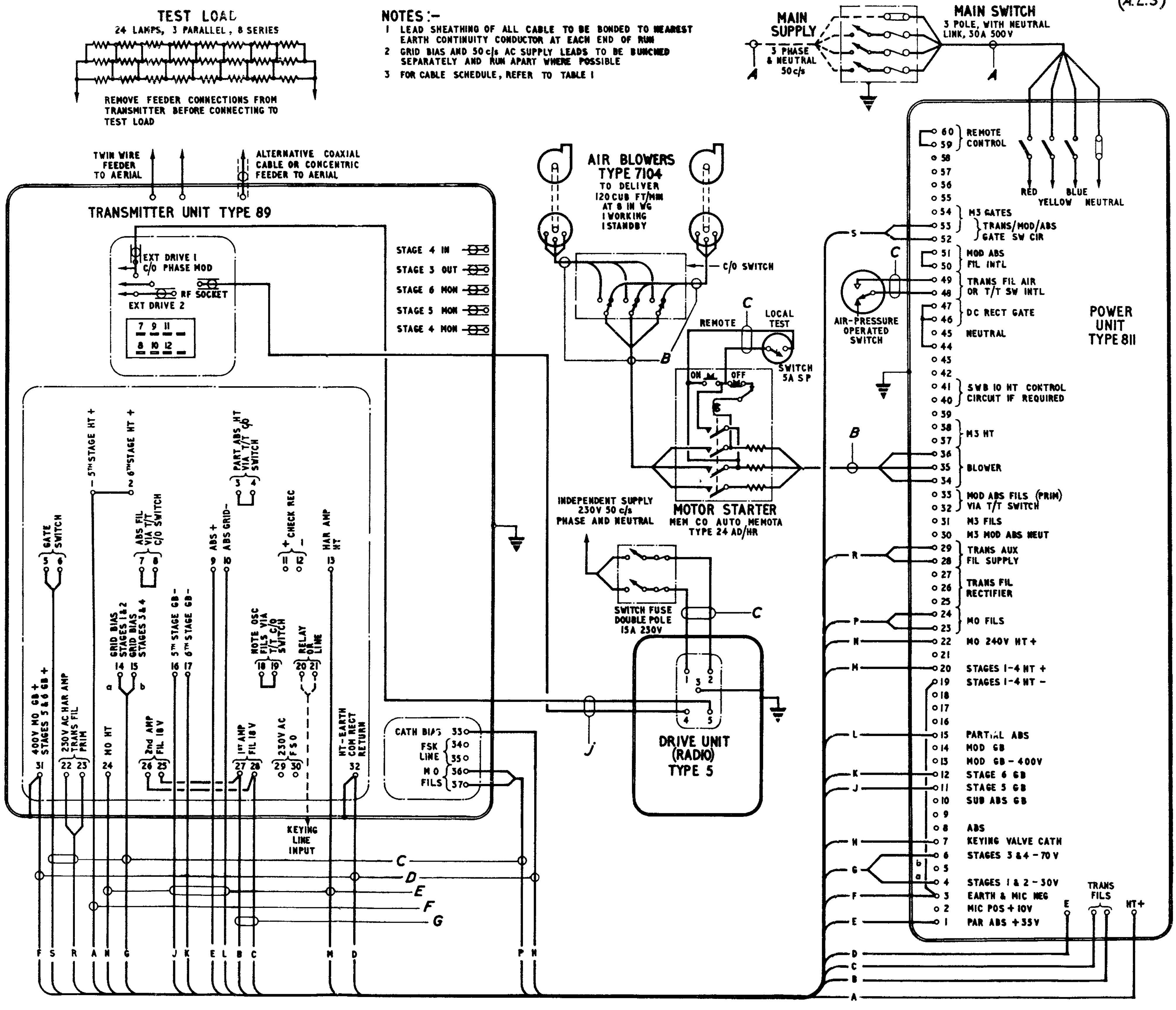



Fig. 8 Transmitter Type T. 7095, installation diagram Fig. 8

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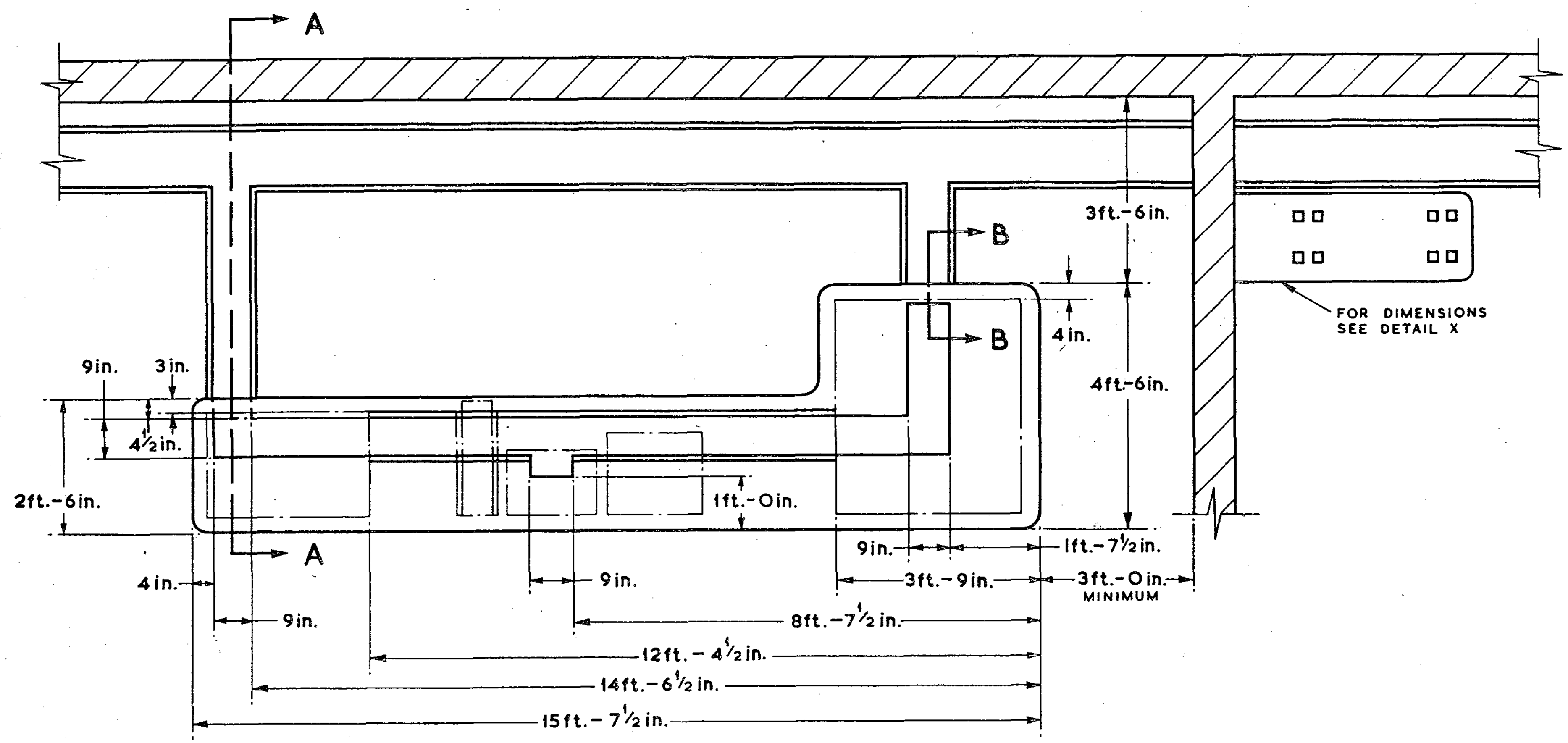
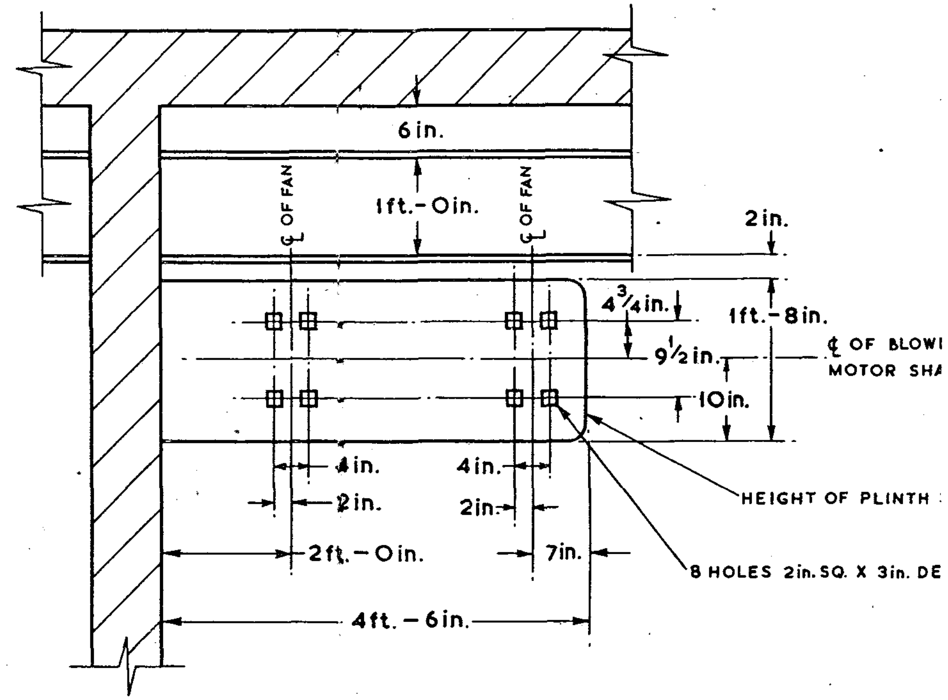



PLAN




DETAIL X

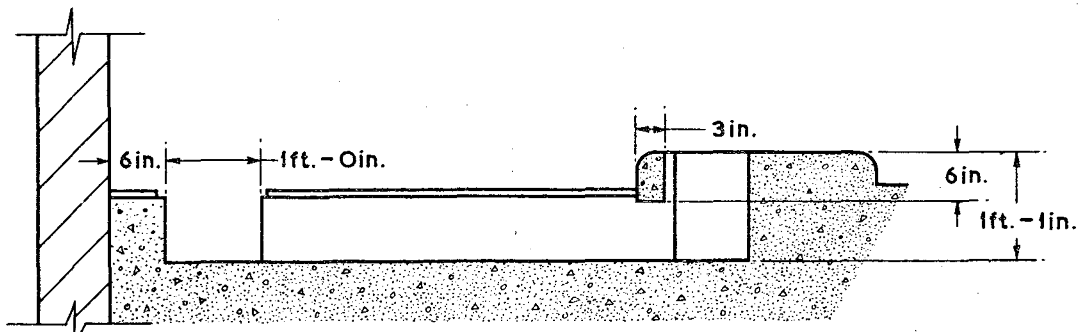
AIR BLOWER PLINTH FOUNDATIONS

NOTES:-

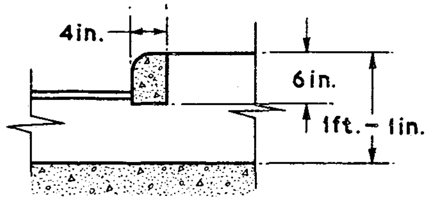
1 HEIGHT OF MAIN PLINTH 4in.
DEPTH OF TRENCHES THROUGHOUT 9in.

2 TRENCHES TO BE CONSTRUCTED WITH A SLIGHT FA
AND DRAINED TO THE OUTSIDE

3 TRENCHES EXTERNAL TO UNITS TO BE CONSTRUCTE
TO ACCOMMODATE CURBING AND COVERS

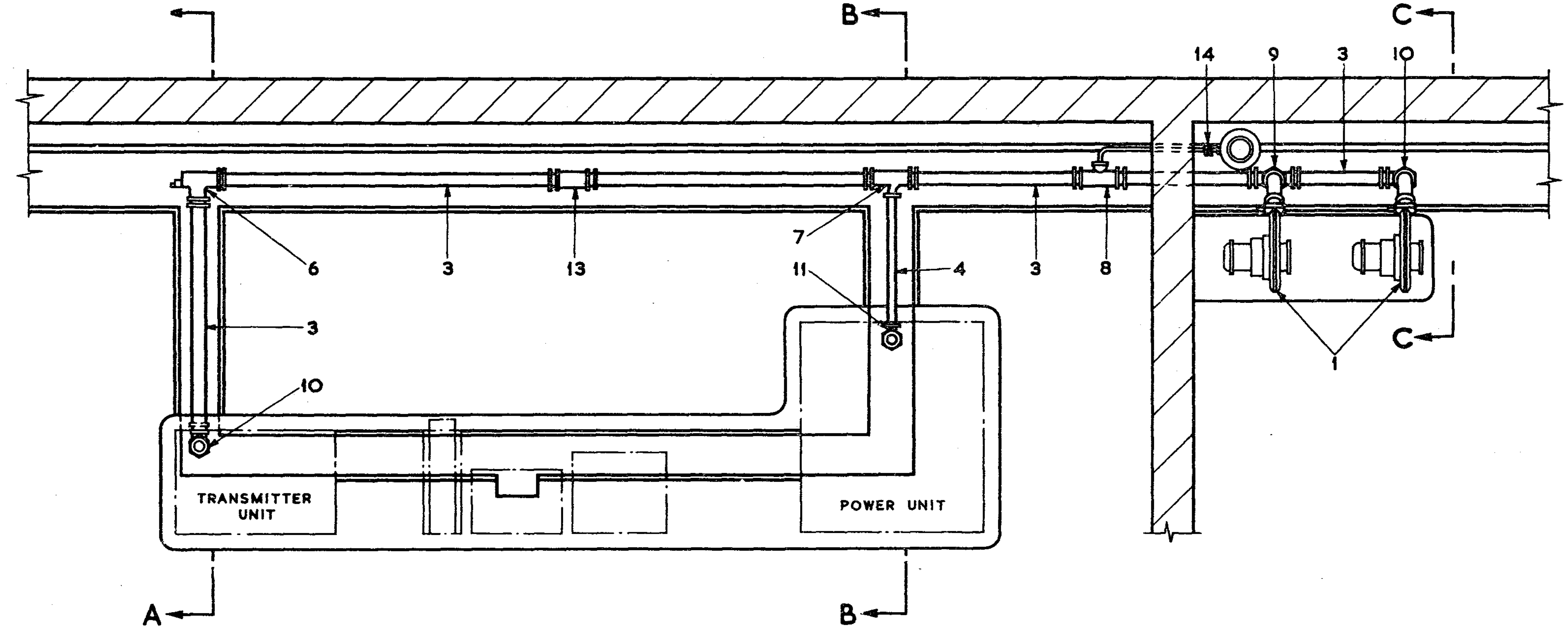



ELEVATION A-A




ELEVATION B-B

Fig.9 Typical foundation details Fig.9

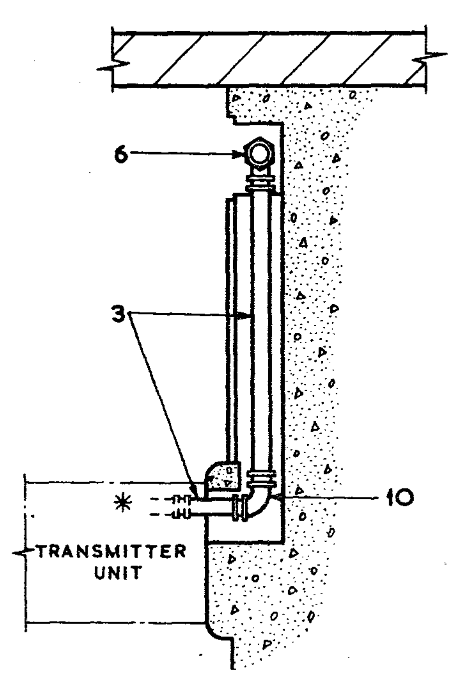



## NOTES:–

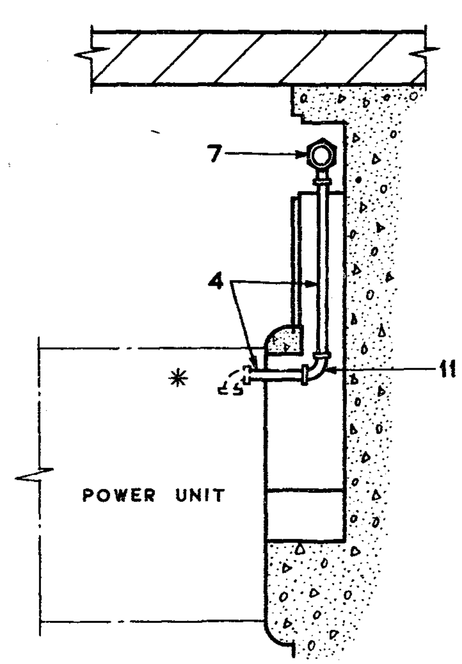
1 TO REDUCE NOISE, IT IS RECOMMENDED THAT BLOWERS BE INSTALLED IN AN ADJACENT ROOM, OR AN EXTERNAL WEATHERPROOF CUPBOARD WITH SUITABLY LOUVERED SIDES, WHICHEVER IS MORE CONVENIENT

2 PIPES TO BE RAISED FROM FLOOR OF TRENCH ON WOODEN VEE BLOCKS, WHERE NECESSARY

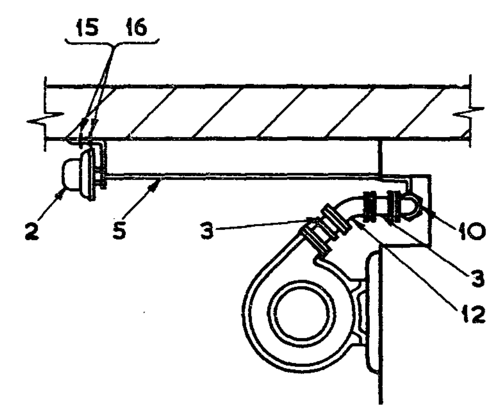
3 FITTINGS MARKED THUS ✳ ARE INCLUDED IN UNITS




SECTION A–A




SECTION B – B




SECTION C–C

## MATERIAL SCHEDULE

| REF | DESCRIPTION | No. REQD. |
|---|---|---|
| 1 | AIR BLOWERS TYPE 7104 | |
| 2 | AIR PRESSURE CUT–OFF SWITCH<br>GAS BOOSTER TYPE | 1 |
| 3 | TUBE 3·144in. O/D X 16 S.W.G. | 4 lgths. |
| 4 | TUBE 1·112in. O/D X 18 S.W.G. | 1 lgth. |
| 5 | TUBE 0·346in. O/D X 20 S.W.G. | 1 lgth. |
| 6 | COMBINED TEE AND DRAIN VALVE FOR 3·144in. O/D TUBE | 1 |
| 7 | SWEEP TEE FOR 3·144in. O/D TUBE AND 1·112in. O/D TUBE | 1 |
| 8 | SWEEP TEE FOR 3·144in. O/D TUBE AND 0·346in. O/D TUBE | 1 |
| 9 | SWEEP TEE FOR 3·144in. O/D TUBE | 1 |
| 10 | 90° BEND FOR 3·144in. O/D TUBE | 3 |
| 11 | 90° BEND FOR 1·112in. O/D TUBE | 1 |
| 12 | 45° ELBOW FOR 3·144in. O/D TUBE | 2 |
| 13 | STRAIGHT COUPLING FOR 3·144in. O/D TUBE | 2 |
| 14 | STRAIGHT COUPLING FOR 0·346in. O/D TUBE | 1 |
| 15 | WOOD SCREWS ROUND HEAD | 1 doz. |
| 16 | RAWLPLUGS | 1 doz. |

Fig.10 Typical air cooling system

Fig. 10

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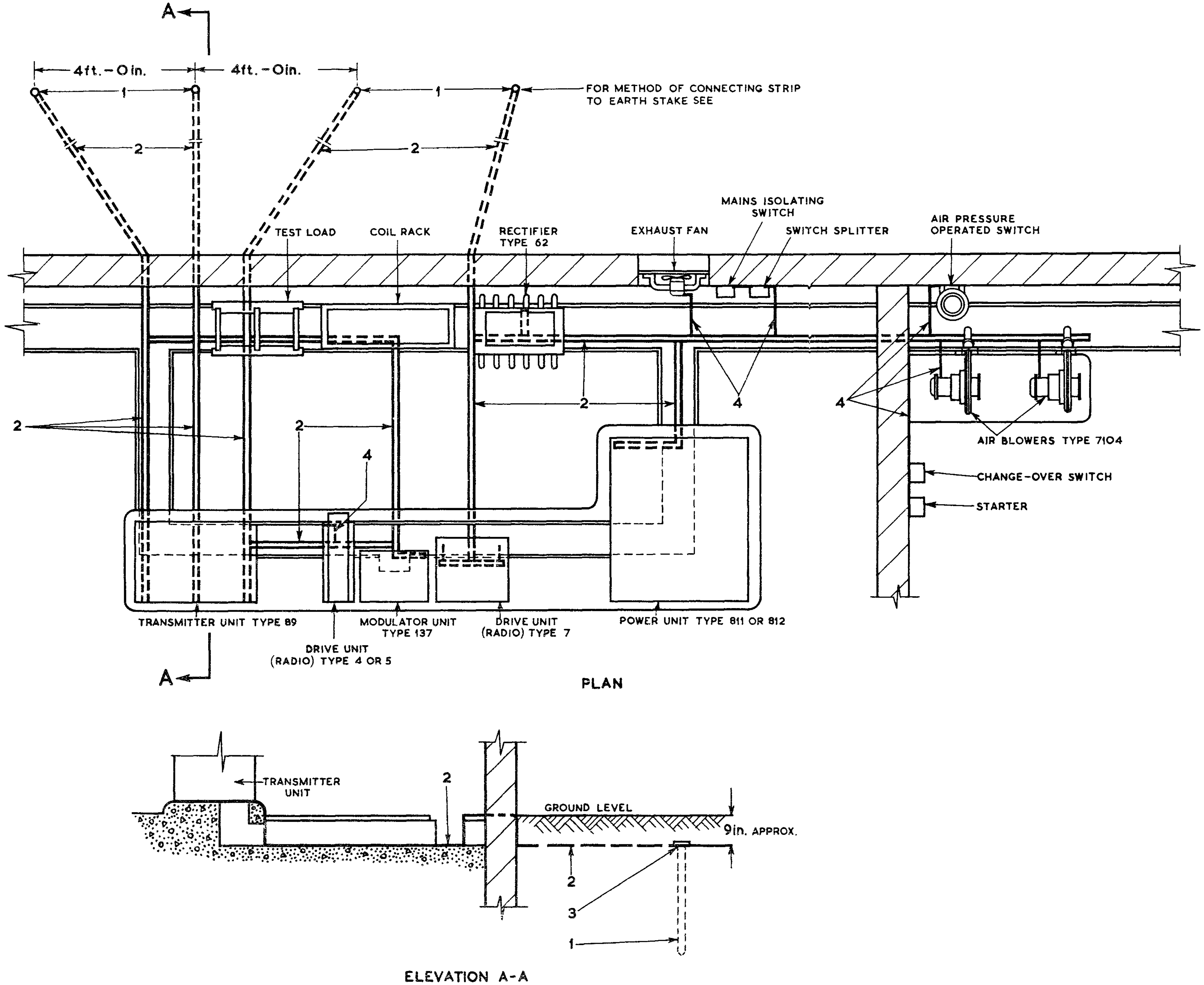


| REF | DESCRIPTION | MATERIAL | No. REQD. |
|---|---|---|---|
| 1 | EARTH STAKE JAVELIN TYPE 3ft.-0in. LONG | COPPER | 4 |
| 2 | EARTH STRIP 1½in. X 1/16in. | COPPER | 180ft. |
| 3 | SCREW O.B.A.X ⅝in. LONG CH. HD. WITH HEX. NUT & 2 WASHERS | BRASS | 8 |
| 4 | 10 S.W.G. BARE WIRE | COPPER | 50ft. |

**NOTES :-**

1 MAIN EARTH STRIPS TO BE LAYED BEFORE INSTALLING TRANSMITTER. CONNECTIONS SHOULD BE AS SHORT AS POSSIBLE, EXTENDING BENEATH TRANSMITTER

2 METAL FRAMES OF ALL ELECTRICAL EQUIPMENT TO BE BONDED TO NEAREST EARTH CONTINUITY CONDUCTOR BY MEANS OF COPPER STRIP OR WIRE. SWEAT AND PAINT ALL COPPER JOINTS

3 OUTSIDE STRIPS AND EARTH STAKES TO BE BURIED IN MOIST VIRGIN SOIL, CLEAR OF FOOTINGS. TO ENSURE LOW ELECTRODE RESISTANCE, POORLY CONDUCTIVE SOIL MAY BE SALTED

Fig. 11 Typical earthing system Fig. 11

Dmd 7025 459356 375 12/54 AB 979/3 9069

# Chapter 3

# SETTING-UP FOR CW OPERATION

# (T.1975, T.1976, T.2000, and T.7095)

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### Introduction

**1.** Before any attempt is made to set up these transmitters, the operator should satisfy himself that the installation is satisfactory. Information on the installation for the four types of transmitter will be found in Vol. 1, Part 1, Sect. 1, Chap. 2, of this A.P.

**2.** On an operational installation, a visual check of the units, air blowers and supply points should be adequate.

**3.** Each of the four types of transmitter described may be used in the common fundamental CW role described in this chapter. Variations on this role, i.e., FSK, SSB and DSB operation, are described in Chapter 4 of this section.

**4.** When considering the CW installation it should be noted that the EXTERNAL crystal drive to the transmitter is derived as follows:—

(1) T.1975—Drive Unit Type 4.

(2) T.1976—Drive Unit Type 5.

(3) T.2000—Drive Unit Type 5.

(4) T.7095—Oscillator Type 7069.

All the drive units given above contain, and provide outputs from, the oscillator Type 7096. (This oscillator is described in A.P.2883Q, Vol. 1, Part 1, Chapter 2.) As the other items provided to make up the various types of drive unit are not used in the CW role they are therefore ignored and the EXTERNAL drive is considered as originating from an oscillator Type 7069.

#### Outline of procedure used

**5.** The first stage in the setting-up procedure is to determine the operating frequencies for the master oscillator and the harmonic amplifier stages (frequency multiplication).

**6.** When these frequencies have been established, the initial setting-up procedure may be carried out using the following logical sequence:—

(1) Check that all links, switches, etc. are set for CW operation.

(2) Insert the correct range of stage 1 to stage 4 coils selected according to the information provided in fig. 1.

(3) Make up and insert the stage 5 and stage 6 coils according to the information provided in fig. 2.

(4) Set the aerial coupling switches and links to the position shown in Vol. 1, Part 1, Sect. 2, Chap. 1, fig. 4.

**7.** At the second stage in the setting-up procedure the power unit is switched on and all the supplies it produces are checked and adjusted. Special attention should be given to the transmitter filament supplies. After these supplies have been checked, the setting-up procedure is carried out as follows:—

(1) Master oscillator.
(2) Harmonic amplifier, stages 1 to 4.
(3) Stages 5 and 6.
(4) Coupling to the aerial.
(5) The keying circuit.

### PRELIMINARY SETTINGS AND ADJUSTMENTS

**8.** The procedure given in the following paragraphs is a descriptive treatment of the instructions given in the Vol. 5 of this A.P. The Vol. 5 instructions are mandatory and will be complied with at all times.

#### Power unit

**9.** The following settings on the power unit ensure that all AC supplies are disconnected from both the power unit and the transmitter and that all switches are correctly set prior to switching on. **(Warning:** Although the MAIN SWITCH is set to OFF, one side of this switch and the supply input fuses are both still "LIVE.") The switch and control settings are:—

(1) MAIN SWITCH to OFF.
(2) HT to OFF.
(3) H.A.H.T. to OFF.
(4) GRID NEGATIVE to OFF.
(5) FILAMENT/STANDBY to STANDBY.
(6) TRANS and AUX FILS, GRID NEG, H.A.H.T., MAIN RECT FILS, controls fully counter-clockwise.
(7) TRANSMITTER HT + VE switch to EARTH
(8) TRANSMITTER HT + VE control to position 1.
(9) Remove the bottom right-hand panel of the power unit and set the CW, PHONE/SSB switch to CW, PHONE. Replace the panel.

#### Transmitter

**10.** The following preliminary checks should also be made on the transmitter, these checks are necessary to check that the equipment is prepared for operation in the CW role:—

(1) Check that the brass box containing the stage 4 auxiliary SSB circuit is removed. The box, if fitted, is located in the rear, left, lower compartment of the transmitter.

(2) Check that the SSB plugs in the top of the same compartment are located in the CW sockets.

(3) Check that the stage 4 clamping resistor leads, also in the same compartment, are located in the inner CW sockets, i.e., that the resistor is in circuit.

#### *Stages 1 to 4 (coil fitting)*

**11.** Refer to the coil chart on fig. 1 and decide which coils are to be used. Fit these coils and then adjust the tuning capacitors until the readings shown on the capacitor scales agree with those specified in the capacitor calibration chart on fig. 1.

#### *Stage 5*

**12.** Select a suitable former and make up the stage 5 coils from the data provided on fig. 2. In certain cases it will be found that the coil may be chosen from "overlapping" graphs. If such is the case the coil is selected from the higher frequency graph, i.e., the coil chosen should give the highest L/C ratio.

**13.** To reduce heating losses the cross links are removed from the inactive coil loops. For the same reason, the arrangement of cross links chosen should given the greatest number of turns in parallel. All tapping strips should be used: in the series arrangement the taps should be connected close together on one turn, for the parallel arrangement the strips should be divided as evenly as possible between the parallel windings. The end tappings should be set the same distance from each end of the coil so that the HT tap is in the centre of the length of active winding between the clips.

**14.** The stage 5 coil is inserted from the rear of the transmitter, the HT centre tap (lying towards the rear of the transmitter) being connected to the stage 5 flying lead immediately the coil is inserted.

**15.** The link determining the tapping on the stage 5 anode resistance is now set as below for the specified radiating frequency. This link will be found in the rear, top, left-hand compartment of the transmitter.

**TABLE I**

**Stage 5 and resistance tapping**

| Radiating frequency M/cs | Tapping |
|---|---|
| 27·3 — 15·0 | 1 |
| 15·0 — 12·3 | 2 |
| 12·5 — 10·7 | 3 |
| 10·7 — 9·735 | 4 |
| 9·735 — 8·333 | 5 |
| 8·333 — 2·0 | 6 |

**16.** When the transmitter is set up to operate between 2 and 22·2 M/cs, check that the stage 5 reactance capacitor switch is closed and that the value of the stage 5 grid resistor (located immediately above the stage 5 valve base at the front of the transmitter) is 100 ohms.

**17.** At operating frequencies above 22·2 M/cs, open the reactance capacitor and replace the 100-ohm grid resistor with the alternative 5-ohm resistor which will be found in the front lower right-hand side of the stage 5 compartment.

**18.** The following adjustments are carried out before despatch by the manufacturer, further adjustment should not be necessary unless the items mentioned are moved for repair purposes:—

(1) The large plate on the left-hand side of the stage 5 tuning capacitor is set so that it is ⅞ in. from the side screen.

(2) The circular plate adjacent to (1) should be approx. ½ in. from the side screen.

(3) Check that when the BALANCING control is fully counter-clockwise (zero), the tips of the balancing capacitor movable plates are 1·1 inch from the tuning capacitor side plates.

*Stage 6*

**19.** The stage 6 coil is selected from the calibration chart, fig. 2. The rules for selection and make-up given for the stage 5 coil also apply to the stage 6 coil.

**20.** Insert the coil into position from the rear of the transmitter and ensure that the centre tap on the coil lies to the front of the transmitter. The stage 6 HT flying lead is not connected to the coil at this point in the procedure, care should be taken however that the flying lead is positioned so that it cannot short to earth

**21.** For operation between 2 and 22·2 m/cs, the stage 6 reactance capacitor switches should be closed and the 100-ohm grid resistor (located beneath the stage 6 tuning capacitor) in position.

**22.** When operating at frequencies above 22·2 m/cs, open the reactance capacitor switches and replace the two 100-ohm grid resistors with the alternative 5-ohm grid resistors (located in the front of the stage 6 compartment on the left-hand side).

**23.** The preliminary settings for the stage 6 balancing plates are identical to those given for stage 5 (*para.* 18).

**24.** The brass plate at the rear of the stage 6 capacitor forms an additional capacitor with the brass screen. This plate is set by the manufacturer and should not be adjusted unless the operating temperatures of the two stage 6 valves widely differ and cannot be otherwise corrected.

*Aerial coupling circuit and the artificial aerial*

**25.** The aerial coupling circuit links and switches are to be set as given in Vol. 1, Part 1, Sect. 2, fig. 4. Check that the AERIAL INDICATOR meter is shorted out by the links provided.

**26.** An artificial aerial consisting of twenty-four 250W carbon filament lamps is provided for use while setting-up the transmitter. These lamps are connected up as a resistive load to present an impedance equivalent to that presented by the aerial and feeder in use on the Station.

**27.** *600-ohm, twin-wire feeder.* When the network is substituted for an aerial fed by a 600-ohm, twin-wire feeder, the twenty-four lamps are connected up to give eight sets of three lamps in parallel. These sets are then connected in series across the feeder terminals on top of the transmitter.

**28.** *77-ohm concentric output.* The arrangement used in this case requires the lamps to be arranged in sets of eight lamps in parallel. These sets are then connected in series and connected across the concentric outlet.

## SETTING-UP THE POWER SUPPLIES

**WARNING**

***The supplies exposed on the power unit and transmitter are lethal.***

**29.** Before attempting to switch on the equipment, check that all gate switches are made by ensuring that the panels operating these switches are secure.

**AC power supplies**

**30.** Set the MAIN SWITCH on the power unit to ON and then press the blower motor ON button. The air blowers should now start up. Should the blowers fail at any time, switch off the equipment and allow the stage 5 and 6 valves to cool down before re-starting the blowers. Failure to take this precaution may result in cracked valve seals. Such cracks are caused by cool air blowing on to the valves which were overheated when the blowers failed.

**31.** Set the AC voltmeter switch to MAIN RECT FIL and turn the MAIN RECT FIL control clockwise until the meter reading shown is 360V. (This voltage is the supply to the primary of the main rectifier filament transformer.)

**32.** The filament supplies for the transmitter should now be checked by setting the VOLTMETER SWITCH associated with the FILAMENT VOLTS meter to 6·3V FILS. A reading of 6·3V should be obtained. When this switch is set to STAGE 5 and STAGE 6, the filament voltages marked on these valves should be obtained.

**33.** If any of the filament voltage readings are incorrect, after a suitable warming-up period, the appropriate resistors behind the front, lower, centre, hinged panel should be adjusted.

**Note . . .**
*The filament switch should be returned to* STAND BY *and the* MAIN SWITCH *to* OFF *before any adjustments are made.*

**34.** Two tapped resistors are provided to allow each filament supply to be adjusted. When an adjustment is to be made to these tappings, care should be taken that both taps are left at the same distance from the end of the resistor.

**35.** Should the stage 5 or 6 valves be changed, a careful check of the filament voltage must be made on the new valve and any adjustments necessary made to the filament resistors.

**DC power supplies**

*Master oscillator*

**36.** When the MAIN SWITCH is set to ON, the master oscillator supplies are automatically switched on. The voltage of this supply is not metered, although its presence may be ascertained by setting the FEEDMETER switch, associated with the ANODE AND SCREEN FEEDS meter, to MO and noting that current is being taken by the master oscillator.

*Grid neg.*

**37.** Set the GRID NEG switch on the power unit to ON and the DC voltmeter switch to GRID NEG. Turn the GRID NEG control clockwise until the reading on the GRID NEG and H.A.H.T. meter agrees with that given in the Test Report.

*H.A.H.T.*

**38.** Set the H.A.H.T. switch on the power unit to ON and the AC metering switch to H.A.H.T. Turn the H.A.H.T. control clockwise until a reading of 300V is obtained on the GRID NEG and H.A.H.T. meter. (This low H.A.H.T. supply voltage is used only while initially setting-up the harmonic amplifiers. It is increased to 430V before finally setting-up these stages (*para.* 51).

## SETTING-UP THE TRANSMITTER

**Master oscillator**

**39.** The drive used for setting-up the transmitter is obtained from the INTERNAL Franklin oscillator. The setting-up procedure for the crystal EXTERNAL drive is also described at this point although this drive is only brought into the procedure after the harmonic stages have been set up using the Franklin master oscillator (*para.* 41).

**40.** Before setting-up the master oscillator the drive frequency for the specified radiated frequency must first be evolved. This drive frequency is found by dividing the radiated frequency by the multiplication factor "M" which will be found in the coil chart on fig. 1.

*Franklin master oscillator*

**41.** When the Franklin master oscillator is in use its operating frequency, derived in para. 40, is set by referring to the calibration chart supplied with each oscillator. The setting specified on this chart is then set on the FMO.

**42.** The amount of backlash in the logging knob drive should now be established. (A certain amount of backlash is deliberately inserted in this drive to prevent the master oscillator tuning capacitor being moved by mechanical expansions and contractions in the drive.)

**43.** The FMO range switch (calibrated 1 to 8) is turned to the tapping specified, care being taken that the switch is properly set in its new position. The tuning capacitor "logging" knob is then turned until the coarse dial cursor "A" indicates the digit immediately below that specified on the chart. The logging knob is now turned in a manner such that its readings increase until the decimal point specified on the chart lies opposite the scale B cursor. The logging knob is now carefully turned back by exactly half the amount found in para. 42

**44.** A reading will be obtained on the CONTROL VALVE meter, this reading must be set to 1 mA by adjusting the screw headed DIODE ANODE CONTROL on the right-hand side of the transmitter. It is most important that this adjustment be carried out correctly as the standing diode current affects the calibration of the FMO.

