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S.S.B. TRANSMITTER TEST AND MONITORING EQUIPMENT S.T.C. TYPE A.1407B

GENERAL AND TECHNICAL INFORMATION

BY COMMAND OF THE DEFENCE COUNCIL

AIR MINISTRY

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SINGLE-SIDEBAND TRANSMITTER TEST AND MONITORING EQUIPMENT TYPE A.1407B

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NOTE TO READERS

The reference number of this publication was altered from A.P. 2883ND, Vol.1 to A.P. 116E-0256-1 in December 1970. No general revision of page captions has been undertaken, but the code number appears in place of the earlier caption on new or amended leaved issued subsequent to that date.

AMENDMENT SHEET NO.1

TO

HANDBOOK NO.1064, ISSUE 1

1.0 ADDITION OF POWER SUPPLY & CONSUMPTION FIGURES

Performance data given on page 10 should include the following:-

2.2.8 Power Supply — 100 to 130 volts or 200 to 250 volts single phase, 50 - 60 c/s.

2.2.9 Power Consumption

Ovens off:-	250 VA
Ovens on:-	550 VA

2.0 CHANGE OF OUTPUT LEVEL LIMIT OF 425 c/s OSCILLATOR

The output level limit quoted in Section 9.0 (b) Chapter 4, page 26, for the 425 c/s oscillator, should be changed to read:- "within 1½ db".

C O N T E N T S

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CHAPTER 1

INTRODUCTION

1.0 GENERAL

Monitoring Equipment, Type A.1407B is intended for monitoring of signals passing through and finally radiated from two independent-sideband transmitters and associated transmitter drive units. It is primarily arranged for use in conjunction with "Standard Radio" equipments, in which a drive unit such as the type A.1406, delivers a 3.1 Mc/s pilot carrier with independently modulated sidebands to the transmitter, for conversion therein to the required radiated frequency and amplification to the required output level.

Either of the sidebands or, alternatively, a double sideband may be selected for monitoring on a built-in-loudspeaker and for visual indication on an output-level meter. The selected sideband may also be tested for intermodulation product and cross-talk at various points in the drive unit and transmitter.

Apparatus comprising the equipment is mounted on three individual chassis and a jack panel, all of which are incorporated in a single cabinet with or without other equipment according to the manufacturing group number. Two such groups are referred to in this manual. One of these groups consists of a Monitoring Equipment Type 1407B plus an I.S.B./D.S.B. Drive Unit Type A.1406. The other consists of a Monitoring Equipment Type A.1407B plus two V.F.O. Drive Units, Type A.1408. Although reference must, of necessity, be made to the overall equipment, it should be understood that the purpose of this manual is to describe the monitoring apparatus only. Detailed descriptions of the drive and v.f.o. units are given in associated handbooks Nos. 1055-A and 1069-A, respectively.

2.0 TYPICAL PERFORMANCE

2.1 Test Tone Quality

2.1.1 Tone Level

1100 and 1775 c/s ..... 0 dbm
425 c/s ..... ± 1.5 dbm

2.1.2 Frequency Tolerance

1100 and 425 c/s ..... ± 7 c/s
1775 c/s ..... ± 10 c/s

2.1.3 Harmonic Distortion

The r.m.s. sum of harmonic distortion components in one tone is not higher than -42 db relative to the level of the fundamental.

2.1.4 Noise and Hum

The unweighted r.m.s. noise level associated with one tone does not exceed -55 db relative to the tone level.

2.1.5 Intermodulation Distortion

The level of the 3rd order intermodulation product (425 c/s) of the two test tones, 1100 and 1775 c/s does not exceed -55 db relative to the level of either tone.

2.2 Overall Performance

2.2.1 Loudspeaker Input

100 mW (at peak output power of transmission)

2.2.2 R.F. Input (4 to 28 Mc/s)

-12 dbm minimum. (R.F. oscillator input = 25 dbm)

2.2.3 3.1 Mc/s Input

-10 dbm minimum. (3 Mc/s oscillator input = 14 dbm)

2.2.4 Harmonic Distortion

The total r.m.s. harmonic content of a single tone, measured at the loudspeaker terminals, does not exceed -42 db relative to the fundamental.

2.2.5 Intermodulation Distortion

In the presence of two equal sideband signals of 1100 and 1775 c/s relative to a carrier frequency of 3.1 Mc/s, the level of the 3rd order intermodulation product at the monitor level meter does not exceed -45 db relative to either tone.

2.2.6 Noise & Hum

Measured at the loudspeaker terminals, the r.m.s. sum of noise components in the frequency band 100 to 6000 c/s, due to a single sideband tone, does not exceed -50 db relative to tone level.

2.2.7 Frequency Response

In the "no filter" condition, the frequency response, measured on the level meter over the band extending 6 kc/s on either side of the carrier frequency of 3.1 Mc/s, is between two lines 3 db apart.

2.2.8 Power Supply

100 to 130 volts or 200 to 250 volts single phase, 50-60 c/s.

2.2.9 Power Consumption

Ovens Off:	250 VA
Ovens On:	550 VA

CHAPTER 2

DETAILED DESCRIPTION

1.0 CONSTRUCTION

Frontal access, only, is required for operating and maintaining the Monitoring Equipment Type 1407B. The cabinet in which it is housed, however, has a readily detachable rear panel to facilitate installation, inspection of general wiring etc.

The three main units of the equipment are arranged in the cabinet racking so that they may be drawn forward, on telescopic runners, for inspection. All wiring connections are maintained during the withdrawal operation but dangerous voltages are automatically removed from the main units (excluding the Filter Unit). The supplies can be restored by fitting a specially designed plug into a socket on the left-hand side of the cabinet, adjacent to the unit. A unit cannot be pushed "home" while the plug is in circuit. Quick-release fasteners of the push-button type lock the units in their "home" positions.

Sub-units in the equipment are of strip construction and employ quick-release fasteners to secure them in position on their parent chassis. Connectors to these sub-units are of sufficient length to enable servicing operations to be undertaken with supplies present.

Operational controls are, as far as possible, protected by hinged panels.

2.0 COMPOSITION OF EQUIPMENT

As mentioned in Chapter 1, a Monitoring Equipment Type A.1407B is normally fitted in a single cabinet together with other apparatus, the complete assembly being allocated an overall code number. Typical assemblies are quoted below:-

(1) Independent-Sideband Transmitter Drive Unit, Type A.1406-B with Monitoring Equipment Type A.1407-B (illustrated in Plate I). This assembly has an overall manufacturing code 188-LRE.2D and units are disposed (from top to bottom) in the cabinet as follows:-

Title	Code
Filter Unit (monitor equipment)	8-LRU.297B
S.S.B. Drive Unit	395-LRU.14A
Monitor Unit	395-LRU.14B

Title	Code
Jack Panel	87-LRU.50A
Filter Unit (drive equipment)	8-LRU.297A
Power Supply Unit (monitor equipment)	94-LRU.204A
" " " (drive equipment)	94-LRU.204A

(2) Variable-Frequency Oscillators, Type A.1408-A, with Monitoring Equipment, Type 1407-B. The overall manufacturing code of this assembly is 188-LRE.2E and the units are disposed (from top to bottom) in the cabinet as follows:-

Title	Code
Variable-Frequency Oscillator	16-LRU.212A
" " "	16-LRU.212A
Monitor Unit	395-LRU.14B
Jack Panel	87-LRU.50C
Filter Unit (monitor equipment)	8-LRU.297B
Power Supply Unit	94-LRU.204A

3.0 OVERALL FUNCTIONAL DESCRIPTION

(The overall block diagram is given in Fig. 1)

3.1 General

Monitoring can be carried out at the following stages of the signal-production processes of the A.1406 Transmitter Drive Equipment and its associated transmitter:-

(a) At the input to the A.1406 carrier modulator (100 kc/s signal)
(b) At the output of the Type A.1406 Drive Unit (3.1 Mc/s signal)
(c) At the output of the transmitter demodulator (3.1 Mc/s signal)
(d) At the main transmitter output. (R.f. signal)

Selection of the above facilities is given by appropriate setting of coaxial U-links and switches on the Jack Panel and by suitable switching of the monitor. As mentioned in Chapter 1, the system normally caters for selection of monitoring points from two Type A.1406 Drive Units and two associated transmitters. It is, however, possible to extend the facilities to further drive units and transmitters by "patching in" to terminals in the base of the monitor cabinet.

During operation, the r.f. signal to be checked is applied (from the transmitter) to a first demodulator in the monitor simultaneously with a

portion of the transmitter beating frequency. A tuned circuit in the demodulator selects the band of frequencies centred on 3.1 Mc/s, i.e. the same frequency spectrum as that of the output of the drive unit.

The 3.1 Mc/s signal thus obtained is passed to a second demodulator using a carrier frequency of 3 Mc/s derived from the Carrier Modulator Unit (Code No. 17-LRU.76B) in the Type A.1406 Drive Unit. The resultant band of frequencies, centred on 100 kc/s, is amplified and applied to sideband filters in the Filter Unit. By means of switching, outputs of the filters can be selected as follows:-

(i) All frequencies
(ii) Upper sideband only
(iii) Lower sideband only
(iv) 3rd Order intermodulation product in the upper sideband
(v) 3rd Order intermodulation product in the lower sideband

The selected frequency is arranged to pass either to a monitor amplifier or to a third demodulator. The monitor amplifier consists of a calibrated variable attenuator followed by a three-stage amplifier and level meter for comparing relative signal levels. The third demodulator converts the 100 kc/s signal to audio frequency by reason that it simultaneously receives a 100 kc/s carrier from the 100 kc/s Oscillator (Code No. 16-LRU.192A) in the drive unit. The a.f. output of the demodulator is amplified and fed to a loudspeaker situated on the Jack Panel.

When monitoring 3.1 Mc/s signals the 1st demodulator is cut out of circuit and the input is applied straight to the 2nd demodulator. For 100 kc/s monitoring the 1st and 2nd demodulators are cut out and the 100 kc/s signal is applied via the Filter Unit to the 3rd demodulator.

Two oscillator units supply audio tones at frequencies of 1775 c/s and 1100 c/s or 425 c/s. These tones are combined in a hybrid transformer and can be applied to the inputs of the Type A.1406 Drive Units via U-links on the Jack Panel. By connecting the 1775 and 1100 c/s tones simultaneously to one sideband input, non-linear distortion in a drive unit or transmitter can be measured by comparing the level of the 3rd order intermodulation product (425 c/s) with that of one test tone alone. Cross-talk between sidebands can be measured by connecting the 425 c/s tone to one sideband input and comparing the resultant signal level in the wanted sideband with that in the unwanted one.

4.0 CIRCUIT DESCRIPTION OF THE MONITOR UNIT Code No. 395-LRU.14B

(The unit is illustrated in Plates II and III)

4.1 General

The Monitor Unit comprises a mounting tray with an associated front panel and contains (from left to right) the following five sub-units:-

Title	Code
1st and 2nd Demodulator	109-LRU.9A
3rd Demodulator	109-LRU.10A
Monitor Amplifier	171-LRU.47A
Oscillator Unit (1775 c/s)	16-LRU.217A
" " (1100 and 425 c/s)	16-LRU.217B

4.2 1st and 2nd Demodulator Unit (Code No. 109-LRU.9A)

(Plate IV illustrates the unit and the circuit diagram is given in Fig. 2.)

The 1st and 2nd Demodulator Unit has three stages. They are an r.f. demodulator, a 3.1 Mc/s demodulator and a 100 kc/s amplifier. Monitoring points in the drive and transmitter system are connected to the input circuits of the unit via the Jack Panel.

Considering operation when it is required to carry out r.f. monitoring, the transmitter r.f. signal is applied to the control grid of V1, via an R.F. Signal Input control, R2, while a portion of the r.f. oscillator frequency is fed to the cathode via a 25 db attenuator. The Monitor Selector, S2, on the front panel of the unit is placed to R.F. (position 1).

A band of modulation frequencies centred on 3.1 Mc/s, resulting from mixing the two inputs referred to above, is selected by a pi-network (L1, C4, C5 and C6) which forms the anode circuit of V6. This band of frequencies is applied to the control grid of the 3.1 Mc/s 2nd demodulator stage V2. A 3 Mc/s carrier frequency, from the Carrier Modulator in the drive unit, is simultaneously fed to the cathode of V2. A transformer T1, in the anode circuit of V2 is tuned to 100 kc/s and accepts the demodulation product (a band centred on 100 kc/s) of the stage.

The 100 kc/s signal thus obtained undergoes amplification by V3 before being applied via the Filter Unit (described later) to the 3rd Demodulator or the Monitor Amplifier.

When it is required to monitor a 3.1 Mc/s signal from the drive unit or transmitter the Monitor Selector, S2, is placed to 3.1 Mc/s (position 2) thus connecting the input circuit of the 2nd demodulator, V2, to the 3.1 Mc/s signal line via a 3.1 Mc/s Signal Input control R.12. Similarly, when a 100 kc/s signal from the drive unit is to be monitored the Monitor Selector is placed to 100 kc/s. This action connects the 100 kc/s signal to the input of amplifier, V3, from where it is fed in the normal way to the Filter Unit.

Cathode current metering for V1, V2 and V3 is provided by M1 functioning in association with Meter Switch S1.

4.3 3rd Demodulator Unit (Code No. 109-LRU.10A)

(Plate V illustrates the unit and the circuit diagram is given in Fig. 3)

The 100 kc/s signal conveyed from the 1st and 2nd Demodulator Unit to the Filter Unit is presented to one of four filter circuits therein, according to switching. One of these passes the upper sideband (100.1 to 106 kc/s), the second passes the lower sideband (94 to 99.9 kc/s) the third passes 100.425 c/s $\pm$ 40 c/s which represents the 3rd Order intermodulation product of the test tones (1775 c/s and 1100 c/s) in the upper sideband, and the fourth passes 99.575 c/s $\pm$ 40 c/s i.e. the 3rd Order intermodulation product in the lower sideband.

Upon leaving the selected filter the signal is fed, according to switching, either to the 3rd Demodulator Unit or to the Monitor Amplifier.

The 3rd Demodulator has five stages as follows:-

(a) A 100 kc/s amplifier
(b) A cathode follower
(c) A balanced demodulator
(d) A phase splitter
(e) An a.f. amplifier

The 100 kc/s signal input enters the demodulator unit at T1 and, following application to the 100 kc/s amplifier (V1), is passed, via T3, to the push-pull input of the balanced modulator formed by rectifiers Rect 1, Rect 2 and associated components. The parallel input is derived from the 100 kc/s Oscillator (Code No. 16-LRU.192A), in the drive unit, via cathode-follower V2. The signal input level is adjusted by preset potentiometer R2, in the grid circuit of V1, and the oscillator

input level by preset potentiometer, R8.

The 2nd harmonic of the audio output of the demodulator is balanced out by appropriate adjustment of potentiometer R15 and the 100 kc/s carrier leak is suppressed by the parallel tuned circuit formed by T4, C9 and trimmer condenser, C10.

The resultant A.F. developed across Audio Gain potentiometer R16 (a front panel control) is applied to a double-triode V3, functioning as a phase splitter. The anti-phase outputs of this stage are, in turn, fed to the grids of a low-mu push-pull double-triode amplifier, V4. One secondary winding on the output transformer, T5, of the amplifier, is arranged to feed a loudspeaker on the Jack Panel and another secondary winding provides a variable negative feedback to the grid of V3a. The degree of feedback is adjustable by pre-set potentiometer, R29.

Cathode current metering for all the valves is effected by means of M1, selection of the required circuit being made with a front panel Cathode Current switch, S1.

4.4 Monitor Amplifier Unit (Code No. 171-LRU.47A)

(Plate VI illustrates the unit and the circuit diagram is given in Fig. 4)

There are three wide band amplifier stages and one detector stage in the Monitor Amplifier Unit.

When the output of the Filter Unit is switched to the Monitor Amplifier, the 100 kc/s signal enters the latter at T1 and is applied by way of a 0 - 40 db attenuator, R2, to the control grid of V1. The attenuator, which is controlled from the front panel of the unit, is calibrated in 2 db steps and provides adjustment of input level.

Valve V1, referred to above, is the first of three wideband resistance-capacity coupled amplifiers, V1-V3. The output from the last of these stages is rectified by a germanium crystal and applied to a level meter, M1, which is calibrated from -10 db to + 3 db. A preset variable resistor, R21, is provided in the circuit for adjustment of zero db reference level on the meter scale. By appropriate switching of S1 (a front panel control) cathode currents of V1-V3 may also be metered by M1. A second scale is provided on the meter for this purpose.

4.5 Oscillator Unit (1775 c/s). Code No. 16-LRU.217A

(Plate VII illustrates the unit and the circuit diagram is given in Fig. 5)

The 1775 c/s Oscillator Unit uses one half of a type 12AT7 valve in an oscillator stage and the remaining half in an amplifier stage.

The oscillator is of the Hartley type with resistance stabilization via C4, R1. Padding condensers across the oscillator coil enable the resonant frequency of the circuit to be adjusted to within ± 5 c/s of the nominal 1775 c/s. Since the cathode of the oscillator valve is not decoupled negative feedback is present.

The oscillator output is taken off via a potentiometer R5, R6, in the anode circuit of V1, and applied to the amplifier section of the double-triode. This section feeds into a pi-network which can be tuned to within ± 15 c/s of the nominal frequency by means of padding condensers C10, C11. As in the oscillator, negative feedback occurs due to absence of decoupling in the cathode circuit.

The output of the amplifier is passed, via a preset level potentiometer, R14, to a 600 ohm hybrid transformer, T1, where it is combined with the output of the 1100 c/s oscillator. The secondary winding of T1 is connected to the Jack Panel from which it can be linked to the drive units.

Cathode current metering is accomplished by means of M1 in association with front panel switch S1.

4.6 Oscillator Unit (1100/425 c/s). Code No. 16-LRU.217B

(Plate VIII illustrates the unit and the circuit diagram is given in Fig. 6)

The design of the oscillator and amplifier used in this unit is similar to that described in the previous sub-section. Such differences as do occur are mainly confined to component values and to the switching necessary to change frequency from 1100 c/s to 425 c/s. This is accomplished by means of an Oscillator Selector S2 (a front panel control). It will be observed that no padding condensers are used to adjust the circuits for operation at 425 c/s. Limits at this frequency are approximately ± 5 c/s for the oscillatory circuit and ± 10 c/s for the amplifier.

The tone output of the unit is fed away, via a preset level potentiometer, R15, to the 1775 c/s Oscillator Unit where, as previously explained, it is applied to hybrid transformer T1.

5.0 CIRCUIT DESCRIPTION OF THE FILTER UNIT (Code No. 8-LRU.297B)

(Plate IX illustrates the unit and the circuit diagram is given in Fig. 7)

The unit incorporates six crystal filters each mounted in an hermetically sealed container and having input and output impedances of 75 ohms, unbalanced.

To ensure stability the containers are enclosed in an oven, the temperature of which is maintained at 60° ± 2°C by three resistance mats R1, R2, R3. The mats are fed from a 75 volt a.c. supply, controlled by thermostatic action. The control circuit consists of two 60°C thermostats, TH1, TH2, and a relay, REL1, series connected in a 50 volt d.c. supply, derived via a bridge rectifier Rect.1 across the a.c. supply. During the heating cycle the relay circuit is completed, contacts, REL1a are closed and the resistance mats heat up. Upon reaching a temperature of 60°C, TH1 opens and releases relay REL1 thus disconnecting the supply to the mats. The second thermostat TH2 is purely precautionary and functions at the same temperature as TH1. A further protection against failure of thermostats to open, with consequent overheating of the equipment, is provided in the form of a thermal cut-out C.O.1A. This uses an alloy having a melting point of approximately 70°C.