*Crystal oscillator*

**45.** The crystal drive enters the transmitter through the matching terminating unit. The capacitor in the terminating unit is set for the drive frequency in use after reference to fig. 1.

**46.** Assuming that stages 1 to 4 in the transmitter have been set up (*para.* 50 *to* 52), the switch should be turned to EXT and the link on the terminating board set to EXT DRIVE 1.

**47.** The output lead from the oscillator 7069 is now inserted into SK1 on the terminating unit

**Note . . .**
*To ensure frequency stability, the oscillator should be* ON *for as long as possible before it is brought into use: the time taken for the crystal oven to reach a stable temperature from a room temperature of* 22 *deg. C* (71·6 *deg. F*) *is approximately* 4 *hrs.*

**48.** Withdraw the oscillator 7096 chassis from its case to expose the frequency multiplier tuning capacitors (numbered 1-10) on the right-hand side of the chassis. On the front panel of this unit, set the METER switch to RF and the CRYSTAL switch to the number corresponding to the crystal required (1 to 10). Tune the appropriate crystal capacitor until maximum output is indicated on the meter.

**Note . . .**
*Several spurious tuning points may be found, the correct point is that which gives a maximum reading on the* STAGE 5 GRID *meter on the transmitter.*

**49.** Final adjustments to stages 1 to 4 on the transmitter should now be made using the crystal EXTERNAL drive before proceeding to set up the rest of the transmitter.

**Stages 1 to 4**

**50.** The procedure used to set up the harmonic amplifier stages 1 to 4 (given also in tabular form for convenience) is to tune each stage sequentially. As each stage is tuned, the grid current of the following stage is observed and used as an indicator for the "ON TUNE" condition. In tabular form, the procedure is as follows:—

(1) Set the keying switch to MARK. (This setting ensures full "reduced" HT to the harmonic amplifier.)

(2) Set the FEEDMETER switch associated with the GRID AND ANODE FEEDS meter to ST2.

(3) Tune stage 1 for maximum meter reading on this meter.

(4) Set the switch to ST3.

(5) Tune stage 2 for maximum reading on this meter.

(6) Set the switch to ST 4×4.

(7) Tune stage 3 for maximum reading on this meter.

(8) Set the switch associated with the ANODE AND SCREEN FEEDS meter to ST 4 S G.

(9) Tune stage 4 for a minimum reading on this meter.

**51.** The harmonic amplifiers are now basically tuned and the reduced H.A.H.T. (*para.* 38) can now be increased to its full value. This supply voltage is increased by turning the H.A.H.T. control on the power unit clockwise until the H.A.H.T. and GRID NEG meter on this unit reads 420 to 440V. With this new value for the H.A.H.T. supply repeat the procedure given in para. 50.

**52.** When this procedure is completed, set the switch associated with the ANODE AND SCREEN FEEDS meter to ST 4×4. Ensure that during the following adjustments the ST. 4 S.G. current does not exceed 40 mA. Observe the STAGE GRID meter and turn the STAGE 3 GAIN CONTROL in small steps, retuning stage 4 for minimum current on the ANODE AND SCREEN FEEDS meter at each step, noting that the 40 mA limit is not exceeded.

**Stage 5**

**53.** Set the handle of the STAGE 6 GRID BIAS switch to BALANCING STAGE 5 and turn the STAGE 5 BALANCING control fully counter-clockwise. Watch the STAGE 6 GRID meter and turn the STAGE 5 TUNE control until a maximum reading is observed on this meter. If no current reading is obtained, turn the STAGE 5 BALANCING control clockwise until a substantial reading is obtained. Retune stage 5 for maximum reading on the meter and then reduce this reading by means of the STAGE 5 BALANCING control. Repeat this tune/balance procedure until no grid current is shown at the point of tune.

**Stage 6 and the output circuits**

**54.** Ensure that the stage 6 HT flying lead is disconnected from the stage 6 coil. Set the handle of the STAGE 6 GRID BIAS switch to the WORKING position. Establish minimum coupling to the artificial aerial by turning the OUTPUT COUPLING control fully clockwise. Open circuit the output coil by opening the link on the capacitor switch base, behind the output tuning capacitor (concentric output only), or by sliding back link D (open wire feeder). Set the handle of the STAGE 6 GRID BIAS switch to the open position.

**55.** Make up a balancing lamp with a flashlamp bulb (MES 3·5V, 0·3A) holder and a pair of short leads terminated with clips.

**56.** Attach this lamp to the central cross strip of the stage 6 coil with its clips equidistant from the centre top of the coil.

**Note . . .**
*The closer the clips lie together, the smaller the voltage across the lamp and thus less chance of burning out the lamp.*

**57.** Turn the STAGE 6 TUNE control fully clockwise to detune stage 6 and turn both BALANCING STAGE 6 controls fully clockwise.

**WARNING**

***Close and secure stage 5 and 6 doors. At this point in the procedure the 6 kilovolt transmitter HT is switched on—this voltage is lethal.***

**58.** On the power unit, turn the TX. HT+ to TX and then turn the HT control clockwise until "1" is presented in the window to the right of this control.

**59.** The HT supplies are now connected to stage 5 and 6. Stage 5 is retuned while the STAGE 5 ANODE meter is observed. The "in tune" condition is shown by a minimum reading on this meter.

**60.** Slowly turn the STAGE 6 TUNE control until the balancing lamp starts to glow. Turn both balancing controls clockwise by equal small amounts, the lamp glow should diminish. Retune for maximum glow and then re-balance for minimum glow: repeat this operation until no glow can be seen. Ensure that the readings on both balancing controls are identical.

**WARNING**

*Set the TX. HT. + switch on the power unit to earth.*

**61.** Remove the balancing lamp, reconnect link D (open-wire feeder) or close the link on the capacitor switch base behind the output tuning capacitor (concentric feeder). Set the handle of the STAGE 6 GRID BIAS control to the working position.

**WARNING**

*Close and secure stage 5 and 6 doors and then set the TX. HT + switch on the power unit to TX.*

**62.** Re-check the tuning of stage 5 before tuning stage 6 for minimum reading on the STAGE 6 ANODE meter.

**63.** Adjust the OUTPUT TUNING CONDENSER control to give maximum reading on the STAGE 6 ANODE meter. (If the tuning appears to be indefinite turn the OUTPUT COUPLING control slightly further counter-clockwise to increase slightly the coupling to the artificial aerial.) Note that as little coupling as possible should always be used. Retune stage 6 for a minimum STAGE 6 ANODE meter reading.

**64.** The transmitter HT is now increased by turning the HT control on the power unit to present "2" in the window adjacent to the control.

**65.** Increase the OUTPUT COUPLING in small steps until the STAGE 6 ANODE meter gives a reading of half the value of the full load reading specified in the Test Report. After each increase in coupling check that stage 6 is still tuned for minimum STAGE 6 ANODE meter reading.

**66.** Turn the HT control on the power unit to "4" and turn the OUTPUT COUPLING control further counter-clockwise until the full load reading given on the Test Report is shown on the STAGE 6 ANODE meter. Recheck the stage 6 tuning.

**Keying**

**67.** Set the keying unit switch on the left-hand side of the transmitter to MARK. In this MARK condition the keying valve is cut off and no grid or anode current should be flowing. This condition may be checked with the switch associated with the GRID AND ANODE FEEDS meter set to the GRID × 10 and ANODE × 20 positions.

**68.** Set the keying unit switch to KEY and repeat the checks made in the previous paragraph. The readings should now be 30 mA and 60 mA respectively.

**69.** The bias supply for the keying valve may be checked by setting the switch associated with the NEG GRID BIAS meter to PARTIAL ABSORBER GB (250V). The cathode potential of the keying valve may be checked when the switch is turned to the KEYING VALVE CATHODE position (105V).

**70.** Provision is not made to measure the voltage on the absorber grid, it should, however, be 40V. If any of the bias voltages are incorrect they may be adjusted by moving the taps on the bias potentiometer in the back of the power unit.

**71.** Table 2 gives an indication of the keying valves electrode potentials and currents in the MARK and KEY conditions.

**TABLE 2**

**Keying circuit—voltage and current readings**

**Current readings**

| | Mark (mA) | Space (mA) |
|---|---|---|
| Keying valve grid | 0 | 30 |
| Keying valve anode | 0 | 165 |
| Partial absorber grid | 0 | 16 |
| Partial absorber anode | 0 | 300 |

**Voltage readings**

| | Mark | Space |
|---|---|---|
| Partial absorber GB+ | + 40 | — 45 |
| Partial absorber GB— | —260 | —200 |
| Keying valve cathode | —105 | — 55 |

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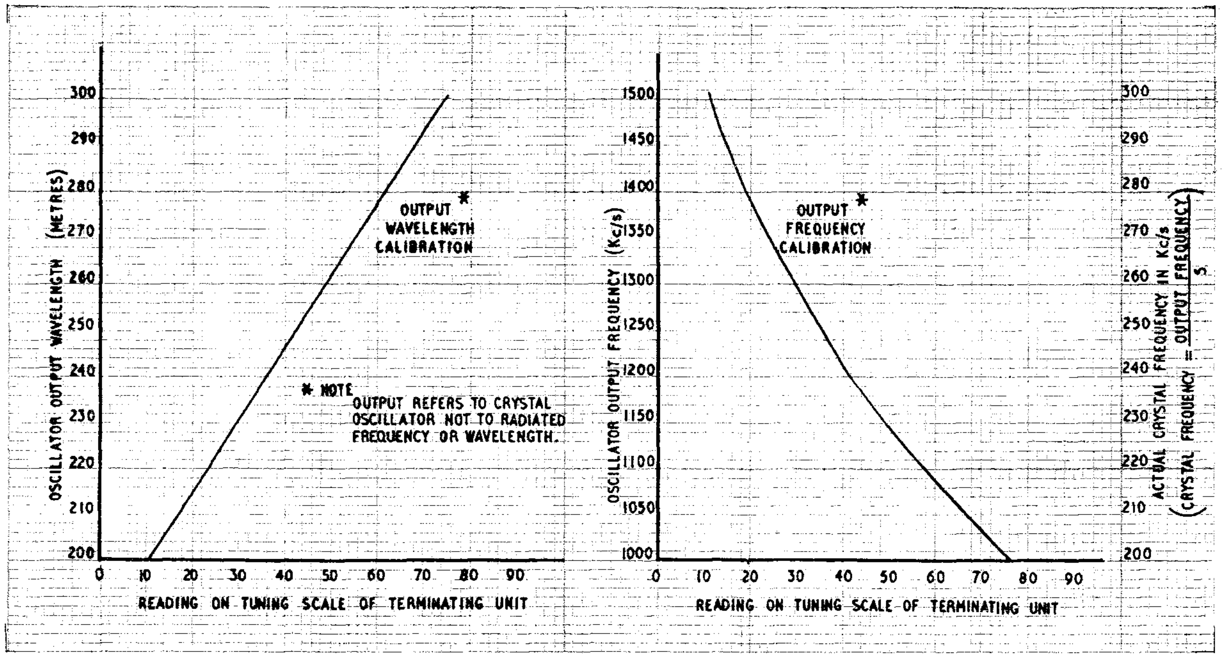
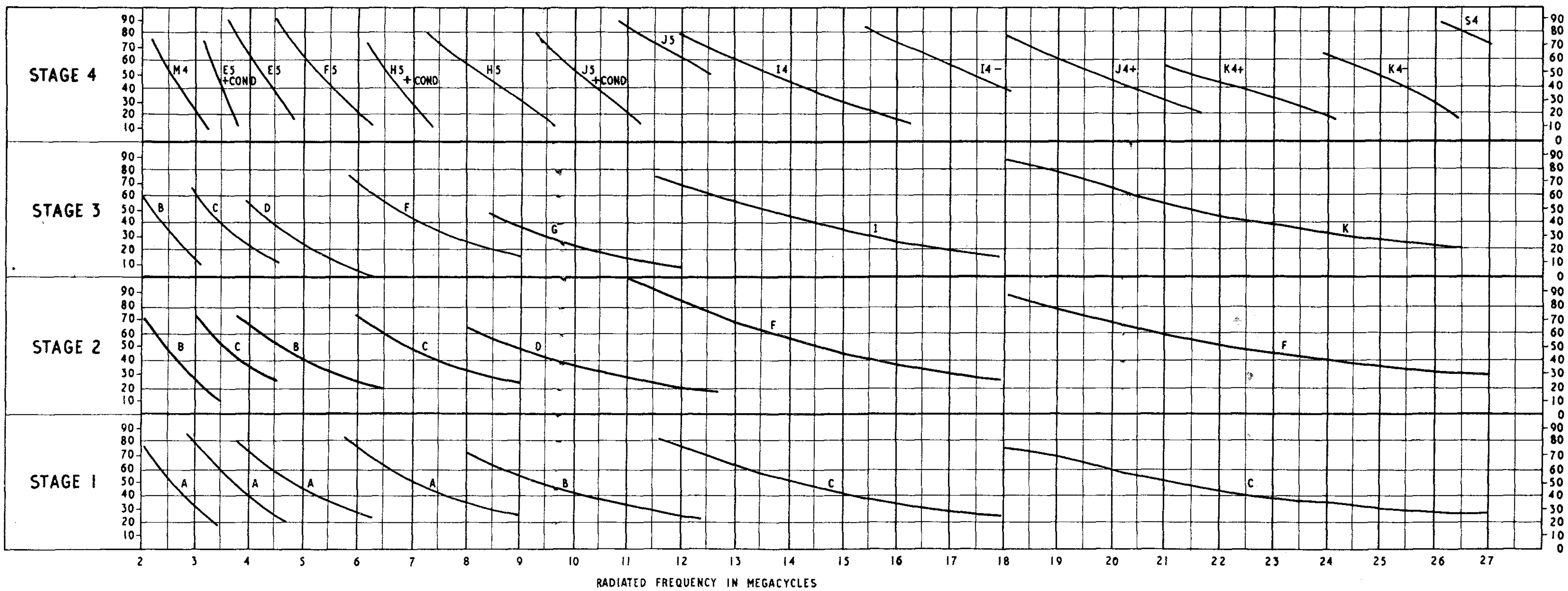



CALIBRATION CHART FOR TERMINATING UNIT

| RADIATION | | FREQ. MULTIPLICATION OSC. TO 4th. STAGE | | | | | COIL REQUIRED AND TUNING RANGE OF COILS (METRES) IN EACH STAGE | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FREQ. IN Kc/s | WAVELENGTH IN METRES | O/ALL M | STAGE MULTIPLICATION 1 | 2 | 3 | 4 | STAGE 1 COIL | RANGE | STAGE 2 COIL | RANGE | STAGE 3 COIL | RANGE | STAGE 4 COIL | RANGE | STAGE 4 PADDING CAPACITOR |
| 2000 – 3000 | 150 – 100 | 2 | 1 | 2 | 1 | 1 | A | 300 – 200 | B | 150 – 100 | B | 150 – 100 | M4 | 150 – 100 | OUT |
| 3000 – 4500 | 100 – 66·66 | 3 | 1 | 3 | 1 | 1 | A | 300 – 200 | C | 100 – 66·6 | C | 100 – 66·6 | E5<br>E5 | 100 – 85<br>85 – 66·6 | IN<br>OUT |
| 4500 – 6000 | 66·66 – 50 | 4 | 1 | 2 | 2 | 1 | A | 300 – 200 | B | 150 – 100 | D | 66·6 – 50 | F5 | 66·6 – 50 | OUT |
| 6000 – 9000 | 50 – 33·33 | 6 | 1 | 3 | 2 | 1 | A | 300 – 200 | C | 100 – 66·6 | F | 50 – 33·3 | H5<br>H5 | 50 – 42<br>42 – 33·3 | IN<br>OUT |
| 9000 – 12000 | 33·33 – 25 | 8 | 2 | 2 | 2 | 1 | B | 150 – 100 | D | 75 – 50 | G | 33·3 – 25 | H5<br>J5<br>J5 | 33·3 – 31·5<br>31·5 – 27<br>27 – 25 | OUT<br>IN<br>OUT |
| 12000 – 18000 | 25 – 16·66 | 12 | 3 | 2 | 2 | 1 | C | 100 – 66·6 | F | 50 – 33·3 | I | 25 – 16·6 | I4<br>I4 – | 25 – 19<br>19 – 16·6 | OUT<br>OUT |
| 18000 – 27000 | 16·66 – 11·11 | 18 | 3 | 2 | 3 | 1 | C | 100 – 66·6 | F | 50 – 33·3 | K | 16·6 – 11·11 | J4 +<br>K4 +<br>K4 –<br>S4 | 16·6 – 14<br>14 – 12·5<br>12·5 – 11·45<br>11·45 – 11·11 | OUT<br>OUT<br>OUT<br>OUT |

STAGES 1 TO 4–COIL CHART




STAGES 1 TO 4–CAPACITOR SETTINGS

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## Transmitter SWB8X—Calibration charts for terminating unit and stages 1 to 4

Fig. 1

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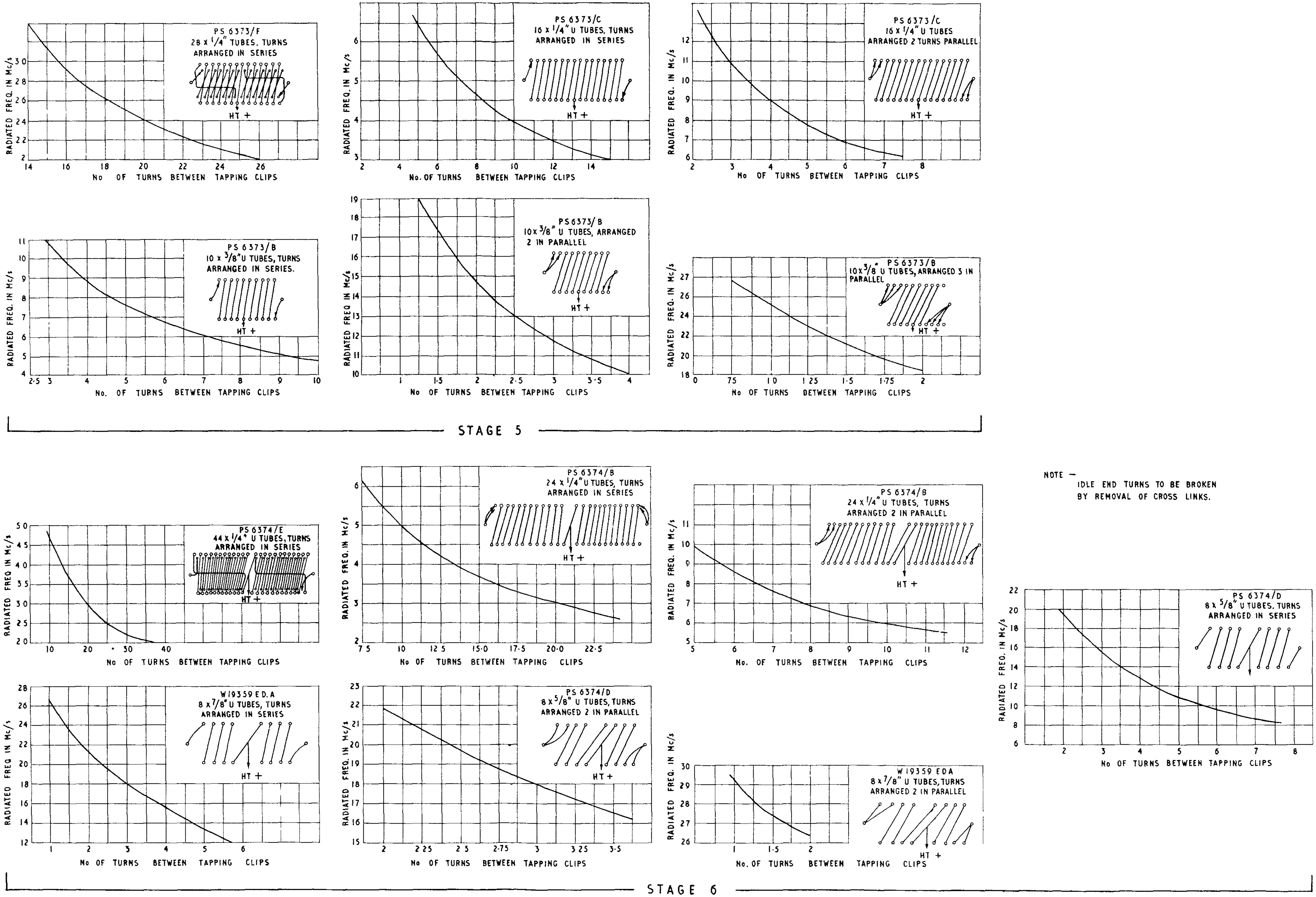


Transmitter SWB8X–Approximate calibration of stage 5 and 6 inductances with CC capacitor set at mid-scale Fig. 2

(A.L. 8, Mar. 57)

AIR DIAGRAM
6254B/MIN.

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# Chapter 4

## SETTING UP FOR FSK, SSB, DSB AND TELEPHONY OPERATION

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**General introduction**

**1.** In this chapter it is assumed that the transmitter has already been set up for CW operation. The alternative roles are established by the addition of certain other items of equipment which are listed under the "role" headings. Relatively simple adjustments are also made to the transmitting unit and power unit.

**2.** It should be borne in mind that the procedure given in the following test is only a descriptive treatment of the instructions given in the Vol. 5 of the units concerned. The Vol. 5 instructions are mandatory and should be complied with at all times.

**WARNING**

*When the MAIN SWITCH on the power unit Type* 811 (*or* 812) *is set to OFF, one side of this switch and the supply input fuses are still "live." To disconnect all supplies from the equipment, the external isolating switch must be set to OFF.*

**FSK OPERATION**

**3.** FSK operation may be obtained on the transmitter Type T.1975 by making some simple modifications to the basic CW installation, one additional unit (the drive unit Type 4) being required. The detailed setting up procedure for the D.U.4 will be found in A.P.2883Q, only the routine setting up procedure for this item will be included in this chapter. Items and circuits in the basic CW installation affected by the change to FSK operation are as follows :—

(1) *RF drive.* In the CW installation this drive is obtained from an oscillator 7069, while on FSK this drive is obtained from the D.U.4.

(2) *Partial absorber.* As this item is only required to provide ON/OFF modulation, it is disconnected.

(3) *Harmonic amplifier coils.* These items are selected from Table 4 in A.P.2883Q, Vol. 1, Part 1, Chapter 6. (The information con-

tained in this Table is so similar to that contained in fig. 1 of Chapter 3, Part 1, Sect. 1 in this A.P. that it may not be necessary to change the coils already fitted for CW operation).

**4.** The remainder of the basic transmitter installation is set up as for CW operation. From this brief operational outline it can be seen that for FSK operation it will be unnecessary to repeat the applicable CW information and, to avoid repetition, references will therefore be made where necessary to the CW chapter (*Chap.* 3, *Part* 1, *Sect.* 1).

**Preliminary adjustments**

*Drive unit*

**5.** Set up the sub-chassis of the drive unit as follows :—

(1) Oscillator 7069
  (a) Set the MOD/CW switch to CW.
  (b) Set the CRYSTAL selector switch to the number corresponding to the desired oscillator frequency.
  (c) Set the METER switch to RF and switch on the AC supply.

(2) Mixer and FSK unit
  (a) Select the centre frequency for the keying shift threshold using the SPOT FREQUENCY control.
  (b) Set the FSK METERING switch to position 7 connecting the meter on this unit into the MIXER METERING switch. Then set this latter switch to position 1 (In this position the anode current of the harmonic generator is metered).
  (c) Set the TEST switch to FSK.
  (d) Set the SERVICE switch to FSK. This action makes the following connections :—
    (i) Connects the keying line to the input of the FSK unit.
    (ii) Connects the output of the Oscillator 7069 to the harmonic generator in the mixer unit. . .
    (iii) Connects the FSK output of the mixer unit to the input of the transmitter.

(3) Power unit. Set the HARMONIC NUMBER to correspond to the multiplication factor in use ("*m*", *Chap.* 3, *fig.* 1). This switch, together with the DEVIATION CONTROL determines the amount of frequency shift appearing in the radiated signal, the amount of frequency shift being varied in the D.U.4 to allow for the frequency multiplication that this shift undergoes in the transmitter. The DEVIATION control setting may be found from the chart in A.P.2883Q.

*Transmitting and power units*

**6.** Prepare the transmitting and power units for FSK operation in the following manner :—

(1) Check that all links, switches etc., are set for CW operation.

(2) Select and insert the Stage 1 to 4 coils as in Chap. 3, para. 11.

(3) Make up and insert the Stage 5 and 6 coils as in Chapter 3 para. 11 to 24.

(4) Set the aerial couplings, switches and links to the positions shown in Part 1, Sect. 2, Chap 1, fig. 4.

**Setting up**

*Drive unit*

**7.** Switch on and set up the drive unit as follows :

(1) Set the power unit switches to ON.

(2) Monitoring unit. Adjust the FILTER TUNE for a maximum reading on the meter.

(3) Mixer and FSK unit
  (a) Set the MIXER METERING switch to position 4 to measure the anode current of the balanced modulators, and see that this current reaches a maximum as the MONITOR TUNE is adjusted, i.e., the filter is adjusted to pass only the frequency generated in the Oscillator 7069.
  (b) Set the MIXER METERING switch to position 7 and check that the RF output from the D.U.4 to the transmitter is correct.
  (c) Set the TEST switch to CW.
  (d) Connect an oscilloscope into the CRO jack at the foot of the unit.

(4) Monitoring unit
  (a) Set the TEST/NORMAL switch to TEST. An AC supply (6·3V. 50c/s) is now supplied to the energizing circuit of the keying relay in the mixer and the FSK unit to simulate a keying signal.
  (b) Adjust the oscilloscope FREQUENCY and GAIN controls until a satisfactory rectangular waveform is presented.
  (c) Adjust MONITOR TUNE until the rectangular pulses displayed on the oscilloscope are reduced to the point where further adjustment will invert the waveform. This adjustment does not affect the output of the D.U.4, it does however allow the operator to establish the centre frequency of the D.U.4 by means of the calibrated knob on this control.
  (d) Reset the TEST switch to FSK and set the TEST/NORMAL switch back to NORMAL. Disconnect the oscilloscope.

*Transmitting and power units*

**8.** As the D.U.4 is now fully operational as an FSK drive unit, it is coupled into the transmitter via the EXT DRIVE 2 socket at the rear of the transmitting unit. The links adjacent to this coupling are set to the EXT DRIVE 2 position and the FSK setting up procedure is completed as follows :—

(1) Power unit Type 811. Set up the power supplies as specified in para. 29 to 39 of Chapter 3.

(2) Set up the transmitter according to the instructions in para. 39 to 66 of Chapter 3.

(3) Check the transmitter radiation frequency with a wavemeter, record this reading together with the calibration date used.

## SSB OPERATION

**9.** SSB operation can be obtained on the Transmitter Type T.1976 by using the basic CW installation together with the modulator Type 127 and the drive unit Type 7. As the detailed setting up procedure for this latter item is given in A.P.2877W, this information will not be repeated in this chapter. The performance tests carried out on this equipment when it has been set up are however outlined and examined in this chapter to ensure that the operator understands the reason for carrying out these tests.

**10.** The items and circuits affected by changing from a basic CW installation to that for CW are as follows :—

(1) *Power unit Type* 812. This power unit, together with a rectifier Type 62, is provided for all installations where CW/SSB operation is to be used. (The power unit Type 812 is a modified version of the Type 811, the rectifier being used to provide a DC supply to the transmitter filaments in place of the AC supply used for telegraphy operation.)

(2) *Drive unit Type* 5. This drive unit provides the fundamental RF drive to the transmitting unit. (The D.U.5 is simply an oscillator Type 7069 amounted on a blank cabinet, A.P.2883Q.)

(3) *Transmitting unit.* This unit is virtually unmodified, only the circuits concerned with keying being switched out. Revised matching arrangements are made between the output of Stage 3 and the input of Stage 4 to allow the Mod. 127 to be effectively inserted between these two stages. Alternative matching coils are selected from those stored in the Mod. 127. The operation of the final stages is altered from Class C to Class B to avoid distorting the modulated signals before radiation.

(4) *Modulator Type* 127. As previously stated, this unit is effectively inserted between Stages 3 and 4 in the transmitter. It is used to modulate the drive to the power output with SSB signals from the drive unit Type 7.

### Calculations

**11.** Before making any adjustments to the transmitter, determine the following factors :—

(1) Radiated frequency (fcr).

(2) Frequency of the transmitter stage 3 output (fc3) to the modulator Type 127.

(3) The multiplication factor (m) *i.e.*, the factor by which the output of the drive unit Type 5 (1,000 to 1,500 kcs) is multiplied before radiation (*fig.* 1 *Chap.* 3).

(4) Output frequency of the drive unit Type 5 for each of its CRYSTAL switch settings. (At each setting the output frequency will be five times that marked on its respective crystal.)

### Preliminary adjustments

*Power unit*

**12.** Ensure that all AC supplies are disconnected from the circuits in the power unit and the transmitters and that all switches are correctly set for SSB operation prior to switching on, by setting the following switches and controls to the positions indicated :—

(1) Main switch to OFF.

(2) HT to OFF.

(3) H.A.H.T. to OFF.

(4) GRID NEGATIVE to OFF.

(5) FILAMENT/STANDBY to STANDBY.

(6) TRANS. AND AUX FILS, GRID NEG, H.A. H.T., and MAIN RECT FILS fully counter-clockwise.

(7) TRANSMITTER HT + VE switch to EARTH.

(8) TRANSMITTER HT + VE control to position 1.

(9) Remove the bottom right hand panel on the power unit and set the CW PHONE/SSB switch to CW.PHONE. Replace the panel.

*Drive unit Type 5*

**13.** Set the controls to the positions given in the following list and allow the unit to warm up at least two hours before attempting to handle any traffic.

(1) MOD/CW to CW.

(2) METER switch to RF.

(3) Set the CRYSTAL selector switch to the number corresponding to the desired oscillator frequency.

(4) AC switch to ON.

*Transmitting unit*

**14.** Make the following adjustments to the transmitter with the supplies OFF :—

(1) Set the FM switch to OFF.

(2) Disconnect and lock the stage 4 tuning knob. To do this, pull and turn the knob until it disengages and locks in the outward position.

(3) Refer to fig. 1 and select the appropriate "Z" coil for the stage 4 input unit from the storage compartment in the Modulator 127. Plug the stage 4 unit, with the knurled screws uppermost, into the back of the fourth stage and clamp the unit in position. Then plug the RF input lead from the Mod 127 into the underside of the stage 4 unit. Set the input unit capacitor to the position specified on fig. 1.

(4) Rotate the capacitor knob until it springs back and engages with the tuning shaft on the input unit.

(5) Withdraw the plugs from the inner (CW) sockets in the stage 4 compartment damping resistor and insert them into the outer (SSB) sockets. (On CW, this resistor is not in circuit.)

(6) Withdraw the plugs from the outer pair of sockets (CW) in the top of the stage 3 compartment and insert them in the inner (SSB) sockets.

(7) Fit the special SSB stage 3 and 4 coils according to the information provided in fig. 1. Set the stage 4 tuning condenser to the setting specified on the same chart.

(8) Open the front door of the harmonic amplifier compartment to expose, in the top of this compartment, the sockets for plugging in the stage 4 coil. Connect the clips on the flexible leads adjacent to this socket on to the inner coil sockets.

(9) Set the stage 5 changeover link to the right hand terminal. (This results in the full +5kV supply being applied to stage 5 for class B operation when the transmitter is subsequently switched on.)

(10) Insert the stage 6 grid damping resistors (2000 ohms). The resistors are removed from the storage clips behind the front meter panel and are fitted into clips behind the large porcelain insulators of the closed circuit capacitors.

(11) Open the partial absorber compartment door, disconnect the filament links and open the absorber anode circuit by removing the absorber anode resistor and placing it in the storage clips provided.

(12) Remove the aerial indicator shorting link from between the terminals marked AERIAL INDICATOR and either OUTPUT+ or OUTPUT−

*Drive unit Type 7*

**15.** Switch on the drive unit and check that the crystal oven pilot light comes on. Close the three HT switches and allow the equipment to warm up for at least 1½ hours. If necessary, the unit should be set up according to the instructions in A.P.2877W Vol. 1, Chap. 4. This unit operates from its own power supplies and therefore may be allowed to warm up without interfering with the rest of the transmitter units.

*Modulator*

**16.** From fig. 1, select the required V and W coils, corresponding to the third harmonic frequency (fc3) determined in para. 11, for the input amplifier and then set the anode and grid capacitors to the positions shown on the same illustration.

**17.** Select and fit the appropriate coil, for the radiated frequency (fcr) determined in para. 11, in the Mod.3 and set the Mod.3 damping resistor to the value given in the test report provided with the equipment. Fit the appropriate "Y" coil in the OM3 stage.

**Setting up**

*Power unit*

**18.** Switch on the power unit according to the instructions in Chap. 3, para 29 to 38.

*Drive unit Type 5*

**19.** Since it is necessary to allow the drive unit to warm up for at least two hours before use, the unit was switched on to warm up (para. 13) while various "cold" adjustments were made to the transmitter and Modulator Type 127.

*Transmitting unit*

**20.** Switching on the power unit connects the heater supplies to the filaments of all the valves in the transmitter and also provides a "low" H.A. H.T. supply for the harmonic amplifier stages. It does not connect the +5kV supply to the transmitter, this supply is not required until the final P.A. stages are set up. (*Para.* 53 *to* 66, *Chap.* 3.)

**21.** The initial procedure followed is identical to that for CW operation (with external drive) in para. 39 to 49, Chap. 3. When this procedure has been carried out, tune the 1st and 2nd harmonic amplifier stages for a maximum grid current reading on the succeeding stage (*para.* 50 (1) *to* (5), *Chap.* 3). Tune stage 3 for maximum grid current on the modulator Type 127 MOD 3 GRID FEED meter (for CW operation, stage 3 was tuned in the same manner as stages 1 and 2). Assuming that the modulator has been set up according to the instructions in para 22 to 31, the fourth, fifth and sixth stages are set up as for CW operation (Class B operation for SSB was established in para. 14) as is also the output circuit (*para.* 52 *to* 66, *Chapter* 3).

*Modulator*

**22.** The drive unit Type 4 must be set up to provide an output of -6dB (relative to 0·25W) on both "test" tones before any attempt is made to set up the modulator. Using these tones in the setting-up procedure has the added advantage that the transmitter will automatically be prepared for taking distortion measurements (para. 32 and 33).

**23.** The filament supplies for the modulator are automatically switched on when the power unit Type 812 is switched on (*para.*14) and, as this latter unit was switched on to enable the transmitter to be set up, the bias from the GRID NEG supply in the power unit will therefore be available in the modulator. The HT supply for each of the modulator stages can be made available by setting the appropriate switches on this unit to ON.

**24.** *Mod 3-input circuit.*—The mod 3 input circuit couples the signals from the SSB drive unit into the transmitter. Before tuning, switch off the GRID NEG and H.A.H.T. supplies on the power unit. Tune by means of the screwdriver control on the unit front panel for a maximum reading on the MOD 3 GRID FEED meter.

**25.** *Mod 3—input from SSB drive unit.*—Switch on the GRID NEG supply on the power unit and use the MOD 3 BIAS control (on the modulator) to adjust the bias on this stage until the MOD 3 GRID FEED meter just shows grid current. Note the bias voltage applied to the Mod 3 stage, this voltage is the peak value of the 3·1 M/cs unput from the SSB drive unit and should be about 10 volts.

**26.** *IM3—tuning the grid circuit.*—Set the keying selector switch on the transmitting unit to MARK, set the IM3 BIAS to –25V and then switch on the H.A. H.T. on the power unit. Check that stages 1, 2 and 3 on the transmitter are tuned as in para 21. Adjust the IM3 GRID TUNE control for maximum grid current in the IM3 stage; finally slightly retune the third stage in the transmitter to further increase this value of grid current. Adjust the STAGE 3 GAIN control on the transmitting unit to produce a grid feed of 2mA in the IM3 stage. This latter action sets the level of the RF feed to the IM3 stage and to the monitor receiver.

**27.** *IM3—tuning the anode circuit.*—Switch OFF the MOD3 and OM3 HT supplies and switch ON the IM3 HT supply. Adjust the IM3 ANODE TUNE for minimum anode feed current and then reduce the MOD 3 BIAS until grid current just shows. Check that when the anode circuit is tuned for minimum feed current, the grid circuit is tuned for a maximum grid current reading; if necessary, re-adjust the STAGE 3 GAIN control to maintain a grid current level of 2mA.

**28.** *Mod 3—transmitter drive level.*—Disconnect the drive from the SSB drive unit by removing the link on the front panel of the modulator. Switch ON the IM3 and OM3 HT supplies, switch OFF the MOD. 3 HT, set the meter switch to the MOD 3 BIAS and adjust the MOD 3 BIAS control to set a bias level of –40 volts on the right hand meter. Adjust the IM3 GAIN control until a grid current reading just shows on the MOD 3 IG meter. The peak voltage will then be approximately 40 volts. The OM3 HT supply is switched on during this operation to ensure that the HT supply is well loaded.

**29.** *Mod 3-anode circuit.*—Switch ON the IM3 and MOD 3 HT supplies and set the OM3 HT and GB switches to OFF. Replace the SSB drive link on the front panel of the modulator and then adjust the MOD 3 BIAS control for a reading of 20mA on the MOD 3 ANODE FEED meter. Set the meter switch to the OM3 IG position and adjust the MOD 3 ANODE TUNE for a maximum reading on the meter.