An indicator lamp, L1, on the front panel of the unit, is arranged to glow brightly during the heating cycle of the oven and to become dim during the cooling cycle. In the event of the thermal cut-out opening, the lamp is extinguished.

As explained in sub-section 4.3 there are four filter circuits in the unit. Dealing with these, F1A and F1B, connected in tandem, pass the upper sideband of the 100 kc/s signal i.e. 100.1 kc/s to 106 kc/s. Filters F2A and F2B pass the lower sideband 94 to 99.9 kc/s. Filter F3 passes 100.425 c/s ± 40 c/s (which represents the 3rd order intermodulation product of the 1775 c/s and 1100 c/s test, tones in the upper sideband). Filter F4, passes 99.575 c/s ± 40 c/s i.e. the 3rd order intermodulation product in the lower sideband. Two 9 db pads (R10, R11, R12, and R13, R14, R15) bring the insertion loss of F3, F4 up to 12 db i.e. that presented by F1, F2. A "T" type attenuator of equivalent loss enables both sidebands to be passed.

A Filter Selector, S1, controlled from the front panel, enables the 100 kc/s input to be switched to the required filter circuit or to the 12 db attenuator. An Output Selector, S2, also controlled from the front panel, connects the output from the selected circuit to the 3rd Demodulator Unit or to the Monitor Amplifier Unit.

6.0 DESCRIPTION OF JACK PANELS

6.1 General

Two types of Jack Panel are available according to whether the monitoring equipment is incorporated in a cabinet containing the Drive Unit, Type A1406 or in a cabinet containing the Variable Frequency Oscillators, Type A1408. Jack Panel, Code No.87-LRU.50A, is used in the former instance and Jack Panel, Code No. 87-LRU.50C, in the latter instance. They will be dealt with separately below.

6.2 Jack Panel Code No.87-LRU.50A

(Plates X & XI illustrates the Jack Panel and the circuit is given in Fig. 11)

The Jack Panel incorporates a series of U-link sockets and selector switches, whereby monitor pick-up points on two transmitters, and on two associated drive units may be linked through to the monitor receiver. It also incorporates a loudspeaker and a telephone jack.

Dealing with the facilities provided, an R.F. Monitoring Selector S3, enables the r.f. signal and oscillator frequencies of either transmitter No.1 or No.2 to be switched to the 1st and 2nd Demodulator Unit. Similarly, a series of coaxial plugs grouped under the designation 3.1 Mc/s Drive and Monitoring, enable the output from drive units Nos. 1 or 2 to be connected to transmitters Nos.1 or 2 or, alternatively, for monitoring to the 1st and 2nd Demodulator Unit. Additionally 3.1 Mc/s outputs from demodulator units incorporated in the transmitters may be connected through to the 1st and 2nd Demodulator Unit. Spare coaxial plugs are provided.

The 100 kc/s Monitoring Selector, S2, enables the 100 kc/s signal from either drive unit to be switched through to the 1st & 2nd Demodulator Unit. It is so arranged that one drive unit may be monitored without interruption of the other. The 100 kc/s oscillator frequency from either drive unit is switched to the 3rd Demodulator Unit and the 3 Mc/s oscillator frequency to the 1st and 2nd Demod Unit, by means of Oscillator Selector S1.

U-link sockets on the right-hand side of the panel permit connection of the programmes from the station terminal equipment to the 600 ohm inputs of the drive units. They also permit connection of the test tones from the 1775 c/s A.F. Oscillator Unit to the drive units. Spare sockets are provided.

Further U-link sockets (situated immediately beneath the loudspeaker) are series connected between the speaker and the 3rd Demodulator Unit. Accordingly, the links may be removed from these sockets and a wave analyser or other test equipment inserted in the circuit.

The telephone jack is connected to terminals in the base of the cabinet and is for use in accordance with any station requirements.

6.3 Jack Panel, Code No.87-LRU.50C

(The circuit diagram is given in Fig.12).

The above jack is similar to that described in sub-section 6.2. Arrangements are however made for connecting outputs from the v.f. oscillators to the transmitters via coaxial U-links.

7.0 POWER SUPPLY UNIT

(Plate XII - illustrates the unit and the circuit diagram is given in Fig.8).

The power unit is of conventional design and produces 250 and 150 volt d.c. h.t. supplies, a 6.3 volt a.c. valve heater supply and a 75 volt a.c. oven heater supply. The Mains input to the unit is single-phase 50 c/s A.C. at nominal voltages of 110V or 230V. The input current is 2 amps at 230 volts and at 4 amps at 110 volts. Tappings on the primary winding of the input transformers cater for Mains supplies within the limits 200 - 250 volts and 100 to 130 volts.

Input to the h.t. transformer, T1, is switched under the control of relay A/2. This relay is, in turn, energised from a bridge rectifier, Rect. 1, across the 75 volt oven supply and its operation is dependent upon all gate switches in the cabinet being closed. Since a gate switch is associated with each main unit (excluding the Filter Unit) all h.t. and filament supplies are removed when a main unit is withdrawn. Oven supplies are, however, unaffected.

The d.c. h.t. supply is obtained from a full-wave rectifier, V1, which feeds into a choke-input filter designed to give a high degree of smoothing (better than 60 db). The 150 volt section of this supply is stabilised by neon, V2.

The On/Off switch, S1, is mounted on the front panel together with the Oven Supply lamp, LP1, and the H.T. Supply lamp LP2.

INSTALLATION

CHAPTER 3

RECEIVING AND UNPACKING THE EQUIPMENT

1.0 THE SHIPPING SPECIFICATION

Before unpacking the equipment reference should be made to the Shipping Specification, copies of which are packed with the Equipment, and also sent separately by mail. An explanation sheet included with the specification shows how the latter can assist in easy identification of apparatus.

All equipment should be inspected for damage. If any parts have become detached they should be set aside for later restoration in their appropriate places.

2.0 PREPARATION OF SITE

Since rear access to the equipment is normally only required during installation, the cabinet may be positioned comparatively close to the walls of the building. Cables are arranged to enter the base of the cabinet by way of conventional ducting cut in the floor.

The measurement of fixing holes in the plinth of the cabinet should be noted, by referring to Fig. 9, and $\frac{1}{2}$" diameter Rigifix inserts set into the floor at appropriate points.

3.0 UNPACKING AND INSTALLING THE EQUIPMENT

(a) Remove the cabinet from its container. (NOTE: Four eyebolts are packed with the equipment. These may be screwed into the roof of the cabinet, if required, to provide anchorages for lifting hooks).

(b) Remove the back panel from the cabinet. (The panel is held in position by quick-release fasteners).

(c) Remove the locking brackets at the rear of the chassis runners. (The brackets are painted yellow and are fitted by the Shipping Department to maintain the chassis securely in position during transit).

(d) Place the equipment in its allocated position on the floor of the station. (Note: Any floor covering must not be higher than the bottom surface of the cabinet.)

(e) Bolt the cabinet firmly down, remove the front lower panel, and connect up all power and monitoring cables. As previously mentioned, these will normally be laid in ducting cut in the floor of the building. If laid on the surface of the floor or walls, however, they must be adequately protected by suitable covering.

Uniradio 32 coaxial cables are used for carrying the r.f. signals from the external drive units to the monitoring equipment. The correct method of terminating these cables is detailed in Fig.10 but reference should be made to Figures 11 or 12, as appropriate, to obtain information regarding the actual connections to be made.

(f) Pull forward the units on their runners and inspect and if, necessary, clean them.

(g) If the valves have been shipped separately fit in the positions indicated by attached labels.

(h) Replace back panel.

CHAPTER 4

LINING-UP AND TESTING

1.0 TEST EQUIPMENT REQUIRED

1 - Avometer Model 7 (or equivalent meter)

1 - S.T.C, Type 74602A Coaxial Transmission Measuring Set -

1 - Valve Voltmeter. Range 0.5 to 25 volts, A.F. to 3 Mc/s.

2.0 OUTLINE OF PROCEDURE

A power supply check is carried out to ensure correct output voltage from the Power Supply Unit. Supply voltage to the oven should be 75V ± 10% and control voltage to the oven, measured across Rect 1, in the Power Supply Unit, should be 50V ± 15%. A check is made to ensure that indicating lamps are functioning correctly.

The drive unit is then put into operation, and the 100 kc/s signal and oscillator outputs connected through to the demodulating units and are measured with the T.M.S. The output of the loudspeaker is then checked.

The output of the 2nd Demodulator is switched through to the Monitor Amplifier and the level indication of the monitor amplifier meter is checked.

The 3.1 Mc/s output of the drive unit is connected through to the monitor and the 3.1 Mc/s signal input and the 3 Mc/s oscillator inputs to the 2nd Demodulator checked.

The 3.1 Mc/s drive is applied to the required r.f. truck (for the explanation it is assumed to be truck No.1 of transmitter No.1) and the output of the transmitter demodulator (if fitted) is monitored by feeding it back to the 2nd Demodulator. Finally, if required, a portion of the main transmitter r.f. output is fed back to the 1st Demodulator. After under-going initial demodulation it is then passed to the 2nd Demodulator.

With the demodulators adjusted, sidebands selection is checked and then the output of the 1100 and 1775 c/s Oscillator Units is measured, individually and in combination.

3.0 POWER SUPPLY CHECKS

(a) Adjust the primary tappings on the h.t. and oven transformers, T1 and T2, to the voltage of the mains supply. Check that the short circuit across R5 has been removed.

(b) Check that the main units are pushed home and then place the Mains On/Off switch, on the Power Supply Unit, to ON. Observe that the Oven Supply indicator lamp, LP1, and the Filament Supply indication lamp, LP2, on the power unit are illuminated. Pull forward the power supply unit and re-close the gate-switch circuit. Check the potentials of the outgoing a.c. and d.c. supplies. (See test sheets supplied with equipment). Return the unit to its normal position.

(c) Check that withdrawal of the Monitor Tray breaks the h.t. supply, i.e. lamp LP2 is extinguished.

(d) Observe the Oven Indicator lamp, L1, on the Filter Unit and note that it glows brightly during the heating cycles and dimly during the cooling cycles.

(e) Allow a period of at least 1 hour before commencing any alignment tests.

4.0 CHECKING THE FUNCTIONING OF THE 3rd DEMODULATOR AND THE MONITOR AMPLIFIER

(It is assumed below that line-up is being carried out with the type A1406 Drive Unit. It is also assumed that, of the two drive units which may be monitored, it is No.1 that will be selected and that it will be provided with a 1000 c/s tone input at zero db line-up level. The drive unit will be switched to operate into truck No.1 of transmitter No.1).

(a) Turn the Oscillator Selector, S1, and the 100 kc/s Monitoring Selector, S2, on the Jack Panel to position 1. Turn the Filter Selector, S1, on the Filter Unit, to U.S.B. or L.S.B. (as appropriate), and the Output Selector to L/S (i.e. loudspeaker). Set the Monitor Selector on the 1st and 2nd Demodulator to 100 kc/s and set the traffic circuit of the drive unit for s.s.b. operation. Switch on the 1000 c/s tone.

(b) Check, with the T.M.S., that the signal input to SK31 on the 3rd Demodulator is -24 ± 2 dbm and the oscillator input to SK32 is +4 dbm ± 1 db.

(c) With the loudspeaker U-links plugged into position on the Jack Panel, connect the valve voltmeter across them. Check that with the Audio Gain control, R16, turned fully clockwise an output of 0.55V (100 mW) is indicated by the valve voltmeter.

(d) Turn the Output Selector on the Filter Unit to Level. Check the input level at SK34 on the Monitor Amplifier. This should be -24 dbm ± 2 db. Set the Input Level control for 40 db attenuation and place the Meter Switch to Level. Adjust R21, if necessary, for a meter indication of zero db.

5.0 CHECKING THE FUNCTIONING OF THE 2nd DEMODULATOR

(a) Connect the 3.1 Mc/s signal at P1, on the Jack Panel, to monitor input plug P4, by means of the 15 db attenuator plug.

(b) Turn the Output Selector, on the Filter Unit, to Level and the Filter Selector for the required sideband.

(c) Turn the Monitor Selector, on the 1st and 2nd Demodulator Unit, to 3.1 Mc/s and check that an input of level of +12 dbm is available at SK27 and +14 dBm at SK26. Adjust R12 for an output level of -12 dbm at SK25 (i.e. into the filters.)

6.0 CHECKING THE FUNCTIONING OF THE 1st DEMODULATOR (IF USED)

(a) Connect the 3.1 Mc/s output, plug, P1, on the Jack Panel, to plug P2 (connection for Transmitter No.1, Truck No.1) by means of a coaxial U-link. Turn the R.F. Selector to position 1 (Transmitter No.1, Truck No.1).

(b) Operate the truck and tune the transmitter to a frequency of 6 Mc/s. Check that the r.f. oscillator voltage, appearing across R3 in the 1st and 2nd Demodulator is not less than 1.0 volt.

(c) Turn the Monitor Selector to R.F. (position 1) and check that an input of approximately 10 dbm is obtained across socket SK29 (this value will depend on the signal level in the transmitter). Adjust the R.F. Signal Input control for zero dbm as indicated by the meter in the Monitor Amplifier.

7.0 CHECKING THE SIDEBAND SELECTION

(a) Change the signal input to the other sideband of the Type A1406 Drive Unit and change the Filter Selector switch position appropriately. Check that the resulting change in output,

indicated by the Monitor Amplifier meter, is less than 2 db for an equivalent tone input. (The change in output here will be due to both the drive unit and the monitor unit).

(b) Check that when the Filter Selector switch is tuned to the sideband having no input, no output is indicated.

8.0 CHECKING THE 1775 c/s OSCILLATOR (Code No.16-LRU.217A)

(a) Connect a 600 ohm load across sockets of the Test Tones monitoring point on the Jack Panel.

(b) Place the Oscillator Selector switch, on the oscillator unit, to the On position.

(c) Connect the valve voltmeter across the 600 ohm load and check that an output of 1 mW (i.e. zero dbm or 0.775 Volts) is indicated. If necessary adjust R14 for the correct condition. Switch off the oscillator.

9.0 CHECKING THE 1100/425 c/s OSCILLATOR (Code No.16-LRU.217B)

(a) With the valve voltmeter connected as in Section 8.0, switch on the 1100 c/s oscillator and check that the output indicated is 0.775 volts (zero dbm). If necessary adjust R15 in the 1100/425 c/s Oscillator Unit for the correct condition.

(b) Switch the oscillator to 425 c/s and check that the output level is within 1½db of that quoted above.

10.0 CHECKING THE COMBINED OUTPUT OF THE OSCILLATORS

(a) Switch on both oscillators (1100 and 1775 c/s).

(b) Check that the combined output is 2 to 3 db above the level of either oscillator operating singly.

CHAPTER 5
OPERATING

1.0 GENERAL

It is most essential that operating personnel should have fully acquainted themselves with the general functioning of the equipment. When they are in possession of this knowledge they can readily make use of the monitoring apparatus, not only for rapid fault finding in the drive units, but also in the transmitter/s.

This chapter deals with the adjustments required for driving two transmitters type DS.12 or DS.13 from two drive units type A.1406, and monitoring the system at the following four points:-

(a) Transmitter output (R.F.)
(b) Output of the transmitter demodulator (3.1 Mc/s)
(c) Output of the drive unit (3.1 Mc/s)
(d) Output of the drive unit channel modulator (100 kc/s)

The filter ovens should have been switched on for at least two hours before any of the tests detailed in following sections are made.

2.0 INITIAL SETTING-UP PROCEDURE FOR THE JACK PANEL

2.1 To connect up a 3.1 Mc/s drive to an r.f. truck

(a) Insert a pair of U-links to connect the required drive unit input to its programme line.

(b) Connect the 3.1 Mc/s signal (at P1 or P9, as appropriate), from the relevant drive unit, to the r.f. truck input by means of a coaxial U-link.*

(c) Ensure that the 100 kc/s Monitor Selector, S2, is in the OFF position.

NOTE: If it is required to cross-patch the drive units and transmitters, e.g. to drive transmitter No. 1 from drive unit No. 2, this can be done by using patching cords in place of U-links. Similarly, programme lines can be cross-patched with drive unit inputs.

* (The coaxial U-link attenuator (15 db) must not be used in this position - It is intended only for monitoring the output of the Drive Unit (see p.28)

2.2 To switch in the monitor points

2.2.1 Selection of the transmitter output frequency

(a) Set the R.F. Monitoring Selector, S.3, to the appropriate r.f. truck position and set the Monitor U-link on the r.f. truck, to the stage to be monitored.

(b) Set the Oscillator Selector, S1, to the type A.1406 Drive Unit associated with the r.f. truck undergoing monitoring. Unless cross-patching has been used, each r.f. truck on transmitter No.1 will be associated with drive unit No. 1. Similarly, each r.f. truck on transmitter No. 2 will be associated with drive unit No. 2.

(c) Ensure that the 100 kc/s Monitor Selector is in the OFF position.

2.2.2 Selection of the 3.1 Mc/s output from the transmitter demodulator

(a) Connect the monitor signal, from the r.f. truck under test, to the Monitor Input plug (P4) by means of a coaxial U-link.

(b) Set the Oscillator Selector to the associated drive unit.

(c) Ensure that the 100 kc/s Monitor Selector is in the OFF position.

2.2.3 Selection of the output of the drive unit (3.1 Mc/s)

(a) Connect the 3.1 Mc/s signal (at P1 or P9 as appropriate), from the relevant drive unit, to the Monitor Input plug (P4) by means of the coaxial U-link attenuator. (NOTE: A drive unit cannot be monitored while it is driving a transmitter.)

(b) Set the Oscillator Selector to the drive unit.

(b) Ensure that the 100 kc/s Monitor Selector is in the OFF position.

2.2.4 Selection of the output of the drive unit channel modulator (100 kc/s)

(a) Set the 100 kc/s Monitor Selector to the relevant drive unit.

(b) Set the Oscillator Selector to the drive unit.

3.0 DETAILED MONITORING INSTRUCTIONS

3.1 General

The instructions given below enable a series of checks to be carried out at any of the four monitoring points listed in Section 1.0. The checks are as follows:-

(a) Aural monitoring of transmission

(b) Measurement of 3rd order non-linear distortion.

(c) Measurement of cross-talk.

3.2 Aural Monitoring

(a) Set up the U-links and switches on the Jack Panel in accordance with the instructions given in Section 2.0.

(b) Set the Monitor Selector, S2, on the 1st and 2nd Demodulator Unit to R.F., 3.1 Mc/s or 100 kc/s, as required.

(c) If monitoring an s.s.b. or d.s.b. transmission set the Filter Switch, S1, to U.S.B. + L.S.B. If monitoring i.s.b. transmissions, set the Filter Switch to U.S.B. or L.S.B. as appropriate. Set the Output Selector, on the Filter Unit, to LEVEL.

(d) Turn the Input Attenuator control, R2, on the Monitor Amplifier Unit, to the fully anti-clockwise position. Set the Meter Switch, S1, to LEVEL.

(e) Adjust the appropriate Signal Input control, R2 or R12, on the 1st and 2nd Demodulator Unit, for line-up level, i.e. a zero db indication on peaks as shown by the level meter in the Monitor Amplifier.

(NOTE: Since the 100 kc/s monitoring input comes in at a fixed level no control is provided in the 100 kc/s input circuit.)

(f) Turn the Output Selector, on the Filter Unit, to L/S and adjust the Audio Gain Control, R16, on the 3rd Demodulator for a convenient output on the loudspeaker.

3.3 Measurement of non-linear distortion

In the test for non-linear distortion, two audio tones are applied simultaneously to one input of a drive unit. The resultant 425 c/s intermodulation product is filtered off and its level is measured with

respect to the level of one tone alone. To make such measurements carry out the following operations:-

(a) Set up the U-links and switches on the Jack Panel in accordance with the instructions given in Section 2.0. At the same time, disconnect the programme input to the drive unit by removing the relevant U-links. Connect a patching cord between the Test Tone sockets U.9 and U.19 and the input sockets of the drive unit.