**30.** *OM3.*—Set the OM3 BIAS control towards maximum and then switch on the IM3, MOD 3 and OM3 HT supplies. Adjust the OM3 BIAS control for a reading of 60mA on the right hand meter. Turn the OM3 TUNE for a dip in anode feed (this dip will be small because the stage is operating as a class A amplifier).

31. *Matching the Modulator 127 to the transmitting unit.*—Set the GRID FEEDS switch on the transmitter to ST4 GB and adjust the STAGE 4 INPUT TUNE control for a maximum reading on the associated GRID AND ANODE FEEDS meter. (The STAGE 4 BIAS control on the transmitting unit must be rotated counter-clockwise to reduce the bias reading on the G.B. & H. AMP HT meter to 35 volts.)

**Measurements**

*Distortion*

**32.** The principle of measurement utilises the fact that two tones inserted into a linear system will reappear unaltered at its output, additional intermodulation products will also appear in the output ~~while in a non-linear system.~~ The amplitude of the lowest intermodulation product (425c/s) is then used as a measure of distortion in the system, all measurements being made by the calibrated attenuators in the linear monitor receiver which is located in the SSB drive unit.

**33.** The procedure used is as follows :—

(1) Set up the SSB drive unit using each tone in turn to give equal outputs (–6dB, 50 mW) on its IFA volume indicator.

(2) Switch on both tones simultaneously, the IFA volume indicator should now read zero (250 mW). Switch in the re-inserted carrier and couple in the signal to be monitored.

(3) With the monitor 425c/s filter switched out, and the attenuator set to 0, check the IFA volume indicator reads O.

(4) Switch in the 425 c/s filter. As this filter allows only the 425c/s signal to pass, the IFA volume indicator reading will drop. Reduce the amount of monitor attenuation until the IFA volume indicator again reads 0, this reduction in attenuation is a direct measure of the amplitude of the 425c/s intermodulation product.

*Peak envelope power*

**34.** Using an SSB transmission with a pilot carrier, the carrier level is so low that the type of peak power measurement used for MCW would be inapplicable. An alternative method is used which utilises the two test tones developed in the SSB drive unit together with the pilot carrier in a test transmission. The stage six waveform of this transmission (fig. 2), is monitored in the usual manner to allow the peak level of the resulting waveform envelope to be measured.

**35.** The separate waveforms in fig. 2 illustrate the stages in the production of this envelope. The upper waveform is that produced by a single tone. When two such tones are transmitted simultaneously, the waveforms synchronize periodically and produce the central waveform.

When the pilot carrier is added, the waveform resolves into a form similar to that of the lower waveform.

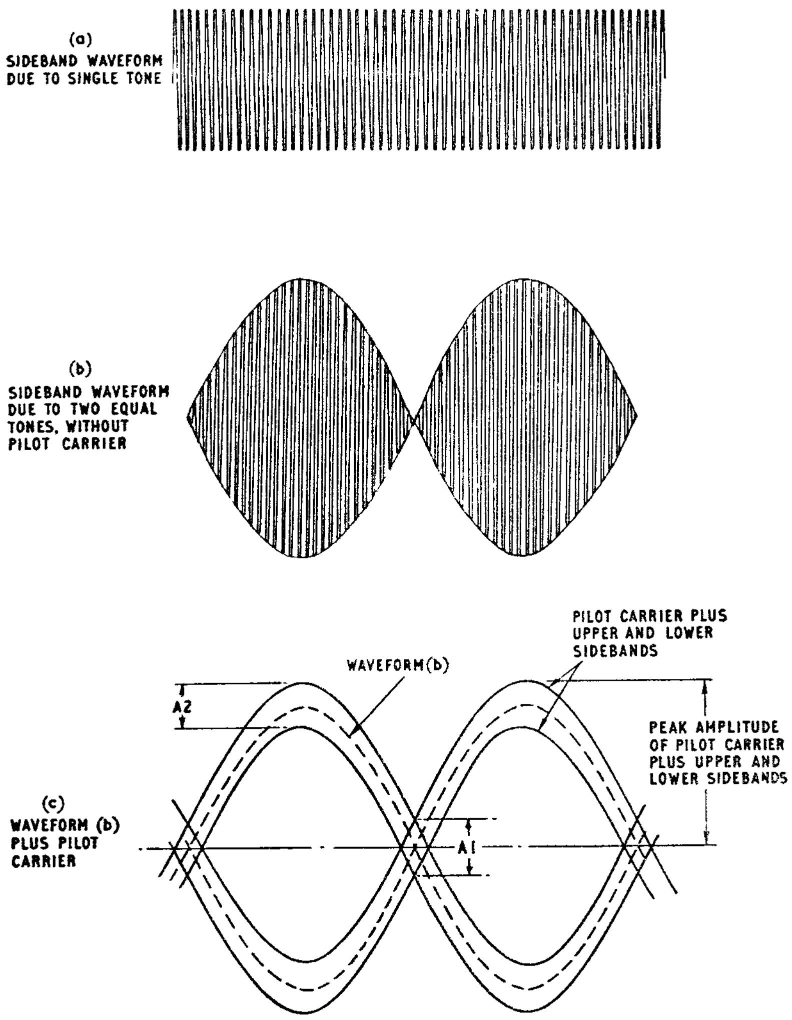


**Fig. 2. SSB waveforms**

**36.** For practical purposes, it is sufficiently accurate to double the power obtained in the two-tone distortion test to obtain the value of the peak sideband power since the power level in the carrier is so small. It should be borne in mind however that the peak envelope power is affected by the level of the pilot carrier. Where "W" is the mean power for each condition, this effect can be demonstrated as follows :—

(1) Two tone modulation plus carrier at "single channel" level gives a peak envelope power of 2·55W.

(2) Two tone modulation plus carrier at "two channel" level gives a peak envelope power of 2·194W.

(3) Single tone modulation plus carrier at "single channel" level gives a peak envelope power of 1·036W.

*Peak side band power*

**37.** The peak sideband power is the power which would be radiated by a continuous carrier, the amplitude of which is equal to the peak amplitude of a signal consisting of one, two or more sideband components, the pilot carrier being excluded.

*Carrier compression*

**38.** Carrier compression is defined as the reduction in the level of the pilot carrier which occurs when a sideband signal is simultaneously transmitted with the carrier. It is caused by non-linearity in the transmitter and by imperfect power supplies. Two methods may be used to measure this compression.

**39.** The first method involves the use of a signal generator in conjunction with the standard SSB drive unit monitoring equipment. The 100 kc/s demodulating frequency, normally fed to the demodulator of the monitor receiver, is replaced by a frequency of 100 kc/s minus 425 c/s from the signal generator. This shifts the pilot carrier into the mid-band of the 425 c/s filter where its level can be measured by the monitor attenuator and its associated volume indicator. For single-tone modulation up to levels not exceeding –6dB relative to the peak sideband power, the carrier compression should not exceed 3dB. This method is suitable only for single-tone modulation.

**40.** To use the second method it is necessary to present the transmitter stage 6 output on an oscilloscope. A waveform should be presented similar to that of fig. 2. If the dimensions A1 and A2 on this illustration are now measured, the carrier compression may be found from the formula :—

$$\text{Compression (in dB's)} = 20 \log_{10} \frac{A1}{A2}$$

## DSB OPERATION

**41.** The equipment used in the DSB role (transmitter Type T.1976) is identical to that used for SSB operation. Changing over from SSB to the DSB role is accomplished by setting the SSB/DSB switch on the drive unit Type 7 to DSB. Certain adjustments may have to be made for which a CRO will be required, this instrument being used to display the envelope of the transmission. It is assumed in the following text that the equipment has already been set up for SSB operation.

### Procedure

**42.** Connect up the CRO to the drive unit and set up both items to display the carrier envelope. Use the following procedure :—

(1) Set the LA(A) input selector to OFF so that only the carrier appears at the drive unit output.

(2) Monitor this output by connecting up the CRO as follows :—
- (a) Connect the IFA output at PL4 on panel 1 to the coaxial input of the 3·1 Mc/s CRO tuning unit.
- (b) Connect the tuning unit earth to the CRO earth terminal.
- (c) Connect the Y terminal on the tuning unit to the CRO Y terminal.
- (d) Adjust the controls of the CRO for a clear waveform, and then adjust the tuning unit for maximum amplitude.

**43.** The next step in the procedure is to set the level of the carrier output from the modulator 1. (This output is balanced out on SSB, the re-inserted carrier being used in this former role.) This is done by adjusting the DSB BALANCE R control in the circuit substituted for the SSB balancing-out circuit, this circuit being switched in when the role selection switch is set to DSB. The control is adjusted until the IFA volume indicator reads -6dB.

**44.** When the carrier level has been established, set the LA(A) input selector to F1 in order to modulate the carrier with the f1 test tone. Set the LA(A) LEVEL control to step 34 and adjust the LA(A) F1 LEVEL control until the CRO displays a waveform which is modulated slightly more than 100 per cent. (As the carrier is modulated to about 100 per cent., the IFA volume indicator should read zero). If necessary, adjust the DSB Ø phase control to obtain a true sinusoidal envelope.

**45.** Switch the LA(A) input selector back to OFF and ensure that the carrier level has not altered, i.e. the IFA volume indicator still reads -6dB. Reset the input selector to F1 and adjust the setting of the LA(A) F1 LEVEL control until a 100 per cent. modulation envelope is obtained.

**46.** Set the input selector to F2 and then adjust the LA(A) F2 LEVEL control until a 100 per cent. modulation envelope is obtained. When a satisfactory waveform has been obtained, turn the input selector to F1 + F2 and reduce the LA(A) GAIN by 6dB. The drive circuits are now set up for two-tone working.

### Measuring the intermodulation products

**47.** The DSB intermodulation products are measured in a manner similar to that used to measure the SSB products. This test is carried out in the following manner :—

(1) Set the SIDE BAND/CARRIER selector switch to IPA, 425 c/s band pass filter switch (BPF) to OUT, and the monitor amplifier OUTPUT selector to IPS. (These actions switch out all the filters in the monitor receiver so that its volume indicator shows the level of the combined f1, f2 and carrier signals.)

(2) Set the monitor amplifier attenuator to 6dB, the monitor volume indicator should read 2¼. (The 6dB difference in level between DSB and SSB signals is catered for by this setting, on SSB the attenuator is set to 0 and the indicator reads 0. On DSB, the setting is increased by 6dB to give the same output level on DSB as on SSB.)

(3) Switch IN the band pass filter. The monitor volume indicator reading will drop by an amount which will depend on the level of the intermodulation products.

(4) Increase the attenuator setting until the monitor volume indicator reads zero. This change in setting gives the level of the 425 c/s intermodulation products below that of the 3·1 mc/s output.

## TELEPHONY OPERATION

**48.** Telephony operation (transmitter Type T.2000) may be obtained by using the basic CW installation in conjunction with a Class B modulator unit Type 7436, and a line amplifier Type 7488. In general the transmitting unit Type 89 and the power unit Type 811 are set up as for CW operation, the TELEGRAPH/TELEPHONE switch on the latter unit being set to TELEPHONE to ensure that the appropriate bias voltages are supplied to the modulator and the transmitting unit.

### Preliminary adjustments

**49.** Set all the switches on the power unit to OFF and turn the FILAMENT REGULATOR NO. 1 and NO. 2 controls on the modulator to DIM. Turn the TELEGRAPH/TELEPHONE switch to TELEPHONE and switch on all filaments. Check that the TRANS AND AUX FILS meter on the power unit shows 380 volts. Adjust the two FILAMENT REGULATOR controls, previously set to DIM, to the voltage marked on the appropriate ACT.9 valves on the modulator.

**50.** Set the CATHODE FOLLOWER NO. 1 and NO. 2 GRID BIAS controls to maximum and the MODULATOR NO. 1 and NO. 2 GRID BIAS controls to about one third of their travel from maximum. Set the CATHODE BIAS RESISTANCE to the position of maximum resistance ("30" should be presented in the window above this control). Remove the cover from the line attenuator on the front panel and set this control to maximum.

**Setting up**

*Transmitting and power units*

**51.** Switch on the H.A. H.T., GRID NEG and HT supplies on the power unit. Before moving the HT control on the latter unit from position 1, reduce the output coupling on the transmitting unit. (To prevent overloading by peak modulation in the SSB role, it is necessary to operate with a STAGE 6 ANODE current of 500 to 700 mA ; on telegraphy the operating current lies between 800 and 900 mA.) For frequencies below 22·2 Mc/s, the STAGE 6 ANODE current should not exceed 700mA ; at higher frequencies the current should not be allowed to exceed 500mA.

*Modulator*

**52.** The CATHODE BIAS RESISTANCE is now adjusted until the line amplifier feed from the amplifier Type 7488 is as given in the test report (about 37mA).

**53.** The next step in the procedure is to set the bias of the two cathode followers. It should be noted however, that the bias adjustments for these valves depend to an extent on the grid voltage of their associated modulator valves. To overcome this factor, deal with one side of the push-pull circuit at a time, simultaneously adjusting the bias of the two associated valves in this half of the circuit.

**54.** Adjust the MODULATOR NO. 2 GRID BIAS and CATHODE FOLLOWER NO. 2 GRID BIAS controls until the ACT.9 CATHODE FEED NO. 2 meter to the right of the modulator compartment reads 30mA and the MODULATOR CATHODE FEED NO. 2 meter reads 50mA. Repeat this procedure for the other half of the push pull circuit, where necessary, making correcting adjustments to the side previously adjusted.

**55.** Switch on the amplifier Type 7488, reduce the line attenuator setting from infinity and apply modulation. Readings should be obtained on the anode feed meter and the AF MODULATION METER. With a reading of E volts on the INPUT LEVEL meter, the level in milliwatts is given by the following formula :—

$$\text{Level (in mW)} = \frac{E^2 \times 1000}{600}$$

**56.** To obtain 100 per cent. modulation, an input giving a reading of 0·78 volts on the relevant INPUT LEVEL meter (*i.e.* 1mW input) is required.

**57.** The line attenuator is set for the modulation depth required while the volume control on the amplifier Type 7488 is adjusted to set the AF level from the line in accordance with the maximum depth of modulation required.

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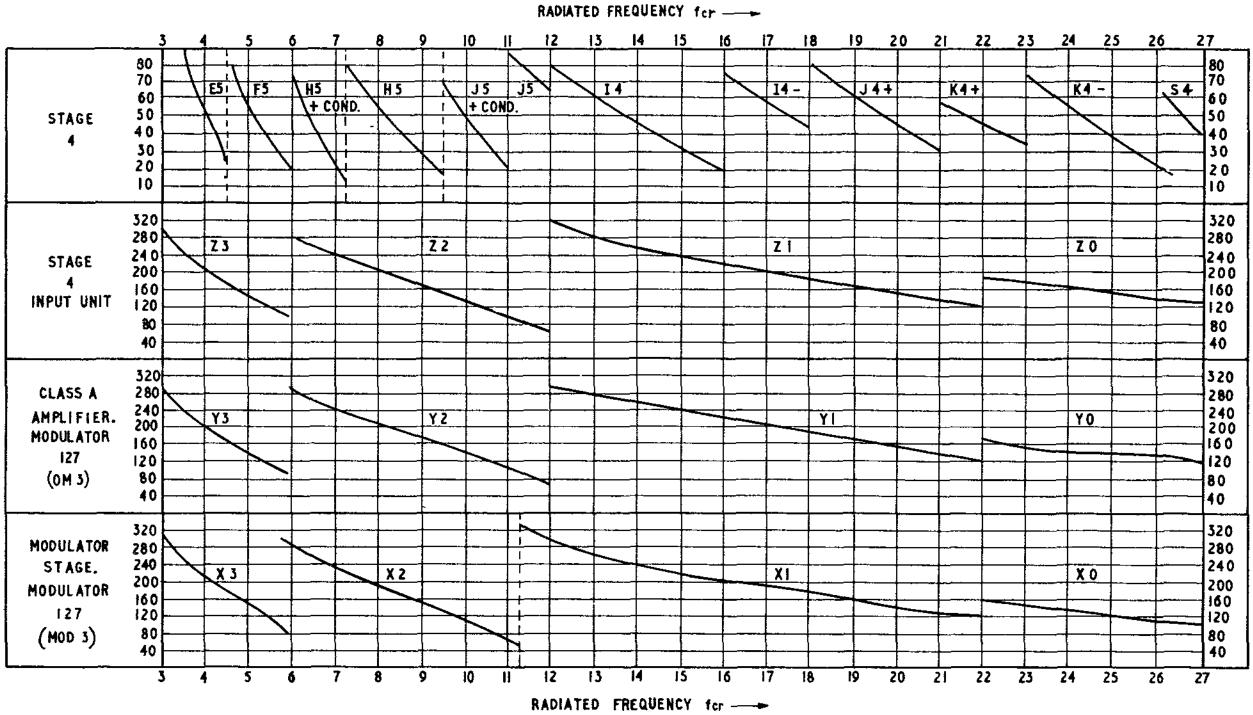


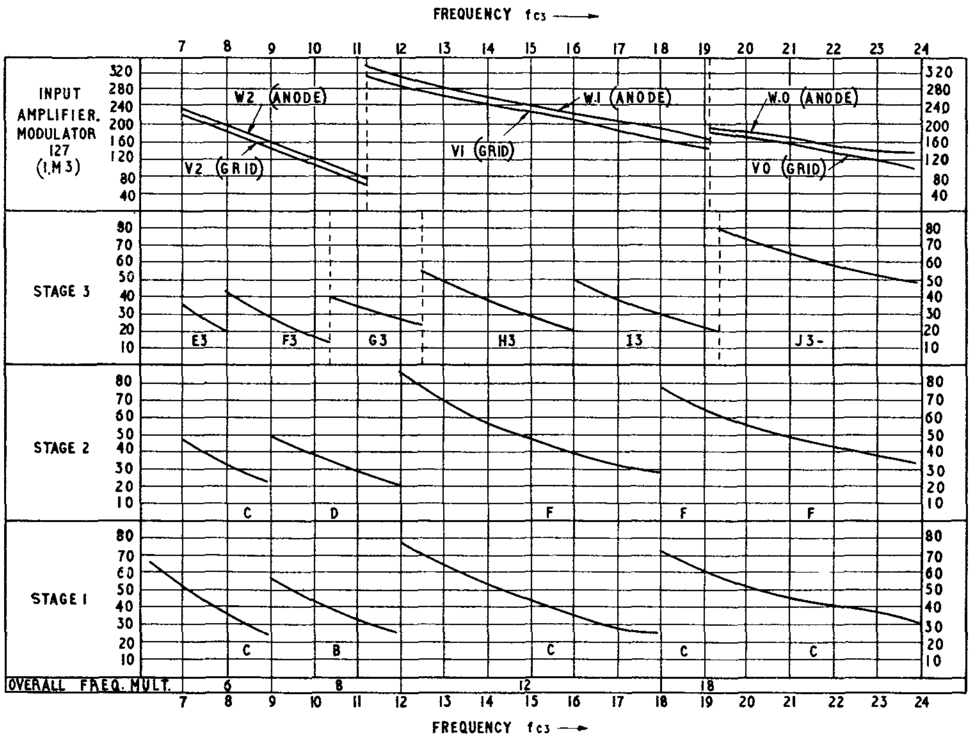


Fig.1. Transmitter SWB8X-calibration charts for modulator unit Type 127 and the transmitter unit

## SECTION 2

# TECHNICAL DESCRIPTION

# Chapter 1

# TRANSMITTER UNIT TYPE 89

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### GENERAL DESCRIPTION

**1.** Transmitter unit Type 89 (*fig.* 1) consists essentially of a variable-frequency master oscillator, harmonic amplifier (frequency multiplying) stages, sub-amplifier and final power amplifier stages.

**2.** The unit may be used to provide the following services:—

(1) *CW on-off telegraphy.* In this service the transmitter has a frequency range of 2 to 27 Mc/s. The RF power output on mark is from 4 to 3kW over a frequency range of 2 to 22·2 Mc/s., and 2kW over a range of 22·2 to 27 Mc/s. In these conditions the power input is 9·6kW. The maximum keying speed is 200 w.p.m. Provision is made for applying anti-fading frequency modulation to the master oscillator, or phase modulation to an external crystal oscillator when this is used as drive in lieu of the internal source.

(2) *FSK telegraphy.* When used in this service the transmitter has the same frequency range and power ratings as when used for CW telegraphy. In this instance the frequency-shift drive is derived from an external phase-modulated crystal oscillator (drive unit (radio) Type 4).

(3) *DSB telephony.* In this application the transmitter has an RF carrier output power of 2·5 to 2kW over a frequency range of 2 to 22·2 Mc/s and 1·0 to 0·7 kW over the range 22·2 to 27 Mc/s. High-level modulation of the final power amplifier stage is provided by an external Class B modulator (modulator unit Type 7436).

(4) *SSB telephony.* SSB telephony may be transmitted over a frequency range of 4 to 27 Mc/s. The peak envelope power output is 4 to 3kW between 4 and 22·2 Mc/s and 1·7kW between 22·2 and 27 Mc/s. The SSB signals are generated

initially from an external drive unit (drive unit (radio) Type 7) and third modulator (modulator unit Type 127).

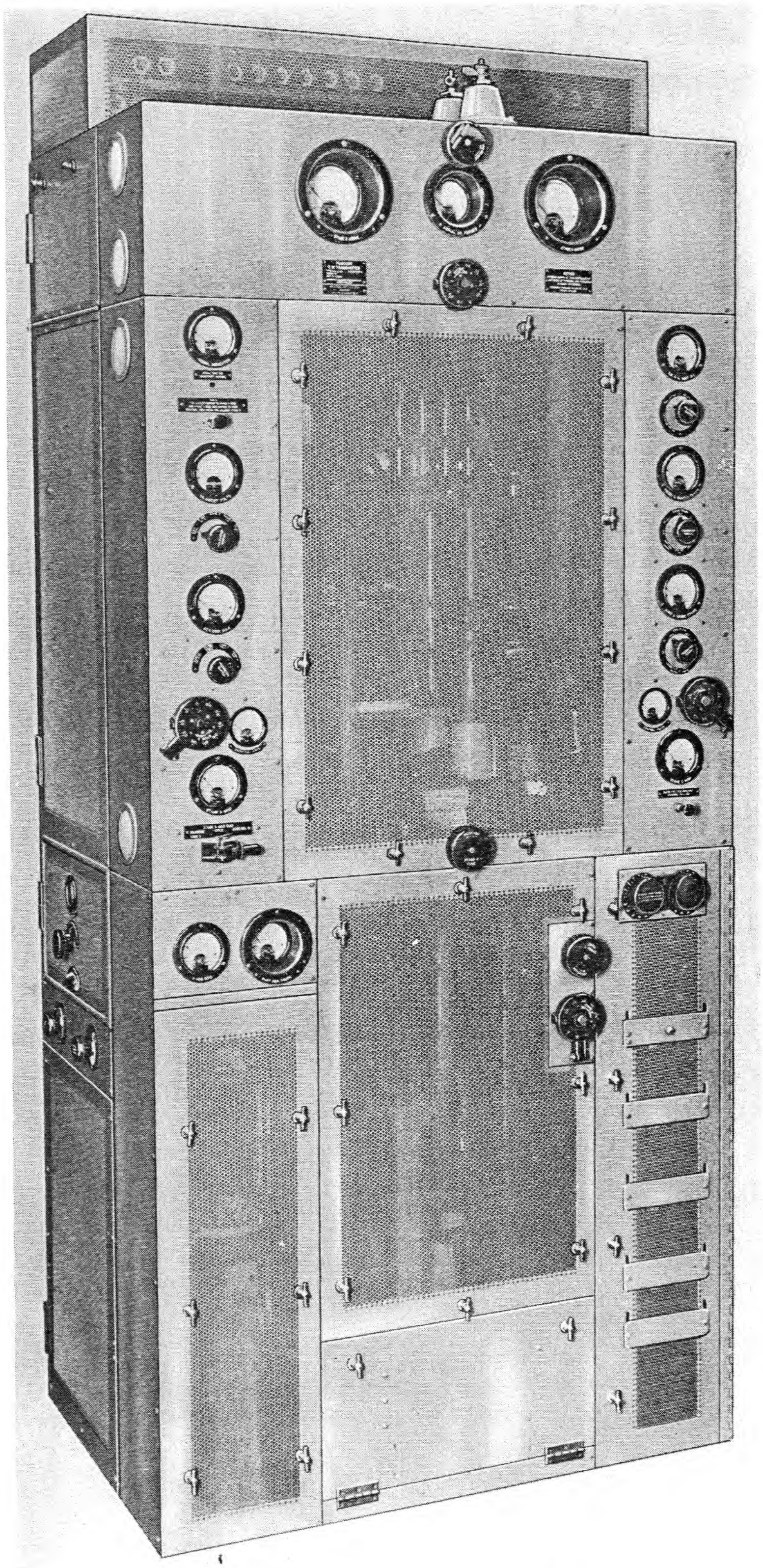

Fig. 1. Transmitter unit Type 89

#### CIRCUIT DESCRIPTION

**3.** The circuit of the transmitter unit is shown in fig. 13.

**4.** The transmitter may be driven either from an internal variable-frequency master oscillator or externally from a crystal-controlled source.

##### Franklin master oscillator

**5.** The internal drive is provided by a Franklin master oscillator. This type of oscillator consists essentially of a two-stage resistance-coupled amplifier (V1 and V2) with a tuned circuit L14, C64 connected via C67 to the grid circuit of V1; the anode of V2 is also coupled back to the grid circuit of V1 via C68. As voltages at the grid of V1 and the anode of V2 are in phase, the correct conditions for the maintenance of oscillations across the tuned circuit are obtained.

**6.** A two-valve circuit is employed partly because the high gain thus obtained permits very loose coupling between the tuned circuit and the maintaining circuit, and also because one side of the tuned circuit may be earthed which simplifies the mechanical design of the oscillator.

**7.** Due to the high gain of the two-valve circuit the coupling capacitors C67 and C68 are of very low value, having a capacitance of approximately 1 pF; this is much lower than the input and output capacitances of the valves, and the effect is as if the grid and anode of V1 and V2 respectively are tapped down on the tuned circuit (*fig.* 2).

**8.** The oscillator is provided with automatic compensation for frequency drift achieved by a compensating capacitor C65 connected across the tuned circuit. The capacitor is adjusted so that any increase in the value of the inductance due to rise in temperature is offset by a decrease in the capacitance of C65, and vice versa. The actual frequency stability of the oscillator is less than 1 part in 20,000.

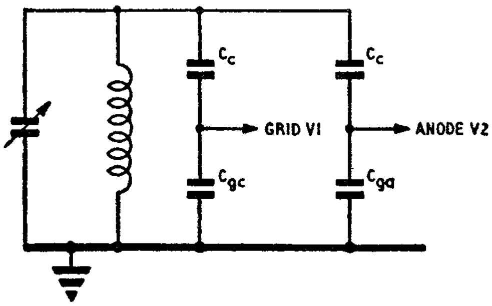


**Fig. 2. Franklin master-oscillator tuned circuit**

**9.** The eight tapping points on L14, selected by S16, enable the oscillator to cover a frequency range of 1·0 to 1·5 Mc/s.

**10.** The anode loads of V1 and V2 consist of the inductor L1 in series with R30 and L2 in series with R32 respectively. The use of an inductor in series with a low value resistor increases the stage gain at the relatively high frequency of operation.

**11.** The barretter R31 connected between the output of V1 and the input to V2 stabilizes the amplitude of the RF output over the frequency range. Should the output voltage from V1 increase at any frequency, an increased current will flow through R31; this will increase the resistance of the barretter which will automatically reduce the current flowing through it. The input voltage to V2 grid is thus maintained at a substantially constant level.

**12.** Either the Franklin master oscillator or an external crystal-controlled drive is selected by the INTERNAL/EXTERNAL DRIVE switch S1. When set to the INTERNAL position, contacts of S1 switch the master oscillator into circuit as follows:-

(1) S1a applies HT to the oscillator via the metering switch contacts S4/1; S1b disconnects the backload R33.

(2) S1c connects the output of the oscillator to the input circuit of the first harmonic amplifier; S1d short-circuits to earth the external drive input circuit.

(3) S1e switches the output of the note oscillator to the frequency modulation control diode (*para.* 23).

(4) S1f and S1g short-circuit the two resistors R125 and R126 in the oscillator heater circuit, thus applying the rated voltage to the valve heaters.

#### External drive circuits

**13.** The external drive, which may consist of either a crystal-controlled oscillator or a FSK unit, is normally connected via a 75-ohm coaxial cable to the EXTERNAL DRIVE NO. 1 socket (SK1). When the changeover link LKF is set to either of the EXTERNAL DRIVE positions, the external circuit is connected to a low-impedance terminating unit consisting of L14 series-tuned by C65. The RF drive is extended from a tap on L14, via C64 to the changeover switch contacts S1c and S1d.

**14.** When S1 is set to EXTERNAL, the external drive is connected to the transmitter unit and the master oscillator is placed in a standby condition. The contacts of S1 perform the following functions:—

(1) S1a disconnects the HT supply from the master oscillator, S1b switches the backload R33 across the HT supply.

(2) S1c connects the external drive via the feeder terminating unit to the input circuit of the first harmonic amplifier; S1d removes the short-circuit from across the feeder terminating unit.

(3) S1e switches the output of the note oscillator to a fixed potential divider R21 to R24. The 400 c/s AF voltage across R24 is available at SK3 for anti-fading phase modulation of the external crystal oscillator (*para.*28).

(4) S1f and S1g connect the resistors R125 and R126 in series with the master oscillator valve heaters, thus reducing the voltage applied to the heaters when in the standby condition.

#### Frequency modulation of the master oscillator

**15.** Frequency modulation used in this connection should not be confused with the more usual meaning of the term which implies the transmission of intelligence by varying the frequency instead of the amplitude of a carrier.

**16.** When the transmitter is used for CW on-off telegraphy, and frequency modulation is applied, instead of keying a continuous wave of constant frequency, the radiated frequency is made to vary sinusoidally 600c/s above and below its average frequency, this variation takes place 400 times a second.

**17.** The system is thus analogous to MCW, but instead of a carrier of constant frequency being varied in amplitude at an audio frequency, a carrier of constant amplitude is varied in frequency at a rate equivalent to an audio frequency. Both methods provide a wider frequency spectrum (due to the formation of sidebands) than pure CW telegraphy, which is of advantage in that it reduces fading on a short-wave telegraph circuit.

**18.** Frequency modulation of the carrier has the following advantages over MCW:—

(1) There is no reduction in the CW power output of the transmitter. With MCW the power output cannot be greater than 50 per cent of the output on CW.

(2) By a suitable choice of frequency deviation and modulation frequency, a considerable propor-

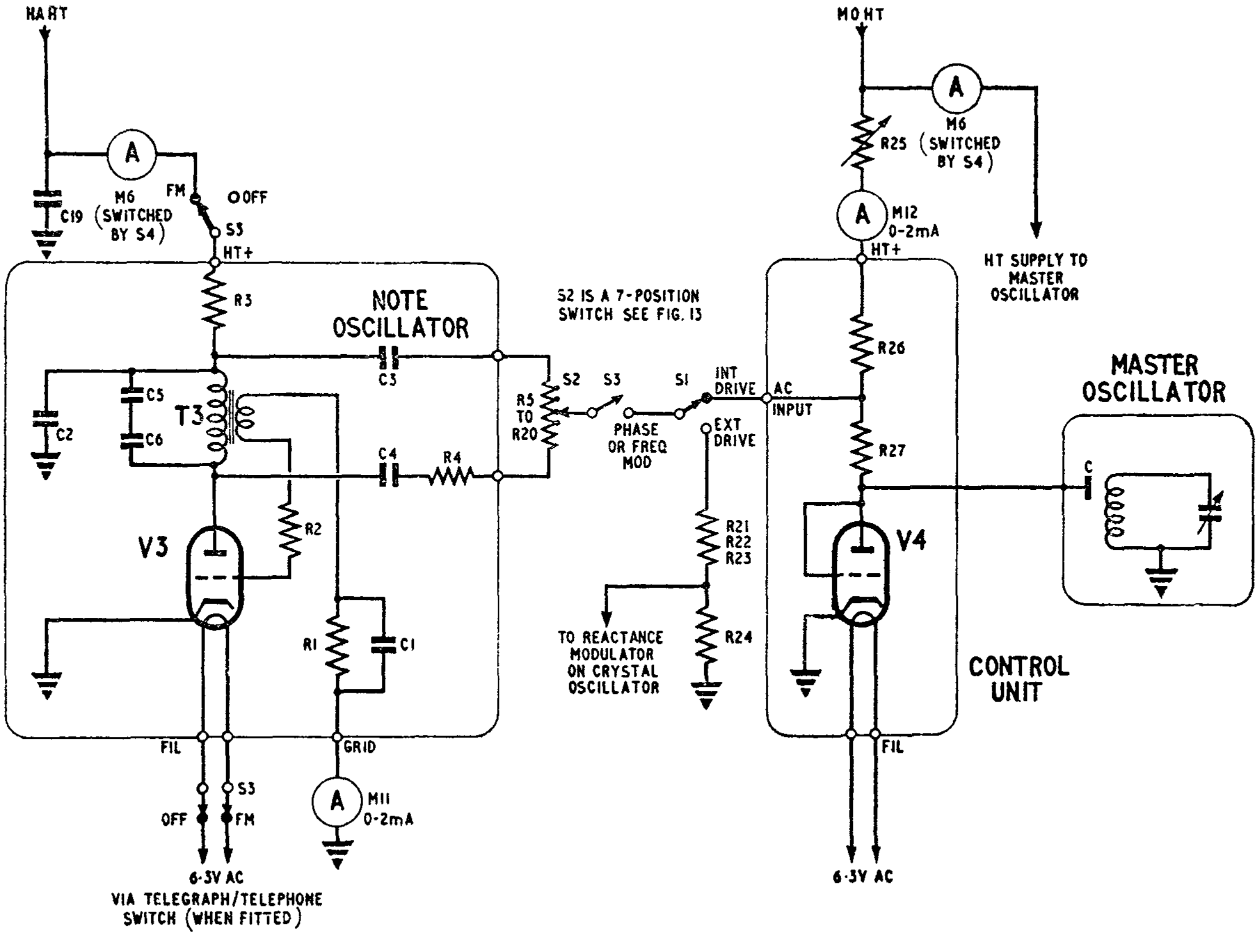


**Fig. 3. Note oscillator circuit**

tion of energy can be transferred from the carrier to the sideband.

(3) The total sideband spread, and therefore the interference to neighbouring channels is considerably reduced as compared with MCW.

*Note oscillator*

**19.** A simplified circuit of the frequency-modulation equipment is shown in fig. 3. The triode valve V3 functions as a note (audio-frequency) oscillator. The anode winding of the transformer T3 is tuned to a frequency of 400c/s by the two capacitors C5 and C6 connected in series. Grid bias is provided by the grid resistor R1, bypassed by C1; grid current is measured by the milliammeter M11 (NOTE OSC. GRID). R2, connected in series with the feedback winding of T3, functions as a stabilizing resistor.

**20.** The HT supply to the oscillator is derived from the harmonic amplifier supply via the meter switch contacts S4/8, switch contacts S3c (PHASE OR FREQUENCY MODULATION) and a dropping resistor R3; the HT supply is decoupled by C2 and C19.

**21.** The audio output of the oscillator is applied via the two DC blocking capacitors C3 and C4 to a potential divider formed by the resistors R5 to R20 in series. Tappings on the potential divider are selected by the switch S2 (FREQUENCY OR PHASE MODULATION (DEPTH) CONTROL). The position of S2 controls the amplitude of the audio-frequency modulating voltage and hence determines the resultant deviation of the oscillator frequency.

**22.** The deviation of the final radiated frequency is greater than that of the oscillator frequency by a factor equal to the total harmonic order in the transmitter unit. Thus to provide a given deviation of the final frequency (in this instance $\pm$600c/s) the audio voltage must be proportionally reduced as the harmonic order is increased. For this reason the seven positions of S2 are calibrated in terms of the transmitter harmonics from 2 to 18. It will be observed from fig. 13 that when S2 is set to position 2 (second harmonic) practically the total voltage appearing across the potential divider is used. When S2 is set to position 18 (eighteenth harmonic) only that voltage developed across the resistors R12 to R15 is available for modulation.

*Diode control valve*

**23.** The diode-connected triode V4 functions as a frequency-modulation control valve, and is connected across the master oscillator HT supply through a load resistor consisting of R25 (DIODE ANODE CONTROL) and the two fixed resistors R26 and R27 in series. The anode is connected in parallel with the master oscillator tuned circuit via a small capacitor C.

**24.** The alternating voltage from the note oscillator is applied via the modulation depth control and modulation on-off switch to the junction of R26 and R27. As V3 is always conducting, the alternating voltage varies the conductance and conversely the resistance of the diode. This in turn varies the effective capacitance of C, which results in frequency modulation of the master oscillator.

**25.** The HT supply for the control valve is obtained from the independent supply to the master oscillator. The preset variable resistor R25 (DIODE ANODE CONTROL) enables the diode feed current to be adjusted to give the same condition as that under which the master oscillator was originally calibrated by reference to the HT feed milliammeter M12 (CONTROL VALVE).

**26.** When FM is not required, the heater and HT supplies of the note oscillator are switched off, and the output to the control valve is disconnected. In this condition the static feed current flows through the control diode; this is necessary to avoid upsetting the frequency calibration of the master oscillator.

**27.** Application of frequency modulation when the transmitter unit is working on telephony is prevented by an interlock on the TELEGRAPH/TELEPHONE switch on the modulator unit (*Chap.* 3).