(b) Turn the Oscillator Selector, on the 1100/425 c/s Oscillator Unit, to 1100 c/s.

(c) Line up the type A.1406 drive unit for s.s.b. or i.s.b. operation and decrease the input level by 6 db. (This is accomplished by turning back the input attenuator on the Line Amplifier and Channel Modulator Unit.)

(d) Turn the Filter Selector to U.S.B. or L.S.B., as required and turn the Input Attenuator, on the Monitor Amplifier Unit, fully anti-clockwise. Set the monitor for line-up level, i.e., adjust the appropriate Signal Input control, on the 1st and 2nd Demodulator Unit, for an indication of zero db as shown by the Monitor Amplifier level meter.

(e) Set the Oscillator Selector switch, S2, to 1775 c/s and turn the Filter Selector Switch to 425 c/s U.S.B. or 425 c/s L.S.B., as required.

(f) Adjust the Input Attenuator, on the Monitor Amplifier, for an indication of approximately zero db as shown by the level meter. Calculate the new level obtained by observing the Input Attenuator setting and the meter indication.

3.4 Measurement of cross-talk

In making measurements of cross-talk level on audio signal is applied to one input of the Type A.1406 Drive Unit and the level of the resultant signal in the unwanted sideband is measured with respect to the level in the wanted sideband. The operations are carried out in the following manner:-

(a) Set up the U-links and switches on the Jack Panel in accordance with the instructions given in Section 2.0.

(b) Disconnect the programme input and patch the drive unit input "A" to the Test Tone sockets on the Jack Panel.

(c) Set the Oscillator Selector, on the 1100/425 c/s Oscillator Unit to 425 c/s.

(d) Align the type A.1406 Drive Unit for s.s.b. operation.

(e) Set the Filter Selector, on the Filter Unit, to 425 c/s and adjust the appropriate Signal Input control, on the 1st and 2nd Demodulator Unit, for line up level.

(f) Put the Filter Selector, on the Filter Unit, to 425 c/s L.S.B. and observe the indication now obtained on the level meter in the Monitor Amplifier.

CHAPTER 6

RE-ALIGNMENT

1.0 GENERAL

The re-alignment instructions given in this chapter are designed to enable personnel to check adjustments of pre-set controls periodically or after changes of valves or other components. The following test equipment will be required:-

1 - S.T.C. Type 74602A Coaxial Transmission Measuring Set.
1 - Valve Voltmeter. Range 0.5 to 25 volts, A.F. to 3 Mc/s.
1 - Wave Analyser.

2.0 RE-ALIGNING THE TEST OSCILLATORS

If re-alignment of the test oscillator becomes necessary it may be carried out by following the procedure detailed in Sections 8 to 10, Chapter 4.

3.0 RE-ALIGNING THE DEMODULATORS

3.1 The 1st Demodulator

(a) Set up the A.1406 Drive Unit No. 1 for s.s.b. operation with a 1100 c/s a.f. input and switch off the re-inserted carrier. Switch off the a.f. input.

(b) Remove the r.f. signal input socket SK.29 and 3.1 Mc/s sig input socket SK.27. Connect SK.29 to P.27.

(c) Switch on the re-inserted carrier in the drive unit and adjust it for a level of zero dbm as indicated by the TMS across P.27.

(d) Connect the valve voltmeter across R.13 in the 1st and 2nd Demodulator. Set the R.F. Signal Input control, R1, to the maximum position and turn the Monitor Selector to R.F. Tune variable inductor L1 for maximum output as indicated by the valve voltmeter.

(e) Switch off the re-inserted carrier and restore sockets SK.27 and SK.29 to their normal positions. Restore re-inserted carrier to normal level.

3.2 The 3rd Demodulator

(a) Place the Monitor Selector, on the 1st and 2nd Demodulator to the 3.1 Mc/s position, turn the Filter Selector for the appropriate sideband and the Output Selector, on the Filter Unit, to L/S. Turn the Oscillator Selector, on the Jack Panel to the position 1.

(b) Connect a valve voltmeter, set to the 15 Volt range, between T3-1 and earth on the 3rd Demodulator Unit. Adjust potentiometer R8 for an indication of 4.5 volts on the valve voltmeter.

(c) Switch on the 1100 c/s tone and adjust the 3.1 Mc/s Input Control on the 1st and 2nd Demodulator until the 101.1 kc/s signal input to SK.31 on the 3rd Demodulator is - 24 dbm and observe that the output, as indicated by the valve voltmeter is 5.0 volts (carrier plus signal). If not, adjust potentiometer R2.

(d) Remove the loudspeaker U-links on the Jack Panel and terminate the incoming pair with a 3-ohm load.

(e) Remove the valve voltmeter, set it to the 1.5 Volt range and connect it across the 3-ohm load.

(f) With the Audio Gain control, R.16, on the 3rd Demodulator set fully clockwise, adjust R.29 for an output of 0.55V as indicated by the valve voltmeter.

(g) Remove the valve voltmeter and connect a wave analyser in its place. Tune to the second harmonic (about 2200 c/s) and adjust R.15 for minimum indication on the analyser. In the absence of a wave analyser R15 should be tuned for minimum carrier leak as in (h), below.

(h) Switch off the 1100 c/s tone, remove the wave analyser and connect a T.M.S. (set to "Level") across the loudspeaker U-links. Adjust C10, on the 3rd Demodulator Unit for minimum indication of 100 kc/s carrier leak.

3.3 The Monitor Amplifier Unit

(a) Place the Monitor Selector on the 1st and 2nd Demodulator to the 100 kc/s position, turn the Filter Selector for the appropriate sideband and the Output Selector, on the Filter Unit, to LEVEL. Turn the Oscillator Selector on the Jack Panel to the position 1.

(b) Set the Input Attenuator R2 on the Monitor Amplifier Unit fully anti-clockwise.

(c) Switch on the 1100 c/s tone and adjust the A1406 for line up level (Odb).

(d) Check that the level meter M1 on the Monitor Amplifier Unit reads 0 db. If not adjust potentiometer R21.

4.0 VALVE CURRENTS

Typical valve currents given in this section apply when equipment is lined up and no signal voltages are applied.

4.1 1st and 2nd Demodulator Unit, 109-LRU.9A

Valve	Current
V1	4 mA ± 20%
V2	4 mA "
V3	7 mA "

4.2 3rd Demodulator Unit, 109-LRU.10A

Valve	Current
V1	12 mA ± 20%
V2	2.0 mA "
V3a	0.3 mA "
V3b	0.3 mA "
V4a	11 mA "
V4b	11 mA "

4.3 Monitor Amplifier Unit, 17-LRU.47A

Valve	Current
V1	4.0 mA ± 20%
V2	4.0 mA "
V3	4.0 mA "

4.4 1775 c/s Oscillator Unit, 16-LRU.217A

V1a	3.5 mA ± 20%
V1b	2.5 mA "

4.5 1100/425 c/s Oscillator Unit, 16-LRU.217B

Valve	Current
V1a	3.5 mA ± 20%)
V1b	3.4 mA ") at 425 c/s

5.0 ORDERING A SPARE PART

If, in the course of re-alignment or repair a component is required which is not among the spares provided, it should be obtained through Standard Telephones and Cables Ltd. (Radio Division), Oakleigh Road, New Southgate, London N.11, England. Quote:-

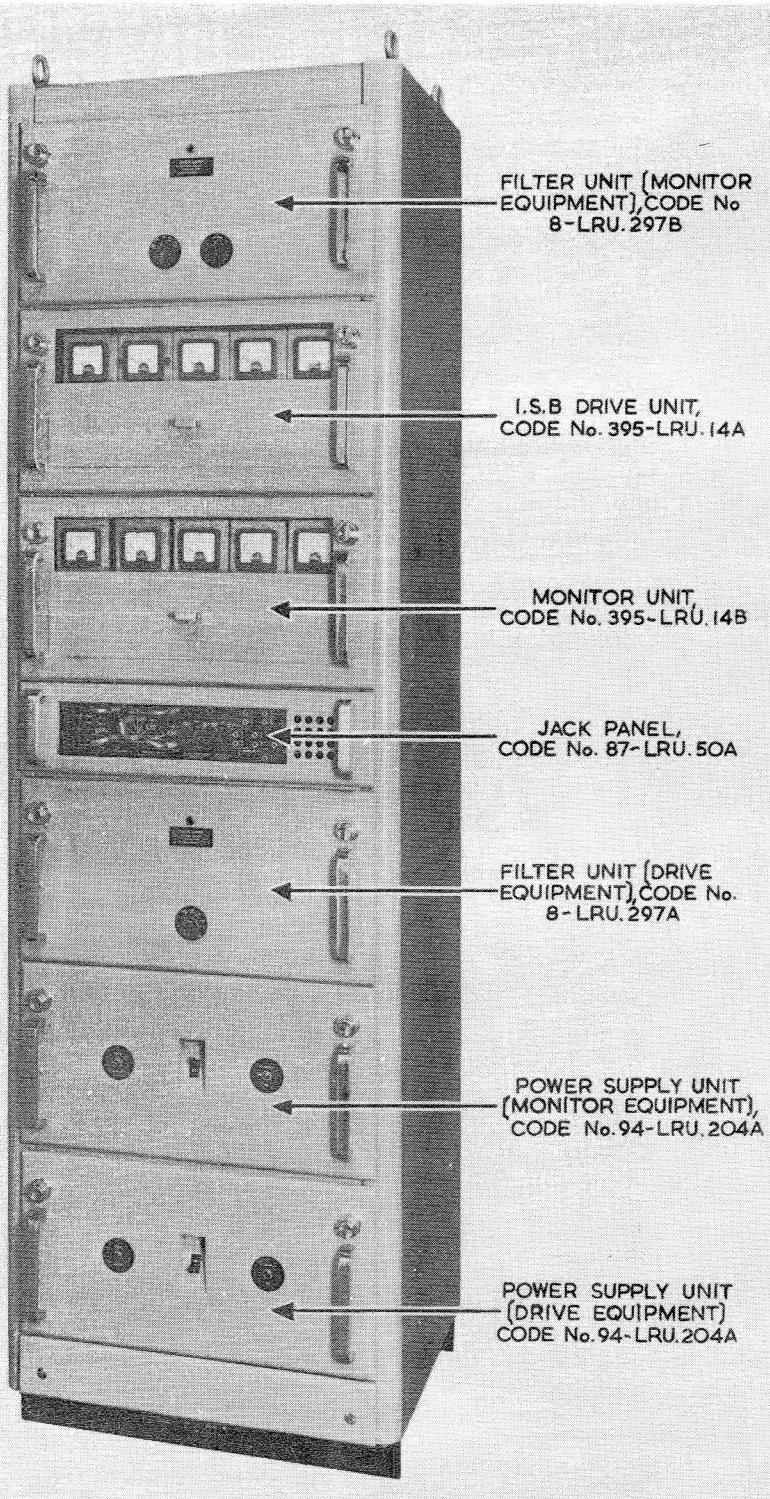
(a) The appropriate drawing number, e.g. "Fig. 5, Circuit diagram of 1775 c/s Oscillator Unit, 16-LRU.217A Sht. 7.1" as given in the list of drawings in the front of this Handbook.

(b) Component identification as shown on the drawing, e.g. "resistor R6" plus any additional information given in the components lists for the unit.

(c) All data which may appear on a label fixed to an item not made by Standard Telephones and Cables Ltd.

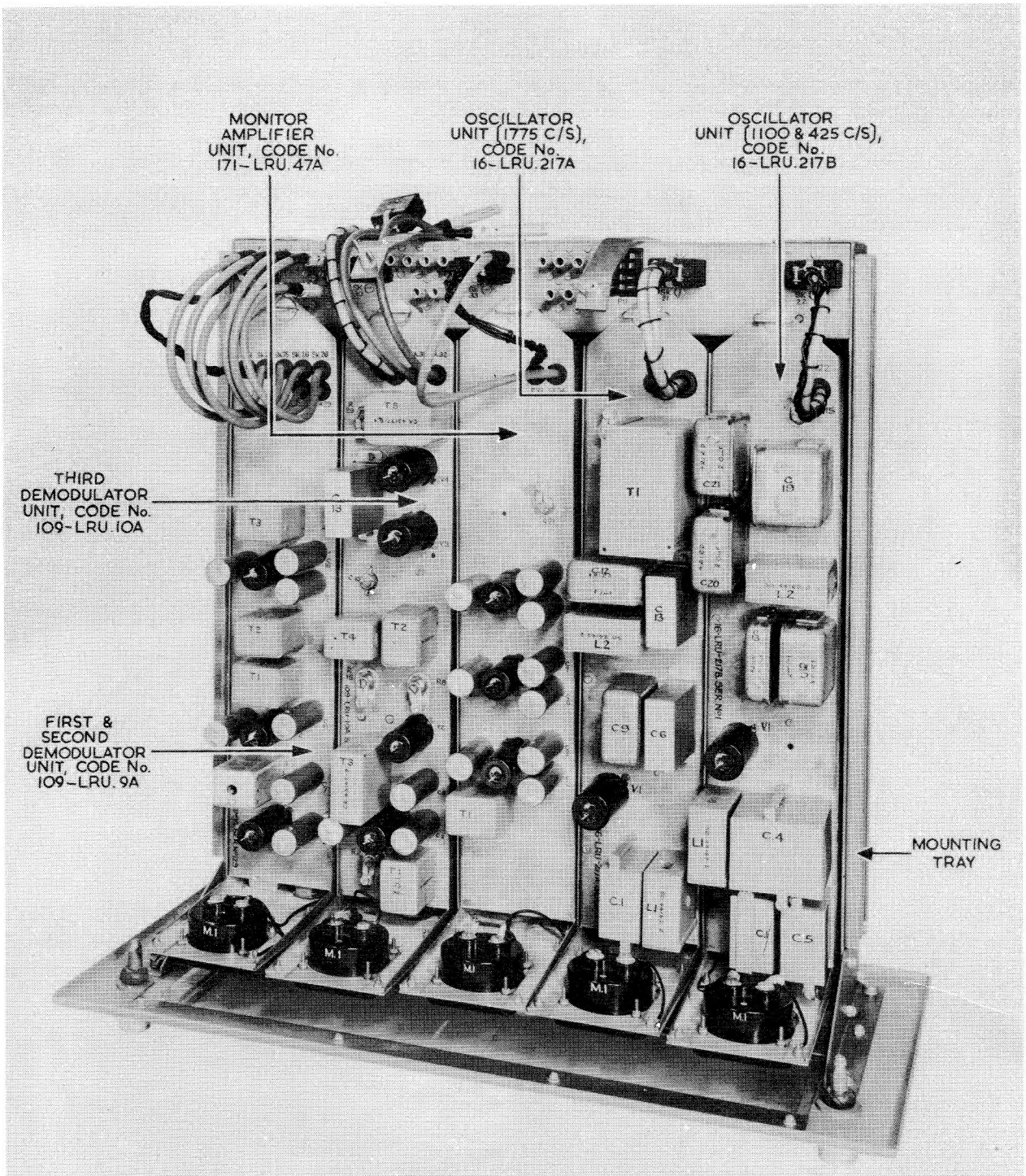
(d) The type and aerial number of the equipment. The serial number will be found on the test report.

(e) Full shipping instructions.



INDEPENDENT-SIDEBAND TRANSMITTER DRIVE UNIT TYPE A.1406B WITH MONITORING EQUIPMENT TYPE A.1407B. OVERALL CODE No. 188-LRE. 2D

PLATE I



MONITOR UNIT, CODE No. 395-LRU.14B. (PLAN VIEW)

PLATE II

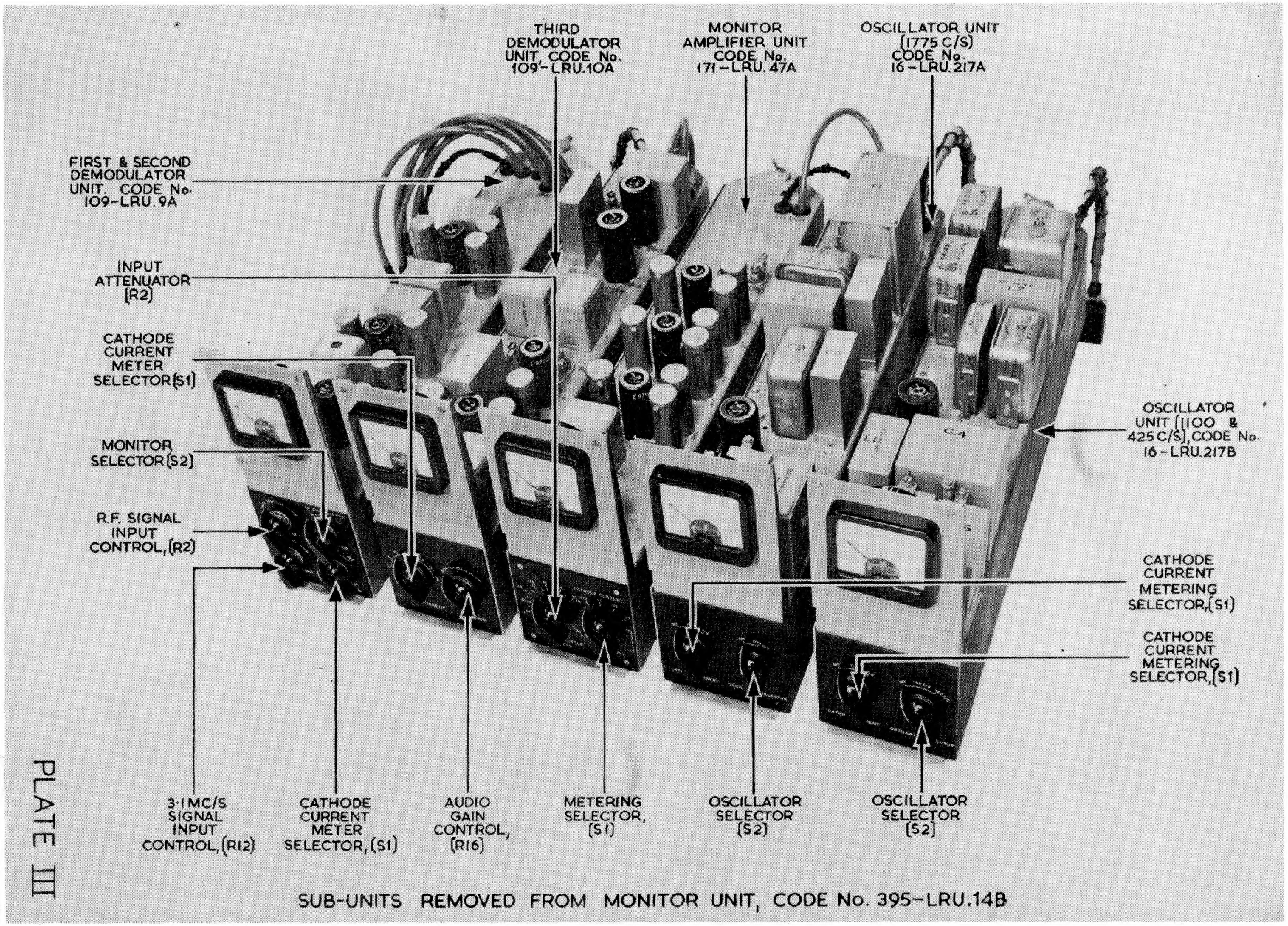


PLATE III

SUB-UNITS REMOVED FROM MONITOR UNIT, CODE No. 395-LRU.14B

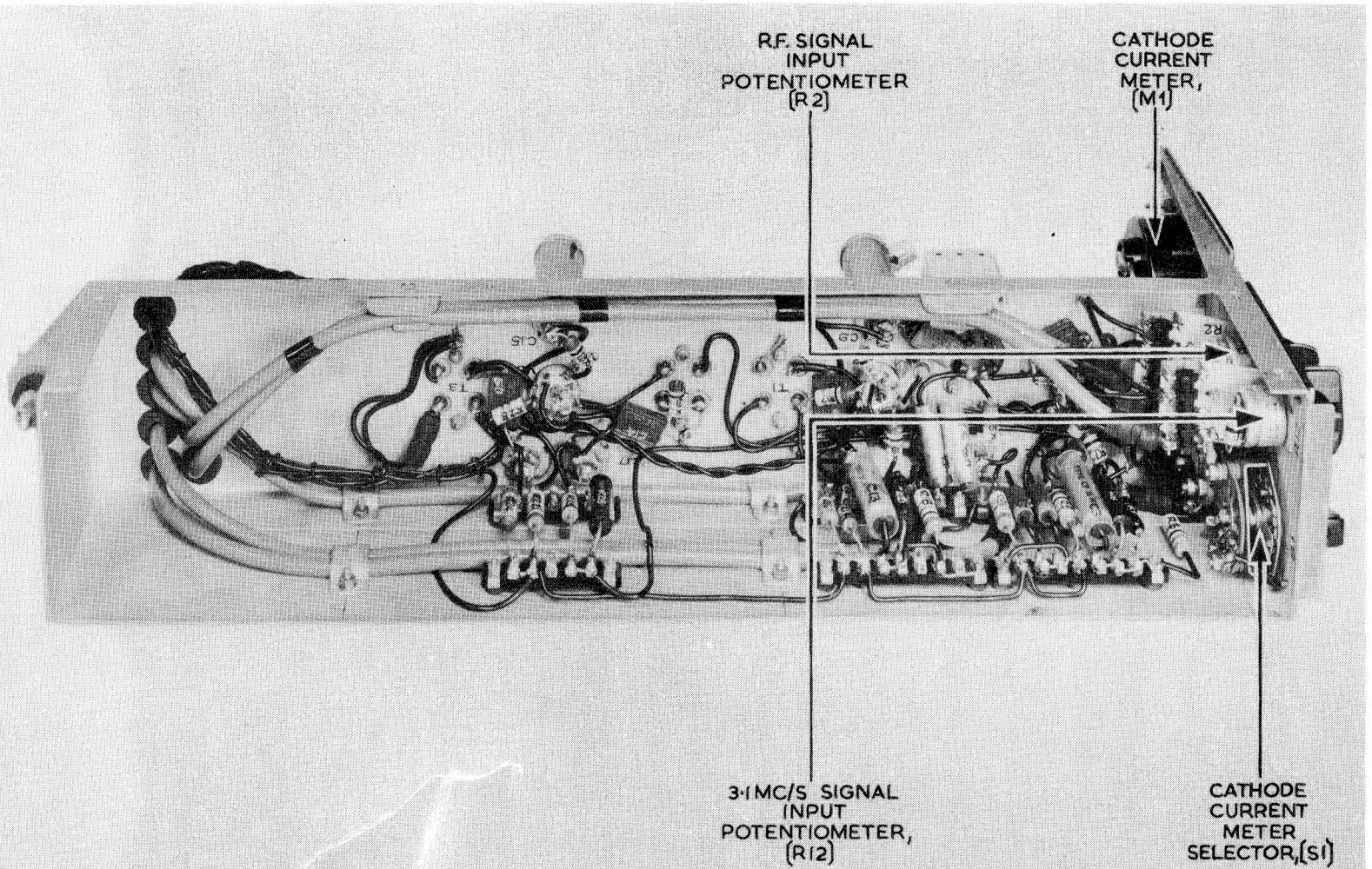
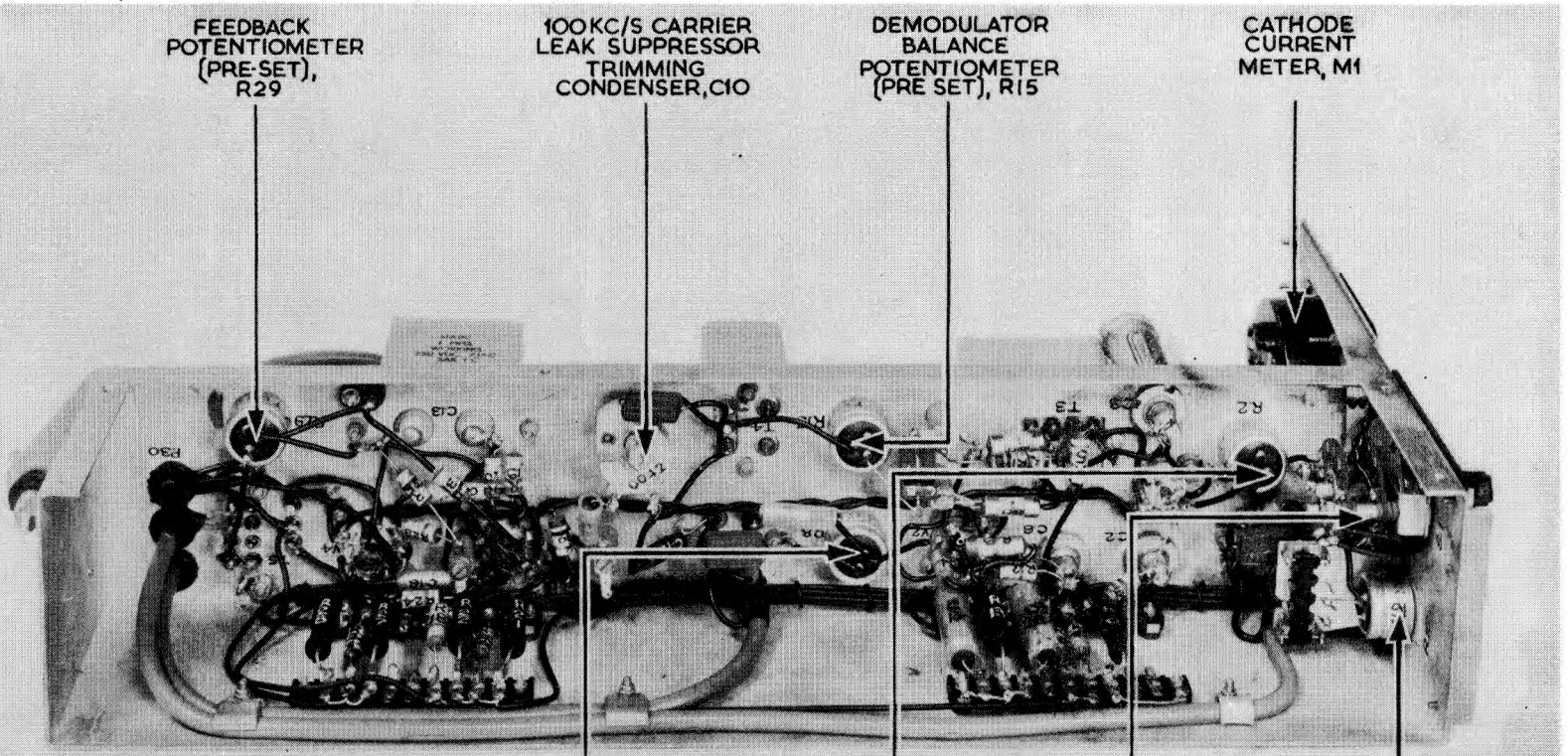


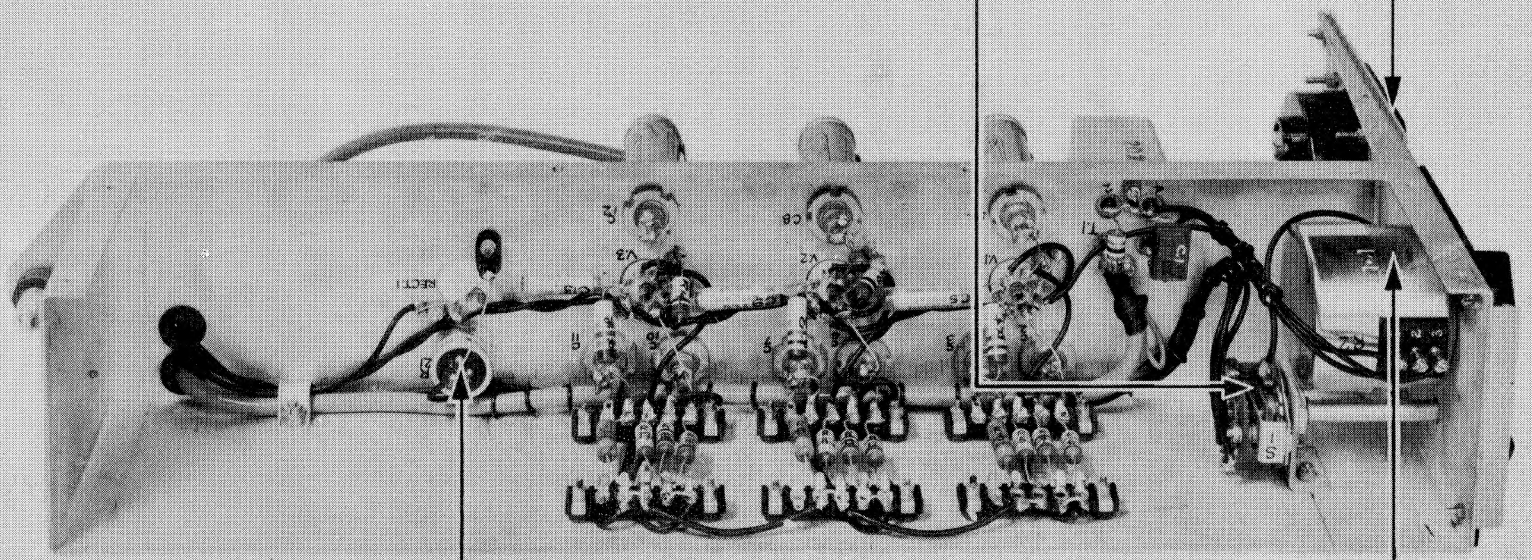
PLATE IV

UNDERSIDE VIEW OF FIRST AND SECOND DEMODULATOR UNIT, CODE No. 109-LRU.9A



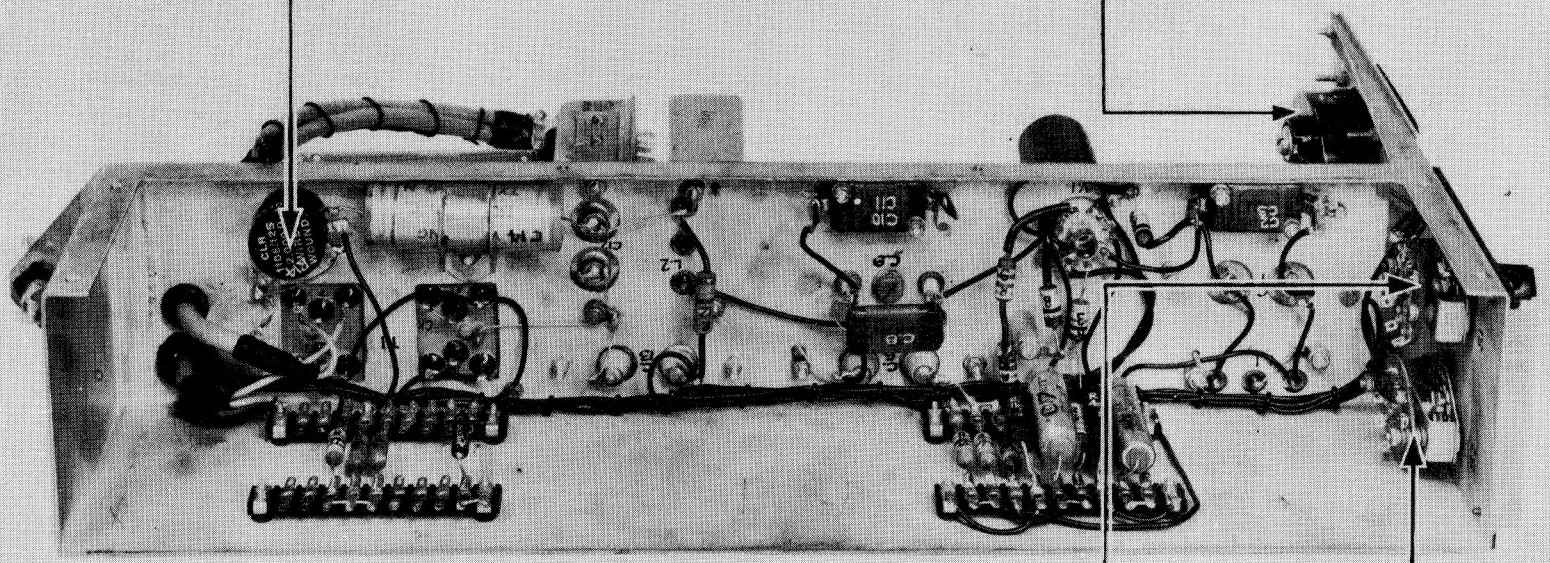
UNDERSIDE VIEW OF THIRD DEMODULATOR UNIT. CODE No. 109-LRU.10A

PLATE V



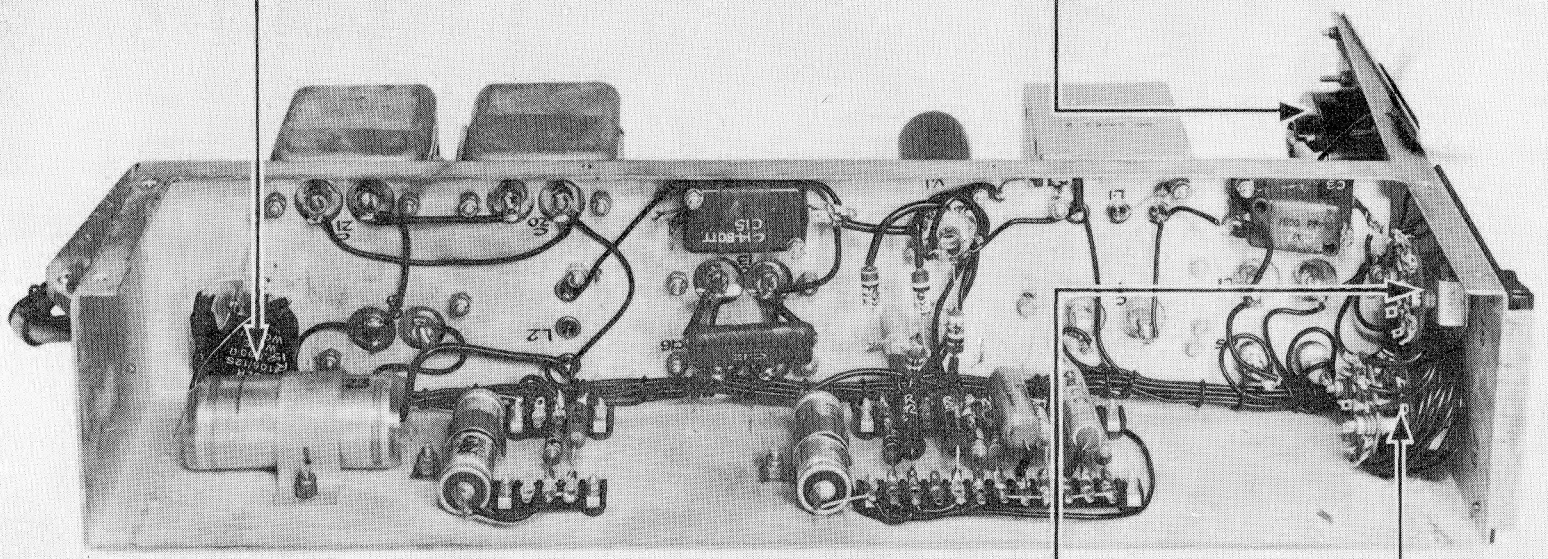
UNDERSIDE VIEW OF 'MONITOR AMPLIFIER UNIT, CODE No.171-LRU.47A