**Phase modulation of the crystal oscillator**

**28.** When the internal to external drive changeover switch is set to EXTERNAL the output of the note oscillator is switched from the control valve to a potential divider consisting of the four resistors R21 to R24, in series; the voltage developed across R83 is now available at the CRYSTAL OSC. PHASE MOD socket for phase modulations of an external crystal oscillator.

**29.** The level of the modulating frequency is arranged to give a certain phase deviation for all radiated frequencies when the note oscillator output potential divider (R5 to R20) is at the correct setting for the harmonic in use. When the potential divider (*para.* 28) consists of three 20kΩ resistors and one 10kΩ resistor a deviation of 0·9 radians is available; when the divider consists of two 20kΩ, one 10kΩ and one 25kΩ resistor the deviation is 1·5 radians.

**Harmonic amplifier (Stages 1, 2, 3 and 4)**

**30.** The harmonic amplifier, which consists of four stages, provides the necessary frequency multiplication to raise the oscillator frequency to the final radiated frequency. In addition, the amplifier provides part of the overall power amplification.

**31.** Stages 1, 2 and 3 may be operated either as frequency multipliers or straight amplifiers, but Stage 4 is operated solely as an amplifier. The first three stages may be arranged to give an overall multiplication of 2 to 18; the actual multiplication per stage and the coding of the tuning inductances to obtain any final frequency within the range of the unit are given in Part 1, Sect. 1, Chap. 3.

*Stages 1, 2 and 3*

**32.** The first three stages are single-ended and employ the beam-tetrode valves V5, V6 and V7 connected in cascade. The circuitry of each of the three stages is similar, with the exception that Stage 3 is provided with a gain control R48, (STAGE 3 GAIN CONTROL) which permits adjustment of the screen voltage to V7.

**33.** Grid bias for Stages 1 and 2 is derived from the —30V tap on the potential divider in the power unit (power unit Type 811 or 812); the bias supply is smoothed by C20 and C21 connected in parallel. Bias for Stage 3 is obtained from the —70V tap on the potential divider and smoothed by a filter consisting of C25, R53 and C26.

*Stage 4*

**34.** The fourth harmonic amplifier stage consists of the beam-tetrode valves V8 to V11 connected in parallel push-pull. RF output from the anode circuit of V7 is applied to the push-pull grid circuit of Stage 4 via the blocking capacitors C29, C30, and the plugs and sockets designated CW.

**35.** Variable grid bias is derived from the potentiometer R54 (STAGE 4 GB-), which is connected across the —70V bias supply. The supply is filtered by C31 and applied to the grids of the valves through the resistor R55 and RF chokes L6, L7. Variable grid bias to Stage 4 is necessary to enable it to function as a Class C amplifier in CW service, and as a Class B amplifier when operating on SSB.

**36.** The grids of the parallel-connected valves V8, V9 and V10, V11 are strapped by the resistors R60 and R64 respectively. This is to prevent any tendency to self-oscillation that might otherwise occur due to the inductance in the leads from L6 and L7 to the grids of the valves. A similar arrangement is adopted in the anode circuit.

**37.** The tuned anode circuit of Stage 4 consists of L8 tuned by C36; the plug-in capacitor C37 is connected in parallel with C36 when the transmitter is working on the lower frequency ranges.

**38.** HT is applied to the anodes of the valves through the stopper resistor R127 and the centre-tap on L8; the screen supply is derived from a potential divider consisting of R70, R71 and R72, R73 connected across the harmonic amplifier HT supply. The voltage is applied to the screens through stopper resistors R61, R62, R65 and R66 connected in each screen lead, and through R68 and R69 which are common to each parallel-connected pair of valves.

**39.** The push-pull output from Stage 4 is applied via the coupling capacitors C38, C39 to the grid circuit of Stage 5. In CW service the capacitors are connected to the extreme ends of L8; this is achieved by connecting the flexible leads from the coupling capacitors to the outer sockets on the coil holder (CW). In SSB service (*para.* 82) the capacitors are connected directly across the tuned circuit via the inner sockets (SSB). This change is necessary to achieve matching between Stage 4 and Stage 5 under the two different conditions of operation mentioned in para. 35.

**Power supplies**

**40.** 400V HT supply to all harmonic amplifier stages is obtained from the power unit Type 811 or 812, via terminal 20 on the power unit and terminals 13 on the transmitter unit.

**41.** 6·3V heater supply is obtained from the mains transformer T1. The primary of the transformer is energized by the 230V AC supply from the power unit, which is connected to the insulated terminals 22 and 23 on the transmitter unit. The secondary voltage of T1 is reduced to 6·3V by the preset dropping resistors R122 and R123. The resistor R124 provides an artificial centre-tap to the heater circuit.

**42.** The heater supply is filtered by the capacitance between the harmonic amplifier LT busbars (filament capacity busbars) and frame of the transmitter unit (*para.* 115).

**Sub-amplifier (Stage 5)**

**43.** The output of the fourth harmonic amplifier is applied to the input of Stage 5, which consists of the neutralized triode V12; in CW service this valve operates under Class C conditions.

**44.** The anode circuit of Stage 4 is coupled to the grid of V12 through the blocking capacitor C39. At frequencies above 22·2 Mc/s a reactance capacitor C43 is inserted in the grid circuit; at lower frequencies this capacitor is short-circuited by a link S11.

**45.** The preset capacitor C40 enables the capacitances across the Stage 4 anode tuned circuit to be balanced. C40 is connected, in effect, across one half of L8 and is adjusted to have a capacitance equal to the grid-cathode capacitance of V12.

**46.** The anode circuit of Stage 5 consists of L9 tuned by the split-stator capacitor C47. The stage is neutralized by the balancing capacitor C44, which in conjunction with C41 and C42 forms a balanced bridge circuit. Any tendency to parasitic oscillation is prevented by the centre-tapped resistor R83 connected between the moving plates of C47 and earth.

**47.** Anode voltage is derived from the main HT supply. With the link LK E in the CW position HT is applied via R85, the six-position switch S6, anode current meter M2 and R84 to the centre-tap of L9.

**48.** R85 consists of 34 850-ohm resistors. Of these, 20 are permanently connected in the anode circuits of both V12 and the partial absorber V16; the voltage drop across these resistors is utilized in keying the transmitter (*para.* 69). The remaining 14 resistors are in the anode circuit of V12 only, the actual resistance in circuit being determined by S6. This adjustable resistance is necessary so that the anode voltage and hence the power input to V12 may be regulated over the frequency range of the transmitter unit.

**49.** Negative grid bias for Class C operation is derived from the power unit. When operating on CW the bias supply at terminal 16 is applied to the grid through the normally-closed contacts of the push-button S16, R81, decoupling resistor R82 and grid resistor R79. The value of R79 is dependent on the operating frequency, being decreased from 100 ohms to 5 ohms at frequencies above 22·2 Mc/s.

**50.** The four parallel-connected resistors R75 to R78 are used on SSB service only (*para.* 82).

*Filament supplies*

**51.** 18V filament supply, which may be either AC or DC according to the application of the transmitter, is obtained from the power unit Type 811 or 812. The LT supply at terminals 27 and 28 is applied to the filament of V12 through the preset resistors R118 and R119. R120 and R121 provide an artificial centre-tap to the filament circuit. Filtering is achieved by the filament capacity busbars.

**Final amplifier (Stage 6)**

**52.** The final power amplifier employs the two triode valves V13 and V14 operating in Class C push-pull. The anode circuit of V12 is coupled through the blocking capacitors C48, C49 and the reactance capacitors C52, C54 to the grids of V14 and V13 respectively; the reactance capacitors are short-circuited at frequencies below 22·2 Mc/s.

**53.** The anode tank circuit consists of L10 and the split-stator capacitor C58. Neutralization of the stage is effected by C53 and C55 cross-connected between anode and grid of V13 and V14. The moving plates of C58 are earthed through the anti-parasitic resistors R93 to R96 connected in parallel; parasitic suppression in the grid circuit is provided by R87, C50 and R88, C51.

**54.** Grid bias is derived from the power unit and applied via terminal 17, S10, grid current meter M5 and grid resistors R89, R91 to the grids of the valves. S10 has two positions, WORKING and OPEN. The switch is set to the WORKING position in normal CW service, that is, CW telegraphy or amplitude-modulated telephony. In the OPEN position, which is used when lining-up on SSB, the grid circuit of Stage 6 is earthed.

**55.** Anode voltage is obtained from the main HT supply amd applied via M3, RF choke L12 and resistor R97 to the centre-tap of L10.

*Filament supplies*

**56.** The valve filaments are heated from the 18V AC or DC supply connected to terminals 25 and 26 on the transmitter unit. Each valve is supplied through individual preset control resistors. R114 and R115 control the filament voltage to V13; R118 and R119 control the voltage to V14. Artificial centre-taps to the filament circuits are provided and filtering is achieved by the filament capacity busbars.

#### RF output circuit

**57.** The output coupling circuit enables the transmitter to be correctly matched to a 600-ohm twin-wire feeder, a 77-ohm coaxial feeder, or to an aerial presenting any other impedance, for example, a harmonic aerial or one operating off its resonant frequency.

**58.** The output circuit consists of the tapped coupling coil L12, the position of which may be adjusted to vary the loading on the anode circuit of Stage 6, and the capacitor C59. Different combinations of series or parallel connection of the coil and capacitor are possible according to the positions of the SERIES-PARALLEL switch S12 and the links LK A and LK B.

**59.** The different connections in respect of 600-ohm and 77-ohm feeders for all frequencies within the range of the transmitter are shown in fig. 4. With a coaxial feeder the coil and capacitor are connected in series for frequencies between 2 and 12 Mc/s, and in parallel for frequencies between 12 and 27 Mc/s. When a twin-wire feeder is in use the coil and capacitor are connected in parallel at all frequencies.

**60.** The link D connects the output circuit to either the TWIN WIRE or CONCENTRIC feeder terminals. Link C earths one side of the output coupling circuit when a coaxial feeder is used. Feeder current is indicated on the meter M1.

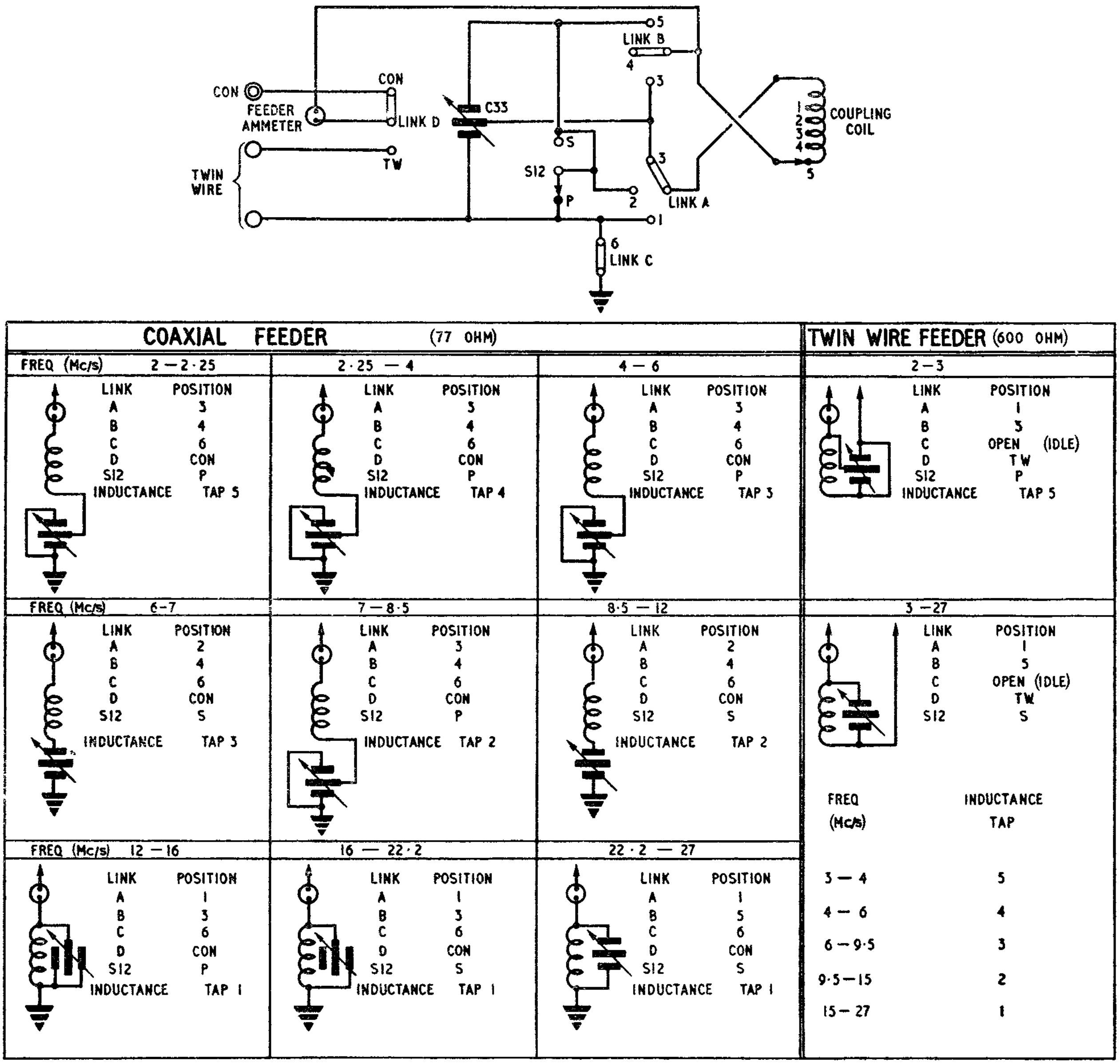


**Fig. 4. Aerial coupling unit connections**

**Monitoring unit**

**61.** The diode-connected triode V15 functions as an untuned RF monitor rectifier. The anode of the valve is coupled to the output unit through the capacitance between C33 and the adjustable plate Cm. In the presence of an RF carrier a DC voltage is developed across C60, and a current flows through the diode load consisting of the meter M16 and resistor R98 in series. C61 forms an RF bypass across the meter. The link LK H enables the local monitor meter to be short-circuited if not required. Provision is made for connecting an external monitor e.g. a recorder, to the transmitter through terminals 11 and 12 on the monitor unit.

**Meter switches**

**62.** Selector switches enable conditions in circuits not permanently metered to be monitored as indicated in para. 63 to 68.

**63.** FEEDMETER switch S4. This switch connects the meter M6 monitor to the following valve feeds.

(1) Master oscillator anode current.

(2) Stage 1 anode and screen currents.

(3) Stage 2 anode and screen currents.

(4) Stage 3 anode current.

(5) Stage 4 anode current

(6) Stage 3 screen current.

(7) Stage 4 screen current.

(8) Note oscillator anode current.

**64.** FEEDMETER switch S5. This connects M7 to monitor the following feeds:—

(1) Stage 1 grid current.

(2) Stage 2 grid current.

(3) Stage 3 grid current.

(4) Stage 4 grid current.

(5) Drive keying valve grid current.

(6) Drive keying valve anode current.

**65.** VOLTMETER switch S7. This switch connects the voltmeter M15 to measure the following voltages:—

(1) Partial absorber grid bias (G).

(2) Drive keying valve cathode (H).

(3) Stage 5 grid bias (J)

(4) Stage 6 grid bias (K)

**66.** A press-button switch S15 is connected across part of the voltmeter series resistor R108 and is closed to make the meter more sensitive when operating on SSB. This is necessary in view of the reduction in grid bias voltage applied to stages 5 and 6 when operating in Class B.

**67.** VOLTMETER switch S8. The voltmeter M14 is connected to monitor the following voltages:—

| | | |
|---|---|---|
| (1) | Harmonic amplifier HT | (A) |
| (2) | Stage 1 and 2 HT | (B) |
| (3) | Partial absorber positive grid bias | (C) |
| (4) | Stage 4 grid bias | (D) |
| (5) | Stage 3 grid bias | (E) |
| (6) | Stage 1 and 2 grid bias | (F) |

**68.** VOLTMETER switch S9. This switch connects the filament voltmeter M3 across the following circuits:—

| | | |
|---|---|---|
| (1) | Partial absorber filament | (a) |
| (2) | Stage 6 (V13) | (b) |
| (3) | Stage 6 (V14) | (c) |
| (4) | Stage 5 | (d) |
| (5) | All 6·3V heaters except | (e) |
| (6) | Master oscillator heaters | (f) |

**CW service—keying circuits**

**69.** When the transmitter is operating on CW on-off telegraphy, any one of four different keying methods may be employed.

(1) Partial absorber keying without signal curbing

(2) Partial absorber keying with signal curbing

(3) Partial absorber keying without signal curbing plus valve drive keying

(4) Valve drive keying alone.

*Partial absorber keying*

**70.** Partial absorber keying is effected by reducing on space the anode voltage of Stage 5 (V12) to such a low value that the stage is rendered inoperative. This is accomplished by the triode valve V16, the anode voltage for which is obtained through part of a load resistance common to the anode circuit of V12. When the transmitter is in the mark condition the grid of V16 is biased negatively and the valve is cut off. On space the grid is biased positively and the valve conducts heavily; this action increases the voltage drop across the common anode resistor (R85), thus reducing the voltage at V12 anode to a very low value, and the drive from Stage 4 is therefore suppressed.

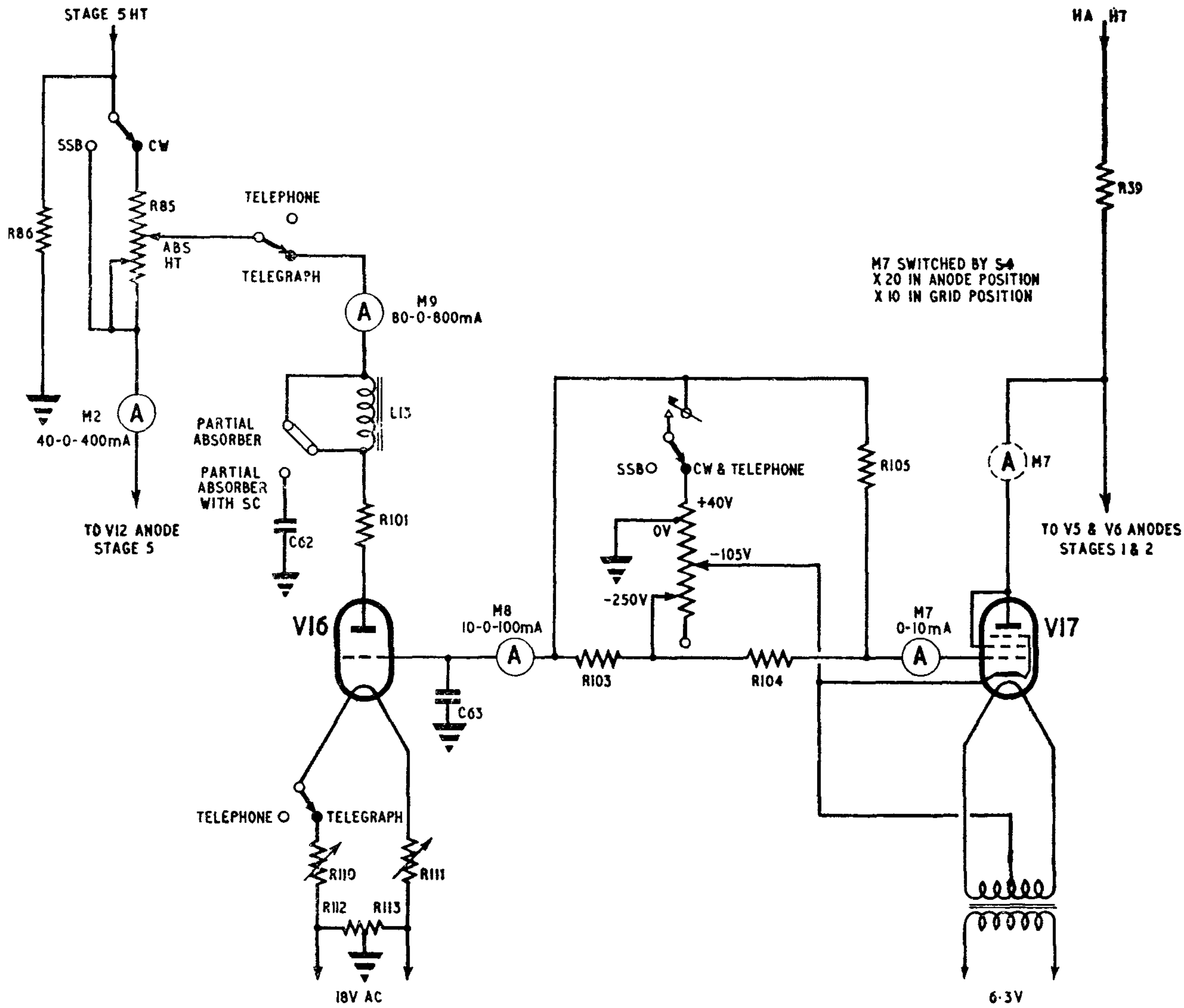


Fig. 5. Keying circuit

**71.** A simplified circuit of the partial absorber keying system is shown in fig. 5. When the SSB/CW link LK E is set to the CW position HT is applied to the anode of V12 through the resistor R85, contacts of S6 and the meter M2. HT is also applied through the upper portion of R85, the closed contact of the TELEPHONE/TELEGRAPH switch, meter M9, PARTIAL ABSORBER link LK G and resistor R101 to the anode of V16.

**72.** On mark, approximately 250V negative bias is required to cut off the partial absorber valve. This voltage is delivered from a tap on the grid bias potentiometer in the power unit, and is applied to the grid of V16 via a resistor R103 and meter M8. On space a 40V positive bias derived from the same source is applied to the grid through the contacts of the keying relay (*para.* 78) or the test key.

*Partial absorber keying with signal curbing*

**73.** Signal curbing is accomplished by inserting an AF choke L13 in the anode circuit of the partial absorber valve, and connecting a capacitor C62 between anode and earth; these components are switched into circuit when the partial absorber link is set to the PARTIAL ABSORBER WITH SC position.

**74.** When using signal curbing it is essential that the drive from previous stages is not suppressed, consequently the drive keying valve V17 (*para.* 75) must be removed.

*Partial absorber and valve drive keying*

**75.** Radiation on space can also be suppressed by reducing the anode voltage to the harmonic amplifier stages 1 and 2. The method is similar in principle to the absorber system, and makes use of a keying valve V17 operating in the same manner as the partial absorber and keyed in parallel with it.

**76.** The anode supply to the first two harmonic amplifier stages and the keying valve is drawn through a common resistor R39 and the grid bias for the keying valve is obtained from the potentiometer that supplies the absorber valve. On space, the positive bias is reduced to —16V by the potential divider formed by R104 and R105. The meter M7 can be switched to monitor either the anode or grid current of the drive keying valve by the switch S4 (FEEDMETER SWITCH).

*Valve drive keying*

**77.** When valve driving keying alone is used the partial absorber is rendered inoperative. This is done by connecting the FIL. SUPPLY links LK H and LK J to the SSB position, thus opening the filament circuit of V16.

*Relay circuits*

**78.** When operating on CW telegraphy the transmitter is keyed remotely over an external line. Two keying relays are provided, one working and one standby; the particular relay is selected by the switch S6, which has the following positions:—

(1) KEY. In this position the transmitter is keyed by the test key located in the relay drawer. When the key is unoperated the positive spacing bias is applied to the absorber and drive keying valve (when fitted). Operation of the key removes the positive bias and applies the negative marking bias to the valves.

(2) MARK. When the switch is set to this position the negative marking bias is applied to the grids of the keying valves. This position is used for test purposes.

(3) RELAY 1 and RELAY 2. In these positions of the switch the external keying line connected to terminals 20 and 21 is extended via the centre-zero LINE CURRENT meter M10 to the coil of the appropriate polarized relay. Marking and spacing bias is now applied to the keying valves according to whether the relay tongue is against the mark or space contact.

**FSK service**

**79.** When FSK is employed the transmitter is operated permanently in the " mark " condition; the keying valve V17 is removed and the partial absorber valve (V16) filament and anode leads are disconnected.

**80.** The INTERNAL/EXTERNAL DRIVE switch S1 is set to EXTERNAL; the frequency-shift drive connected to either of the coaxial sockets EXTERNAL DRIVE NO. 1 or EXTERNAL DRIVE NO. 2 is then applied via the drive changeover link (LK F), feeder terminating unit and switch contact S1c to the grid of the first harmonic amplifier V5.

**AM telephony service**

**81.** When operating as an amplitude-modulated telephony transmitter, the TELEGRAPH SSB/ TELEPHONE switch on the modulator unit Type 7436 (*Chap.* 3) is set to the TELEPHONE position. This performs the following operations in the transmitter unit Type 89:—

(1) Disconnects the partial absorber (V16) anode and filament circuits. The transmitter unit s thus placed in the " mark " condition.

(2) Connects the modulation reactor in the modulator unit in series with the HT supply to Stage 6 (via terminals 1 and 2 on the transmitter unit). Stage 6 thus operates as an anode-modulated Class C amplifier.

**SSB service**

**82.** When operating as an SSB transmitter the following changes are made in the circuit of the transmitter unit:—

(1) The RF output from Stage 3 is disconnected from the input of Stage 4 and applied to the input of the 3rd modulator (modulator unit Type 127). This is achieved by changing the output leads of Stage 3 from the CW to the SSB sockets. Output from Stage 3 to the 3rd modulator is taken from a tap on L5, via C69 and the external coaxial cable to socket 0 on the modulator unit.

(2) The 3·1 Mc/s SSB signal from the drive unit (radio) Type 7 is applied to the input of Stage 4. A tuned circuit (*para.* 100) consisting of L5 and C68 is coupled to the push-pull grid circuit of Stage 4 via blocking capacitors C66 and C67; the SSB signal is applied to a low-impedance tap on L15. The circuit is damped by R59.

(3) The HT Link LK E in the anode circuit of Stage 5 is set to the SSB position. This removes the regulating resistance R85 from circuit.

(4) The input from Stage 5 is taken from the SSB sockets on the coil L8 in the anode circuit of Stage 4 (*para.* 39). This effects an impedance match between the two stages under the different conditions of operation. L8 is damped by R75 to R78, connected across the circuit when the flexible leads are inserted in the SSB sockets.

(5) The partial absorber (V16) filament circuit is disconnected by setting the links LK H and LK J to SSB.

**83.** In SSB service Stages 4, 5 and 6 are operated as Class B amplifiers. Reduced grid bias to these stages is obtained through operation of the SSB/ CW AND PHONE switch on the power unit.

**84.** Variable RF pick-ups are fitted in Stages 4, 5 and 6. These are connected through external coaxial cables to the monitor U-link selector on the 3rd modulator unit.

## CONSTRUCTIONAL DETAILS

**85.** The transmitter unit measures 7 ft. high × 3 ft. wide × 2 ft. deep and weighs approximately 13 cwt. The unit is assembled on a framework of angle-brass, and is fully screened and protected all panels and internal screens being made of brass to reduce frame losses to a minimum.

**86.** Doors or removable screens are provided to give access to coils and valves. The large upper screen at the front of the unit gives access to Stage 6. The hinged door on the right of the lower half of the unit covers the master oscillator and harmonic amplifier stages. Stage 5 is located behind the lower centre screen; the partial absorber valve and auxiliary filament transformer are situated behind the screen at the left-hand side. Preset filament resistors are fitted to the rear of the bottom centre hinged panel.

**87.** All doors and removable screens, with the exception of that on which the filament resistors are mounted, are fitted with gate switches which cut off all supplies except those to the valve filaments, master oscillator and one side of the gate switch circuit when a door is opened or a screen removed.

**88.** At the rear of the unit are four hinged doors, each fitted with a gate switch. All gate swicthes are connected in series.

**Master oscillator and harmonic amplifier stages** (*fig. 6 and 7*)

*Master oscillator*

**89.** The master oscillator is a sealed unit situated at the bottom of the lower right-hand compartment. The oscillatory circuit and compensating

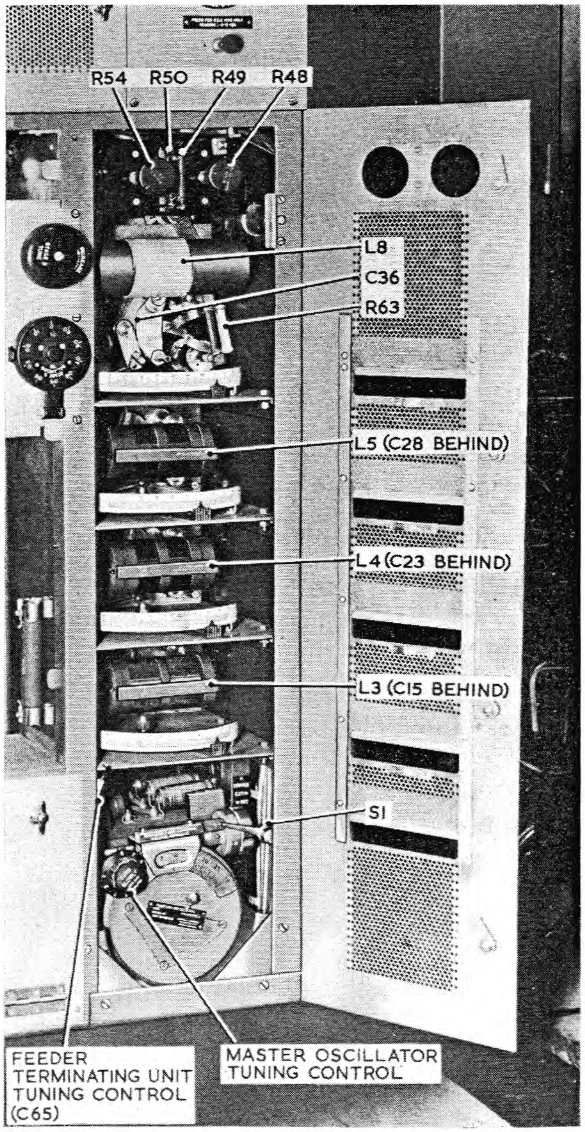


**Fig. 6. Master oscillator and harmonic amplifiers**

capacitor are mounted inside and screened by a double cylindrical brass case which is lagged to prevent rapid changes in the temperature of the individual components. The oscillator valves and associated coupling components are mounted on the outside of the case; the position of components with the unit viewed from the front, and reading from rear to front, is as follows:—

| *Left-hand side* | *Right-hand side* |
|---|---|
| V1 anode choke (L1) | V2 anode choke (L2) |
| V1 grid resistor (R28) | V2 anode resistor (R32) |
| V2 grid resistor (R29) | V1 anode resistor (R30) |

**90.** The tappings on the oscillator coil are selected by a switch (S16) the control knob of which is engraved from 1 to 8. The tuning capacitor scale is engraved with 30 divisions; the setting of the capacitor is read against an engraved line (A) at the bottom of the window through which the scale is viewed.

**91.** A logging scale (B) having 100 divisions is provided on the tuning control knob, one complete revolution of this knob corresponding to a movement over one division of the main tuning scale.

**92.** The diode control valve V4 and its associated components are mounted at the right-hand side of the oscillator unit as viewed from the rear of the transmitter. The terminal of the frequency-modulation control capacitor in the oscillator is connected to the anode of the diode through a flexible lead and spring socket. The preset variable resistor R25 (DIODE ANODE CONTROL) is located at the right-hand side of the transmitter unit.

*External drive coupling and changeover equipment*

**93.** The coaxial sockets EXTERNAL DRIVE NO. 1 (SK1) EXTERNAL DRIVE NO. 2 (SK2) and the external crystal oscillator phase modulation socket (SK3), together with the changeover link LK1 are mounted on a panel at the rear of the master oscillator compartment (*fig.* 8). The 8-pin Jones plug located towards the bottom of the panel is not used in the present applications of the transmitter unit.

**94.** The external oscillator feeder terminating unit is totally screened and is mounted towards the rear of the master oscillator compartment. The tuning capacitor C65 is operated from the front of the transmitter through an extension spindle. The spindle is fitted with a small scale engraved from 0 to 90 deg.; this scale can be seen in fig. 7.

**95.** The internal-to-external drive changeover switch S1 is located at the right-hand side of the oscillator compartment when viewed from the front. The switch is operated by a lever through an extension spindle (*fig.* 7). The lever is rotated in a clockwise direction to switch the terminating unit and external oscillator in circuit, and in a

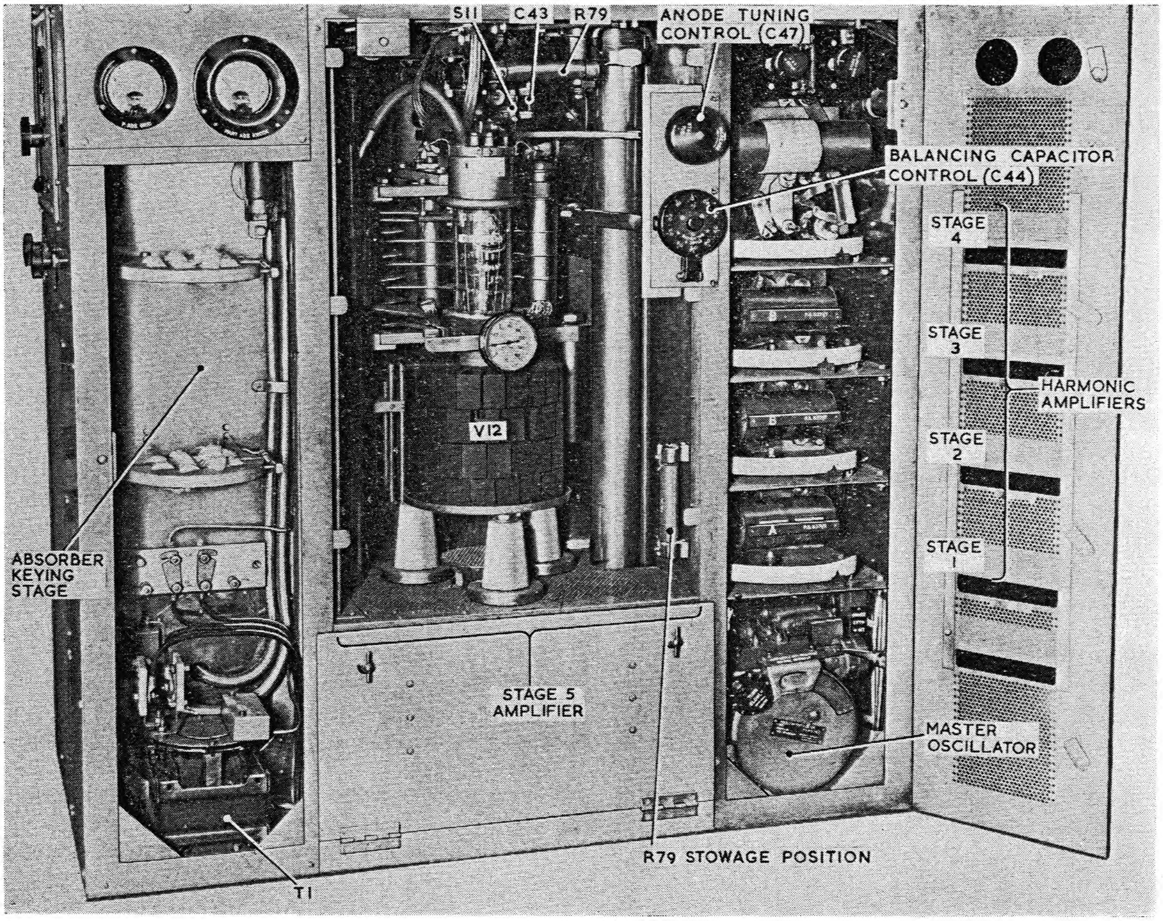


**Fig. 7. Lower front view**

counter-clockwise direction to switch the Franklin master oscillator in circuit.

**96.** As the transmitter gate switches do not affect the filament and master oscillator HT supplies, the oscillator may be set up and grid drive to the first harmonic amplifier obtained with the door of the compartment open.

*Harmonic amplifiers*

**97.** The four harmonic amplifier stages are located immediately above the master oscillator compartment. The construction of Stages 1, 2 and 3 is similar. The plug-in anode coils are tuned by butterfly-type split-stator capacitors. Each capacitor is adjusted through a horizontal slot in the door of the compartment by a thumb-operated lever; the end of the lever carries a pointer which moves over a scale engraved from 0 to 90 deg.

**98.** The STAGE 3 GAIN CONTROL and STAGE 4 GB— potentiometers are located at the top of the oscillator and harmonic amplifier compartment; these controls are accessible for adjustment after the protective cover over the control knobs has been removed.

**99.** Tuning coils for the harmonic amplifier stages are marked with a distinguishing letter. The correct coils to be fitted in each stage for all frequencies are indicated in Sect. 1, Chap. 3. In the Stage 4 compartment, sockets are mounted on the fixed plates of the tuning capacitor C36 for connecting the plug-in fixed capacitor C37.

*Stage 4 grid input circuit for SSB service*

**100.** The Stage 4 grid input tuning unit is fitted into the transmitter unit only when operating on SSB. The tuning control for this unit is located on the left-hand side of the transmitter unit.

**101.** To fit the tuning unit in position and set up Stages 3 and 4 for SSB operation, proceed as follows:—

(1) Rotate the tuning knob until the shaft can be pulled outwards. Continue turning and pulling until the knob is locked.

(2) Remove the two plug leads from the inner dummy sockets on the Stage 4 damping resistor panel (located at the top of the stage) and plug the leads into the outer sockets. This connects the damping resistance across Stage 4 anode circuit.

(3) Insert the Stage 3 output plugs into the innermost two of the four sockets at the top of the Stage 3 compartment. This disconnects the output of Stage 3 from the input of Stage 4.