PLATE VI



UNDERSIDE VIEW OF OSCILLATOR UNIT (1775 C/S) CODE No. 16-LRU.217A

PLATE VII



UNDERSIDE VIEW OF OSCILLATOR UNIT (1100 & 425 C/S) CODE No. 16-LRU.217B

PLATE VIII

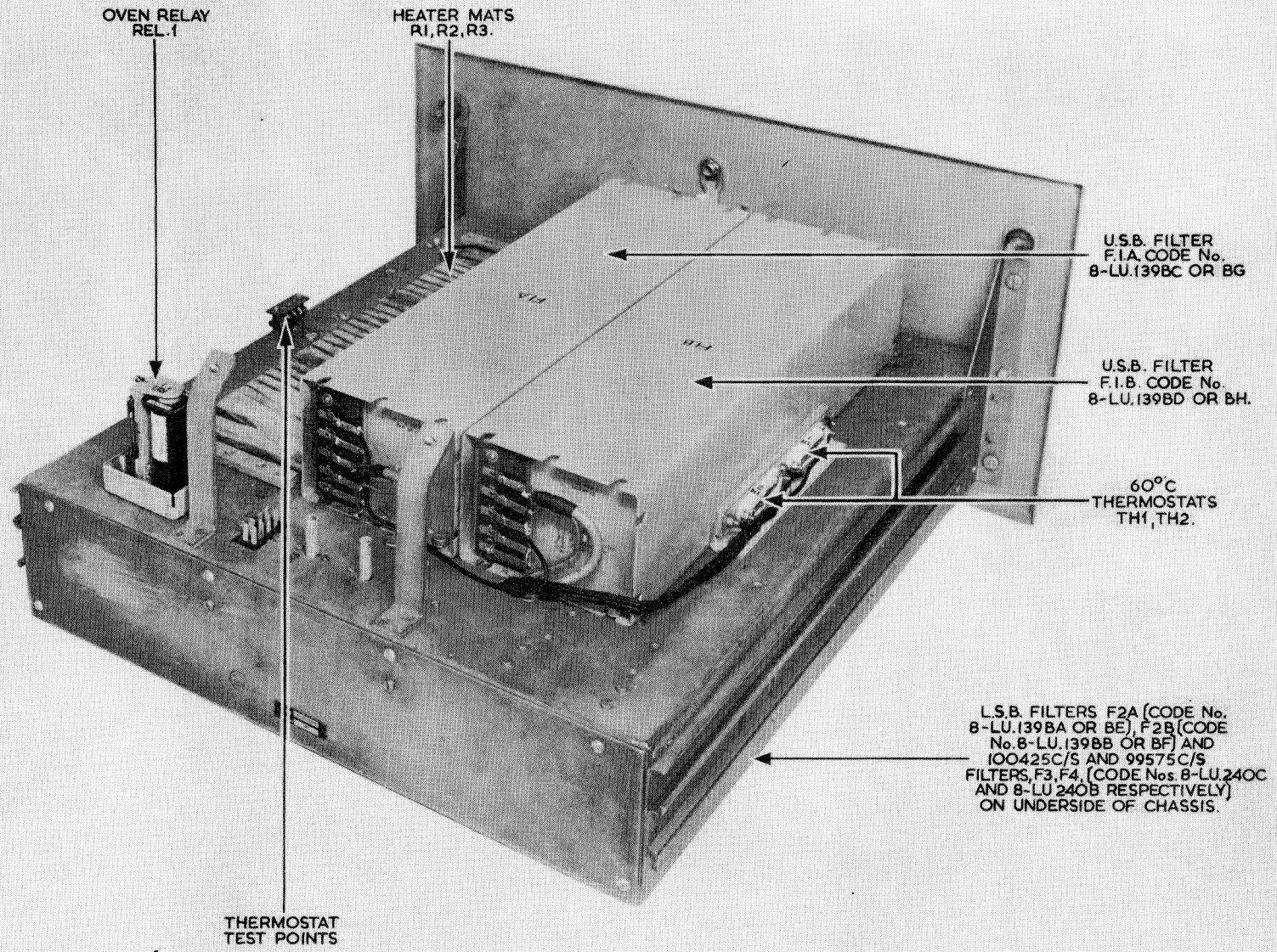


PLATE IX

REAR VIEW OF FILTER UNIT, CODE No. 8-LRU. 297B

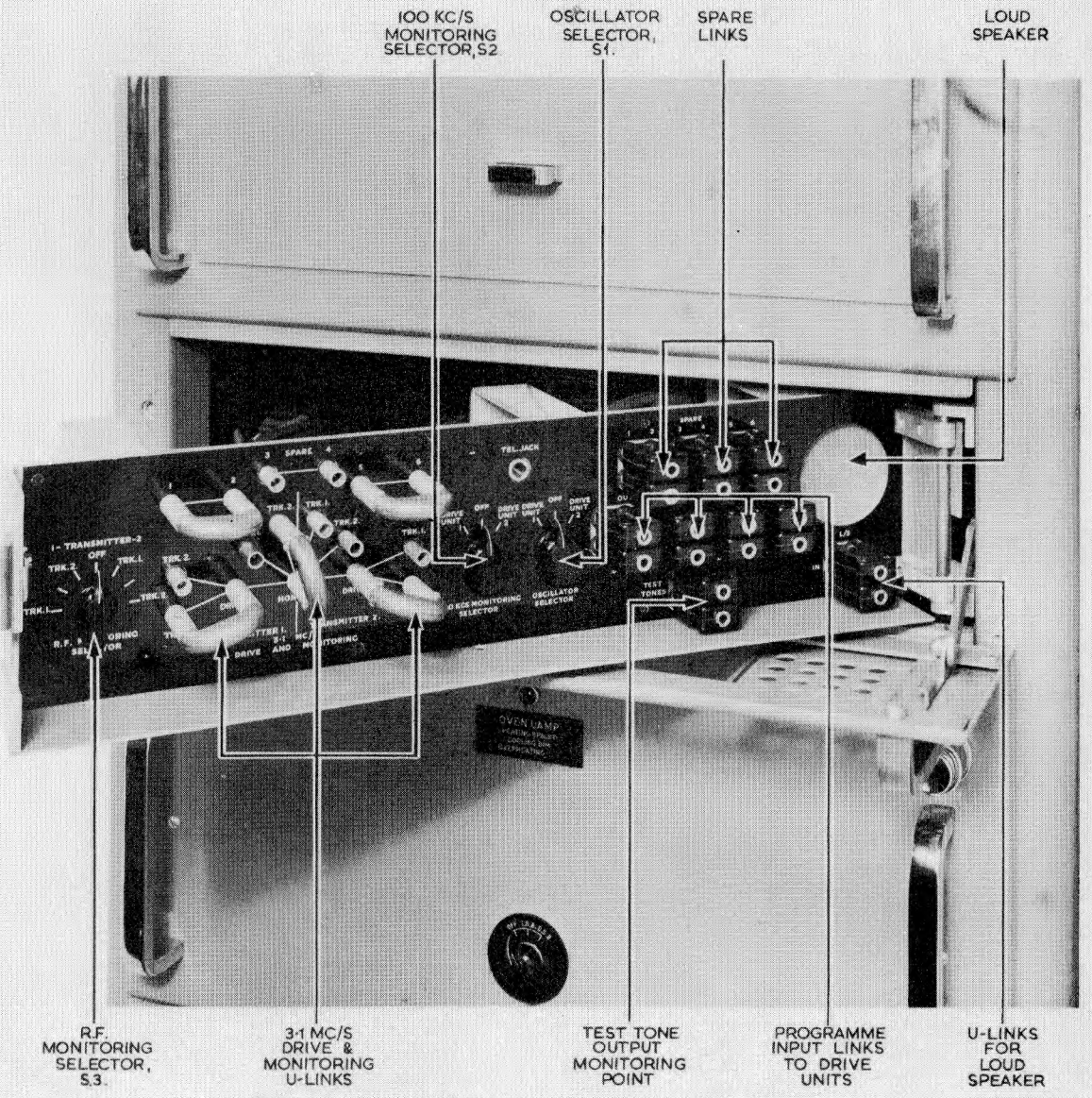
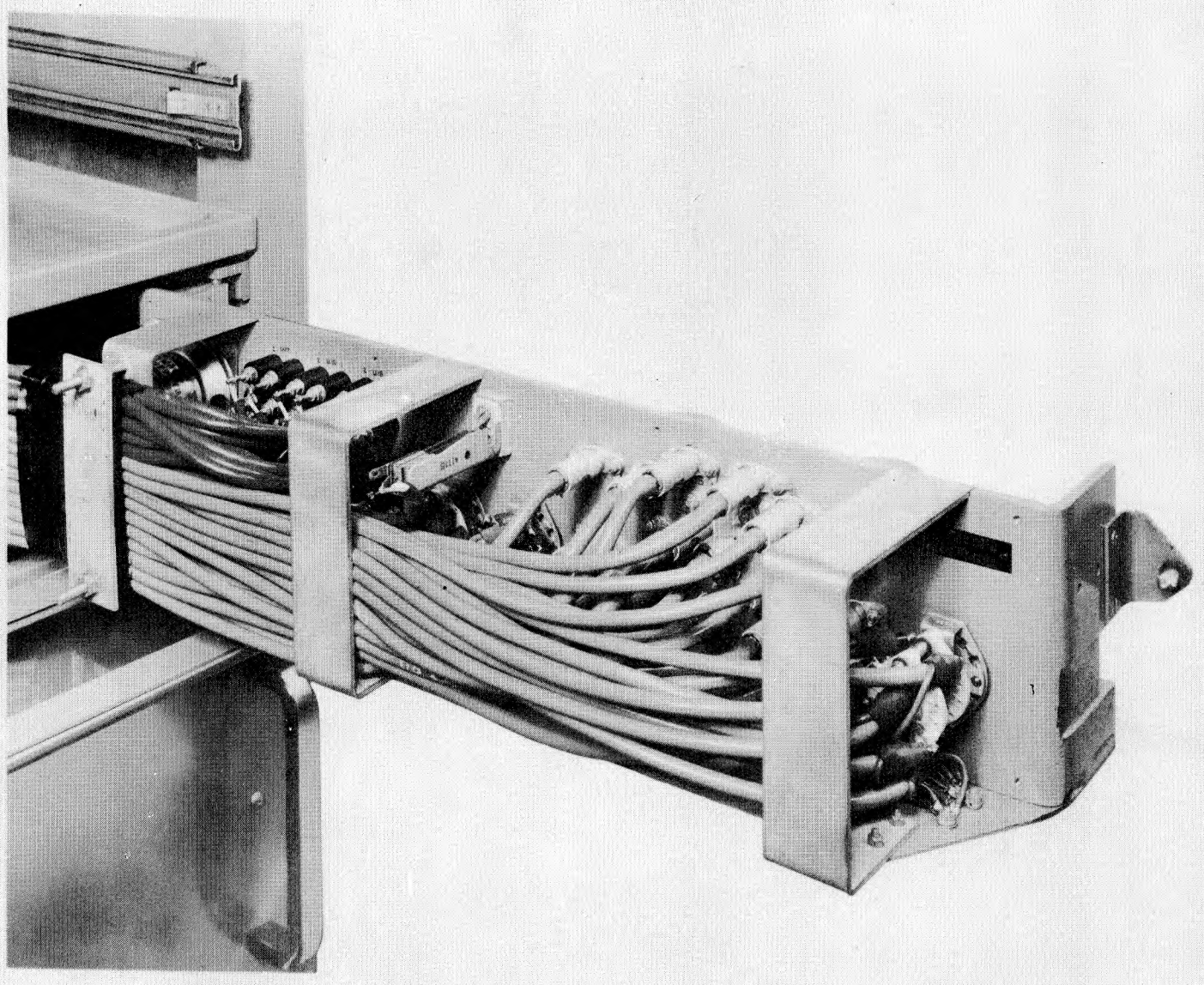


PLATE X

FRONT VIEW OF JACK PANEL CODE No. 87-LRU.50A



REAR VIEW OF JACK PANEL, CODE No. 87-LRU.50A

PLATE XI

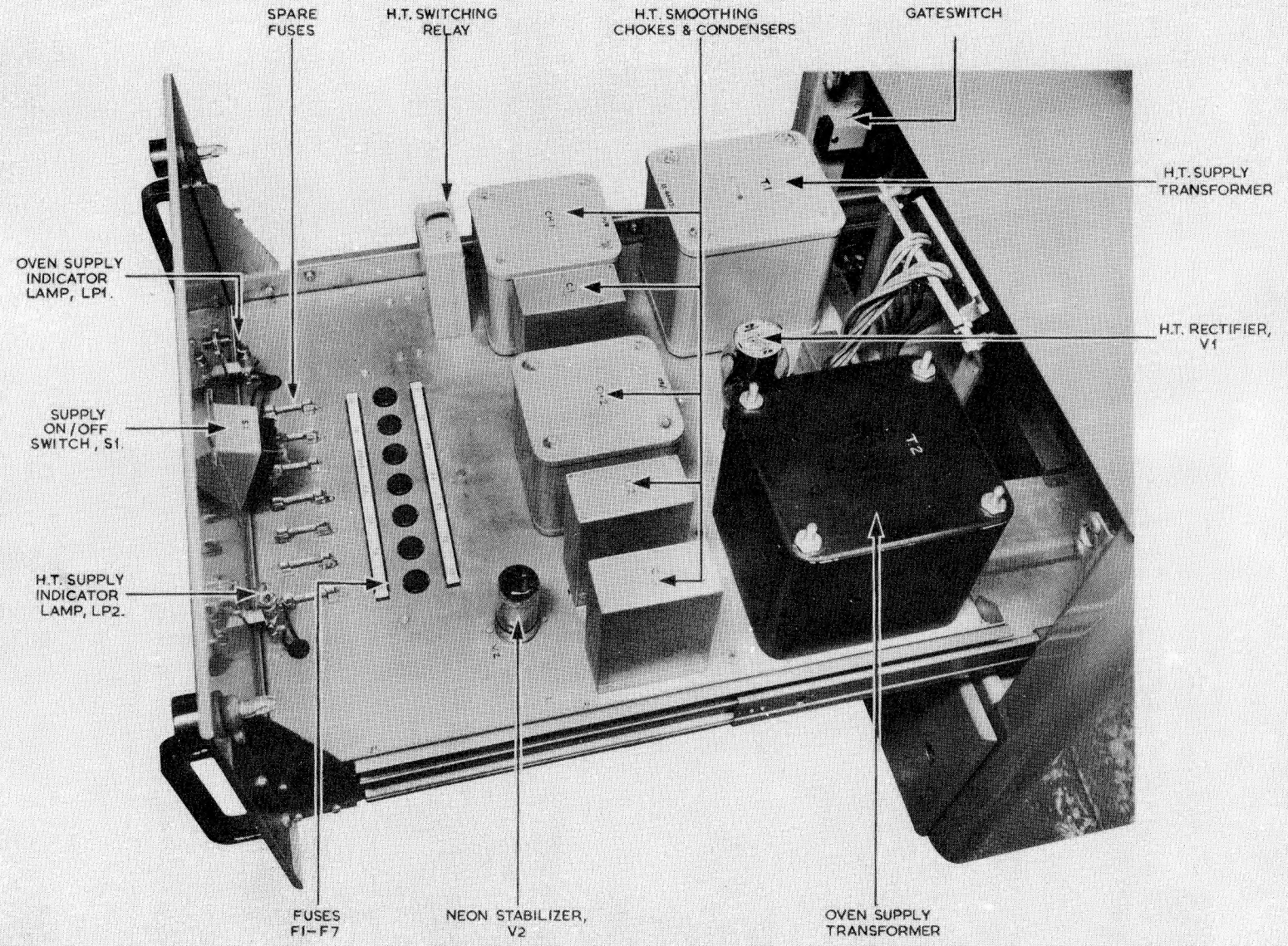
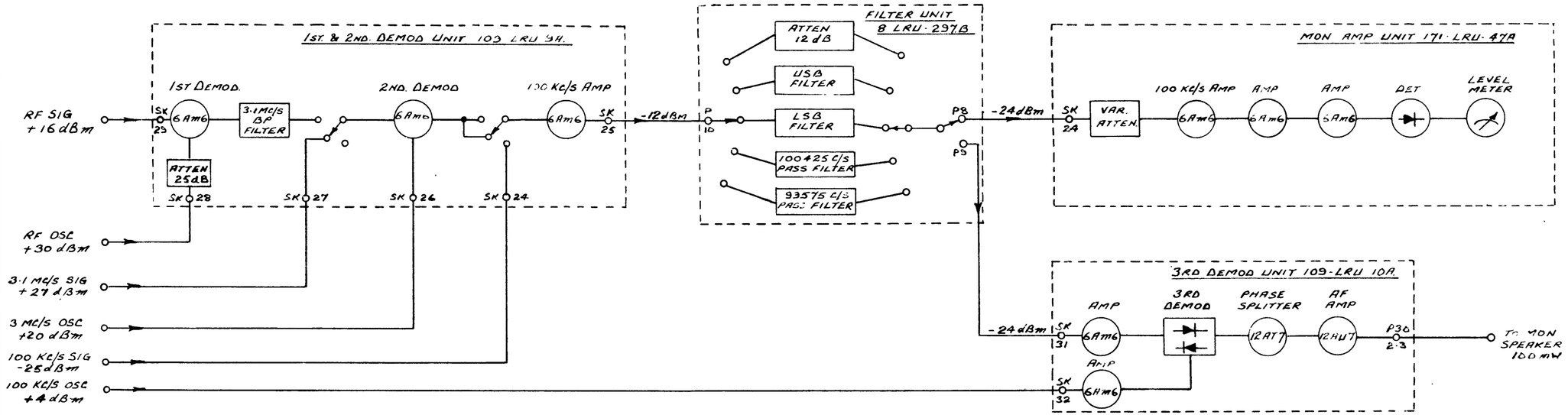
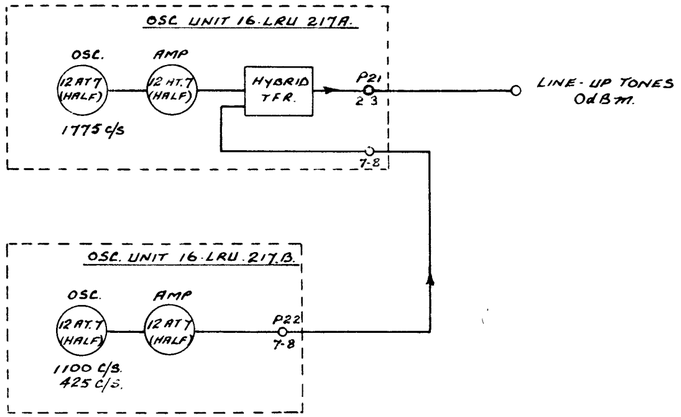


PLATE XII

GENERAL VIEW OF POWER UNIT, CODE No. 94-LRU.204A





SSB MONITOR UNIT TYPE A.1407.B.

DRN BY DEPT
3735
ISS: E.1.
IC / ST
WIRING MODIFIED C.H.N.C. 4321-16.
ISSUE 2

DIST 'H'
3735-1

FIG.1

DRN	CH'KD
RCD	
ENG	APP

188 LRE 2
SHT 3

RESISTORS

SCHEM Nº	VALUE	TOL.	RATING	RCSC CODING	SERVICE REF. Nº	REMARKS
R1	82 Ω	±10%		RCJ 820K		
R2	1 KΩ					POTENTIOMETER. DUBILIER TYPE YA
R3	1.8KΩ	±2%		RCD 182G		WELWYN A3622
R4	100Ω	±10%		RCJ 101K		
R5	10 K	±10%		RCH 103K		
R6	100Ω	±10%		RCJ 101K		
R7	1 KΩ	±10%		RCJ 102K		
R8	8.33Ω	±1%				METER RESISTANCE ETE.I TYPE WE 10mA
R9	6.8KΩ	±10%		RCH 682K		
R10	2.2KΩ	±10%		RCJ 222K		
R11	82Ω	±10%		RCJ 820K		
R12	1 KΩ					POTENTIOMETER DUBILIER TYPE YA
R13	100KΩ	±10%		RCJ 104K		
R14	1KΩ	±10%		RCH 102K		
R15	100KΩ	±10%		RCJ 104K		
R16	4.7KΩ	±10%		RCH 472K		
R17	10KΩ	±10%		RCJ 103K		
R19	1 KΩ	±10%		RCJ 102K		
R20	8.33Ω	±1%				METER RESISTANCE ETE.I. TYPE WE 10mA
R21	10KΩ	±10%		RCJ 103K		
R22	10KΩ	±10%		RCH 103K		
R23	100KΩ	±10%		RCJ 104K		
R24	4.7KΩ	±10%		RCH 472K		
R25	180Ω	±10%		RCJ 181K		
R26	8.33Ω	±1%				METER RESISTANCE E.T.E.I. TYPE WE 10mA
R28	4.7KΩ	±10%		RCJ 472K		
R29	150Ω	±10%		RC6K 151K		
R30	150Ω	±10%		RC6K 151K		
R31	2.4KΩ	±2%		RCD 242G		WELWYN A3622

ISSUED BY - DEPT 3735

ISSUE 1.
17 4 51
R15 WAS RCJ 104 K
R28 ADDED.
CH. Nº 4446-1
JAB

ISSUE 2.
20 / 3 / 51
R3 WAS 100Ω ±5% WELWYN AW2 3111
R12 WAS COLVERN CLR 1106/1115.
R14 WAS 1CKΩ RCH. 103K.
R28, R29, R30 R31 ADDED
CH NO. 4446-2

ISSUE 3
7.1.52
R18 DELETED
R32 33 & 34 ADDED.
CH 4446/7

ISSUE 4.
1 9 52
R32, 33 & 34 DELETED
C/N 4446A

ISSUE 5
6.10.52.
R27 DELTD.
CH. 4446/11

ISS. 6
13.1.53.
R15 WAS SHOWN AS 100 KΩ
CH. 4446/13

ISS. 7
12.6.53
R15 WAS 100Ω RCJ 101K
CH 4446/14

ISS 8
14 9 53.

3781-1
3735-1
DIST 'H'

DRN. JAB	CHKD.
APP.	ENG.

109-LRU-9
SHEET 7.1.1

FOR CONTINUATION SEE SHT. 7.1.2

CONDENSERS

SCHEM. Nº	VALUE	TOL.	RATING	R C S C. CODING	SERVICE REF. Nº	REMARKS
C1	·01 µf	± 20%				T.C.C CP 32 N
C2	0·1 µf	± 15%				S.T.C. 4775 A
C3	0·1 µf	± 20%				TCC - CP 36 H
C4	120 pf	± 2%				DUBILIER S 635
C5	390 pf	± 5%				DUBILIER S 635
C6	390 pf	± 5%				DUBILIER S 635
C7	0·1 µf	± 15%				S.T.C 4775 A
C8	·01 µf	± 20%				T.C.C. CP 33S
C9	0·1 µf	± 15%				S.T.C 4775 A
C10	0·1 µf	± 15%				S.T.C. 4775 A
C11	820 pf	± 2%				DUBILIER S 635
C12	0·01 µf	± 2%				T.C.C. CP 32 N
C13	0·1 µf	± 20%				T.C.C. CP 36 H
C14	650 pf	± 2%				DUBILIER S 635
C15	0·1 µf	± 15%				S.T.C. 4775A
C16	0·1 µf	± 15%				S.T.C. 4775 A
C17	0·1 µf	± 15%				S.T.C. 4775A.
C18	820 pf	± 2%				DUBILIER 5635

ISSUED BY:-
DEPT. 3735

ISSUE. 1.
1/ 4 51
C18 ADDED.
CH. Nº. 4446-1
JRB

ISSUE. 2.
26-7-51
C4 WAS 100pf ± 5%. C17 WAS 0·1uF ± 20% TCC CP36H
CH. NO. 4446-2

ISSUE. 3.
7-1-52
C14 WAS 820
CH. 4446/11

155.4
13-1-53.

3735 - 1
DIST. 'H'

DRN.	CHKD.
APP.	ENG.

109-LRU-9
SHEET 7-1-2

FOR CONTINUATION SEE SHT 7-1-3

TRANSFORMERS

T1	S.T.C. TYPE MO 42161-4 TURNS RATIO 1-2 : 3-4 = 1 : 11.9
T2	S.T.C. TYPE MO 42161-4 TURNS RATIO 11·9 : 1
T3	S.T.C. TYPE MO 42161-4 TURNS RATIO 11·9 : 1

VALVES

V1	6 AM 6 (CV 138)
V2	6 AM 6
V3	6 AM 6

METERS

M1	E.T.E.I MODEL 225 SCALED 0-10 mA FSD 1 MA D.C. 75 Ω

SWITCHES

S1	RL 7016-279 A
S2	RL 7016-205 B

INDUCTANCES

L1	25 μH 20-LU-212 G

END

ISSUED BY DEPT. 3735

ISSUE 1. 17-4-51
T1 TURNS RATIO WERE 11·9·1 (CV 138) ADDED TO V.I.
CH. No 4446-2

ISSUE 2

3735 - 1
DIST. H

DR. GHB | CHK.
APP. | ENG.

109-LU-9
SHEET 7·1·3

DRN BY DEPT
ISSUE 1

TWISTED WIRING
F & R VALVE FILAMENTS
ADDED.
C8 & R28 ADDED
ACROSS T3 TERMS
3 AND 4.
CH NO 4446-1

ISSUE 2

R6, 31
AINS MODIFIED
CH NO 4446-2

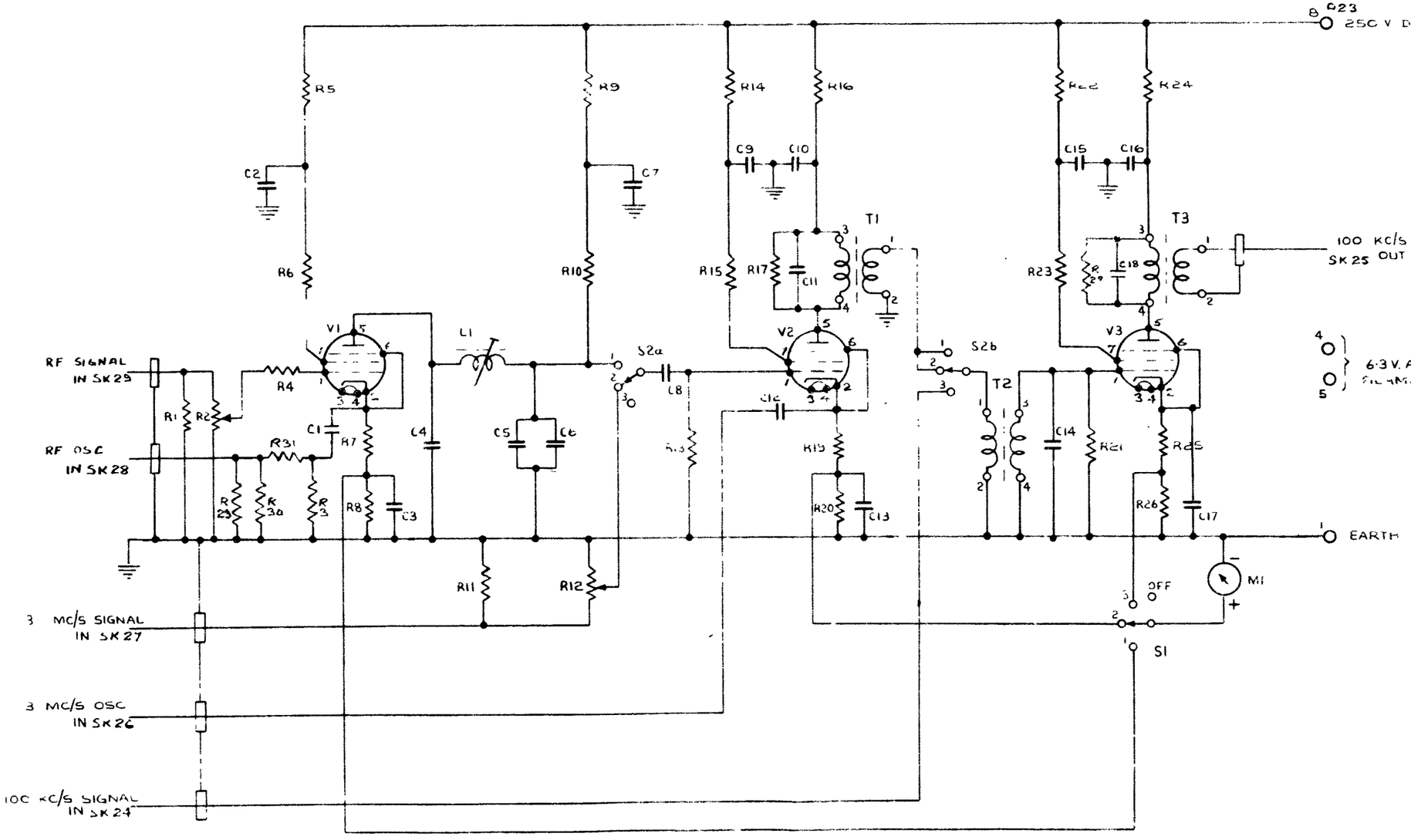
ISSUE 3

C8 DELETED
R30, 33 & 34
ADDED
CH NO 4446-7

ISSUE 4.
1.12.52
R 32, 33 & 34 DELETED
C/N 4446-9

ISSUE 5
6.10.52
R27 DELTD.
C/N 4446

13.1.53.



1ST AND 2ND DEMODULATORS

FOR COMPONENT LIST
SEE SHTS. 7-1-1, 7-1-2 & 7-1-3

FIG. 2.

3745
DIST H

DRN	CHKD
APP	ENGR

109-LRU-9
SHEET 7-1

RESISTORS

SCHEM. Nº	VALUE	TOL.	RATING	R.C.S.C. CODING	SERVICE REF. Nº	REMARKS
R1	82 Ω	±10%		RCJ 820K		
R2	100KΩ	±20%				POTENTIOMETER. DUBILIER TYPE YA
R3	220 Ω	±10%		RCJ 221K		
R4	3·3KΩ	±10%		RCJ 332K		
R5	22KΩ	±10%		RCH 223K		
R6	4 Ω	±1%				METER SHUNT ETEI TYPE WE 20mA
R8	100KΩ	±20%				POTENTIOMETER. DUBILIER TYPE YA
R9	4·7KΩ	±10%		RCH 472K		
R10	3·3KΩ	±10%		RCJ 332K		
R11	680Ω	±10%		RCJ 681K		
R12	470KΩ	±10%		RCJ 474K		
R13	8·33Ω	±1%				METER SHUNT ETEI TYPE WE 10mA
R14	10KΩ	±10%		RCJ 103K		
R15	100KΩ	±20%				POTENTIOMETER. DUBILIER TYPEY A
R16	100KΩ	±20%				POTENTIOMETER. DUBILIER TYPE YA
R17	1KΩ	±10%		RCJ 102K		
R18	47KΩ	±10%		RCH 473K		
R19	220KΩ	±10%		RCJ 224K		
R20	220KΩ	±10%		RCJ 224K		
R21	8·33Ω	±1%				METER SHUNT E.T.E.I TYPE WE 10mA
R22	8·33Ω	±1%				METER SHUNT. ETEI TYPE WE 10mA
R23	470KΩ	±10%		RCJ 474K		
R24	470KΩ	±10%		RCJ 474K		
R25	470KΩ	±10%		RCJ 474K		
R26	470Ω	±10%		RCJ 471K		
R27	4Ω	±1%				METER SHUNT E.T.E.I TYPE WE 20mA
R28	4Ω	±1%				METER SHUNT. E.T.E.I. TYPE WE 20mA
R29	25KΩ	±20%				POTENTIOMETER. DUBILIER TYPE YA
R30	100KΩ	±10%		RCJ 104K		
R31	100KΩ	±10%		RCJ 104K		
R32	470KΩ	±10%		RCJ 474K		

ISSUED BY DEPT. 3735

ISSUE.1
1/4/51
R30 & R31 ADDED
CH. Nº 4447-1
JAB

ISSUE.2.
6/6/51
R.12 WAS 1MΩ
RCJ 105K.
R.32 ADDED.
CH NO. 4447-2.

ISSUE.3.
7/5/52
R7 DELETED.
R6, 27 & 28
WERE 8·33Ω
WE 10 MA
C/N 4447/8

ISSUE.4.
17 9 52

3735-1
DIST H

DRN. JAB	CHKD.
APP	ENG

109-LRU-10
SHEET 7·1·1

FOR CONTINUATION SEE SHT. 7·1·2

CAPACITORS

ISSUED BY:- DEPT. 3735

ISSUE. 1.
1/.4.51
C14 WAS 100 pf
CH No 4447-1
JAB.

ISSUE. 2.
24/5/
C1 C4 C10 & C18 ADDED.
C14 DELETED.
C17 WAS STC. 4775H
CH No 4447-2

ISSUE 3.
CH No 4447-5 DBJ

ISSUE. 4
1/4/52

SCHEM. No	VALUE	TOL.	RATING	RCSC. CODING	SERVICE REF. No	REMARKS
C1	820pf	±2%				DUBILIER S 635
C2	0·1μf	± 15%				S.T.C 4775 A
C3	0·1μf	± 15%				STC 4775 A
C4	820pf	± 2%				DUBILIER S 635
C5	·001μf	± 10%				TCC CP110N
C6	0·1μf	± 15%				STC 4775 A
C7	330pf	± 10%				DUBILIER S 635
C8	330pf	± 10%				DUBILIER S 635
C9	56pf	± 2%				DUBILIER S 635
C10	4-50pf			TYPE CVA5-A RCL 141		(or 5-50 PF POLAR TRIMMER C803)
C11	·01μf	± 20%				TCC CP112H
C12	100pf	± 10%				DUBILIER S 635
C13	1μf	± 20%				TCC TYPE 62 (1M)
C14						
C15	·005μf	± 10%				TCC CP 31 N
C16	·005μf	± 10%				TCC CP 31 N
C17	0·1μf	± 20%				T.C.C. CP 36H
C18	0·1μf	± 20%				T.C.C. CP 36H.

3735 - 1
DIST. H

DRN. JAB	CHKD.
APP.	ENG.

109-LRU-10
SHEET 71-2

FOR CONTINUATION SEE SHT. 71-3

VALVES

V1	6 AM 6 (CV 138)
V2	6 AM 6
V3a	12 AX 7 (CV 492)
V3b	
V4a	12 AU 7 (CV 491)
V4b	

TRANSFORMERS

T1	STC TYPE MO 42161-4 TURNS RATIO 1:11·9
T2	STC TYPE MO 42161-4 TURNS RATIO 1:11·9
T3	STC. TYPE CR 43162-9 TURNS RATIO 5-6 : 1-4 = 1·7 : 1
T4	STC. TYPE MO 42161-8 PRIMARY INDUCTANCE 41·5 mH
T5	STC. TYPE CX 43137-6 TURNS RATIO 1-3 : 4-6 : 7-8 : 9-10 = 100 : 20 : 1 : 2

RECTIFIERS

RECT1	GERMANIUM CRYSTAL B.T.H. TYPE CG-1C
RECT2	GERMANIUM CRYSTAL BTH. TYPE CG-1C

SWITCHES

S1	OAK TYPE MH RL 7016-284 A

METER

M1	E.T.E.I TYPE 225 TO SPEC ZA10B SCALED 0-10 mA FSD 1mA D.C. 75Ω

END

ISSUED BY DEPT. 3735

ISSUE 1. 17 4 51

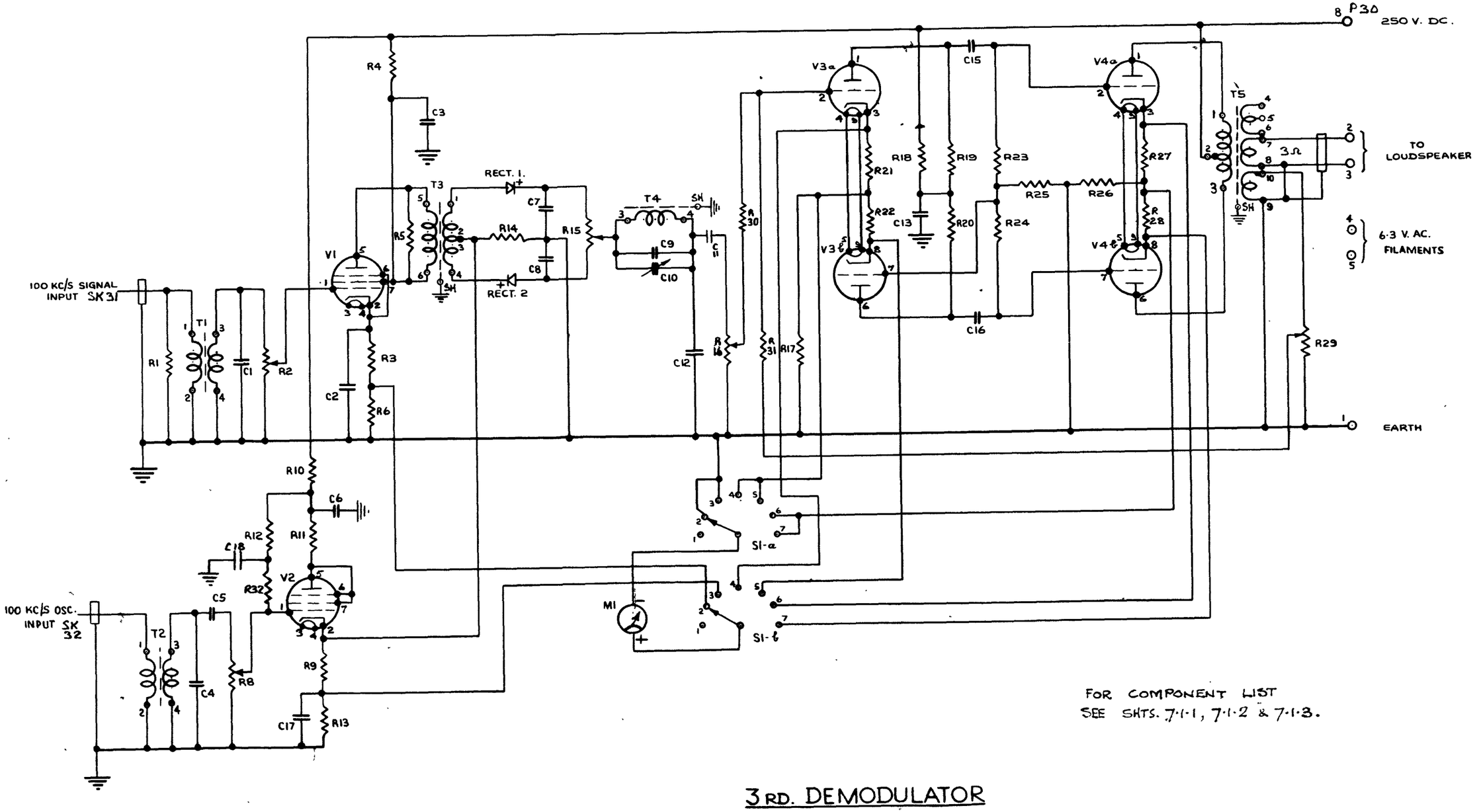
V3a & b WAS 12 AX 7
V4a & b WAS 12 AX 7.
ADDITIONAL INFORMATION ADDED TO T3, T4, T5
CH. NO 4447-2

ISSUE 2. 7.1.52

3735-1
DIST. H

DRN GAB	CHK'D
APP	ENG.

109-LRU-10
SHEET 7·1·3



FOR COMPONENT LIST SEE SHTS. 7·1·1, 7·1·2 & 7·1·3.

3RD. DEMODULATOR

DRN BY DEPT. 3735
ISSUE. 1.
17·4·51
C14 WAS CONNECTED TO GRID OF V3A.
R30 AND R31 ADDED.
T5 - TERMS. 9 AND 10 WERE REVERSED.
FILAMENT WIRES SHD TWISTED.
CH. NO. 4447-1 JAB.

ISSUE. 2.
26·7·51
WIRING MODIFIED CH. NO. 4447. 2

ISSUE. 3.
7·1·52
R7 ACROSS T2-1 & 2 DELETED
CH. 4447/8

ISSUE. 4.
2·9·52.

3735 - 1
DIST - 8

F 6.

APP.- ENG.-

109-LRU-10
SHEET. 7·1

RESISTORS

SCHEM. Nº	VALUE	TOL.	RATING	R.C.S.C. CODING	SERVICE REF. Nº	REMARKS
R1	150Ω	±10%		RCJ 151K		
R2	10KΩ					ATTENUATOR PAINTON TYPE J
R3	8·2KΩ	±10%		RCH 822K		
R4	1·5KΩ	±10%		RCH 152K		
R5	47KΩ	±10%		RCJ 473K		
R6	180Ω	±10%		RCJ 181K		
R7	12Ω	±10%		RCJ 120K		
R8	100KΩ	±10%		RCJ 104K		
R9	8·2KΩ	±10%		RCH 822K		
R10	1·5KΩ	±10%		RCH 152K		
R11	47KΩ	±10%		RCJ 473K		
R12	180Ω	±10%		RCJ 181K		
R13	12Ω	±10%		RCJ 120K		
R14	100KΩ	±10%		RCJ 104K		
R15	8·2KΩ	±10%		RCH 822K		
R16	5·6KΩ	±10%		RCH 562K		
R17	47KΩ	±10%		RCJ 473K		
R18	180Ω	±10%		RCJ 181K		
R19	12Ω	±10%		RCJ 120K		
R21	100KΩ					POTENTIOMETER ±20% DUBILIER TYPE YA

ISSUED BY:-
DEPT. 3735

PROV. ISSUE A
17.4.51
R4 WAS 6·8KΩ
RCH 682K
R6 WAS 180Ω
RCJ 181K
R7 WAS 7·7Ω
PRINTON
R10 WAS 6·8KΩ
RCH 682K.
R13 & R19 WERE
7·7Ω PRINTON
CH Nº 4448-1
JAB

ISSUE 2
R4 WAS 15KΩ
RCH 153K
R6 WAS 15KΩ
RCH 153K
R7 WAS 1%
R10 WAS 15KΩ
RCH 153K
R13 WAS 1%
R16 WAS 6·8K
RCH 682K
R19 WAS 1%
R20 DELETED
CH No 4448-2

ISSUE 3
R [illegible]
CH 4448-[illegible]

ISS 4
13·1·53.

3735-1
DIST H

DRN.	CHKD.
APP.	ENG.