(4) Plug the SSB tuning unit with the knurled screws uppermost into the back of Stage 4; clamp in position by the knurled screws. Plug the RF input lead from the 3rd modulator into the socket on the underside of the tuning unit case.

(5) Rotate the tuning capacitor knob until it springs back flush with the side of the transmitter unit and engages with the shaft of the capacitor.

(6) At the front of the Stage 4 compartment, disconnect the clips from the outer coils sockets and attach them to the two inner sockets.

**102.** When operating on SSB, special coils (e.g. E3, F3) having a 75-ohm output tap are fitted. The low-impedance tap is connected to the input amplifier of the 3rd modulator; this is automatically disconnected on CW when the normal Stage 3 tuning coils are fitted.

**103.** The SSB pick-ups in Stages 4, 5 and 6 are

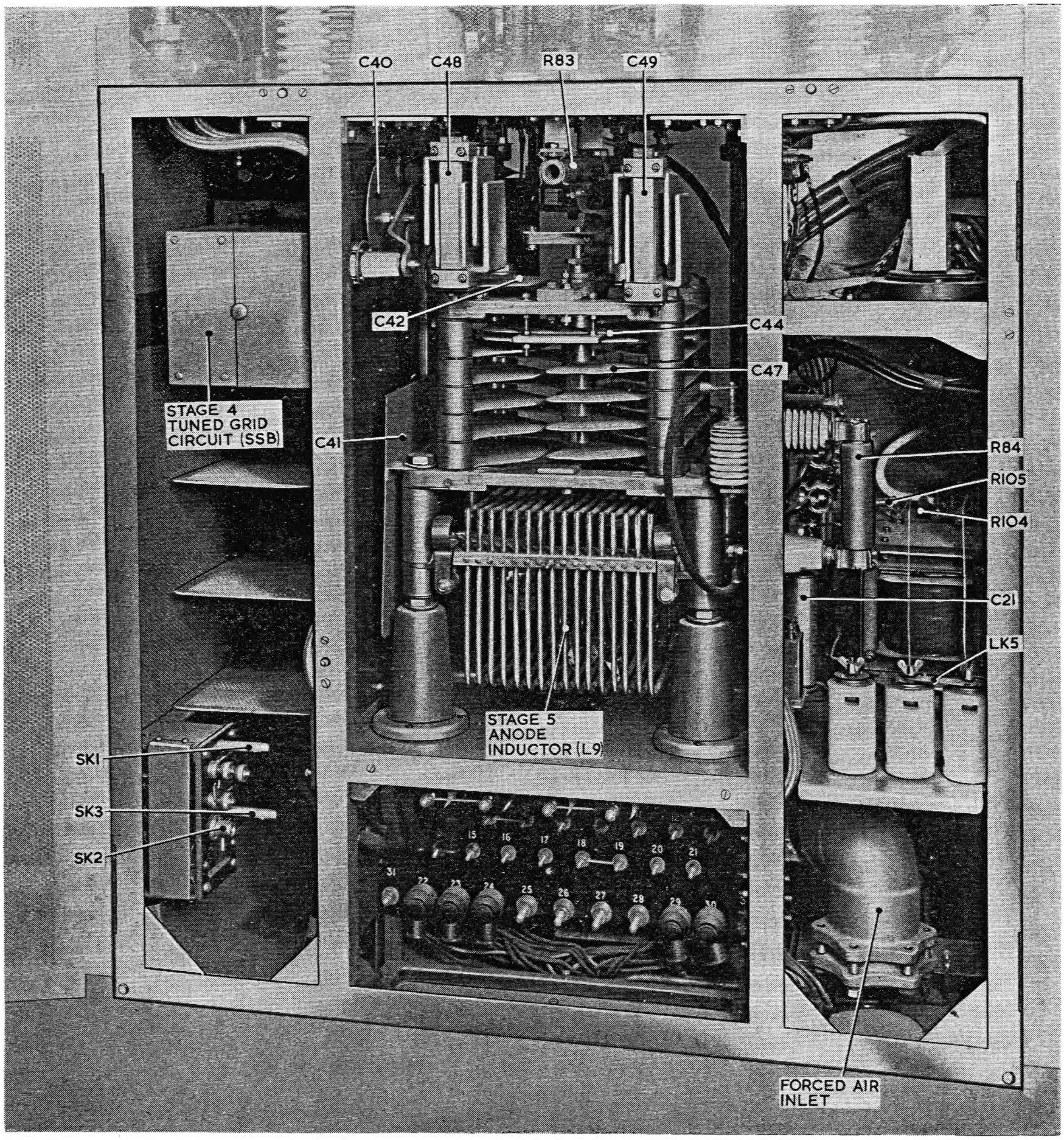


**Fig. 8. Lower rear view**

covered with sliding tubular screens, the positions of which determines the amount of RF pick-up.

**Stage 5**

**104.** Front and rear views of Stage 5 can be seen in fig. 7 and 8 respectively. The forced-air-cooled valve V12 is fitted in an inverted position and is located in a metal ring mounted on three stand-off insulators; the valve is not fixed in position but is held merely by its own weight. The anode thermometer is located immediately above the anode radiator fins and is mounted on a hinged bracket.

**105.** The grid resistor R79 is located at the top of the stage immediately above the valve. This resistor may have a valve of 100 ohms or 5 ohms, depending on the operating frequency. The resistor not in use is mounted in clips on the right-hand side panel of the stage (*fig.* 7).

**106.** The grid reactance capacitor C43 and shorting switch S11 are mounted above the anode tuning capacitor. S11 is accessible from the front of the unit.

**107.** The anode tuning coil L9 is located immediately below the tuning capacitor C47. The coil is fitted with plugs which engage in jacks attached to the extensions of the fixed plates of C47; two handles are provided on the coil to facilitate its removal and insertion.

**108.** The HT lead to the centre-tap of L9 is fitted with a plug and socket connection. The HT supply to Stage 5 is taken through a feed-through insulator at the right-hand side of the stage; a stand-off insulator is provided to which the flexible HT lead can be attached when changing coils (*fig.* 8).

**109.** The Stage 5 anode resistance (R85) consisting of 34 850-ohm tubular carbon resistors is housed in a ventilated compartment at the top of the transmitter unit (*fig.* 10). The selector switch (S6) is located at the top right-hand side of the unit.

**Stage 6**

**110.** Fig. 9 and 10 show front and rear views respectively of Stage 6. The two valves, V13 and V14, are supported on U-shaped brackets in front

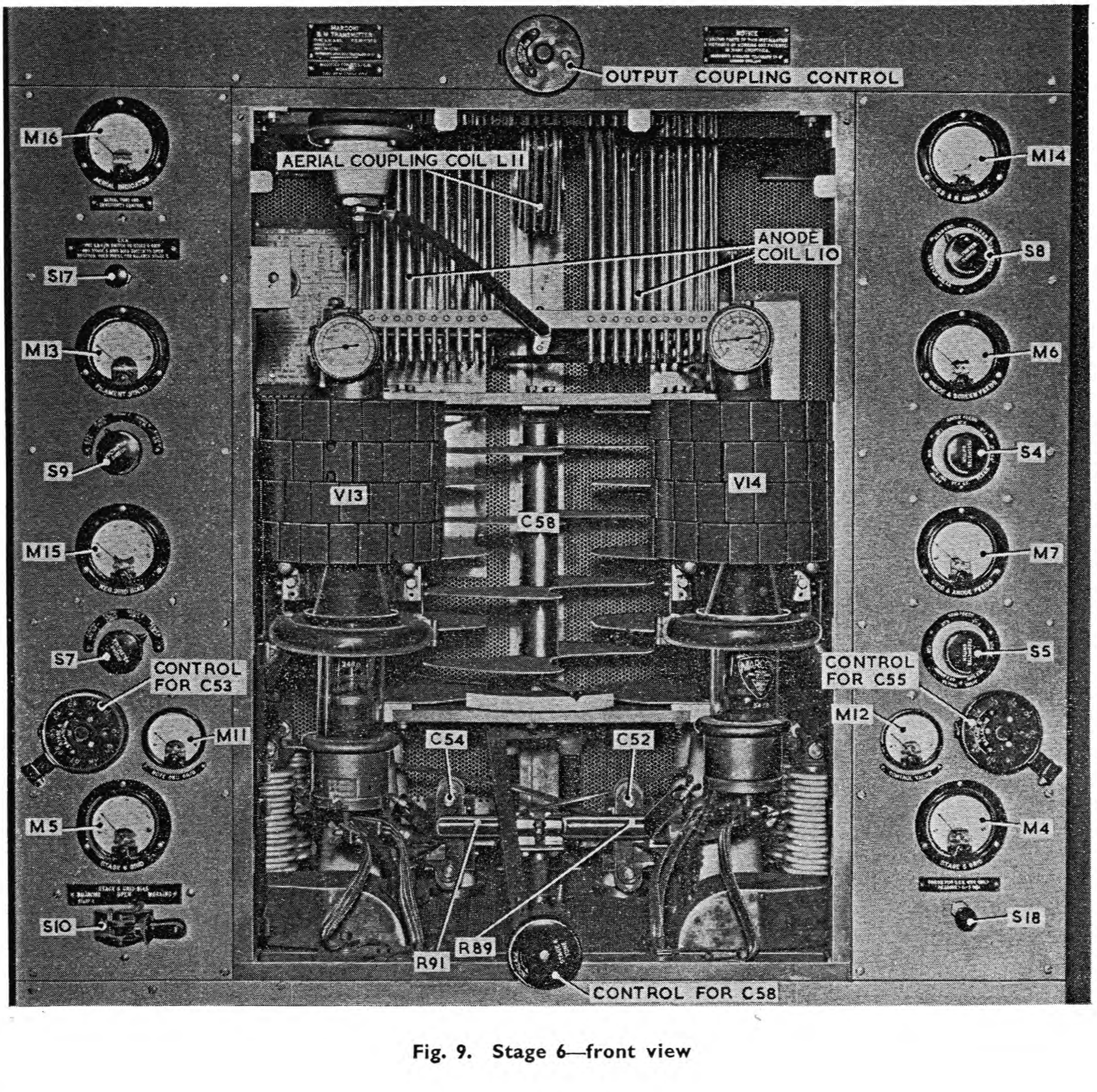


**Fig. 9. Stage 6—front view**

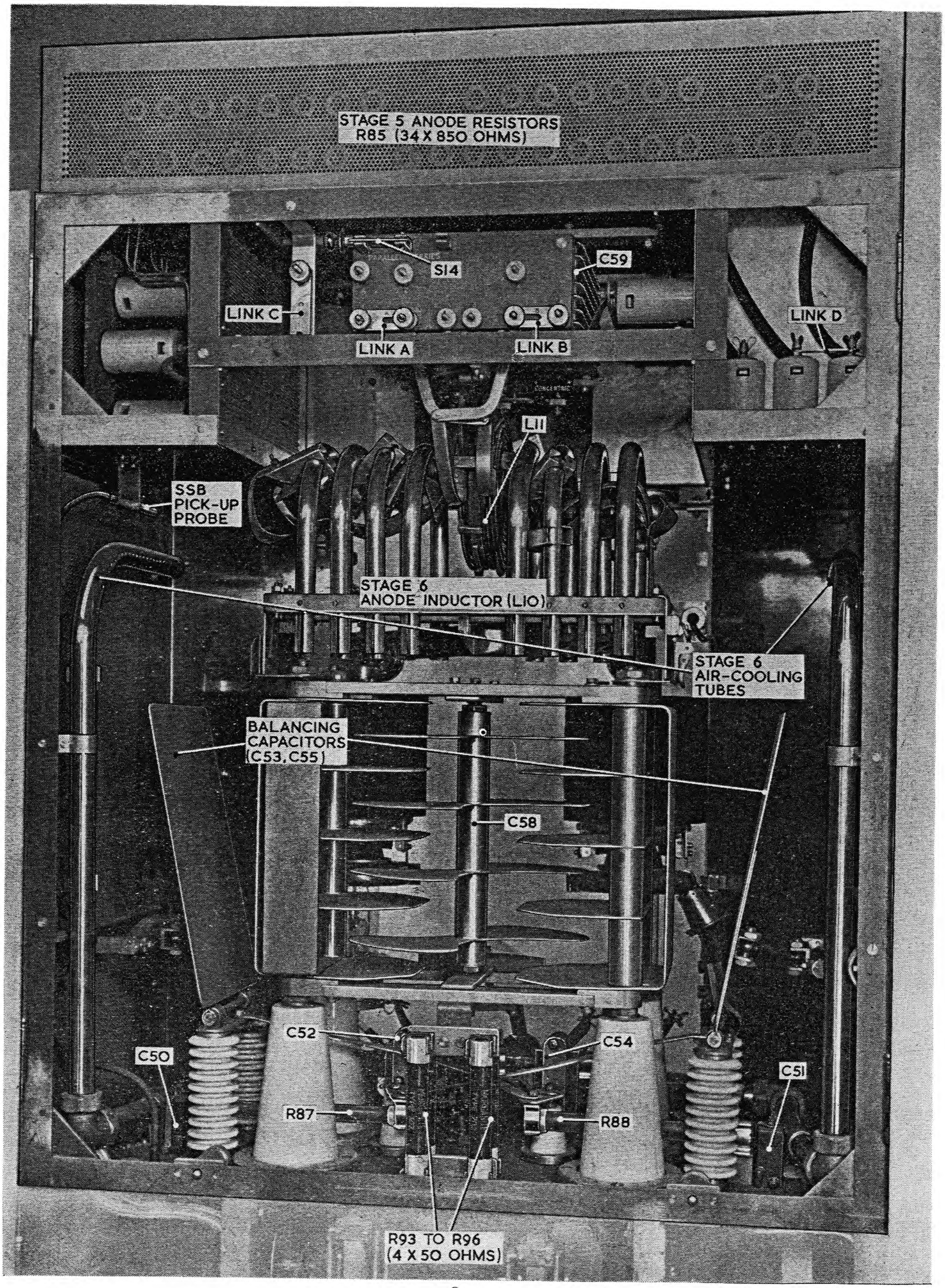


Fig. 10. Stage 6—rear view

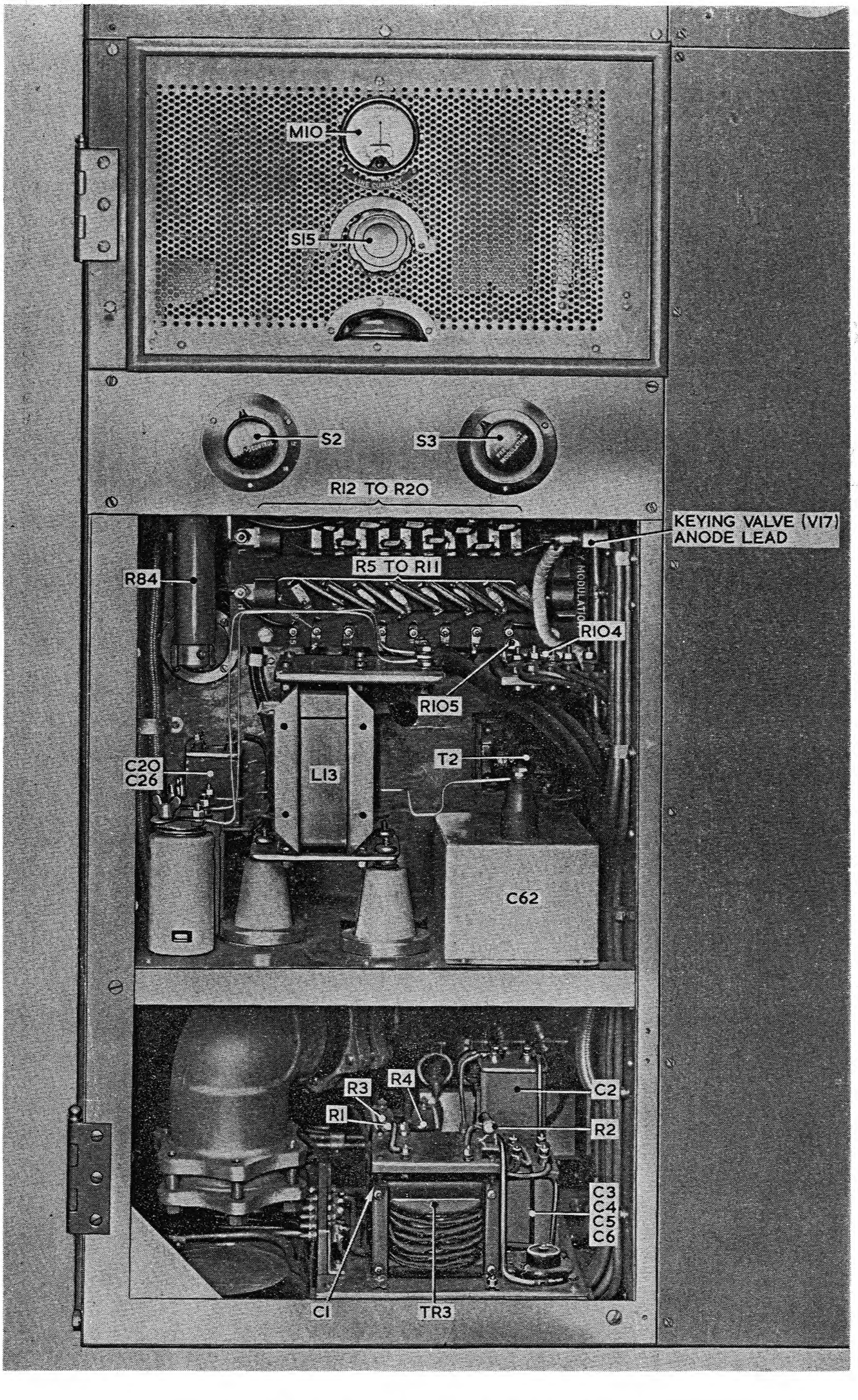


Fig. 11. Lower right-hand side view

of the anode circuit tuning capacitor C58. The anode thermometers are attached to brackets fixed to the top of C58; each thermometer can be raised to facilitate removal and insertion of the valve, and lowered into position by a milled adjusting screw.

**111.** The neutralizing capacitors C53 and C55 are formed by the capacitance between the large movable brass plate at each side of the stage and the fixed plates of C58. The anode coil (L10) is located immediately above the tuning capacitor, being supported by the flat contact plates fixed to the capacitor, and held in place by quick-release catches.

**112.** The grid reactance capacitors C52, C54 and shorting switches S14, S13 are located immediately below C58 and are accessible from the front of the unit. The grid resistors R89 and R91 are mounted in front of the grid reactance capacitors; stowage positions for the alternative valves of resistance are provided at the left-hand side of the stage.

**113.** The aerial coupling circuit is located above Stage 6, and can be seen in fig. 10. The coupling coil L11 is fitted, with a switch to enable any tapping to be selected.

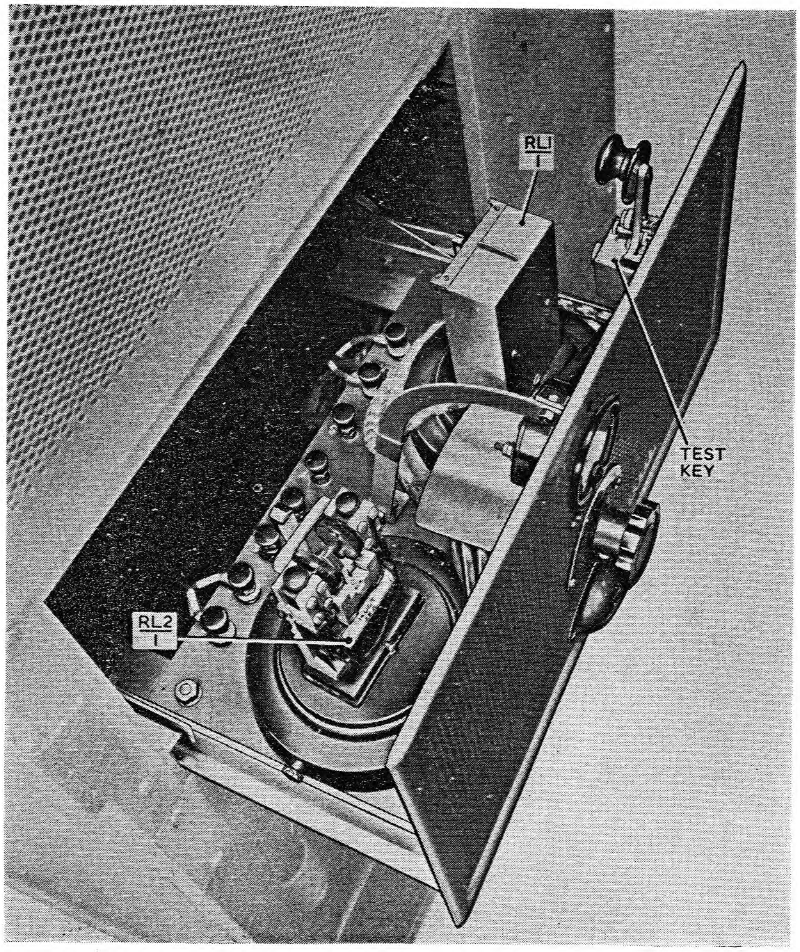


**Fig. 12. Relay drawer**

**Monitoring unit**

**114.** The monitoring unit is located behind a small hinged door at the top left-hand side of the transmitter unit. The monitor is connected to the feeder circuit through a variable coupling plate operated through a shaft fitted with a knob designated PUSH TO INCREASE COUPLING. The knob is calibrated from 0 to 10 and is locked in position by a chuck fitted with a capstan head.

**Filament capacity busbars**

**115.** The filament capacity busbars provide RF filtering of the filament circuits of Stages 4, 5 and 6. The capacitance is that existing between the filament busbars, formed of flap copper strip, and the frame of the transmitter unit. The busbars are completely shielded and are insulated from the frame by strips of leatherside.

**Relay drawer**

**116.** The relay drawer at the left-hand side of the transmitter unit (*fig.* 11 *and* 12) contains the two keying relays (one working and one spare) and the test key. The selector switch (S15) on the front of the drawer has four positions (1) KEY, (2) MARK, (3) RELAY 1 and (4) RELAY 2. When the switch is set to KEY the transmitter can be keyed by the test key; when set to MARK the transmitter is placed in the mark condition, which avoids the necessity for operating the test key; with the switch set to either of the RELAY positions the transmitter can be controlled by one of the Carpenter relays RL1/1 or RL2/1 according to the position of the switch.

**117.** The relays are of the plug-in type and are removable for servicing purposes.

**Forced-air cooling system**

**118.** The anode and filament seals of V12 (Stage 5) and V13, V14 (Stage 6) are forced-air-cooled by an external blower (blower, air, Type 7104, Stores Ref. 10K/17881).

**119.** Forced air is introduced into the transmitter unit through the pipe at the rear (*fig.* 8). V12 anode is cooled by blowing air through a perforated disc below the valve and past the anode fins. The filament seals are cooled by blowing air from a glass nozzle attached to a rubber tube which is inserted in the filament well of the valve.

**120.** The air supply is extended to Stage 6 through two vertical pipes passing through Stage 5. The pipes are terminated by blower boxes in

Stage 6 where the supply is divided; one outlet from each box is connected via a rubber tube and glass nozzle for filament cooling; the other outlet is connected via rubber couplings and a glass tube to the anode cooling ring. This ring has a series of holes around its diameter on the upper side of the ring, through which air is blown upwards past the cooling fins of the valve. The cooling ring is split into two halves which can be opened to permit removal and insertion of valves. The air pipe from the blower box to the cooling ring is fitted with a corona ring at the upper end.

**121.** Further cooling to Stage 6 is provided by blowing air across the stage from the air pipes located at each side.

**122.** The maximum permissible operating temperature of the valve anodes is 130 deg. C. Failure of the air supply opens a switch (switches, air pressure operated, Stores Ref. 10AE/1575) connected in the filament interlock circuit; this disconnects the power supplies from the transmitter.

**123.** The blower motor is controlled by a starter fitted with stop and start buttons, the start button being normally short-circuited by a switch so that the blower starts up automatically. An overload device is incorporated in the starter which ensures that the AC power is switched off in the event of failure of one phase, e.g. should one of the fuses blow.

Dmd 6087 449285 375 12/54 AB 539/3 8888


Fig. 13

Transmitter unit Type 89 – circuit

Fig. 13

Dmd 6088 449286 250 12/54 AB 979/3 8889

# Chapter 2

# MODULATOR UNIT TYPE 127

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**General description**

**1.** Modulator unit Type 127 (*fig.* 1) functions as the "3rd Modulator" in the SSB transmitter Type T.1976.

**2.** The unit consists essentially of three stages:—

(1) A Class C input amplifier (IM3). This amplifies the sub-carrier frequency (fc3) derived from the third harmonic amplifier stage in the transmitter unit.

(2) A modulator stage (Mod. 3). In this stage the sub-carrier and the 3·1 Mc/s SSB signal (fc2) from the drive unit (radio) Type 7 are combined to produce the final radiated frequency (fcr).

(3) A Class A linear amplifier (OM3). This amplifies the SSB signal at the final radiated frequency. The output of the stage is then applied to the transmitter unit for further amplification by stages 4, 5 and 6.

**3.** The frequencies fc2 and fc3 are combined by addition (if fcr is equal to or greater than 10 Mc/s) or by subtraction (if fcr is less than 10 Mc/s). For carrier frequencies in the range 4 to 27 Mc/s, the range of the frequencies fc3 is (4 +3·1) Mc/s or 7·1 Mc/s. to (27 —3·1) Mc/s or 23·9 Mc/s.

**4.** The output frequencies of the drive unit (radio) Type 7 consist of the pilot carrier fc2 (3·1 Mc/s) and the sidebands produced by the audio signals. Suppose audio signals of 3 kc/s are applied to both channels A and B, then the combined input to Mod. 3 consists of the following frequencies:—

| | | |
|---|---|---|
| From SSB drive unit (fc2) | 3·103 | Mc/s Upper sideband |
| | 3·1 | Mc/s Carrier |
| | 3·097 | Mc/s Lower sideband |
| From IM3 (fc3) | 7·1 | Mc/s to 23·9 Mc/s |

*Frequency selection*

**5.** Mixing of the two frequencies fc2 and fc3 produces a number of frequencies which are upper and lower sidebands on a central frequency equal to fc3, in addition to the original frequencies. Of these frequencies the components of one sideband are suppressed by the third modulator and power amplifier tuned circuits.

**6.** For a final radiated frequency of 4 Mc/s, the following frequencies are produced in the third modulator stage:—

| | |
|---|---|
| 3·1 | These frequencies are subsequently rejected |
| 7·1 +3·103 = 10·203 Mc/s | |
| 7·1 +3·1 = 10·2 Mc/s | |
| 7·1 +3·097 = 10·197 Mc/s | |
| 7·1 | |
| 7·1 —3·097 = 4·003 Mc/s | |
| 7·1 —3·1 = 4 Mc/s | |
| 7·1 —3·103 = 3·997 Mc/s | |

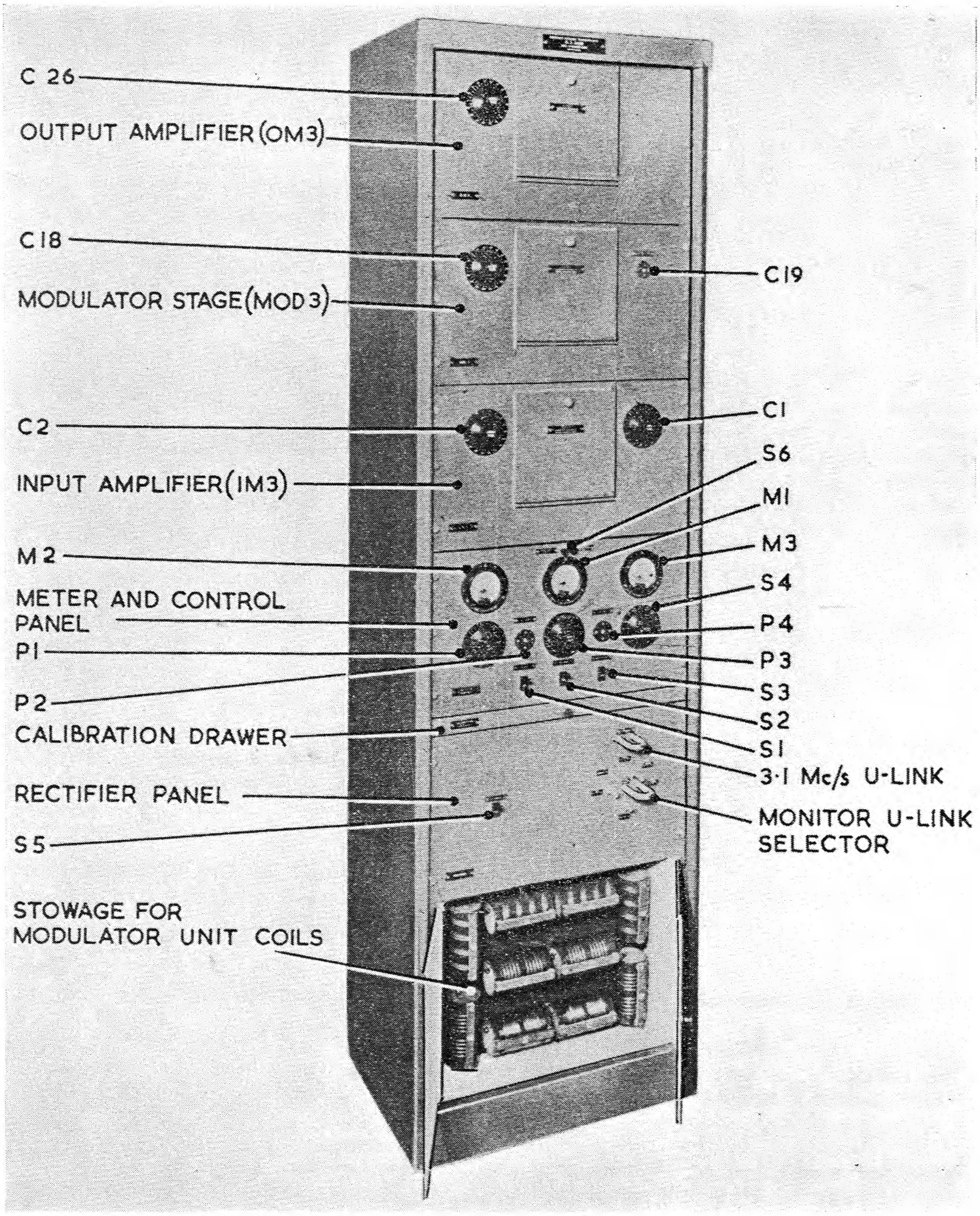



**Fig. 1. Modulator unit Type 127**

**7.** Of these frequencies, the 3·1 Mc/s, 7·1 Mc/s, and 10 Mc/s components are attenuated in the successive tuned circuits. The 4 Mc/s components are amplified to form upper and lower sidebands on a final pilot carrier frequency of 4 Mc/s.

**8.** For a final radiated frequency of 27 Mc/s, the following frequencies are produced:—

23·9 +3·103 = 27·003 Mc/s
23·9 +3·1 = 27 Mc/s
23·9 +3·097 = 26·997 Mc/s
23·9
23·9 —3·097 = 20·803 Mc/s
23·9 —3·1 = 20·8 Mc/s
23·9 —3·103 = 20·797 Mc/s
3·1

} These frequencies are subsequently rejected

**9.** In this instance the 3·1, 23·9 and 20 Mc/s components are rejected; the 27 Mc/s components are subsequently amplified in the transmitter unit.

*Power supplies*

**10.** The modulator unit operates from a 230V 50 c/s single-phase supply, from which are derived the LT and HT voltages for the unit. In addition, a 400V negative grid bias supply is required; this is obtained from the power unit Type 812 (*Chap.* 4).

**11.** The supply circuits are connected so that the power switching sequence for the modulator unit is identical to that of the transmitter unit; thus the modulator filaments are switched on simultaneously with the transmitter unit filaments,

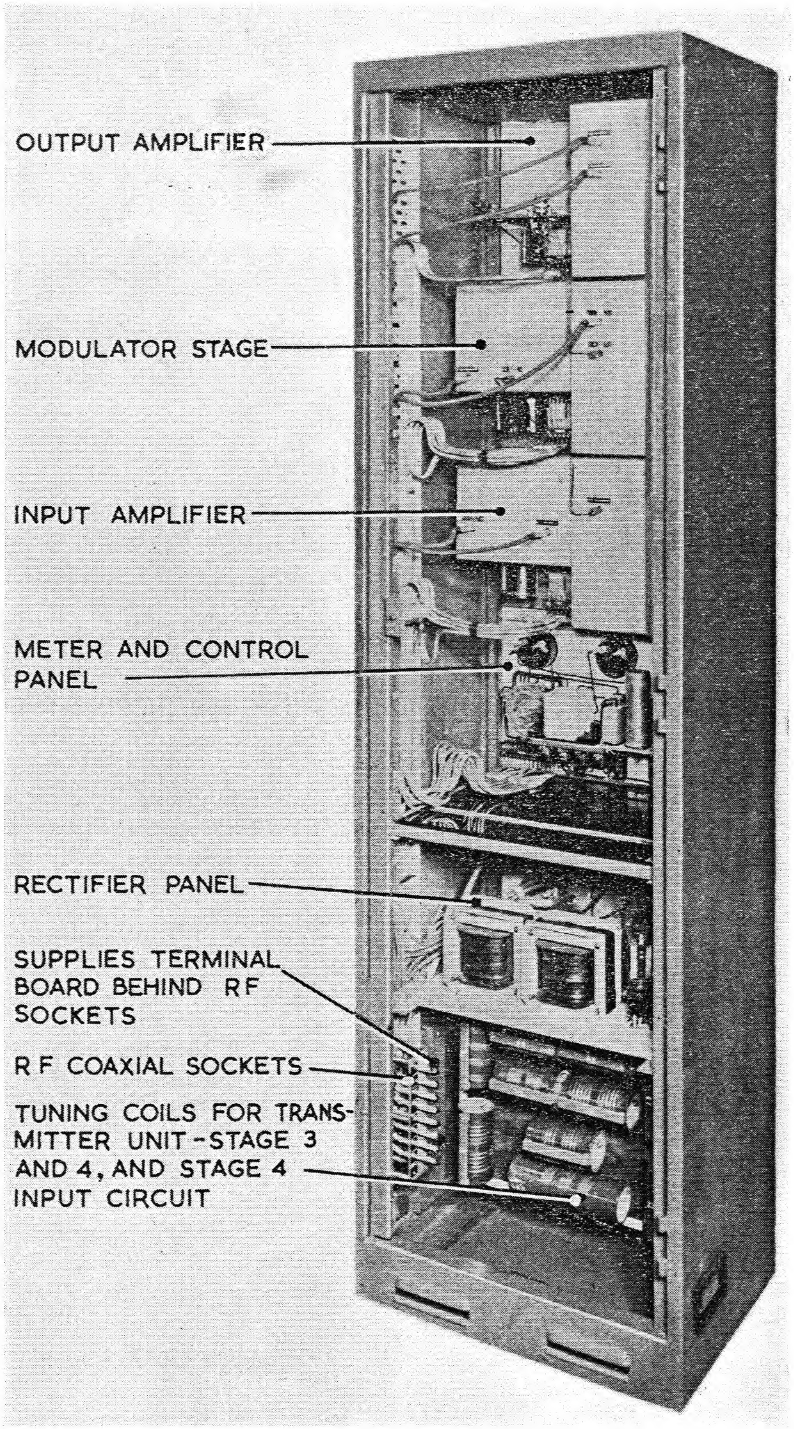



**Fig. 2. Rear view**

and the modulator grid bias is subsequently switched on with the transmitter unit bias. The modulator HT supply is then available and is controlled by a switch.

#### Constructional details

**12.** The modulator consists of the following sub-units mounted in a steel cabinet:—

(1) Output amplifier (OM3).

(2) 3rd modulator (Mod. 3).

(3) Input amplifier (IM3).

(4) Meter and control panel.

(5) Calibration drawer.

(6) Rectifier panel and **U**-link selector.

(7) Coil cupboard.

**13.** The coil cupboard has one compartment at the front and one at the rear of the cabinet. The front compartment houses the tuning coils used in the IM3, Mod. 3 and OM3 stages of the modulator unit. The rear compartment houses special coils for use in stages 3 and 4, and the stage 4 input circuit of the transmitter unit Type 89 when used in SSB service.

**14.** Access to the IM3, Mod. 3 and OM3 panels for the purpose of changing coils is obtained through a door on the front of each panel. Access to all sub-units is obtained through a door at the rear. Fig. 2 shows the modulator unit with the rear door removed. Any panel may be removed from the cabinet after disconnecting the RF plugs and sockets and unsoldering the supply leads from the appropriate terminal board.

**15.** The calibration drawer, located above the rectifier panel, is intended to accommodate the calibration book.

*Safety circuits*

**16.** The rear door of the cabinet and the doors at the front of each panel are fitted with gate switches, connected in the transmitter main trip circuit; this ensures that the main HT and GB circuits become " dead " should the doors be opened while power is on. The 230V AC supply is not tripped by opening of the doors, but these terminals, both in the modulator unit and the power unit are located so that it is practically impossible to touch them. It must be borne in mind, however, that these terminals are live when the main transmitter filaments are on.

**17.** The HT to the modulator should be switched off when changing IM3, Mod. 3 and OM3 tuning coils; warning labels to this effect are fixed on the front doors giving access to the coils.