171-LRU-47
SHEET 7·1·1

FOR CONTINUATION SEE SHT 7·1·2

CAPACITORS

SCHEM. Nº	VALUE	TOL.	RATING	R.C.S.C. CODING	SERVICE REF. Nº	REMARKS
C1	820 pF	± 2%				DUBILIER S 635
C2	0·1 µf	± 15%				STC 4775 A
C3	0·5 µf	± 15%				STC 4775 C
C4	0·1 µf	± 15%				STC 4775 A
C5	·01 µf	± 20%				TCC CP 32 N
C6	0·1 µf	± 15%				STC 4775 A
C7	0·1 µf	± 15%				STC 4775 A
C8	0·1 µf	± 15%				STC 4775 A
C9	·01 µf	± 20%				TCC CP 32 N
C10	0·1 µf	± 15%				STC 4775 A
C11	0·1 µf	± 15%				STC 4775 A
C12	0·1 µf	± 15%				STC 4775 A
C13	·01 µf	± 20%				TCC CP 32 N

ISSUED BY:-
DEPT. 3735

PROV. ISSUE. A
17.4.51
C3 ·05µf ± 15%
STC 4775C
WAS ·01µf ± 15%
STC 4775A
CN NO. 4448-2

ISSUE 2
7/5/K

3735 - 1
DIST. 'H'

DRN.	CHKD.
APP	ENG.

171-LRU-47
SHEET 7·1·2

FOR CONTINUATION SEE SHT. 7·1·3

VALVES

V1	6 AM 6 (CV 138)
V2	6 AM 6
V3	6 AM 6

TRANSFORMER

T1	S.T.C. TYPE MO 42161-4 TURNS RATIO 1:11·9

METER

M1	ETEI TYPE 225, TO RL 7003-64A SCALED 0-10 mA FSD 250 μA D.C.

SWITCH

S1	OAK TYPE "DM" RL 7016-206 C

RECTIFIER

RECT1	GERMANIUM CRYSTAL B.T.H TYPE GC-1C

END

ISSUED BY
DEPT. 3735

- ISSUE 1
17.4.57
RL 7003-64A WAS SPEC. 2A 108.
CH No 4448-1 JAB.

Issue 2
VALVE 4 6AL5 DELETED
RECT 1 ADDED
CH NO. 4448-2

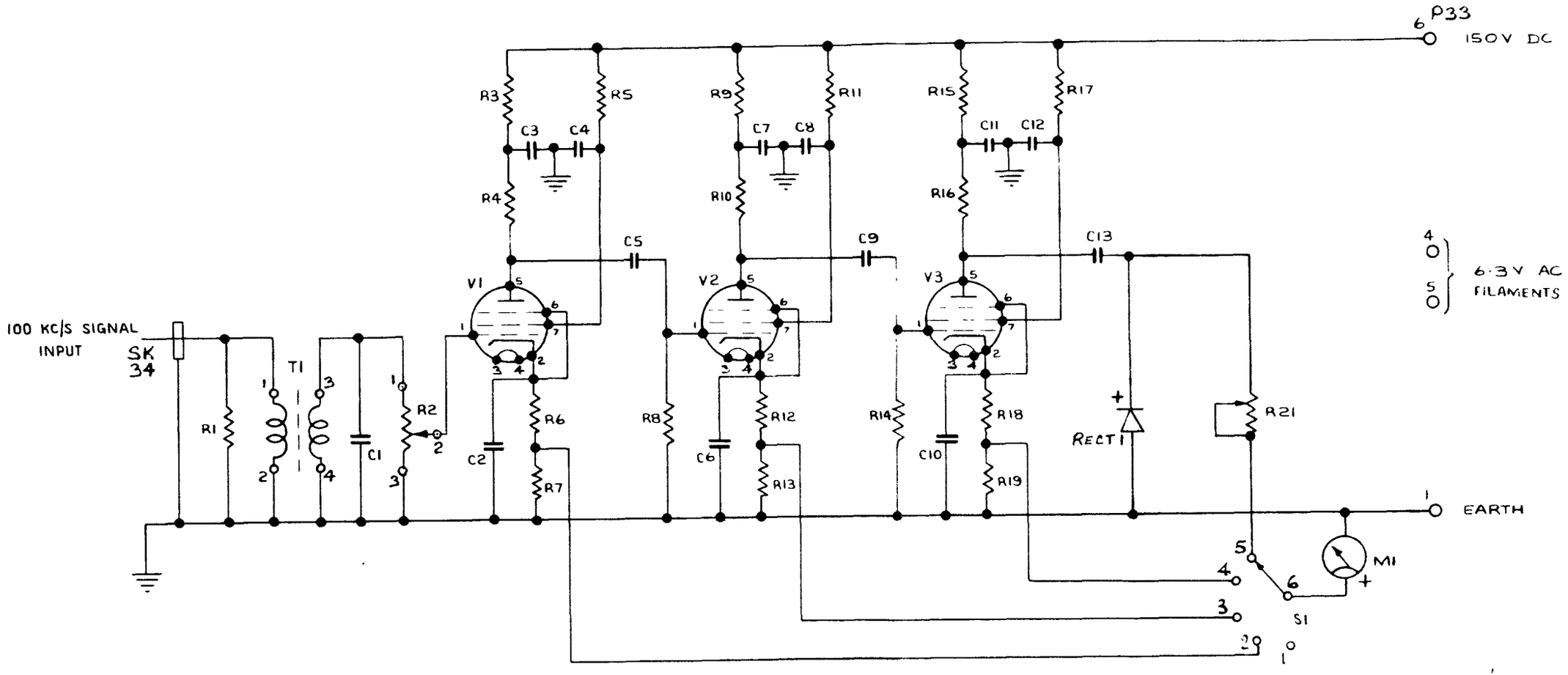
ISSUE 3.
7.1.58
S.I. WAS TYPE "M H" C/N 4448/13 TMB

ISSUE 4.
16.3.54

3735-1
DIST. H

DR JAB | CHKD
APP | ENGR

171-LRU-47
SHEET 7·1·3



100 KC/S MONITOR AMPLIFIER

FOR COMPONENT LIST SEE SHTS 7·1·1 7·1·2 & 7·1·3

DRN BY DEPT 373
ISSUE 1
17 4 51
VALVE FILAMENTS TWISTED WIRES ADDED CH N° 4448-1 JAP

ISSUE 2
20 , 5 1
WIRING MODIFIED RECTIFIER 1 ADDED CH NO 4448-1

ISSUE
CI CCIS
RENUMBERED C/N 4448/13 TAR

ISSUE 4
16·3 54

3735-1
DIST. H

FI
DRN - CHKD:-
APP ENG - H H

171-LRU-47
SHEET 7·1

RESISTORS

ISSUED BY:- DEPT. 3735

ISSUE 1 1/4/51
R6 - WAS 1 KΩ
RCJ 102 K
TOL FOR ALL COMPONENTS ADDED.
CH No. 4445-1
JAB.

ISSUE 2. 26/6/51
VALUE & TOL 3.33Ω ± 1% ADDED TO R9, R11 R18, R19, R20
DELETED R15, R16 & R17 WERE 1K Ω ± 1/2%
CH. 102K R21 ADDED.
CH NO. 4445-2

ISSUE 3. 15-1-52
C/N 11[illegible]/52 PBG

ISSUE 4. 25-4-52

SCHE Nº	VALUE	TOL.	RATING	R.C.S.C. CODING	SERVICE REF. Nº	REMARKS
1		± 10%				
	10	± 10%		4		
R	1K	± 10%		1 K		
R7	8 33Ω	± 1%				METER SHUNT E.E.I.
		± 10%				
	56 KΩ	± 10%		562K		
	K	± 10%				
	Ω	± 10%		14		
		± 10%		RCJ 222		
		± 10%		72		
R1	8·33Ω	± 1				METER HUNT TEITE 10·
1	KΩ	± 10%		CH.		
	3 Ω	± 10%		R		
	2	± 10%				POTENTIOMETER COLVE N R 11 11S
R15	220Ω	± 2°		RC 2		WEL
R16	220Ω	± 2°		R 221		W W' A36 2
R17	8 0Ω	± 2°		R 1		W A
R18						
R19						
R20						
R 3		±		R 301		

DIST 'H' 3735-[illegible]

DRN. ACD | CHKD.
APP | ENG

16·LRU.217A

HT 7·1·

FOR CONTINUATION SEE SHT.

CAPACITORS

ISSUED BY:- DEPT 3735

ISSUE 1
1.4.51
C1 - WAS 0·005μF
4500 AGL.
C2, C3, C10 & C11
VALUE ADDED.
C8 - ADDED
CH. No. 4445-1
JAB

ISSUE 2.
20
2.3.10.51
WERE SMBN
C8 WAS SM3N
C/N 4445/1 APP1

ISSUE 3

SCHEM. Nº	VALUE	TOL.	RATING	R.C.S.C. CODING	SERVICE REF. Nº	REMARKS
C1	·05 μF	±5%				STC TYPE 4500 XG
C2	560 pF	± 2%				TCC TYPE SMAN
C3	1,000 pF	± 2%				TCC TYPE SMAN
C4	0·1 μF	+20%				TCC CP 36 H
C6	1 μF	± 15%				TCC. TYPE 62 IM
C7	0·1 μF	± 20%				TCC. CP 37N
C8	0·002 μF	± 2%				T.C.C. SM2N
C9	0·05 μF	± 2%				STC TYPE 4921.B
C10	820 pF	± 2%				TCC TYPE SMAN
C11	1800 pF	± 2%				TCC TYPE SMAN
C12	1·1 μF	± 2%				STC TYPE 4212 A.
C13	1 μF	± 15%				TCC TYPE 62 IM.
C14	0·5 μF	± 20%				TCC TYPE CP 47N

DIST 'H'
3735-1

DRN. ACD	CHKD.
APP	ENG.

16 LRU 217A

SHT 7·1·2

FOR CONTINUATION SEE SHT.

ISSUED BY - DEPT 3735
ISSUE 1 1.4.51

TRANSFORMERS

T1	600Ω HYBRID STC TYPE CK 4122-36.

INDUCTORS

L1	158 mH ± 1% STC TYPE SD 44162-2
L2	158 mH ± 1% STC TYPE SD 44162 2.

SWITCHES

S1	OAK TYPE MHL RL 7016/205A.
S2	OAK TYPE MHL RL 7016/207A

VALVES

V1	12 AT 7 (CV455)

METERS

M1	E.T.E.I. MODEL 225 0-1 mA DC FSD MOVING COIL 75Ω SCALED 0-10 mA.

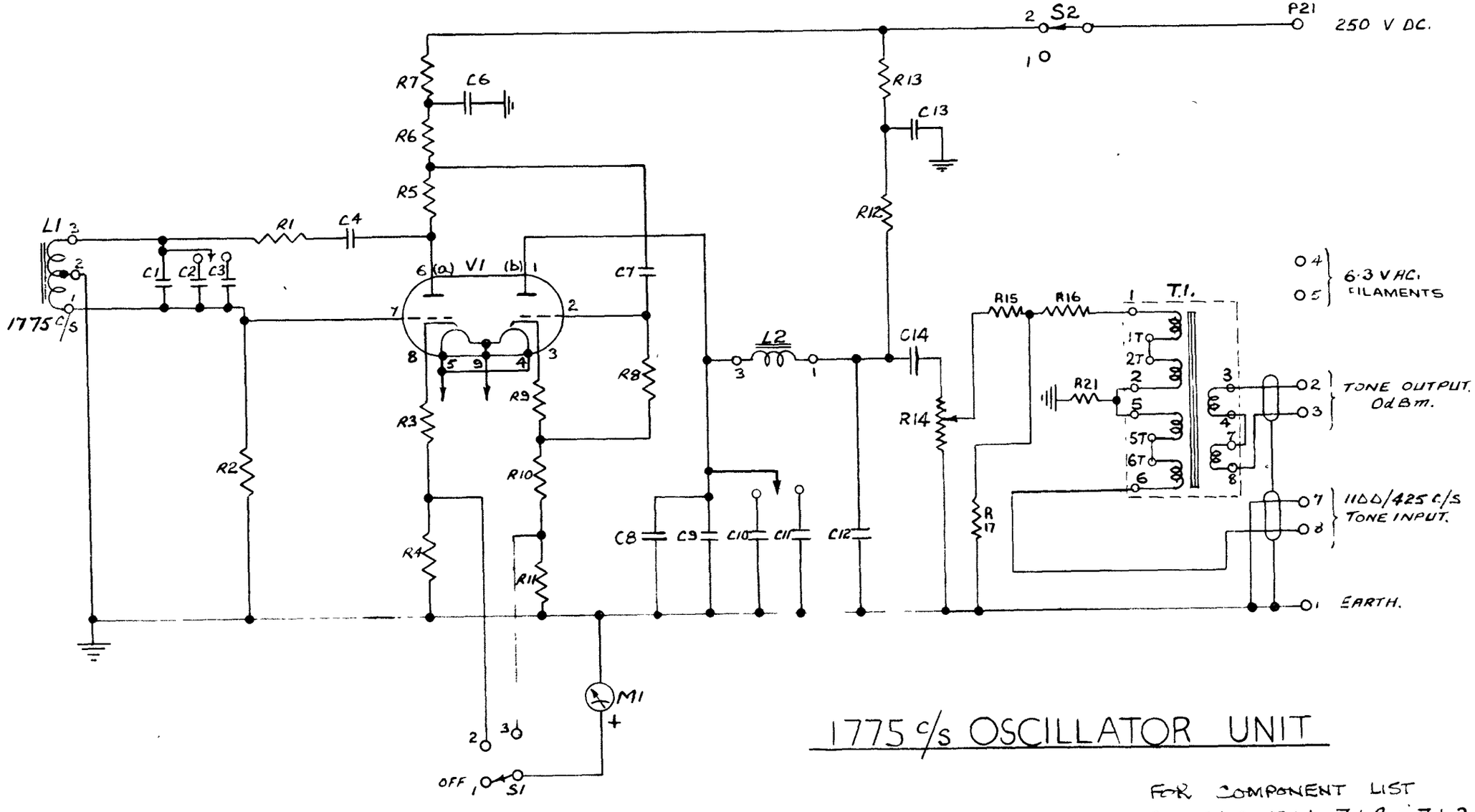
END.

DIST 'H' 3735-1

DRN	CHKD
ACA.	
APP	ENG

16-LRU-217A

SHT. 7·1·3



1775 c/s OSCILLATOR UNIT

FOR COMPONENT LIST SEE SHTS. 7·1·1, 7·1·2 & 7·1·3

DRN By DEPT
3735
ISSUE. 1
17 4 ·
R21 ADDED BETWEEN T1 TERMS 2 AND 5 & EARTH
R19 CONNECTED TO T1 TERM. 5.
FILAMENT WIRING SHOWN TWISTED
CH. No 4445-1 JAB.

ISSUE. 2.
26 · 5 ·
C8 ADDED
No C.N. [illegible]

ISSUE. 3.
[illegible]
WIRING MODIFIED
R18, R19 & R20 DELETED
CH NO 1447 · 2

ISSUE 1
15 [illegible]

DIST. 'H' —— 3735-1

FIG. 5

DRN ACD	CHKD.
APP	ENG

16·LRU 217A

SHT 7·1

RESISTORS.

SCHEM. Nº	VALUE	TOL.	RATING	R.C.S.C. CODING	SERVICE REF. Nº	REMARKS
R1	39KΩ	±10%		RCJ.393K.		
R2	56KΩ	±10%		RCJ 562K.		
R3	100KΩ	±10%		RCJ 104K.		
R4	1KΩ	±10%		RCJ 102K.		
R5	8·33Ω	±1%				METER SHUNT E.T.E.I TYPE WE 10 mA
R6	18KΩ	±10%		RCH.183K.		
R7	10KΩ	±10%		RCJ 103K.		
R8	3·3KΩ	±10%		RCJ. 332K		
R9	100Ω	±10%		RCJ 104K		
R10	1·5KΩ	±10%		RCJ. 152K		
R11	2·2KΩ	±10%		RCJ. 222K		
R12	8·33Ω	±1%				METER SHUNT E.T.E.I. TYPE WE. 10mA
R13	68KΩ	±10%		RCH.682K		
R14	3·3KΩ	±10%		RCJ.332K		
R15	2KΩ					POTENTIOMETER COLVERN CLR 1106/11S
R16	100Ω	±10%		RCJ 101K.		

ISSUED BY:- 3735

ISSUE / 11·4·51
R7-WAS 1KΩ RCJ 102K. CH Nº 4445-1 JAB

Issue 2
26/3/51
VALUE & TOL.
8.33Ω ±1% ADDED TO R5. R7 WAS 56KΩ ±10% RCJ562K R10 WAS 2·2KΩ ±10% RCJ 222K R11 WAS 4·7KΩ ±10% RCJ472K R16 ADDED. CH.NO. 4445/2

ISSUE 3
15-1-52.

DIST 'H' 3735-1

DRN. HCD	CHKD.
APP.	ENG.

16 LRU 217/3

7·2·1

FOR CONTINUATION SEE SHT

CAPACITORS

ISSUED BY:- 3735

ISSUE 1
1/4/51
C2, C3, C14 & C15 VALUE ADDED.
C12 ADDED
CH No. 4445-1
JAB.

ISSUE. 2
26/5/51
C11 WAS SMBN
CH No 4475 APPL
C8-7-17 & 18
DELETED

ISSUE. 3
20/8/51
C11 WAS 1.0 µF
CH. No 4445/2

ISSUE A
15-1-52

SCHEM Nº	VALUE	TOL.	RATING	RCSC CODING	SERVICE REF. Nº	REMARKS
C1	0·1279 µF	±·5%				STC. TYPE 4500 BR.
C2	1800 pF	± 2%				TCC TYPE SMAN
C3	3900 pF	± 2%				TCC TYPE SMBN
C4	0·7 µF	±·5%				STC TYPE 4575E
C5	0·17 µF	± 1%				STC. TYPE 4500 ACJ
C8	0·1 µF	±20%				TCC TYPE CP 36H.
C10	2 µF	+50% −20%				TCC TYPE CE17L
C11	0·1 µF	±20%				TCC TYPE CP 37N.
C12	4,700 pF	± 2%				TCC TYPE SM3N
C13	0·13 µF	± 2%				STC TYPE 4211AF
C14	2,700 pF	± 2%				TCC TYPE SMBN
C15	5,600 pF	± 2%				TCC TYPE SMBN
C16	1·1 µF	± 2%				STC TYPE 4212A.
C19	2·75 µF	± 2%				STC TYPE 4213A.
C20	2 µF	± 2%				STC TYPE 4212D.
C21	2 µF	± 2%				STC TYPE 4212D.
C22	2 µF	+50% −20%				TCC TYPE CE17L
C23	1 µF	±20%				TCC TYPE CP 91N.

FOR CONTINUATION SEE SHT.

DIST'H 3735-1

DRN ACA	CHKD.
APP	ENG.