*Cabinet wiring*

**18.** The cabinet wiring is shown in fig. 3.

**Circuit description** *(fig. 4)*

*Input amplifier (IM3)*

**19.** The tetrode valve V1 operates as a Class C amplifier. The output of the third harmonic amplifier in the transmitter unit is fed via a coaxial plug O to a low-impedance tap on the tuned grid circuit L1C1. The tuned circuit is coupled to V1 grid through a blocking capacitor C4 and grid stopper R2; provision is made for short-circuiting R2 should its inclusion in the circuit be unnecessary.

**20.** The correct operating point for the valve is determined by the negative bias voltage applied to the grid; this is obtained partly from the fixed bias supply and partly from the grid current through R4 due to the RF grid drive. Approximately 26 volts of bias are required; in practice the drive from the transmitter unit is set to give a grid current of 2 mA, and the bias potentiometer P2 is then adjusted until the correct drive to the modulator valve (V2) is obtained.

**21.** A low-level 3·1 Mc/s heterodyne voltage for monitoring purposes is derived from the transformer T1, the primary of which is connected in parallel with L1 via an attenuator resistor R1. The secondary of the transformer is connected to the monitoring plug O, and routed through external cable to the monitor receiver in the drive unit (radio) Type 7.

**22.** The screen voltage of V1 and hence the gain of the stage is controlled by a potentiometer P1 (IM3 GAIN) located in the meter and control panel.

*Modulator stage (Mod. 3)*

**23.** The output from V1 is fed via a tap on the tuned anode circuit and a blocking capacitor C12 to the input circuit of the modulator valve V2. The grid circuit of this valve consists of the secondary of the transformer T2, parallel-tuned by C19 and C20.

**24.** The 3·1 Mc/s SSB signal from the drive unit (radio) Type 7 is applied via the coaxial plug M, **U**-links and attenuator R14, R15 to the primary of T2. This frequency and the output from V1 are combined in V2; the required frequency (fcr) is selected by the parallel-fed anode circuit L5C18. Sufficient discrimination against unwanted frequencies is obtained by this circuit and the successive tuned circuits, namely, the output amplifier, and stages 4, 5 and 6 in the transmitter unit (*para.* 5 *to* 9).

**25.** The tuned anode circuit is damped by the resistors R50 to R56, any one of which may be selected by a plug and socket connection. Damping of the circuit is necessary to maintain good regulation of the RF input voltage to the output amplifier stage.

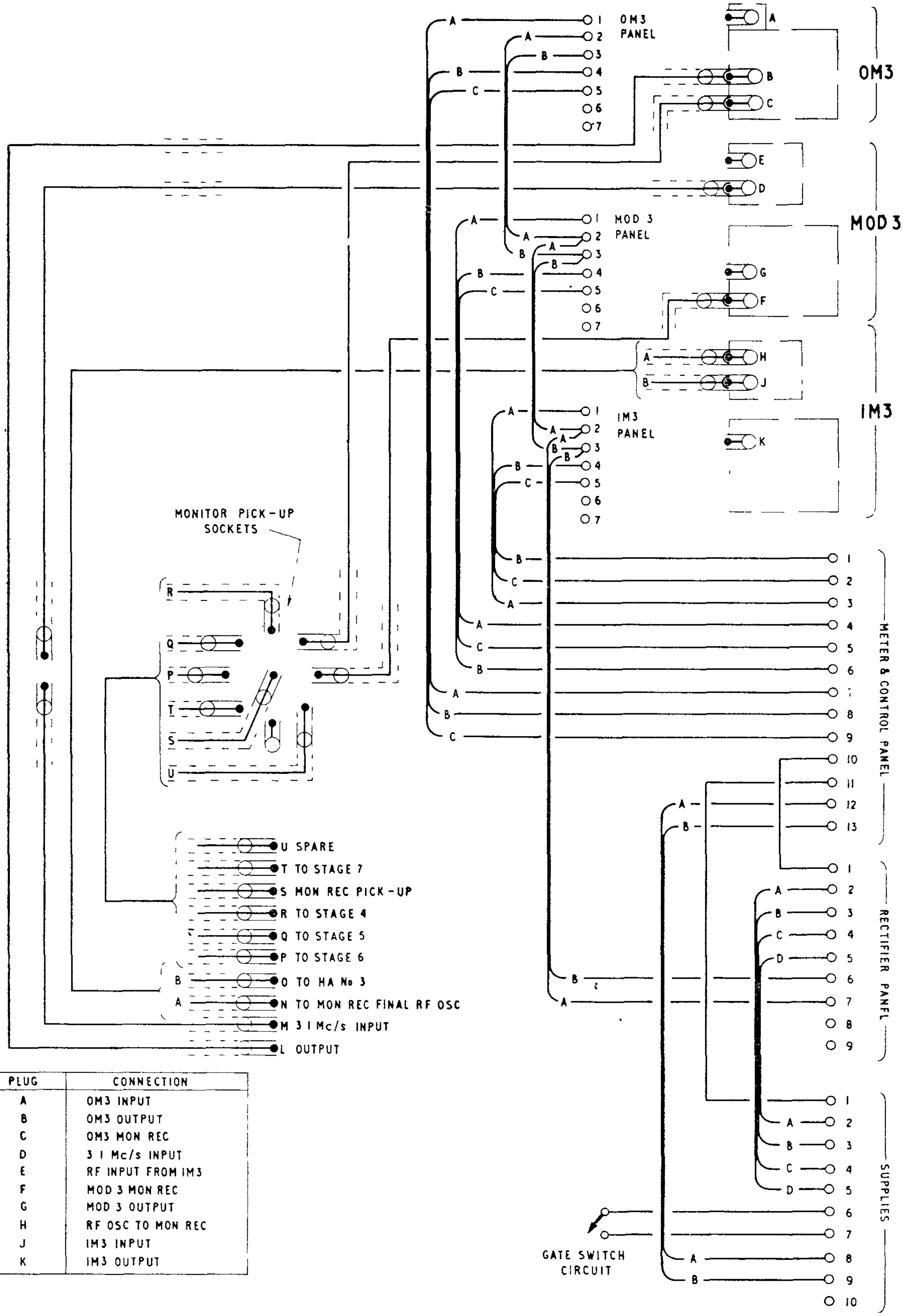
**26.** For efficient mixing the RF voltage applied to V2 from the input amplifier must have a level between three and four times greater than the 3·1 Mc/s SSB signal. The level of the 3·1 Mc/s signal is fixed at a value dependent on the attenuator R14a, R14b, R15 and the length of the coaxial cable between the SSB drive unit and the third modulator. The level of drive from IM3 is variable by the gain control P1 (*para.* 22).

**27.** The 3·1 Mc/s input transformer (T2) and the attenuator (R14, R15) terminate the output circuit of the 3·1 Mc/s amplifier in the drive unit (radio) Type 7. It is important that the amplifier is terminated by a 75-ohm impedance and the attenuator pad is included for this reason.

**28.** As a verification that the termination is correct, the reading on the 3·1 Mc/s amplifier V1 should be the same when directly terminated in the 75-ohm plug provided (which can be inserted in the amplifier output socket on panel 6 of the SSB drive unit) or when connected to Mod. 3 in the normal manner. If the VI reading changes when the Mod. 3 termination is substituted for the 75-ohm resistor, the tapping on the primary of T2 requires adjustment; normally the whole primary winding is used.

*Output amplifier (OM3)*

**29.** The SSB signal from V2 is applied to the untuned grid circuit of the Class A output amplifier




| PLUG | CONNECTION |
|---|---|
| A | OM3 INPUT |
| B | OM3 OUTPUT |
| C | OM3 MON REC |
| D | 3 1 Mc/s INPUT |
| E | RF INPUT FROM IM3 |
| F | MOD 3 MON REC |
| G | MOD 3 OUTPUT |
| H | RF OSC TO MON REC |
| J | IM3 INPUT |
| K | IM3 OUTPUT |

**Fig. 3. Cabinet wiring**

V3. Grid bias for this stage is obtained from the common negative supply via the potentiometer P4 in the meter and control panel.

**30.** The parallel-fed anode circuit L7, C26 is tuned to the final radiated frequency. The modulator output is taken from a low-impedance tap on L7 to the plug B on the OM3 panel, and thence via a coaxial cable to the output plug L of the modulator unit.

*Monitor pick-up points*

**31.** Adjustable pick-up electrodes are fitted adjacent to the output coils in the modulator and output stages, and connected through coaxial cable to the monitor **U**-link selector mounted on the front of the rectifier panel.

**32.** Additional coaxial plugs are provided which are connected through external cabling to monitor points in the amplifier stages of the transmitter unit Type 89. Thus any stage in the SSB chain may be selected by the monitor **U**-link, and routed to the monitor receiver in the drive unit (radio) Type 7.

*Rectifier panel*

**33.** HT is derived from the tapped secondary of the transformer T4 and the full-wave rectifier valve V4. The DC output of the rectifier is smoothed by a 2-section filter C34, C30, C31, L9 and L10. Bleeder resistors R57a to d are connected across the smoothed DC supply. The HT supply is switched by S5 in the primary of T4.

**34.** Filament voltage for V4 and heater voltage for V1, V2 and V3 are obtained from secondary windings on a separate transformer T2.

*Meter and control panel*

**35.** All metering and control facilities are provided by this panel.

**36.** HT is applied to the anode and screen of the modulator valve (V2) through the switch S2 (MOD. 3 HT). The anode current is metered by M2.

**37.** HT is applied to the anode and screen of the input amplifier (V1) through the switch S1 (IM3 HT). The variable screen voltage is derived from the slider of P1, which, in series with R30a, R30b, R31a, and R31b, forms a potential divider across the HT supply.

**38.** The HT supply to the output amplifier is controlled by S3 (OM3 HT AND BIAS). In the OFF position this switch removes the HT and at the same time earths the grid return circuit of V3; this enables the modulator stage to be tuned by observing the grid current of V3.

**39.** Grid bias for all stages is obtained from the 400V negative supply in the power unit Type 812. The 400V supply is connected via a common dropping resistor R41 to two parallel-connected potential dividers as follows:—

(1) *P3, R33 and P4 in series.* Grid bias for Mod. 3 is derived from the slider of P3; a lower bias voltage for OM3 is obtained from the slider of P4.

(2) *R32a, R32b and P2.* Bias for the input amplifier is derived from the slider of P2 (IM3 BIAS).

**40.** The key switch S6 enables the meter M1 to be switched as follows:—

(1) In series with the grid resistor (R12) of the modulator valve to measure the grid current of this stage.

(2) To terminals 8 and 9 on the supplies terminal board. This connects M1 in series with the volume indicator of the monitor amplifier in the SSB drive unit for use as a remote VI.

**41.** The selector switch S4 connects shunt and series resistors in circuit with M1 to measure the following voltages and currents:—

| | | *FSD* |
|---|---|---|
| (1) | Total HT voltage | 500V |
| (2) | Mod. 3 grid bias voltage | 100V |
| (3) | OM3 grid bias voltage | 100V |
| (4) | OM3 anode current | 100mA |
| (5) | OM3 grid current | 5mA |
| (6) | IM3 grid bias voltage | 100V |
| (7) | IM3 anode current | 50mA |
| (8) | IM3 grid current | 5mA |

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NOTE:- TERMINAL NUMBERS REFER TO ACTUAL TERMINALS ON UNITS

PART 1, SECTION 2
Fig.4, Mod.3 panel. Between R14 and primary of TR2 insert capacitor and label it "C37 390pF".

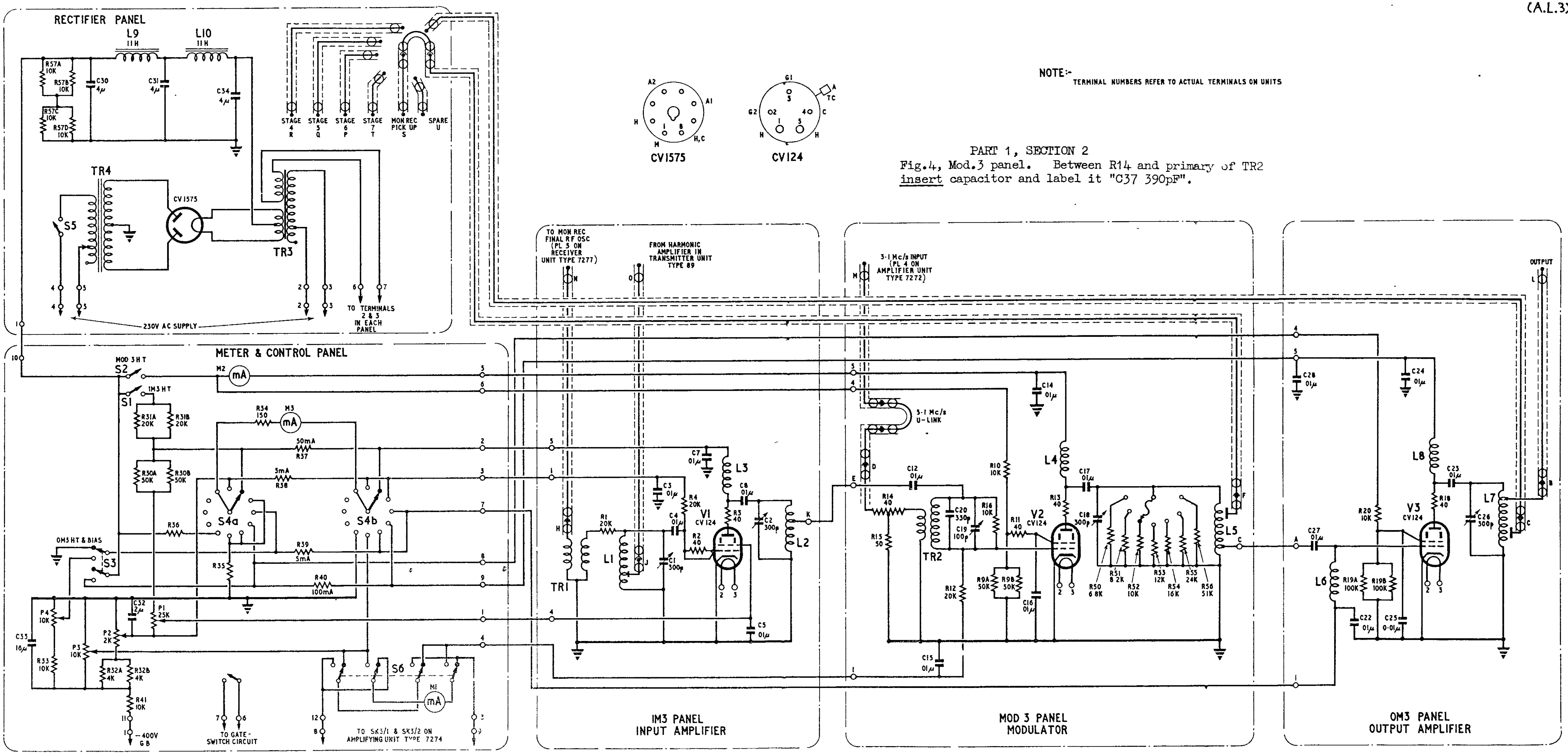


Fig. 4

Modulator unit Type 127 — circuit

Fig. 4
(A.L. 3 Jul. 54)

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# Chapter 3

# MODULATOR UNIT TYPE 7436

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### GENERAL DESCRIPTION

**1.** Modulator unit Type 7436 (*fig.* 1) is a medium-power Class B modulator which forms part of the transmitter Type T.2000. The unit provides high-level modulation of the transmitter unit Type 89 (*Chap.* 1) when the equipment is used for telephony transmissions.

**2.** The modulator unit consists basically of three push-pull stages, viz. a line amplifier, cathode-follower driver stage, and a Class B main modulator stage. The input circuit of the line amplifier may be switched to match lines of 80 to 100 ohms impedance, or 600 ohms impedance.

**3.** All power supplies are derived from the power unit Type 811 (*Chap.* 4). The filaments of all valves are heated by single-phase step-down transformers. The 5kV main HT supply is derived from the 3-phase mercury-vapour HT rectifier in the power unit; this voltage is reduced to 1·5kV in the modulator unit for application to the line amplifier and cathode-follower stages.

### CIRCUIT DESCRIPTION

**4.** The circuit of the modulator unit is shown in fig. 7. The 600-ohm audio-frequency lines, terminated at TB3/21 and TB3/22, are connected to the plug PL1 on the amplifying unit via the change-over switch S6 (A.F. LINES). 80 to 100-ohm lines, connected to TB3/23 and TB3/24, are routed to the amplifier input circuit via a matching transformer T9 and contacts of S6.

#### Amplifying unit Type 418

**5.** The AF input is applied via the 20dB variable attenuator R36 and matching transformer T8 to the grids of the push-pull tetrodes V1 and V2. An AC voltmeter M10 (INPUT LEVEL) is connected across the primary of T8 to monitor the input level to the amplifier.

**6.** The input level in milliwatts is given by

$$mW = \frac{E^2 \times 1000}{600}$$

where E is the reading on the line input voltmeter. An input level of approximately 1 mW is required to give 100 per cent. modulation; this level corresponds to a meter reading of 0·78V.

**7.** T8 is loaded on the primary side by R35 and on the secondary side by R32 and R33. R29 and R31 function as grid stopper resistors.

**8.** Grid bias to V1 and V2 is derived from the variable cathode resistor R34; cathode current is indicated by M9 (LINE AMPLIFIER CATHODE METER), by-passed by C11. HT to the screens is derived from a potential divider R28 and R30 connected across the HT supply to the amplifying unit.

#### *Cathode-follower stage*

**9.** The audio output from V1 and V2, developed

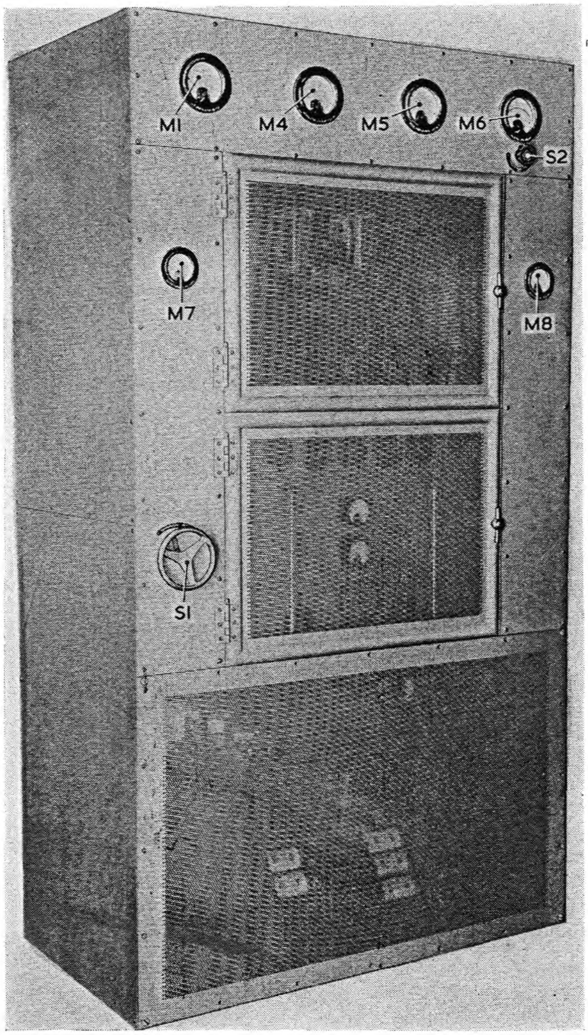


**Fig. 1. Modulator unit Type 7436**

across the anode loads R26 and R27 respectively is applied via C9 and C10 to the grids of the triode valves V3 and V4; R22 and R23 function as grid stoppers.

**10.** V3 and V4 form a cathode-follower driver stage for the main modulator valves V5 and V6. The cathode-follower stage has a slight voltage loss, but its use enables the succeeding Class B stage to be driven very heavily into grid current with a minimum degree of distortion. This is due to the good regulation of the audio input voltage to the Class B stage consequent upon the low output impedance of the cathode-follower stage.

**11.** Grid bias for V3 and V4 is derived from the potentiometers R16 and R17 connected across the common negative bias supply to the modulator unit. HT is fed to the anodes of the valves via parasitic suppressors which consist of the parallel-connected inductors and resistors L7, R18, and L8, R19. The audio output is taken from the cathode circuit of the valves via R24 and R25 to the output plugs PL3 and PL5; the potentiometers R24 and R25 provide an artificial centre-tap to the filamentary cathodes of V3 and V4, and are adjustable to minimize hum. The cathode loads for the valves consist of the two windings of the inductor L6.

**12.** The HT supply to the amplifying unit is derived from a potential divider consisting of R5 and R8 in series across the main HT supply. The 1·5kV supply thus obtained is decoupled by C8.

#### Main modulator stage

**13.** The audio output from the cathode-follower stage is direct-coupled via V3 and V4 cathode current meters (M7 and M8) to the grids of the Class B modulator valves V5 and V6; M7 and M8 are bypassed by C6 and C7. R6, L4 and R7, L5 function as parasitic suppressors in the grid circuits of V5 and V6 respectively. C2 and C3 provide an HF by-pass between grid and cathode circuits.

**14.** Negative grid bias is derived from the potentiometers R14 and R15 across the grid bias supply line and is applied to the valves through the double-wound choke L6. The windings of L6 are so connected that the field due to the DC components through the windings is cancelled. With this method of connection the filaments of V3 and V4 are at the same negative potential to earth as the grids of the V5 and V6.

**15.** The cathode circuits of V5 and V6 are completed via the potentiometers R9 and R10, which provide an artificial centre-tap to the filamentary cathodes, and the cathode-current meters M4 and M5; the filament voltage applied to the valves is monitored by M6, which is connected to either V5 or V6 by the changeover switch S2.

**16.** The anodes of the modulator valves are connected in push-pull to the primary of the modulation transformer T2. The secondary of T2 is parallel-connected via the choke L1 and capacitor C1 to the anode circuit of the final amplifier (stage 6) in the transmitter unit; HT is fed to stage 6 via contacts of S1 (*para.* 22) and the choke L1 to terminal 26.

#### Modulation indicator and monitor

**17.** A modulation indicator M1 is connected across a tertiary winding on T2 via a potentiometer R2. The meter is graduated from 0 to 5kV and indicates the RMS output voltage of the modulator applied to the final amplifier stage in the transmitter unit.

**18.** The potentiometer R2, which is located under a protective cover, is set to the correct position in the factory and should not be re-adjusted subsequently. For sine-wave output from the modulator, the percentage modulation can be determined from the following formula:—

$$\text{Per cent. mod.} = \frac{\text{Mod. meter voltage} \times 1{\cdot}414 \times 100}{\text{Main HT DC voltage}}$$

**19.** With a main HT voltage of 5,000, a meter reading of 3,530 volts thus corresponds to 100 per cent. modulation, and a reading of 3110 volts corresponds to 80 per cent. modulation. It must be emphasized, however, that the instrument is an indicator only, and is not to be regarded as an accurate meter.

**20.** The AF voltage across part of the tertiary winding is applied via a potentiometer R1 to the primary of a step-down transformer T1. The secondary of the transformer, terminated at TB2/17 and TB2/18, matches the circuit to the low-impedance voice coil of a moving-coil loudspeaker. S5 enables the monitor speaker to be switched off when not required.

**TELEGRAPH SSB/TELEPHONE switch**

**21.** When set to the TELEGRAPH/SSB position, S1 performs the following functions:—

(1) Completes the filament circuit of the partial absorber valve in the transmitter unit via terminals 31 and 32.

(2) Completes the heater circuit of the frequency modulation note oscillator valve in the transmitter unit via terminals 9 and 10.

(3) Applies the 5,000V main HT supply directly to stage 6 in the transmitter unit via terminals 25 and 26.

(4) Applies the main HT to the partial absorber and stage 5 anode circuits via terminals 27 and 28.

(5) Completes the interlock circuit via terminals 11, 12 and 20 (*refer to Chap.* 4).

(6) Applies +40V from the power unit to the transmitter unit as keying bias for the partial absorber valve via terminals 1 and 2.

**22.** When set to the TELEPHONE position, S1 performs the following functions:—

(1) Applies AC (from phase B) to energize the modulator filament contactor MF/2 via the interlock circuit connected to terminal 12.

(2) Applies AC (from phase Y) to the modulator valve filament transformers T3 and T4 via terminal 13; applies AC to the line amplifier and cathode-follower filament transformers T7, T5 and T6.

(3) Applies grid bias to the cathode-follower and modulator valves via terminal 14.

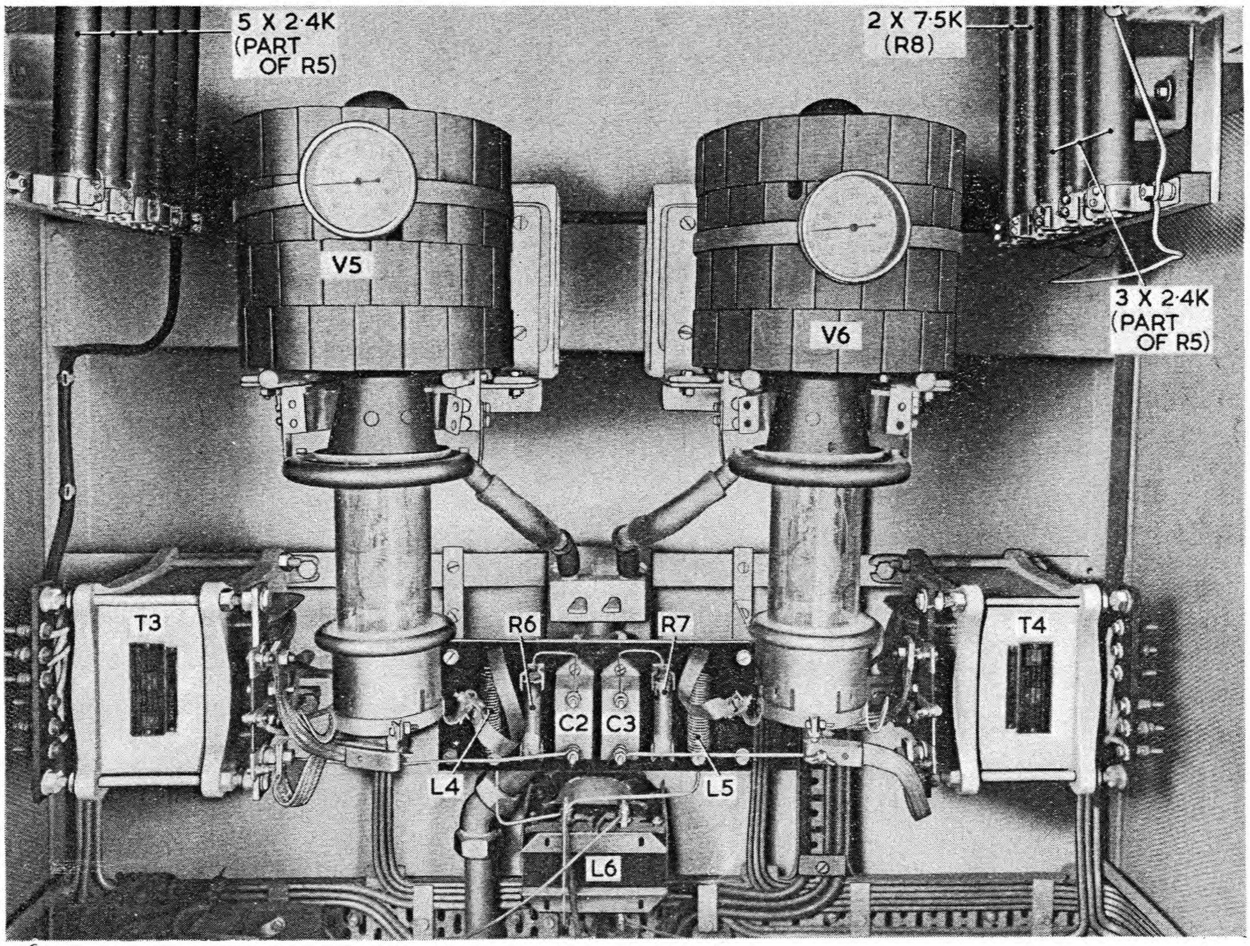


**Fig. 2. Class B modulator stage**

(4) Applies the 5,000V main HT supply to the anodes of the modulator valves and to the anodes of stage 6 valves through the modulation choke L1.

**23.** Contacts of S1 which perform functions other than those enumerated in para. 21 and 22 are not used in the present application.

#### Gate switches and interlocks

**24.** The gate switches S3 and S4 are connected in series with the gate switch circuit of the transmitter and power units. Terminal 15 is connected to terminal 52 on the power unit, and terminal 16 is connected to terminal 5 on the transmitter unit.

**25.** A contact of S1 short-circuits terminals 3 and 4 to complete the transmitter filament interlock circuit when the switch is set to either TELEGRAPH SSB or TELEPHONE but not to an intermediate position. Terminals 3 and 4 are connected to terminals 48 and 49 on the transmitter unit via contacts of the air-pressure-operated switch.

**26.** A diagram showing the complete control circuit of the transmitter, modulator and power units will be found in Chap. 4.

### CONSTRUCTIONAL DETAILS

**27.** The modulator unit measures 6 ft. 5 in. high × 3 ft. 6 in. wide × 2 ft. deep, and weighs 11 cwt.

**28.** Access to the Class B modulator stage (*fig.* 2) is obtained through the upper door at the front of the unit. Opening the door releases a gate switch connected in series with similar switches in the transmitter and power units (*para.* 24). This ensures that the HT supply is disconnected when the door is opened.

**29.** The air-cooled modulator valves V5 and V6 are supported by U-shaped brackets mounted on porcelain stand-off insulators. The anodes only of the valves are forced-air-cooled; the air supply is fed in at the bottom of the modulator unit, and piped via a bifurcated junction at the rear of the Class B stage and flexible couplings to the perforated cooling rings beneath the anode radiator fins. The thermometers are attached to metal bands clamped round the anode fins.

**30.** The two 150-ohm parallel-connected resistors R11 (not visible in fig. 2) are mounted behind the front panel at the left-hand side of the modulator unit.

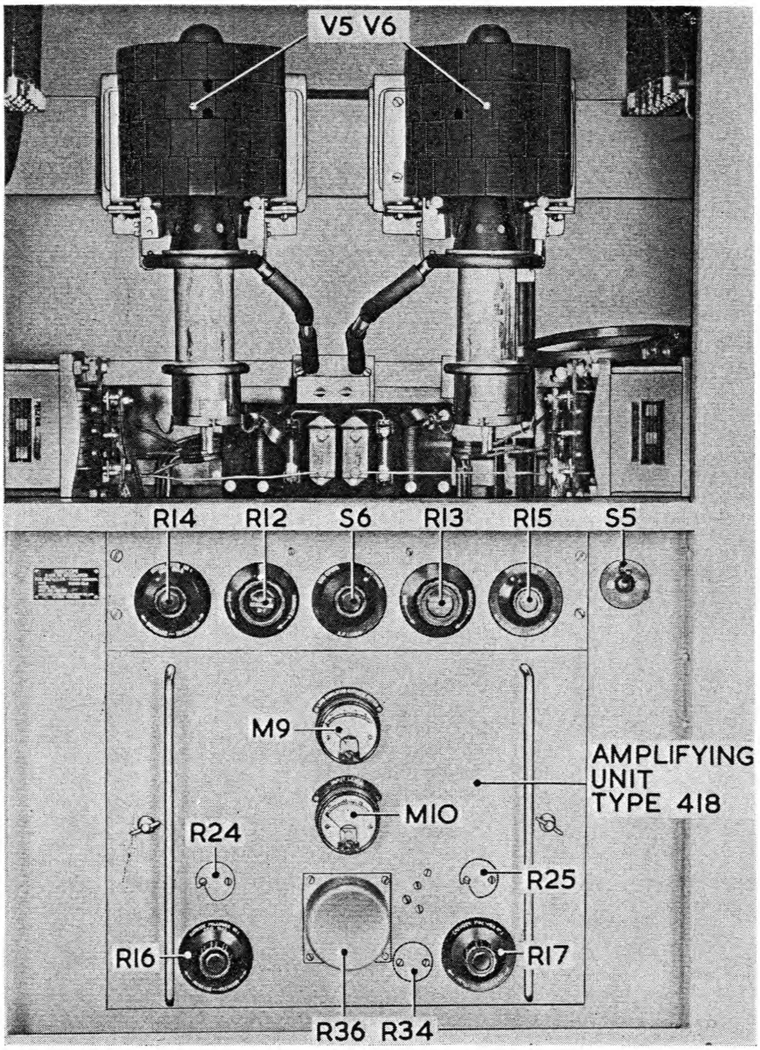


**Fig. 3. Front view showing amplifying unit Type 418**

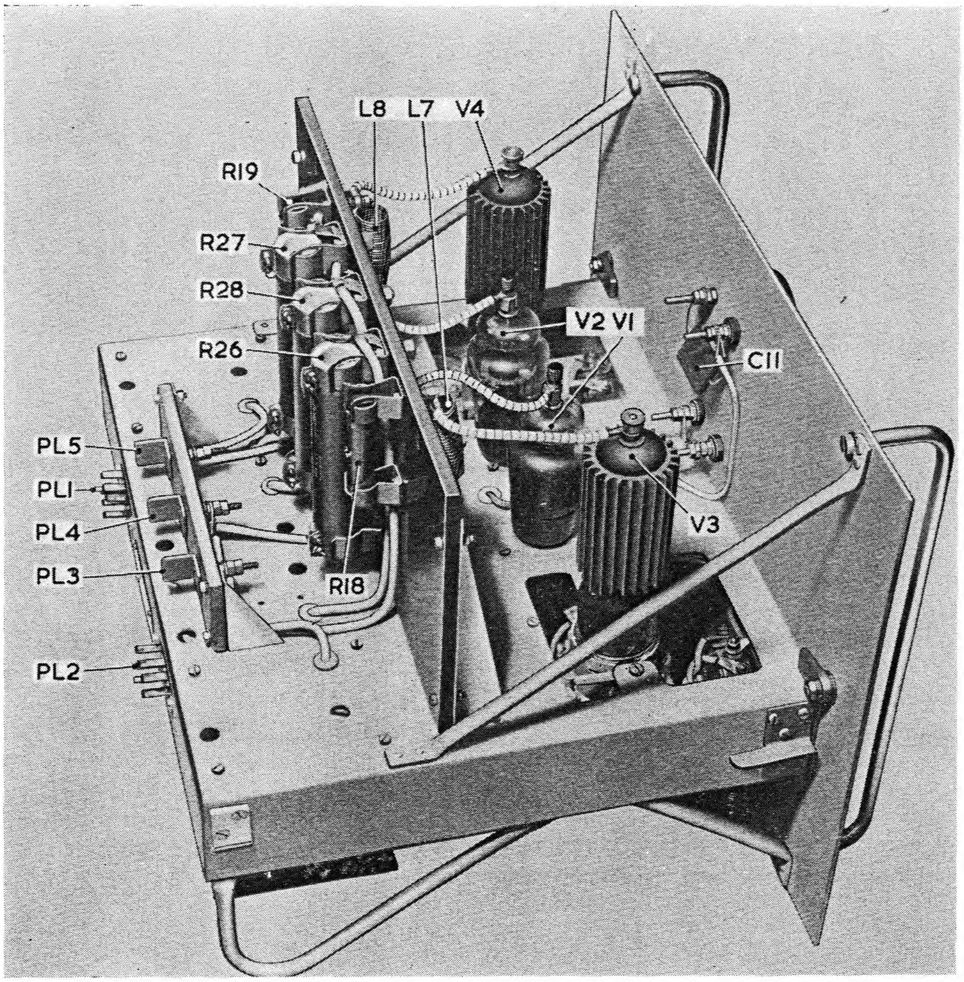


**Fig. 4. Amplifying unit Type 418**

**31.** The lower door at the front of the unit gives access to the amplifying unit Type 418 (*fig.* 3); opening this door releases a gate switch which disconnects the HT supply. The amplifying unit is removed after loosening the catch at each side of the front panel, drawing the unit forward, and disconnecting the cable-mounted sockets SK1 and SK2 at the rear.

**32.** The following controls are mounted immediately above the amplifying unit:—

(1) A.F. LINES switch (S6).

(2) MODULATOR NO. 1 GRID BIAS control (R14).

(3) MODULATOR NO. 2 GRID BIAS control (R15).

(4) FILAMENT REGULATOR NO. 1 (R12).

(5) FILAMENT REGULATOR NO. 2 (R13).

(6) LOUD SPEAKER switch (S5).

**33.** Fig. 4 and 5 show the location of components in the amplifying unit.

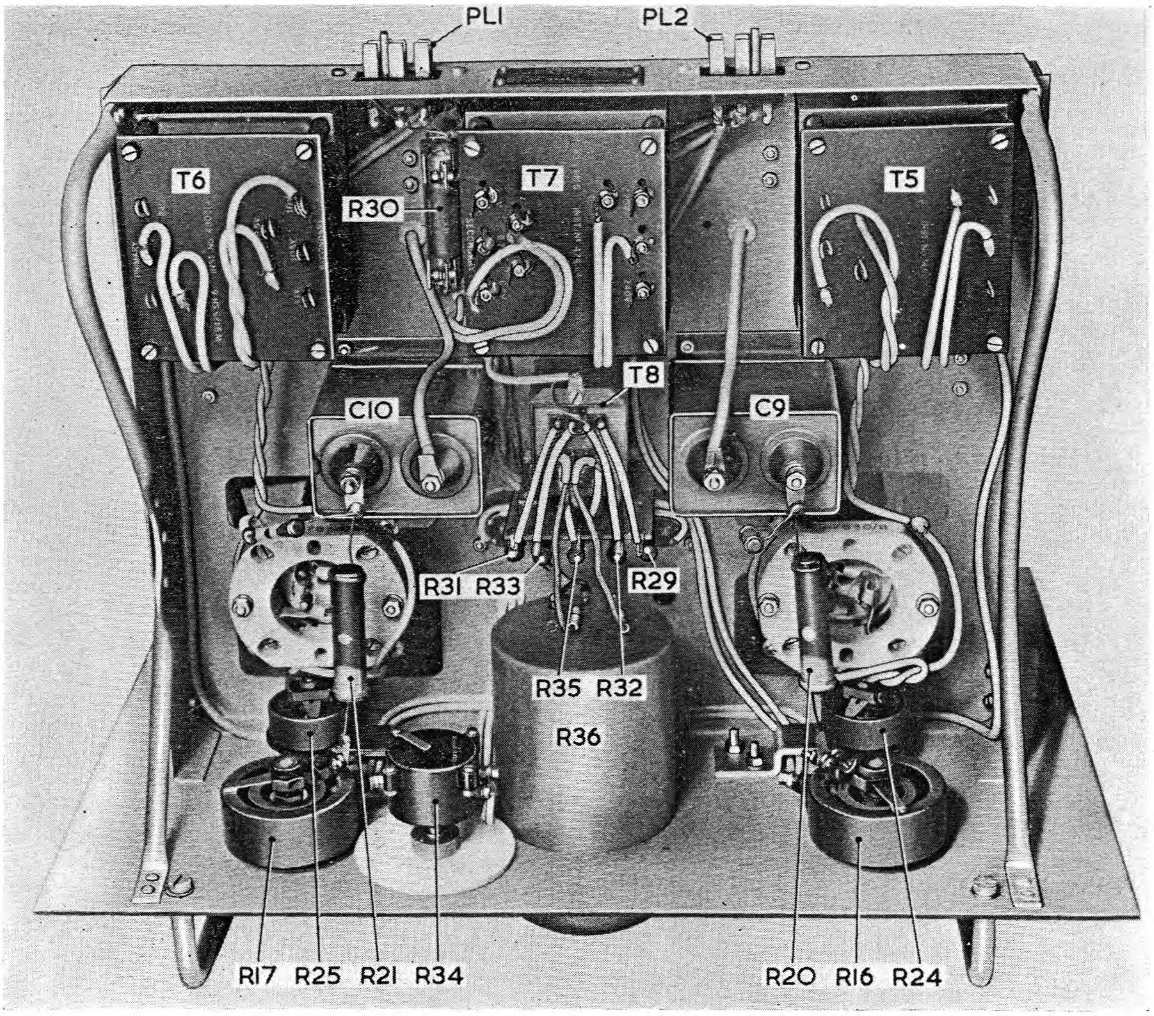


**Fig. 5. Amplifying unit—underchassis view**

**34.** The modulation transformer T2 and reactor L1 are mounted at the bottom of the unit. To obtain access to these components it is necessary to remove the panels from the front or sides (*fig.* 6). The terminal blocks TB1, TB2, TB4 and the high-voltage terminals 25 to 30 are located immediately above the cable entry. The position of the line input terminal block (TB3) below the amplifying unit can be seen in fig. 6. The preset monitoring level control resistor R1 is mounted on top of the modulation transformer.

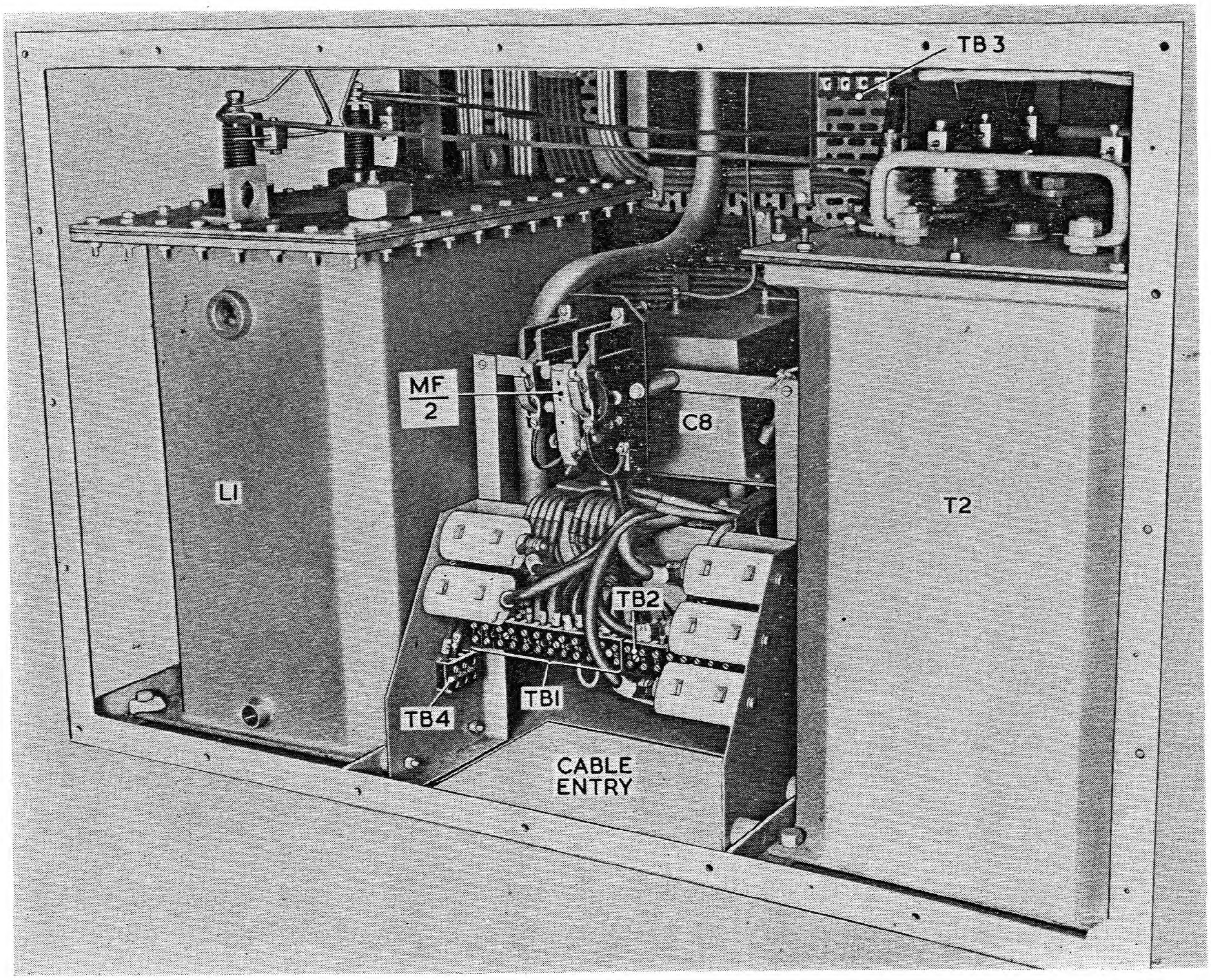


**Fig. 6. Modulator reactor and transformer**



Dmd 5386 445317 375 9/54 AB539/3 8722

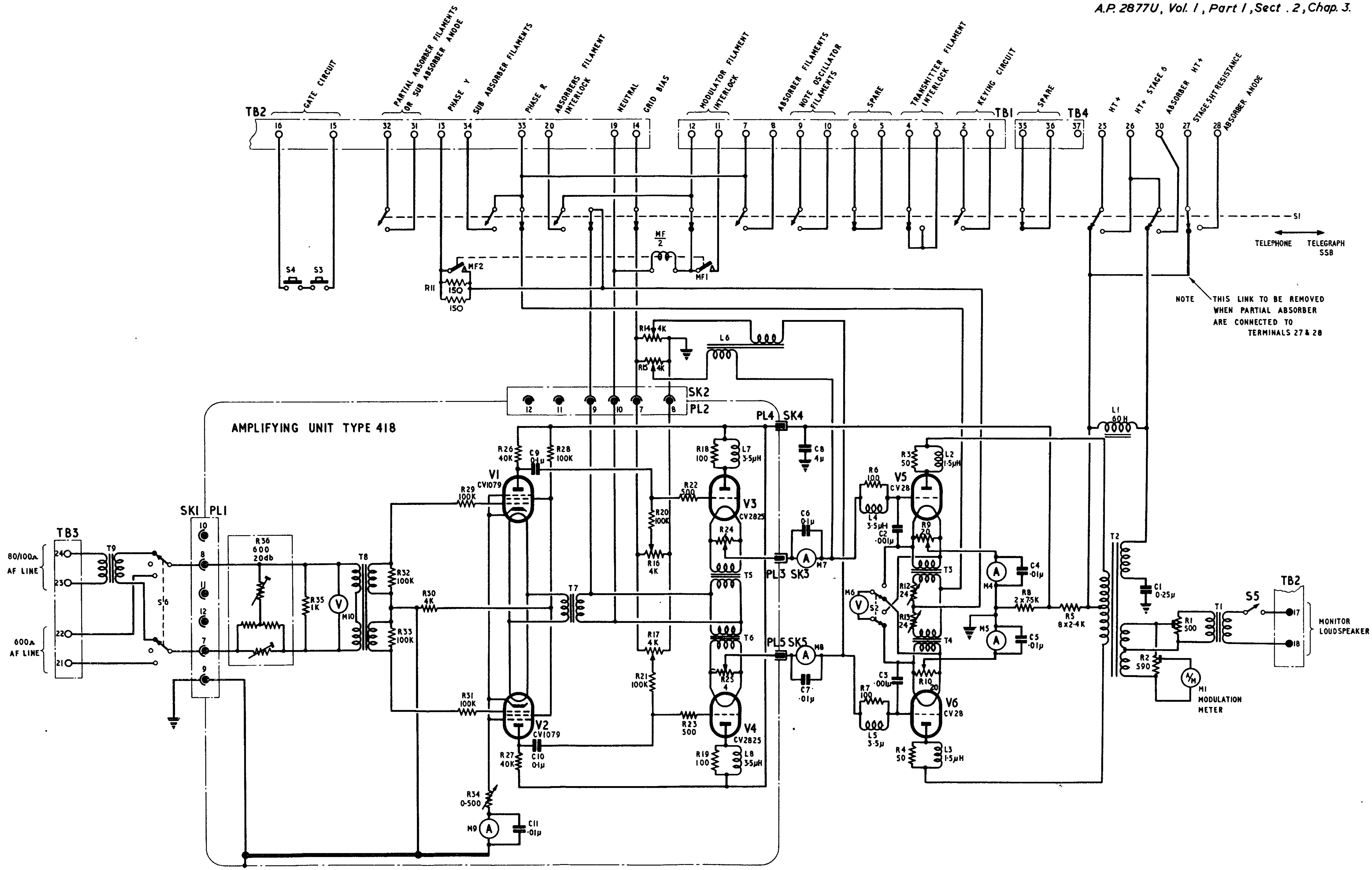


Fig. 7

Modulator unit Type 7436 - circuit

Fig. 7

(A.L. 2, June '54)

Dmd 5387 445318 250 9/54 AB 979/3 8723

# Chapter 4

# POWER UNITS TYPES 811, 812 AND RECTIFIER TYPE 62

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### POWER UNITS TYPES 811 AND 812

**General description**

**1.** Power units Type 811 and 812 supply HT, LT and GB voltages to the transmitter unit Type 89 and modulator unit type 7436. The two units are similar, with the exception that the Type 811 provides an 18V AC LT supply to the stage 5 and 6 valves in the transmitter unit (Chap. 1), and the Type 812 provides an 18 V DC supply to these valves through an external transformer and rectifier unit (rectifier Type 62).

**2.** The units operate from a 400V 50 c/s, 3-phase 4-wire input and deliver the following output voltages:—

(1) Franklin master oscillator supplies: 240V DC HT and 6·3V AC LT.

(2) Harmonic amplifier HT supply: 420V DC at a maximum current of 800mA.

(3) Various grid bias supplies for all stages.

(4) Main HT supply, variable between 5 and 6kV.

(5) Main transmitter filament supply. In the power unit Type 811, the supply is derived from an 18V filament transformer. In the Type 812 the 3-phase input supply is connected to the rectifier Type 62 to produce a DC filament supply for the stages 5 and 6 of the transmitter.

**3.** The master oscillator, harmonic amplifier and grid bias supplies are obtained from single-phase mains transformers and high-vacuum HT rectifier valves. The HT supply to the master oscillator is stabliized by a neon regulator tube. The voltage of the harmonic amplifier and negative bias supply is adjustable by a variable resistor in the primary circuit of each transformer.

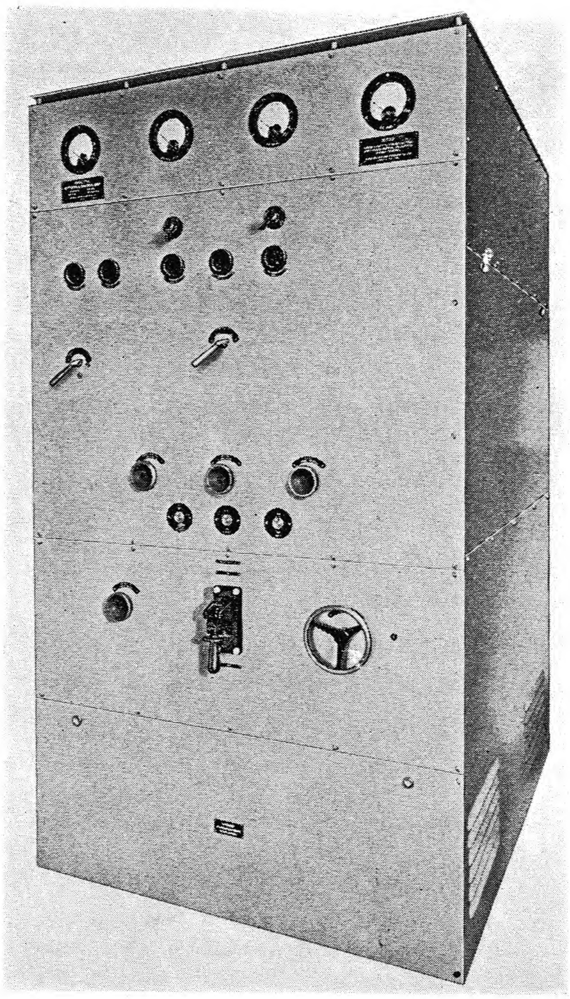


**Fig. 1. Power unit Type 812—general view**

**4.** The main HT supply is derived from a 3-phase transformer and six mercury-vapour rectifying valves. As the filament voltage of these valves must be held constant to within fairly close limits, variable resistors are provided in the primary circuit of the filament transformers; these resistors are fitted with a common control handle, RECTIFIER FILS.

**5.** The primary of the main HT transformer has four tappings which enable the HT voltage to be adjusted from mimimum to maximum in four steps; position 1 of the HT control gives minimum voltage output and position 4 gives a maximum. " Minimum " and " intermittent " contacts are fitted to the HT control, the minimum contacts ensure that the HT can be switched on only when the control is in position 1, the intermittent contacts ensure that the HT supply is momentarily switched off when switching from one tap to another.

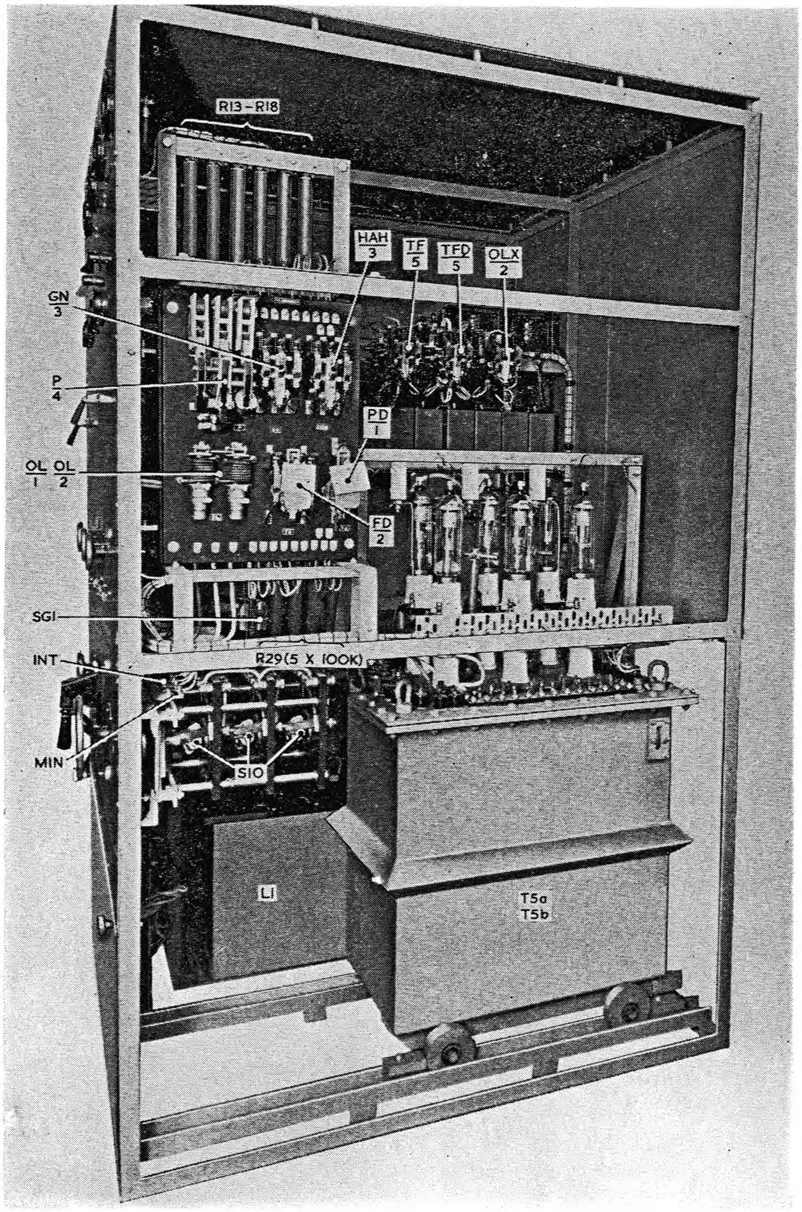



**Fig. 2. Power unit Type 812—right-hand side view**

**6.** Provision is made for adjustment of the voltage applied to the primaries of the Stage 5 and 6 filament transformer in the power unit, and the 6·3V filament transformer in the transmitter unit. The control affects simultaneous compensation of all the filament voltages in the transmitter unit, with the exception of the master oscillator, for any slow voltage variation of the AC mains supply.

**Circuit description**

**7.** The basic circuits of both types of power unit are essentially the same, the only difference being in the LT supply to the air-cooled valves in the transmitter unit. The circuit diagram of power unit Type 812 is shown in fig. 9.

**Note . . .**
*Users of this apparatus will find that early issues of the equipment and certain component schedules bear the manufacturers code of references. To reconcile this with the circuit diagram fig. 9, a Table will be found at the end of this chapter.*

**8.** The circuit is best understood by considering the sequence of events consequent upon the operation of controls when running-up the transmitter. The order of switching on supplies is :—

(1) Filaments
(2) Grid bias
(3) Harmonic amplifier HT
(4) Main HT

**9.** The controls are so interlocked that supplies can be switched on only in the sequence indicated above. Gate switches fitted to the transmitter, unit, power unit and, in telephony transmitters, the modulator unit, prevent any but the filament supplies from being switched on should any door or panel be open.

**Switching sequence**

**10.** Assume the 3-phase input supply switch S9 to be closed. Phase B is extended via the fuse FS1 to the primary of the mains transformer T.1. All supplies to the master oscillator are now available. With the main rectifier filament switch S3 in the STAND BY position the primaries of the filament transformer T5b are connected in star, and a reduced voltage is applied to the filaments of the rectifiers V11 to V16. No other supplies can be switched on with exception of those to the drive units.

**11.** When S3 is set to the FILAMENTS ON position the primaries of T5b are connected in delta; this applies the rated voltage to the filaments of the main HT rectifier valves. The 3-phase supply is extended to the external blower motor via the fuses FS12, FS13, FS14 and terminals 34, 35 and 36; filament supplies also become available as indicated in the following paragraphs.

**12.** *Harmonic amplifier HT Rectifiers* (V3 *to* V6) *and negative grid bias rectifiers* (V7, V8). The primaries of the rectifier filament transformers are connected via the fuse FS9 between phase R and neutral.

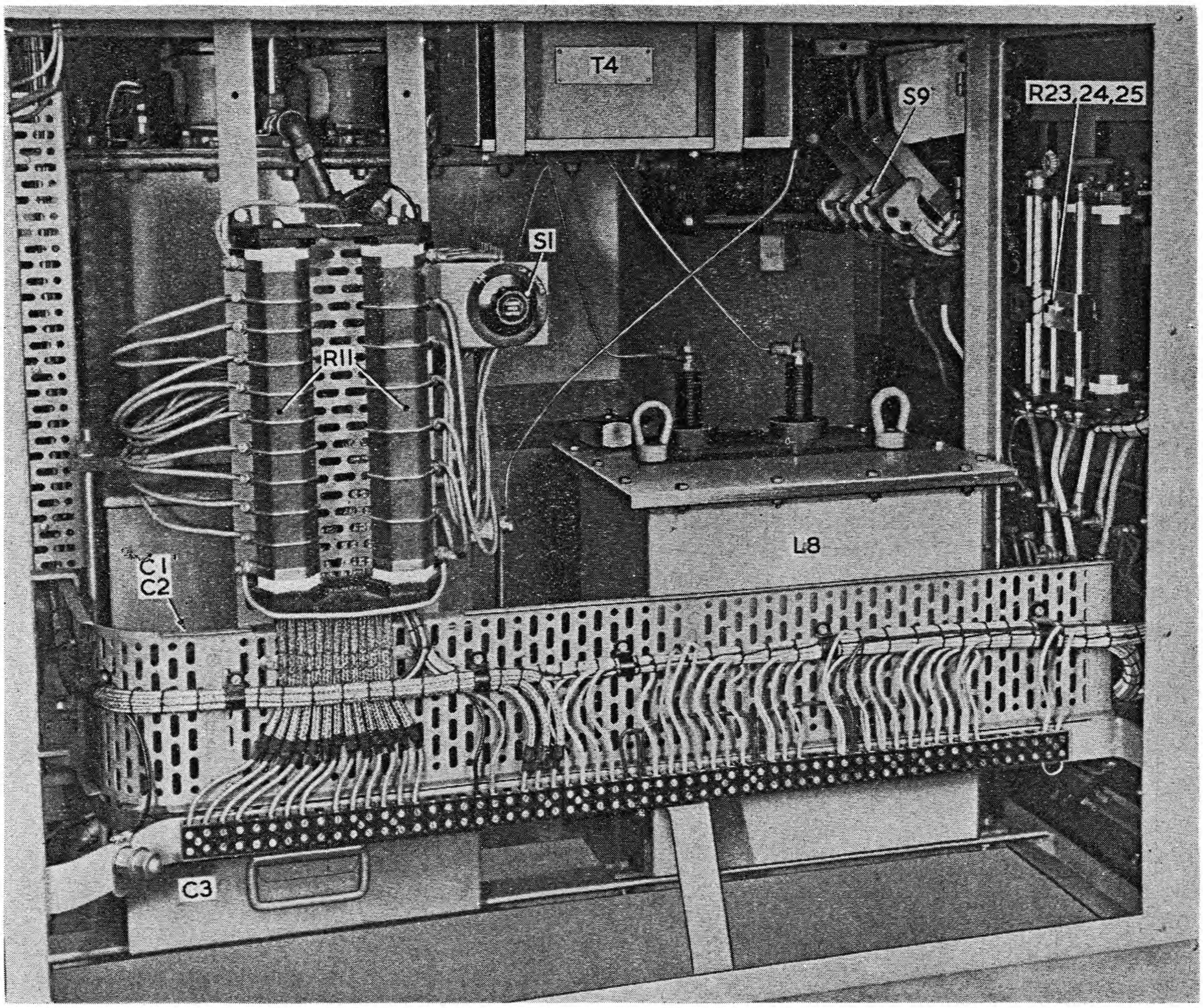



**Fig. 3. Power unit Type 812—lower left-hand side view**

**13.** *Harmonic amplifier filament supply.* Phase R is connected via the fuse FS10 and filament regulator R21, to terminal 28, The red pilot lamp FILS ON is now energised from phase R.

**14.** *Class B modulator filaments.* Phases Y and R are connected, via fuses FS16 and FS15, to terminals 32 and 33. This supply is extended to the heater and filament transformer primaries in the modulator unit Type 7436.

**15.** *SSB 3rd modulator filaments.* A circuit is prepared for supplying the primary of the filament transformer in the modulator unit Type 127. This supply is connected to terminal 31 (phase R), via FS17 and terminal 30 (neutral), and is available when the SSB/CW AND PHONE switch S1 is set to SSB

**16.** *Stage 5 and Stage 6 filaments.* Provided the filament polarity reversing links are correctly connected (parallel to each other and sloping either to the left or right) to short circuit terminals 44 and 47, the contactor TF/4 operates from phase B and neutral. Contacts TF1, TF2 and TF3 close; the 3-phase supply is now extended through the fuses FS4, FS5 and FS6, regulators R19, R20 and R21, and dropping resistors R13 to R18 to terminals 25, 26 and 27. A reduced voltage is thus applied to the input of the filament rectifier Type 62.

**17.** Contact TF4 also closes and completes a circuit for the time delay contactor FD/2. This contactor is energized from phase B via S3, fuses FS4, FS11, TF4 contact and the contact of the air pressure switch connected across terminals 48 and 49. When used with a telephony transmitter, contacts of the TELEGRAPH SSB/TELEPHONE switch on the modulator unit are connected in series with those of the air pressure switch.

**18.** After a delay of approximately 17 seconds the contacts of FD/2 close. The contact FD1 completes a circuit for contactor TFD/4, which operates. TFD1, TFD2 and TFD3 close and short-circuit the resistors in the Stage 5 and 6 filament rectifier circuit; rated voltage is now applied to the filaments of these valves.

**19.** In the power unit Type 811 an AC filament supply is required for stages 5 and 6 in the transmitter. Use is made of the same filament low voltage—full voltage time delay sequence as described in the preceding paragraphs. The final voltage appearing across the terminals 25 and 26, is taken to an additional filament transformer (not shown in fig. 9), stepped down and then taken directly to the TRANSMITTER FILS terminals.

**20.** TFD4 also closes and via terminal 50 on telegraphy, the main absorber valve filament (when an absorber unit is supplied) is raised to full voltage by the operation of absorber unit contactor AF, when AF2 closes and short circuits a fixed resistor. On telephony, MF operates and MF2 short circuits a resistor in the modulator valve filament circuits, thus raising all modulator valve filaments to full voltage. The closing of TFD4 and (on telegraphy) of AF1 or of MF1 (on telephony) energizes via terminals 51 the power delay contactor PD1, the contacts of which close 45 seconds later.

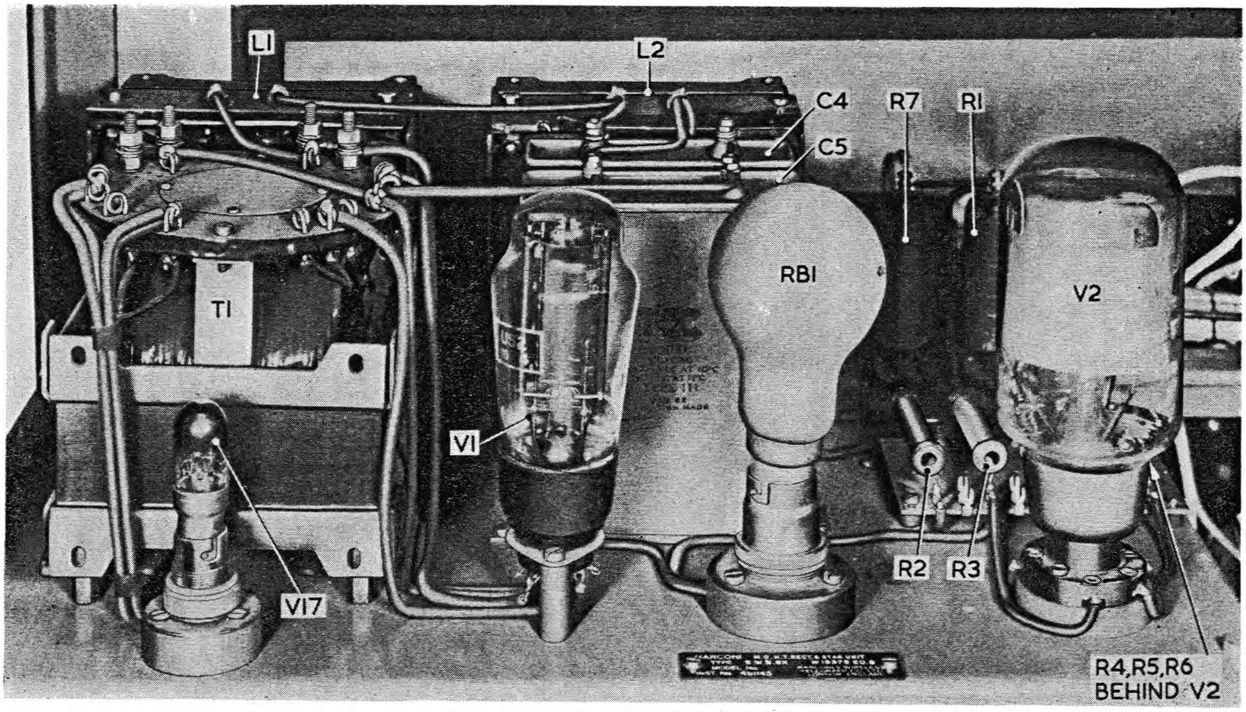



**Fig. 4. Master oscillator HT unit**

**21.** On closing the GRID NEG. switch S5, contactor GN/3 operates and switches on the bias supplies via contacts GN2. It will be seen on referring to fig. 9, that this contactor can only be energized provided all the gate switches on the remote control unit, transmitter and absorber (if supplied are closed and the isolating switch marked ' TRANSMITTER HT + VE ' is at TRANSMITTER.

**22.** On closing the HAHT switch S6, contactor HAH/3 is energized via contacts GN3 and the minimum contacts on the main HT control to which reference has already been made. These contacts are only closed when the main HT control is in position 1 (that is, when the HT volts are at minimum). Contact HAH1 switches on the HAHT and contact HAH3 short-circuits the minimum contacts.

**23.** When the main HT switch S7 is closed, the main power contactor P/4 is energized via contacts HAH2, PD1, intermittent contacts and contact OLX2. Contacts P1, P2 and P3 then close and switch on the main HT. The intermittent contacts associated with the main HT control are momentarily broken when the latter is moved from one position to another, thus switching off HT.

**24.** On an overload, the excessive current through coils OL1/1 and OL2/1 (in the power transfer primary circuit) causes contacts OL1·1 andOL2·1 to close and operate relay OLX/2. OLX2 opens and switches off HT by de-energizing contactor P/4. OLX1 is a hold-on contact and the overload is reset by momentarily opening the main HT switch.

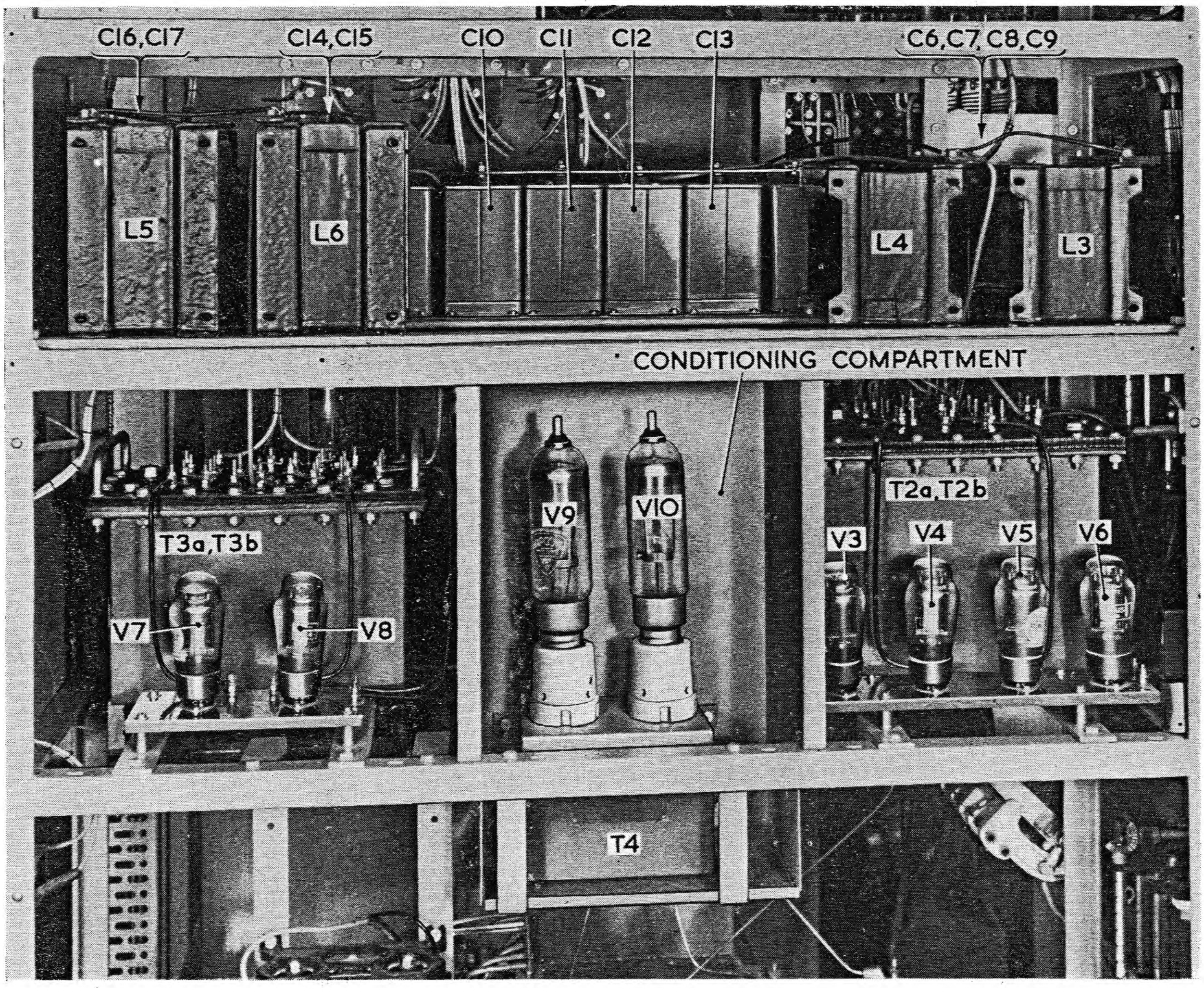



Fig. 5. Harmonic amplifier and grid bias supplies

**25.** On top of the HT transformer are three links (one for each phase) constituting adjustable tappings for the primary windings. The lowest value of HT is obtained when these links are connected across the left-hand pair of the four terminals in each phase, that is, the terminals numbered 4 and 3, an intermediate value with the links across terminals 3 and 5, and the highest voltage when terminals 5 and 2 are linked.

**26.** By putting the isolating switch (marked ' TRANSMITTER HT + VE ') to EARTH, all HT and

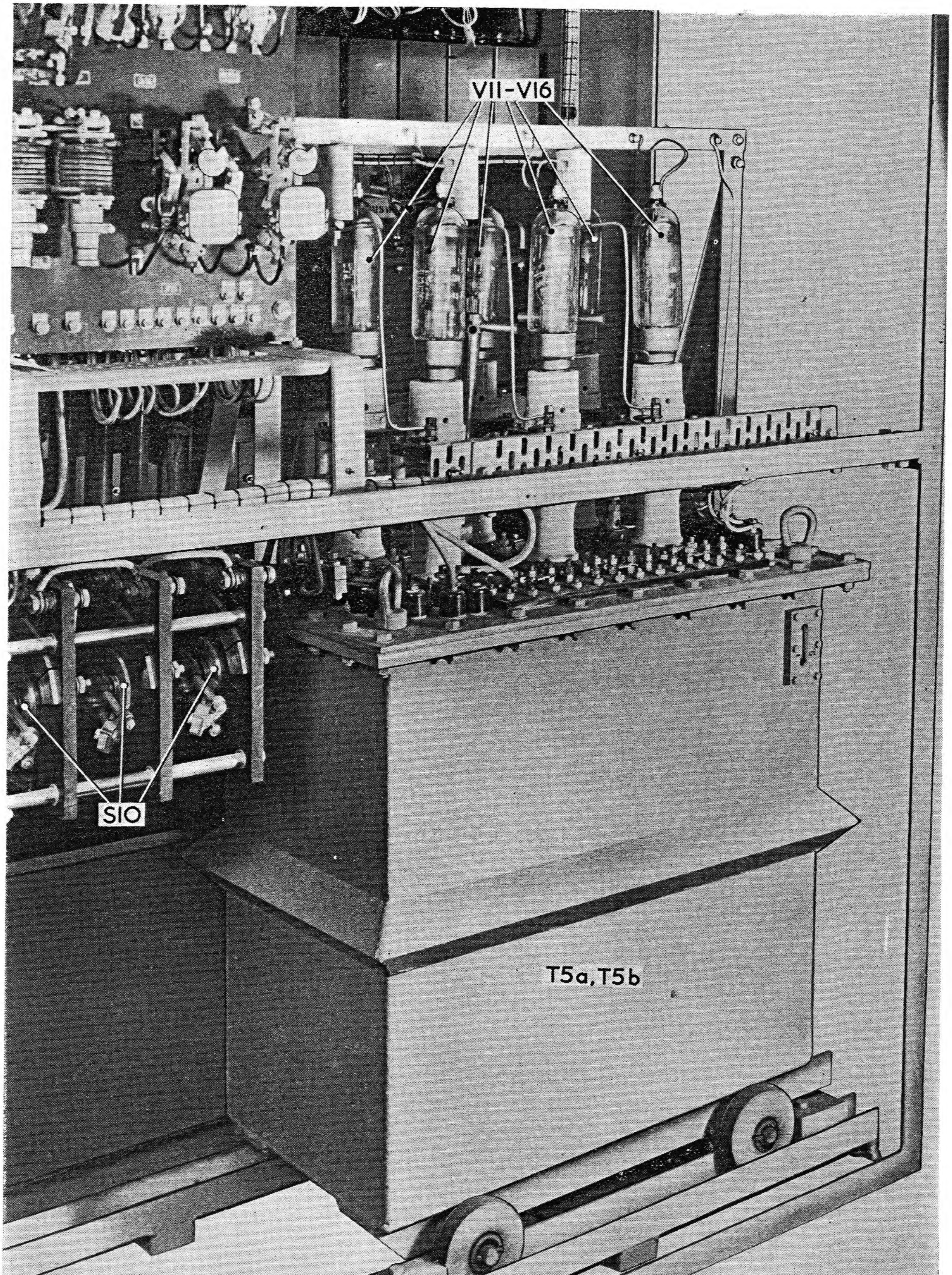



Fig. 6. Main HT transformer and rectifiers

grid negative supplies are removed from the transmitter, and the main HT terminal is earthed (normally the HT supplies should be switched off by their individual switches before turning the isolating switch to EARTH). On turning this switch back to TRANSMITTER the grid negative supplies will be automatically restored, but the main and auxiliary HT supplies can only be restored by turning the main HT control switch to minimum.

**27.** If it is desired to close down the transmitter temporarily, it is sufficient to turn the filament switch from FILAMENT ON to STAND BY. This will ensure that the transmitter may be restarted with a minimum delay as the CV.1435 rectifier valves are kept " conditioned ".

**28.** To restart the transmitter after it has been in the STAND BY position, the main HT control must first be brought to the minimum position (that is, tap 1). If the filament switch is then turned to the FILAMENT ON position, the transmitter will start up automatically and the main power may then be increased as required.

**29.** After the transmitter has been run up to normal working conditions, the main HT may be switched on or off with the main HT control switch in any position, but if the grid negative or the HAHT has been switched off, the main HT control switch must first be set at minimum before the HAHT supply can be switched on again.

#### Constructional details

### WARNING

***The whole installation is shut down by opening the AC supply switch S9 in the centre of the bottom front panel, but the control unit is not then dead since the contacts of the power switch are still live. To remove all supplies from the panel, the external isolator switch must be opened.***

**30.** The power units Type 811 and 812 each weigh 21 cwt. and measure 6 ft, 6 ins. high by 3ft. 6 ins. wide by 4 ft. 0 ins. deep.

**31.** Access to the interior of the unit is obtained by removing covers on the bottom front and sides. On the left-hand side there are three small removable covers in a row. The two outside covers give access to the GN and HAHT rectifier valves respectively (the latter being nearer the front panel), the centre cover is in front of the conditioning unit, where two spare CV1435 valves may be conditioned (*fig.* 5). The larger removable cover below gives access to the GB potentiometer, a CW/SSB switch and various other components of the circuit (*fig.* 3). The top cover gives access to the FMO supply unit (*fig.* 4).

**32.** The fuse-board and polarity-reversing links are mounted behind the cover at the foot of the front panel. On the right-hand side of the unit a single large cover is removed for the purpose of fitting the six working CV 1435 valves on top of the transformer, and for obtaining access to the contactor panel (*fig.* 6).

**33.** All the covers have gate switches associated with them, with the exception of that in front of the conditioning unit. Valves can therefore be inserted or removed from this unit without interrupting transmission.

#### Conditioning mercury vapour rectifying valves

**34.** Reference has been made above to the conditioning of the CV 1435 valves. In the case of these and all mercury vapour rectifying valves HT must not be applied to the valves until a specified time after the filament current has been switched on, and the action of conditioning consists of heating the filaments for the necessary time before HT can be switched on.

**35.** The time during which conditioning must be carried on depends on the ambient temperature, see para. 37 to 40 for full details. The following salient points may be emphasized here.

(1) New valves, or valves which are put into service after any transportation, must be conditioned for 30 minutes.

(2) When valves are already in service and it is merely a question of starting up the transmitter again after it has been closed down for some hours a conditioning of one minute is sufficient provided the ambient temperature is not less than 20 deg.

(3) This conditioning time is provided automatically by the time delay contactors FD/2 and PD/1.

(4) For conditioning purposes, it is not necessary to apply the full filament current to the valves, and the six working valves may be conditioned with the filament switch at STAND BY.

(5) Valves placed in the conditioning unit are arranged to be conditioned with about $\frac{3}{4}$ of the full normal current.

**36.** Two valves should always be kept in the conditioning unit and the tumbler switch on the right-hand side of the base closed, so that these two spares are always kept conditioned when the transmitter is in operation and any faulty valve can thus be replaced with the minimum of delay.

#### Detailed conditioning data for valves Type CV1435 (GU20)

**37.** Assuming still air conditions, the maximum permitted ambient temperature is 35 deg. C. When it is necessary to work above this temperature the valve must be cooled by a stream of air of a temperature of not less than 20 deg. C directed towards the bottom end of the bulb.

**38.** Adequate time delay must be allowed between the application of the cathode and anode voltages. Failure to observe this delay will result in poor performance and reduced life.

**39.** The time delay varies with the ambient temperature and the minimum time delay for various ambient temperatures is as follows:—

| Ambient Temperature (degrees centigrade) | Minimum delay when valve has been unused for more than 20 minutes | When the valve has been running for over 30 minutes and is switched off, the delay may be one minute provided the off period has not exceeded that shown below |
|---|---|---|
| *Not less than* | | |
| 20 deg. C | 1 minute | See note |
| 18 ,, | 2 minutes | 20 minutes |
| 16 ,, | 4 minutes | 20 minutes |
| 14 ,, | 6 minutes | 20 minutes |
| 12 ,, | 7 minutes | 15 minutes |
| 10 ,, | 8 minutes | 15 minutes |
| 8 ,, | 9 minutes | 10 minutes |
| 6 ,, | 10 minutes | 10 minutes |

**Note . . .**
*Provided the ambient temperature is over 20 deg.C the delay is one minute and is independent of the time time the valve cathodes have been switched off.*

**40.** The table in para. 39 is required only when starting time is of importance or where ambient temperatures are under 10 deg.C; in other cases the following simplified procedure can be followed:

(1) When the valves have been off for over 15 minutes, allow a delay of at least 8 minutes.

(2) When the valves have been off for less than 15 minutes, allow a delay of at least 1 minute.

(3) After transit or storage the delay must exceed 30 minutes.

## RECTIFIER TYPE 62

### General description

**41.** Rectifier Type 62 (*fig.* 7) is an oil-immersed transformer and metal rectifier. The unit operates from a 380 to 415V 50 c/s 3-phase input supply, and delivers a maximum output of 18 to 24V at 120 amps.

**42.** Input and output leads are connected to a termination panel (*inset fig.* 8) at the top of the rectifier. The panel is protected by a cover which may be detached after removing four screws.

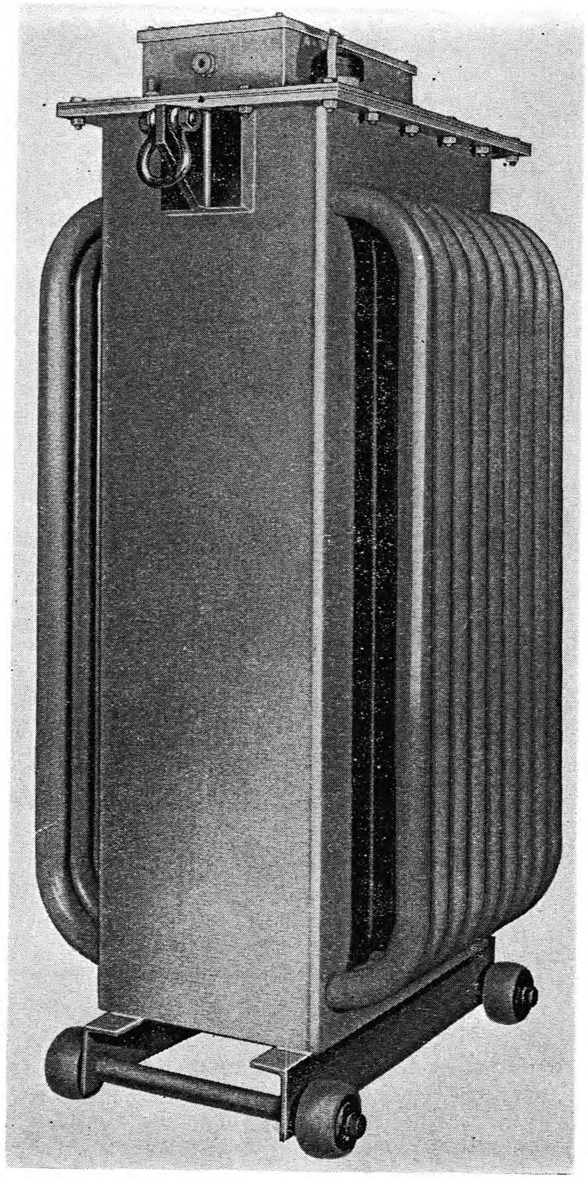


**Fig. 7. Rectifier Type 62—general view**

**43.** The circuit of the rectifier Type 62 is shown in fig. 8. The 3-phase input supply may be connected to the transformer primary via the row of terminals designated P4, or those designated P5 and P6, depending on the input voltage and the output voltage required. The output voltage is a maximum when the input supply is connected to the terminals P4.

**44.** The four rows of terminals designated P0 to P3 constitute alternative positions for the star point on the primary. Any one of these terminals is connected by a strap as shown in the panel layout in fig. 8 The output voltage is a maximum when the row P3 is strapped, and a minimum when P0 is strapped. These taps give a coarser adjustment of output voltage than the mains input taps.

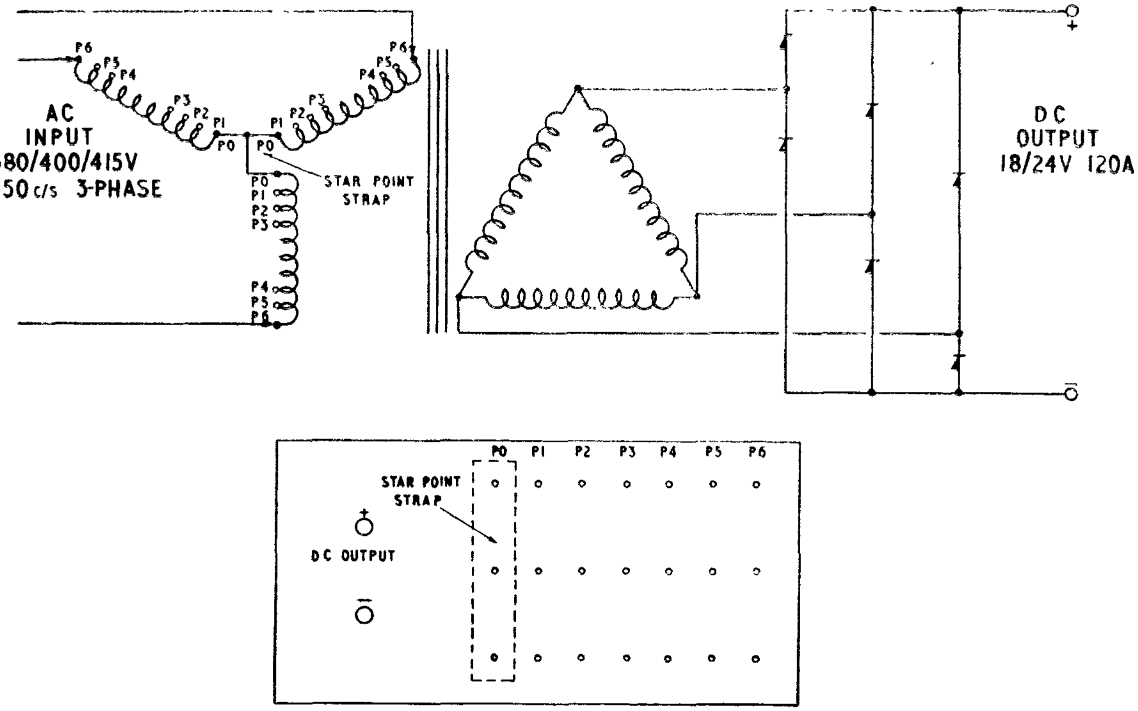
**45.** The connections to the primary input taps and the position of the star point strap for increasing output voltages is shown in the table in fig. 8.

**46.** The AC voltage across the delta-wound secondary is applied to a 3-phase full-wave metal rectifier. The DC output of the rectifier is connected to terminals marked + and — on the termination panel.

**47.** The load imposed on the rectifier by the stage 5 and 6 valves in the transmitter unit is 19V at 70A.

### Constructional details

**48.** The rectifier Type 62 measures 5 ft. 4¾ ins. high by 2 ft. 8⅝ ins. wide by 2 ft. 3⅝ ins. deep and weighs 13¼ cwt. It is filled with oil Type OM16 (Stores Ref. 34D/102).




| INCREASE OUTPUT → | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STAR PT | P0 | P0 | P0 | P1 | P1 | P1 | P2 | P2 | P2 | P3 | P3 | P3 |
| INPUT TAPS | P6 | P5 | P4 | P6 | P5 | P4 | P6 | P5 | P4 | P6 | P5 | P4 |

**Fig. 8. Rectifier Type 62—Circuit**

## TABLE I

**Reconciliation of component references between fig. 9 and manufacturer's drawing**

| Circuit ref. fig. 9 | Description | Type | Circuit Ref. Manufacturers drawing WZ.3277/B |
|---|---|---|---|
| | **CAPACITORS** | | |
| C1 to 3 | 2μF ±10% 600V DC. Wkg. | 5036 | C1 |
| C4 | 4μF ±15% 750V DC. Wkg. | 1009 | C4 |
| C5 | 6μF ±10% 750V DC. Wkg. | 2080 | C5 |
| C6 to C13 | 8μF ±15% 1200V DC. Wkg. | 5035 | C3 |
| C14 to C18 | 8μF ±15% 1200V DC. Wkg. | 5035 | C2 |
| | **RESISTORS** | | |
| R1 | 15,000 ohms ±5%, 10W | 7503 | R11 |
| R2 | 500 ohms ±5% 4·5 W | — | R13 |
| R3 | 250 ohms ±5% 4·5 W | — | R12 |
| R4 | 220,000 ohms ±10% ¾ W | — | R14 |
| R5 | ,, | — | R14 |
| R6 | ,, | — | R14 |

TABLE I (*Contd.*)

| Circuit ref. fig. 9 | Description | Type | Circuit Ref. Manufacturers drawing WZ.3277/B |
|---|---|---|---|
| R7 | 50,000 ohms ±5% 10 W | 1415 | R10 |
| R8 | 100,000 ohms ±5% 100 W | — | R6 |
| R9 | 1210 ohms total, wire wound, variable | 4933 | R4 |
| R10 | M4 internal resistor | — | — |
| R11 | 1270 ohms, 14 tappings, variable | 9518 | R5 |
| R12 | 33 ohms, wire wound, variable | 4935 | R3 |
| R13 to R18 | 100 ohms ±5% 100 W | — | R16 |
| R19 to R21 | 12 ohms, wire wound, variable | 10334 | R17 |
| R22 | M3 internal resistor | — | — |
| R23 to R25 | 267 ohms, wire wound, variable | 4932 | R1 |
| R26 to R28 | 0·32 ohms wire wound | 4950 | R9 |
| R29 | 100,000 ohms ±5%, 100 W | — | R8 |
| | **INDUCTORS** | | |
| L1 and L2 | 17 Henries | 982 | L.4 |
| L3 and L4 | 4·0 Henries | 981 | L.3 |
| L5 and L6 | 14 Henries | | |
| | **TRANSFORMERS** | | |
| T1 | 575-0-575 : 3·2-0-3·2 : 2·5-0-2·5 V | 3266 | T9 |
| T2a | 5 V | 103 | T7 |
| T2b | 1200-0-1200 V | 103 | T6 |
| T3a | 2·5-0-2·5 V | 1864 | T1 |
| T3b | 600-0-600 V | 1864 | T2 |
| T4 | 3 V | 1897 | T8 |
| T5a | 3-phase star 2500—4800 V between lines | 225 | T4 |
| T5b | Six secondaries 4·15 V | 225 | T5 |
| | **SWITCHES** | | |
| S1 | CW—SSB: 12 poles, 6 make, 6 break | 2216 | S14 |
| S2 | HAHT—GRID NEG. d/p, 9 way, 10 posn. rotary | | S8 |
| S3 | FILAMENT ON/STAND BY: 3 pole changeover 400V. ISA | 1543 | S2 |
| S4 | HT EARTHING: Isolator s/p changeover with auxiliary contacts | 1452 | S9 |
| S5 | GRID NEG: s/p, 250V, I5A | 1545 | S6 |
| S6 | HAHT: s/p, 250V, I5A | 1545 | S5 |
| S7 | HT: s/p 250V, I5A | 1545 | S4 |
| S8 | AC supply voltmeter, d/p, 9 way 10 posn., rotary | 494 | S11 |
| S9 | Supply ON/OFF: 3 pole 480V, 250A | 1444 | S3 |
| S10 | HT transformer min/max inductor switch 3 pole 4 way | 1634 | S.12 and S.13 |

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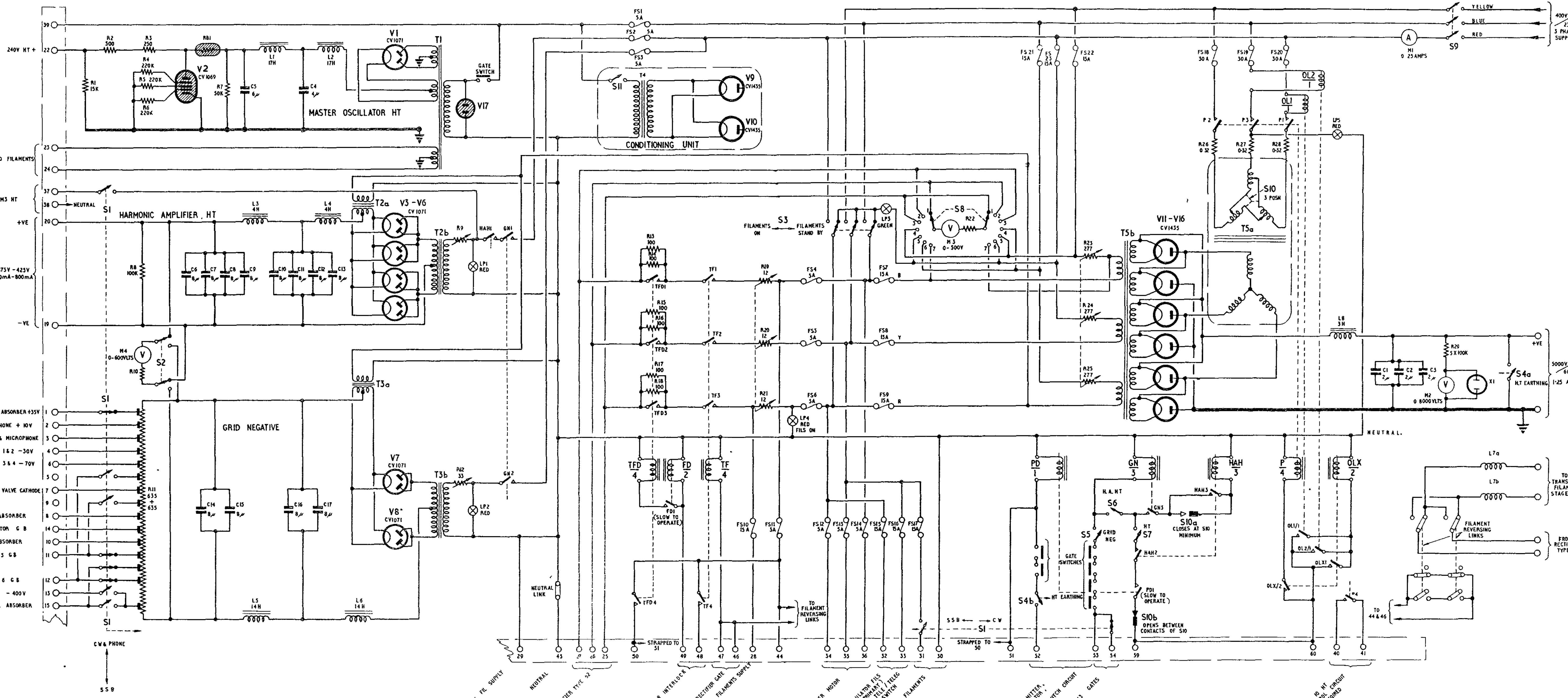


(A.L.6, Aug. 55)

Fig. 9 Power unit Type 812 — circuit Fig. 9

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# PART 2

# SERVICING

# Chapter 1

## PROCEDURE


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### Materials

**1.** The following materials will be required while servicing:—

(1) Cleaners, vacuum; 220–230V (4G/2375), 240–250V (4G/2377) or blowers, air, portable (5A/1902).

(2) Watches, stop, G.S. (6B/539).

(3) Carbon tetrachloride (33C/1030).

(4) Protective PX6 (mineral jelly 34D/262).

(5) Oil, lubricating, light (34B/252).

(6) Oil, lubricating, medium (34B/87).

### General inspection

*WARNING . . . Always switch the main supply isolators OFF before making an inspection. One side of the supply switches on the various units may otherwise be "live".*

**2.** Switch off all supplies, open the doors and check that all nuts, bolts and screws are tight. Check also that all insulators are clean and that the units are free from dust. A portable electric blower or a vacuum cleaner should be used to remove the dust, while a soft rag is used to clean the insulators. Examine all cabling for signs of deterioration and replace where necessary. Check the condition and zeroing of all meters on the various units.

**Note . . .**
*Where instructions are given to use carbon tetrachloride as a cleaning agent, bear in mind that it is most important to remove all traces of both the fluid and its deposit.*

**3.** While making this inspection, particular attention should be paid to signs indicating the presence of vermin, *i.e.*, damage by gnawing, or droppings. When the inspection is completed, the equipment is to be switched on and operationally checked according to the instructions given in Part 1, Sect. 1, Chap. 3 and 4.

### Power unit

**4.** When the general inspection has been completed, a detailed inspection of the power unit is to be made according to the information contained in the following paragraphs. Great care should be taken during these operations because it is necessary to check certain items of the equipment with the power supplies switched on.

**5.** Set the main isolator to OFF, and then:—

(1) Examine the supply fuseholders for signs of overheating, i.e., discoloration or pitting. (Where either the carrier or holder is unsatisfactory, change the complete assembly).

(2) Check that the contacts on each of the gate switches are clean. If not, clean them with carbon tetrachloride.

(3) Examine the rheostat guides and drive mechanisms, if necessary clean with carbon tetrachloride and re-grease with mineral jelly.

(4) Clean the blades and contacts of the MAIN and TRANSMITTER HT + VE and FILAMENTS switches with carbon tetrachloride. After cleaning, smear lightly with mineral jelly. Lubricate the switch bearings and mechanisms with light oil.

(5) Ensure that the oil levels in the HT transformer and the choke are visible in the level indicators. As such indicators are not provided on the HAHT and GB transformers, the levels on these latter items should be measured with a clean dry piece of wood and should be within ½ in. from the transformer top casings. See para. 23 before topping up with transformer oil.

(6) On the contactor panel on the right hand side of the unit, check that there is no sign of oil leaking from the dashpots and that the condition of the contacts of the main relays is satisfactory. The method to be followed for dismantling and cleaning the main relays will be found in appendix F of the Vol. 5.

(7) Clean and lubricate the HT regulating control as follows:—

(a) Clean the contacts and studs with carbon tetrachloride and then smear them lightly with mineral jelly. Replace any studs which are badly pitted.

(b) Repeat this procedure with the auxiliary contacts.

(c) Check the operation of the auxiliary contacts as the regulator is turned.

(d) Lubricate the regulator rod bearings with a few drops of light oil.

(e) Check that contact 4 is made and "4" appears in the aperture on the front panel when the HT control is turned fully clockwise and that contact 1 is made and "1" appears when the control is turned fully counter-clockwise. Replace all panels except the one which normally covers the contactor panel.

**Warning**
*The rectifiers, exposed when this panel is not in position, carry + 5KV and the contactors carry the AC supply potential.*

**6.** Switch on the power unit and at the same time check the timing of delayed action relays by using the following procedure:—

(1) Set the supply isolator and MAIN switch to ON.

(2) HT + VE switch to TRANSMITTER.

(3) At the same time as the FILAMENTS/STANDBY switch is set to FILAMENTS, start a stopwatch. After 17 secs., relay TFD/4 should operate to bring the transmitter filaments up to full power; PD/1 should operate 28 secs. later to allow the HT supplies to be switched on.

(4) Set the GRID NEG switch to ON and check the operation of the gate switches. The relay GN/3 should open each time the gate switch circuit is broken.

(5) Close the HAHT and HT switches, allow the power unit to warm up and then check that the readings of the meters mounted on the power unit agree with those given in the Test Report.

(6) Watch each of the mercury vapour rectifiers in turn and make sure that the blue glow, which is normally present in such valves, does not flicker.

**Transmitting unit**

**7.** The following parts should be cleaned with carbon tetrachloride and then lubricated with a thin film of mineral jelly:—

(1) Wiper arm of the STAGE 5 ANODE RES. switch.

(2) Blades of the STAGE 6 GRID BIAS switch and the output circuit SERIES/PARALLEL switch.

(3) All meter switches.

**8.** Lubricate sparingly with a light oil the following items:—

(1) Stages 1 to 3. Moving vane bearings, ball and socket bearings and pivots.

(2) Stages 5 and 6. Moving vane bearings, link assembly pins and the worm drives for the Stage 5 and 6 condensers and the Stage 5 balancing condenser.

(3) Coupling coil. Worm drive and linkage.

(4) Bearings of the STAGE 5 ANODE RES switch.

(5) Pivot screws and pins of the STAGE 6 GRID BIAS switch.

(6) Hinge pins of the SERIES/PARALLEL switches in the output circuit.

(7) Rollers on the relay drawer and all gate hinges.

***Fitting the ACT 9 valves***

**9.** The method used to fit each of these valves in Stage 6 of the transmitter is as follows:—

(1) Fit the thermometers to the anode bus-bars.

(2) Unscrew the setscrews to bring the anode caps to their highest positions.

(3) Remove the four hexagon headed screws from their storage position on the brackets on each side of the valve seating.

(4) Attach the filament leads from the filament bus-bar terminals to the filament pins on the valves.

(5) Disconnect the air tubes, open the hinged blower ring and carefully slide the valve on to its seating until the flexible anode connecting strips are in position against the brackets.

(6) Using moderate pressure only, screw down the anode cap until it bears evenly on the anode cooling fins.

(7) Secure the anode connecting strips with the hexagon-headed screws removed in (4), close the hinged blower ring and re-couple the air tubes. Make sure that the air tube into the filament well is coupled into one of the side holes and not into the central hole.

(8) Couple the "U" shaped metal strip to the base of the valve by the fly-nuts provided. (This action connects the valve grid into to the transmitter circuit). Ensure that these connections do not impose any side strain on the grid.

**10.** Similar instructions apply to the Stage 5 valve except that in this case the valve is inverted and rests on three ceramic insulators in the base of the compartment. It is secured only by the flexible anode coupling strips. After mounting this valve, the thermometer should be swung in so that it rests against the anode cooling fins.

***Air pressure***

**11.** The air pressure applied to each valve should be checked periodically (with the power unit providing filament supplies to the transmitter,) and should be as follows:—

(1) *Filament wells.* 2 inches water gauge, giving a flow of 0·7 cubic feet per minute.

(2) *Anode rings.* 2 inches water gauge, giving a flow of 5 cubic feet per minute.

**12.** These pressures will only be obtained when a pressure of 5·5 inches water gauge is maintained in the air intake. If this pressure should drop to 2 inches water gauge, the pressure switch in the intake should operate to switch off the HT supplies from the power unit.

**13.** The method used to take these measurements is as follows:—

(1) Insert a "T" piece in the line to be checked.

(2) Connect a line from the "T" piece to a "U" tube half filled with water, one half of which is open to the atmosphere. (Any bore glass tubing may be utilised).

(3) Measure the difference between the water levels in the two arms of the "U" tube to obtain the water gauge pressure in inches.

**Note . . .**
*Normal conditions must prevail while these readings are being taken, i.e., air must be flowing from the outlet being tested, and all other outlets.*

*Carpenter relays*

**14.** The Carpenter keying relays are located in the keying drawer on the left hand side of the transmitting unit. Although these items are only used for telegraphy they should not be neglected. and should be periodically cleaned as follows:—

(1) Remove the relay cover.

(2) Set the bias magnet to the vertical.

(3) Remove all particles of dust with an air jet; a piece of non fluffy paper or a hair brush should be used if the former is not available.

(4) Carefully remove any particles of metallic materials from the air gaps in the magnetic circuit. (The presence of such particles is a common cause of erratic operation).

(5) Pass a feeler gauge of ·002 to ·003 in. between the springs carrying the side contacts and the friction screws on which their ends rest, holding the feeler parallel with the rubbing surface of the spring.

(6) Burnish the contacts (if necessary) by passing a ·003 in. gauge between them.

**15.** Where relay testing apparatus is not available, the relay may be adjusted as follows:—

(1) Repeat (1) and (2) of para. 14.

(2) Slowly screw back both side contacts, at the same time moving the armature from side-to-side (contact to contact) until the positions are reached where the magnetic circuit will hold the armature against either contact.

(3) Slowly advance each contact in turn, moving the armature from side to side, making sure that it will still hold on either contact, until the gap has been shortened to the point at which a faint click can just be heard at each throw when the relay is held close to the ear.

(4) Check that the contacts are so positioned that the armature comes to rest with equal force on either of them.

(5) Replace the relay cover and check the adjustment by moving the arm of the biasing magnet. If correctly set, the armature will throw when the bias magnet lever is about half way between the central and extreme positions on either side.

**16.** A check can be made on the bias magnet setting by means of a Wheatstone automatic high speed sender. Switch on the transmitting unit and note the anode current of Stage 6 with the switch on the keying unit set to MARK. Remove the tape from the Wheatstone sender and run this unit on "revs". The Stage 2 anode current should now be half that on MARK. If the reading is high, the bias is towards MARK and if it is low, it is towards SPACE, assuming that the Wheatstone sender has been correctly adjusted.

*Franklin master oscillator (M.O.)*

**17.** Servicing the master oscillator is not a first or second line operation, the matter included in this chapter is therefore provided for information purposes only. Faults in the master oscillator can be classified under the following headings:—

(1) Non-oscillation.

(2) Frequency instability or intermittant oscillation.

**18.** Where either fault occurs the procedure adopted should be as follows:—

(1) Check the master oscillator supplies at its terminals.

(2) Set the appropriate FEED METER switch to MO and check the current taken by the master oscillator. The two valves in this circuit should together take 28 to 36 mA when oscillating, and 56mA when not oscillating.

(3) If the current is 56mA, one or both valves require changing.

**Note . . .**
*Valve changes will affect the calibration of the master oscillator. These valves should not be changed, therefore, unless facilities are available for recalibrating the master oscillator.*

**19.** If unsatisfactory results are still obtained, remove the master oscillator from the transmitting unit using the following procedure:—

(1) Remove the side screen from the harmonic amplifier unit and remove the two horizontal perforated shelves which screen Stages 1 and 2.

(2) Disconnect the two socket connections which carry the output leads from the master oscillator and Stage 1.

(3) Withdraw the Stage 1 assembly from its mounting as in para. 22.

(4) Disconnect the master oscillator filament leads. These leads are flexible and should be handled from the front of the panel.

(5) Disconnect the HT supply lead from the front of the unit.

(6) Disconnect the two braided flexible earth leads by removing the nuts from the screw mounted on the master oscillator cradle. These leads are on either side of the master oscillator and should be handled from the side of the unit.

(7) Disconnect the socket carrying the lead from the FM condenser to the diode control valve.

(8) The unit can now be slid forward and removed.

**Note . . .**
*Do not dismantle the tuned circuit of the master oscillator.*

**20.** When the unit is removed for inspection, carry out the usual checks for faulty components, paying particular attention to the lamp shown as R31 on fig. 13 of Part 1, Sect. 2, Chap. 1. Check that the flexible connecting wires (which connect the valve circuits to the tuned circuit in the inner case) are properly soldered to their respective brass contact pins.

**21.** In damp locations, excessive moisture may cause the oscillator to fail. In this case thoroughly dry out the unit in the hot sun or, under careful supervision, in a slow oven.

*Harmonic amplifier sub-assemblies*

**22.** Each of the harmonic amplifier stage chassis may be removed for repair or inspection in the following manner:—

(1) Remove the transmitting-unit lower right hand side screen and open the bottom back gates.

(2) Remove the valve and plug-in coils.

(3) Unscrew the three bolts on the extension screen and then remove the screen.

(4) Disconnect the HT and screen-grid connections.

(5) Disconnect the filament leads, RF input and output spring sockets (in Stage 4 the two RF output leads are taken to terminals).

(6) Remove the six bolts which hold the chassis to the angle members of the transmitting unit.

(7) Withdraw the chassis through the right hand side of the frame.

*Transformer oil*

**23.** Only use oil from sealed containers. If such oil is not available, carefully check the cleanliness of the oil supplied before attempting to use it. The following is the procedure for making such a check:—

(1) Pour a sample into a warmed, clean, dry test tube.

(2) Hold the tube up to the light, and check that it is clear and clean.

(3) Heat the oil to about 200 deg. C.; crackling sounds will be heard if the oil has been contaminated by water.

(4) Pour a little of the oil on to a clean sheet of paper; gently spread the oil with the finger tips and feel for traces of solid matter.

(5) Discard the oil used in the tests.

**24.** Oil which passes these tests in a satisfactory manner may be used for the transformers. It should be borne in mind however that great care must be taken to avoid contamination by dust or by the use of dirty containers or funnels during all processes associated with filling the transformers.

**Modulator Type 127**

**25.** As the supplies for the modulator 127 are provided from the power unit, ensure that this power unit is switched off and the main isolator is set to OFF. The safety switch on the rear door of the modulator does not provide complete safety because the AC supplies from the power unit are still connected to the power unit in the modulator.

*Inspection*

**26.** After the foregoing preliminary precautions have been taken, open the rear door of the cabinet and use the air blower to clean out the racks and the base of the unit. Examine all cables, taking particular care to check all coaxial cable terminations (the method of making up these terminations will be found in *Part* 1, *Sect.* 1, *Chap.* 2). Check that all the connections to the terminal blocks on each panel are secure.

**27.** Remove all coils from the storage compartment in the base of the unit and carefully inspect each coil for signs of damage or corrosion before replacing them in their original positions. Do not omit to inspect any coils from this compartment which are in use in the transmitting unit.

**28.** Clean the gate switch and meter switch contacts with carbon tetrachloride. The latter contacts should then be lightly smeared with mineral jelly.

**29.** Inspect the power chassis tray and check for signs of overheating in the transformers and associated components. Check that the envelopes of the rectifier valves are secure in their bases.

**30.** Close the cabinet rear door and then check the following points on the front panels of the modulator.

(1) All panel securing bolts are in position.

(2) Each of the three meters is zeroed correctly and that the meter glasses are undamaged.

(3) Open the coil storage compartment and examine each coil in turn for signs of damage or corrosion.

(4) Open each of the doors on the upper panels and make a similar inspection to the coils fitted in their operating position. Check that the envelopes of the valves are accessible through these doors are secure in their bases.

(5) Close the doors opened during the inspection and switch on according to the instructions given in Part 1, Sect. 1, Chap. 4.

(6) Check the operation of the gate switch circuit by opening the rear door of the cabinet to switch off the HT and GB supplies and then close the door to restore these supplies.

**31.** Operating tests for the modulator 127 are described in Part 1, Sect. 1, Chap. 4 because the modulator must necessarily be set up in conjunction with the other units used in the SSB role. When the modulator has been set up according to these instructions, record the meter readings, control settings and coils used, in the Servicing Log Book.

**Modulator type 7436**

**32.** The modulator Type 7436 is so similar in construction to the transmitting unit that most of the general remarks applied to this latter unit apply also to the modulator. Similarly the tests for air pressure in para. 11 to 13 also apply although slightly different pressures may be obtained.

**33.** Remove the lower front panel and check that the contacts of the filament relay are clean and then manually operate it to check its mechanical condition.

**34.** The only switch which should require attention is the TELEGRAPH SSB TELEPHONE switch. The contacts of this switch should be cleaned with carbon tetrachloride and then lightly smeared with mineral jelly. Lubricate its bearings and mechanism with a light oil.

*Fitting the ACT 9 valves*

**35.** The method used for mounting the ACT9 valves differs from that described for fitting similar valves in the transmitter in the following respects:

(1) There is no anode cap, the valve merely rests upon its chair.

(2) The thermometer is secured to a metal band clamped around the anode cooling fins.

(3) There is only one grid connector.

(4) The two filament leads are connected between the valve terminals and either side of the movable tap on the two discrimination resistors which are attached to the filament bus bar.

(5) There is no air supply fed into the filament walls. Both valves should be selected so that their marked filament ratings do not differ by more than 0·7 volt.

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