16.LRU.2178

7.2.2

	INDUCTORS
L1	158 mH ± 1% STC TYPE SD44162-2
L2	158 mH ± 1% STC TYPE SD44162-2
	SWITCHES
S1	OAK TYPE MHL TO RL.7016/205A
S2	OAK TYPE MHL TO RL.7016/285A
	VALVES.
V1	12 AT 7 (CV.455)
	METER
M1	E.T.E.I. MODEL 225 0-1mA DC FSD MOVING COIL 75Ω SCALED 0-10 mA

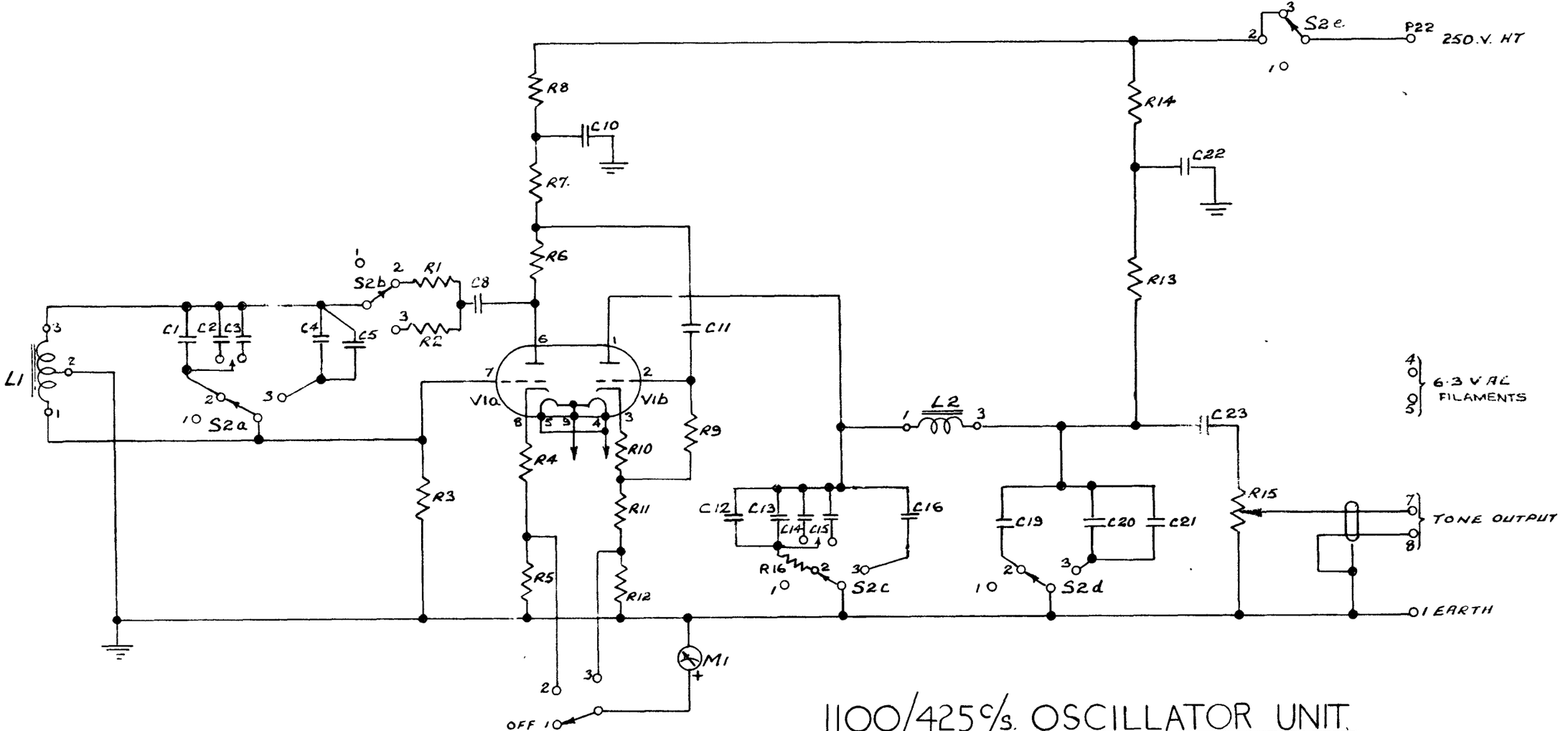
ISSUED BY - 3735
ISSUE 1
11.4.81

DIST 'H' 3735-1

DRN ALD	CrKD
APP	ENG

16-LRU217B

7.2.3



1100/425 c/s. OSCILLATOR UNIT.

FOR COMPONENT LIST SEE SHTS. 7·2·1, 7·2·2 & 7·2·3.

DRN. BY DEPT 3735 ISSUE 1.
17.4.51
FILAMENT WIRES SHOWN TWISTED CH. No 4445-1 JAB.

ISSUE 2.
25.5.51
C12 ADDED
26-7-17-18
DELETED C/N 4445-1 APP. 1

ISSUE 3
25.5.51
WIRING MODIFIED
R16 ADDED IN CIRCUIT
CH No 4445 2

ISSUE 4
15-1-52.

DIST 'H'
3735-1

FIG. 6

DRN. ACD	CHKD.
ENG.	APP.

16 LRU 217B
SHT 7·2.

RESISTORS

SCHEM. Nº	VALUE	TOL.	RATING	R.C.S.C. CODING	SERVICE REF. Nº	REMARKS
R1.						
R2.						OVEN HEATERS.
R3.						
R4.	560Ω	+-10%		RCH 561K.		ERIE
R5.	560Ω	+-10%		RCH 561K.		ERIE
R6.	1KΩ	±5%		RWH 102J		PAINTON
R7	47Ω	±2%		RCD 470G		WELWYN A3622
R8.	47Ω	±2%		RCD 470G		WELWYN A3622
R9.	39Ω	±2%		RCD 390G		WELWYN A3622
R10	36Ω	±2%		RCD 360G		WELWYN A3622
R11	36Ω	±2%		RCD 360G		WELWYN A3622
R12	62Ω	±2%		RCD 620G		WELWYN A3622
R13	36Ω	±2%		RCD 360G		WELWYN A3622
R14	36Ω	±2%		RCD 360G		WELWYN A3622
R15	62Ω	±2%		RCD 620G		WELWYN A3622

ISSUED BY:-
DEPT. 3735

ISSUE 1
1 4 61
R10, R11, R12, R13. R14 AND R15 ADDED
CH Nº 4196-15
JAB

ISSUE 2
1 4 951

DRN. RCD.	CHKD.
APP	ENG.

8 LRN 297 B
SHT 7·4·1

FOR CONTINUATION SEE SHT. 7·2 2

ISSUED BY
DEPT. 3735
ISSUE 1
14 6 51

RECTIFIERS.

RECT.1.	STC TYPE B18·4·182R.

RELAYS.

REL1.	STC TYPE 4662 MEK.

LAMPS.

L1	MES 4011C 50 V. 25 WATT

SWITCHES.

S1.	OAK TYPE MHCL TO RL 7016/282A.
S2.	OAK TYPE MHCL TO RL 7016/204B.
CO.1	STC 8-LRU-297 DET 23 WOODS METAL CUT-OUT

FILTERS

F1	STC. 8·LU·139 BC, BD OR BG, BH USB PASS
F2	STC 8-LU-139 BA, BB OR BE, BF LSB PASS
F3	STC. 8-LU-240C 100425 c/s PASS
F4	STC. 8-LU-240B 99575 c/s PASS

THERMOSTATS.

TH1	BRIT. THERM. LTD. TYPE MB/A/7 60°C.
TH2	BRIT THERM. LTD. TYPE MB/A/7 60°C.

PLUGS

P7	PAINTON 8 WAY 500474
P8, P9 AND P10	P.O. PLUGS W.I. PART A.

END.

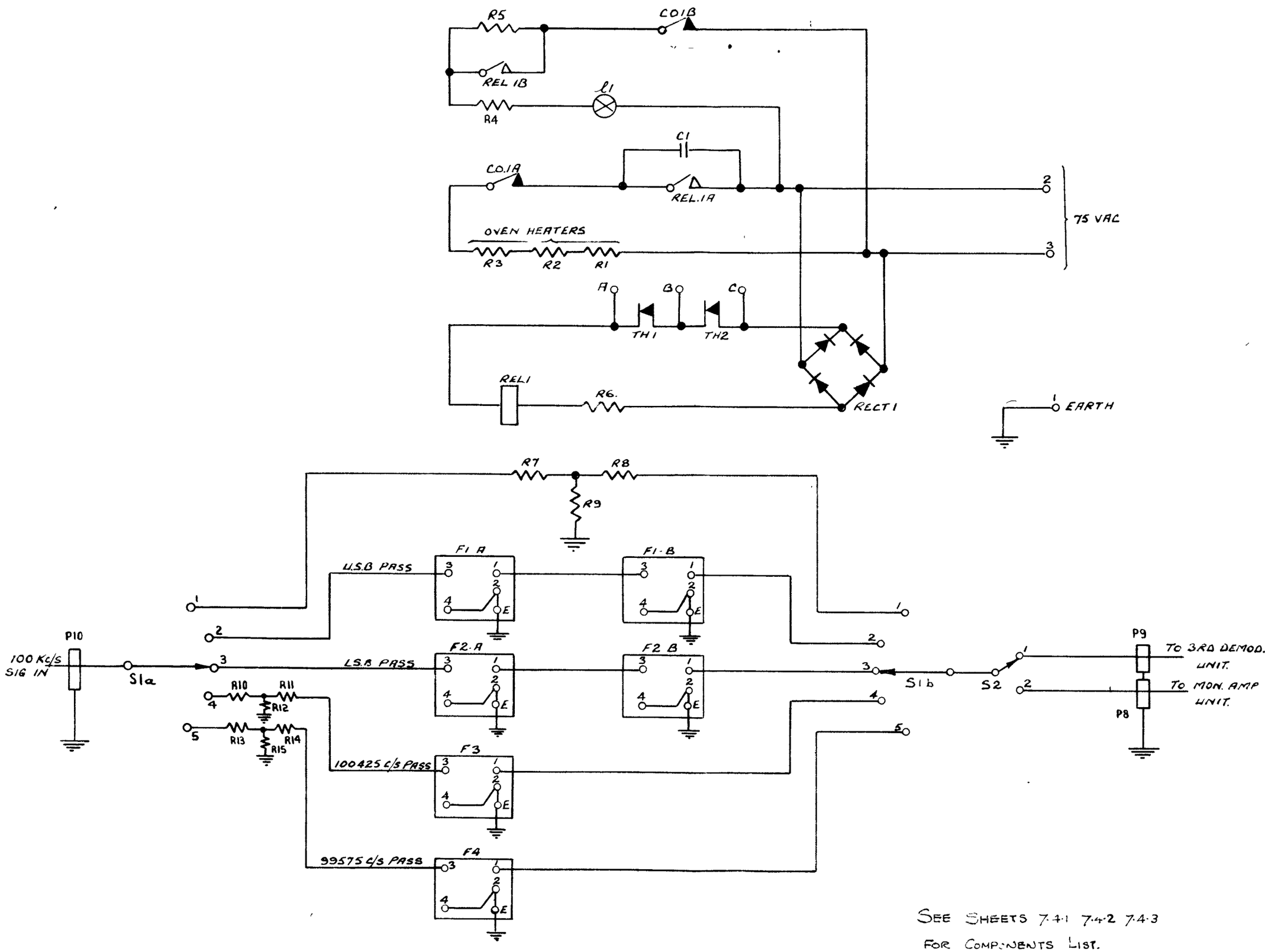
DRN ACP | CHKD
APP | ENG

8·LRU·297B

SHT. 7·1·3

DRN. BY 3735.
ISSUE.1.
1A 6 81
R10, R11, R12, R13, R14 AND R15 ADDED.
CH. No. 4196-15 JAB

ISSUE. 2.
19 9 81



SEE SHEETS 7.4.1 7.4.2 7.4.3 FOR COMPONENTS LIST.

DIST H

FIG.7

DRN. A.C. DANLEY	CH'KD.
ENG.	APP.

8-LRU-297B

SHEET 7.4

TRANSFORMERS

SCHEM. Nº	SUPPLIER	SUPPLIERS CODE	RCSC CODING	SERVICE REF Nº	REMARKS
					TO S.T.C. U.46149/23
					PRI. 0 - 200/250V.
T.1					SEC.1. 5V. 3A. C.T.
					SEC.2. 420-400-0-400-420V 120MA
					SEC.3. 6.5V 6A
					To S.T.C. ARC 46151/1
T.2					PRI. 0 - 200/250V.
					SEC.1. 75V 6A.
					SEC.2. 0-9-10 V.

CHOKES

CH.1	S.T.C.	AS.44147/15			10H. 0.15A D.C. RESIS. 150Ω.
CH.2	"	"			" " "

CONDENSERS

C.1	STATIC	SBR 8			8MFD INV. MTG.
C.2	"	"			" " (2OFF)
C.3	T.C.C.	CP 48N			0.25MFD

RESISTANCES

R.1	PAINTON	P.302	RWH 252K		2.5K
R.2	"	"	" 104K		100K
R.3	"	"	" 102K		1000Ω
R.4	ERIE		RCH 561K		560Ω
R.5	PAINTON	P.305	RWV4L 821J		820Ω

VALVES

V.1	BRIMAR	CV.378			RECTIFIER
V.2	S.T.C.	G180-2M			STABILISER

FOR CONTINUATION SEE SHT 7.4

ISSUED BY:- 3735

ISSUE 3
C.3 ADDED
CH. 4221/21

Iss. 4
19.12.52
T2 WAS AB46151/3
CH 4221/28

Iss. 5
9 9 54

3735-1
2781-1
DIST. H

DRN | CHKD.
APP | ENG

94LRU204
GRP. A
SHT. 7.3

FUSES

CIRCUIT NO	MAKER	MAKER'S CODE	R.C.S.C. CODING	SERVICE REFERENCE	REMARKS
F.1.	BELLING LEE	L1055/5A			5 AMP.
F.2	"	" "			" "
F.3.	"	L1055/250mA			250 mA.
F.4	"	L1055/10A.			10A
F.5.	"	L1055/10A			10 A.
F6	"	L1055/5A			5 A.
F7	"	L1055/5A			5 A.
			SWITCH.		
S1.			RCL151/13	10F/10886	D.P. ON-OFF. 250V. 10A.
			RECTIFIER.		
RECT. 1.	S.T.C.	B18-4-182R			50V. RELAY SUPPLY.
			RELAY.		
REL. A/2.	S.T.C.	4662 MAG.			SUPPLY CCT CONTROL.
			LAMP		
LP.1.	OVEN	SUPPLY "ON" LAMP.			50. VOLT. M.E.S TYPE 4011C
LP2	HT	"ON" LAMP.			8 VOLT 3A. " " "

ISSUED BY
3735

PRE. ISSUE A.
8-4-49.
F6 & F7
LP2 ADDED

PRE ISSUE B
23-8-49.

ISSUE 1
[illegible] 12 49
LP1 WAS PYPE
GAS.
LP1 WAS SWG.
TYPE.
CH NOTE 4221/1

ISSUE 2.
14.5.50.
C/N 4221/4

ISS. 3
[illegible]

DRN [illegible] CHKD
APPD [illegible] ENGR R.A.G.

94LRU204
GRP A
SHT. 7-4.

FOR CONTINUATION SEE SHT.

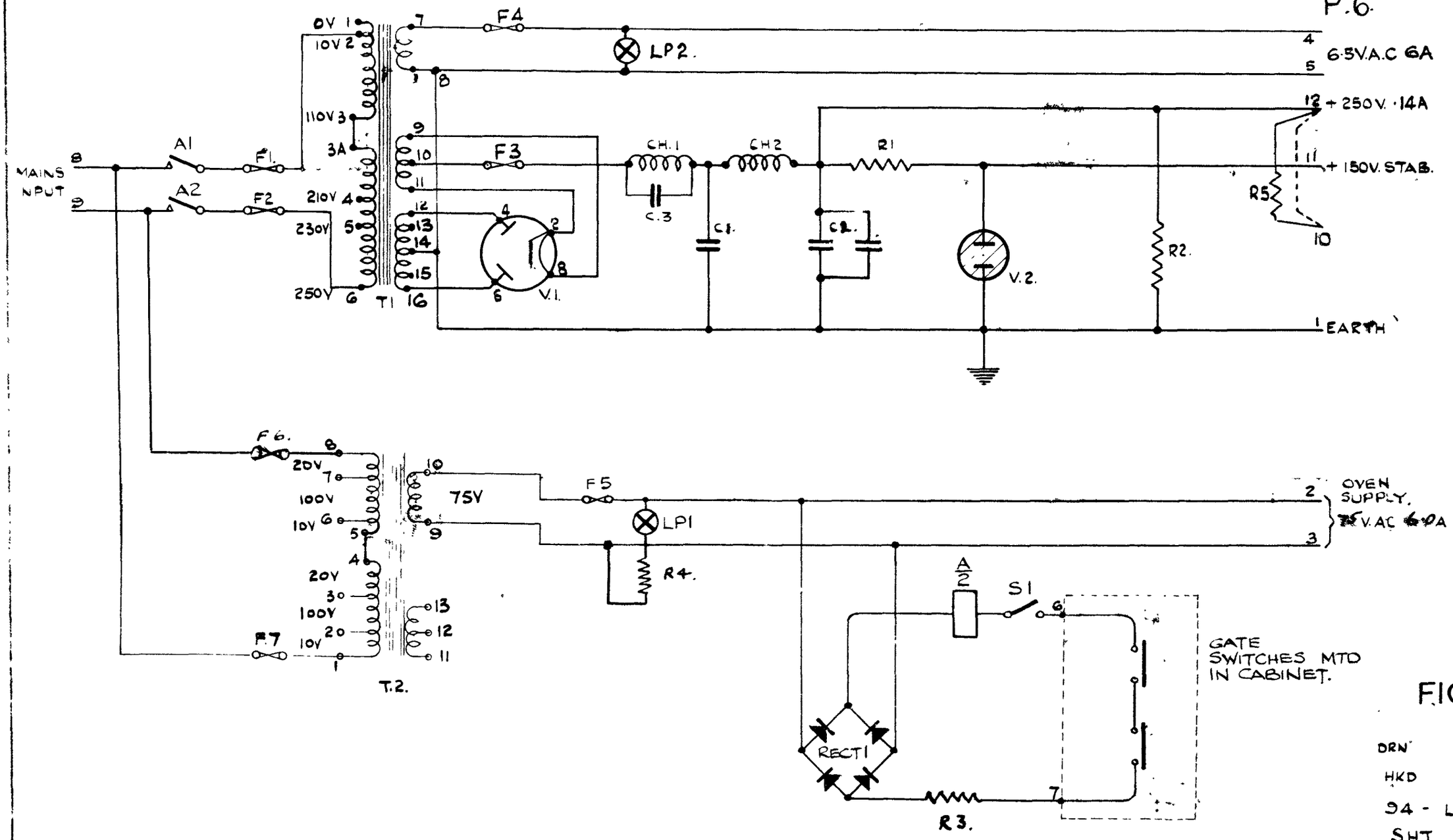


FIG. 8

DRN APP'D
HKD ENG REG.
94 - LRU-204A
SHT 7·2

POWER SUPPLY

SUE A
8/4/49
R3+R4 ADDED.

PREISS. B.
23-8-49.
CODES ADDED TO T.1. & T.2.

PRE.ISS.C.
11-11-49.

ISSUED
20.12.49
4221/4 C/N.

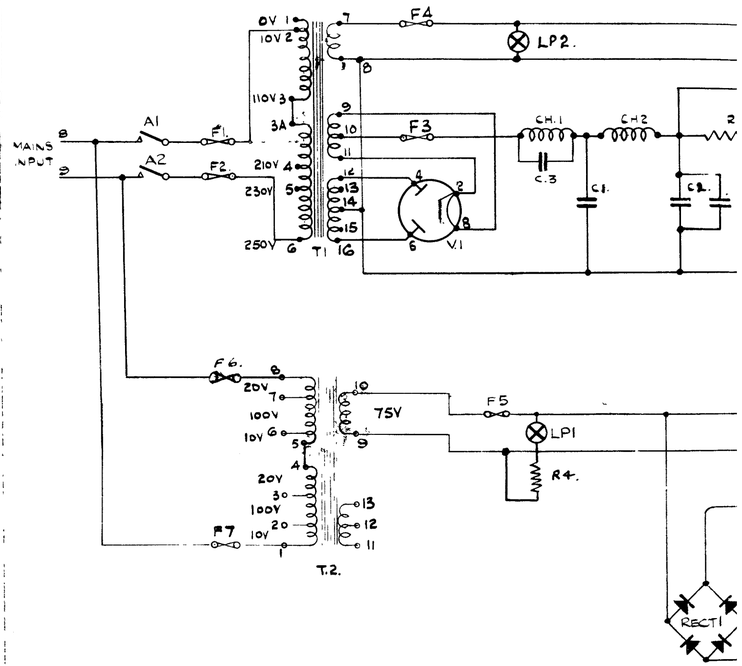
ISS 3
SN 4221/9.

ISS. 3.
T2 9 51
SN 429-15

ISS 4
C 3 ADDED
SN 4221/21

ISS 5
19/12/52

DIST H



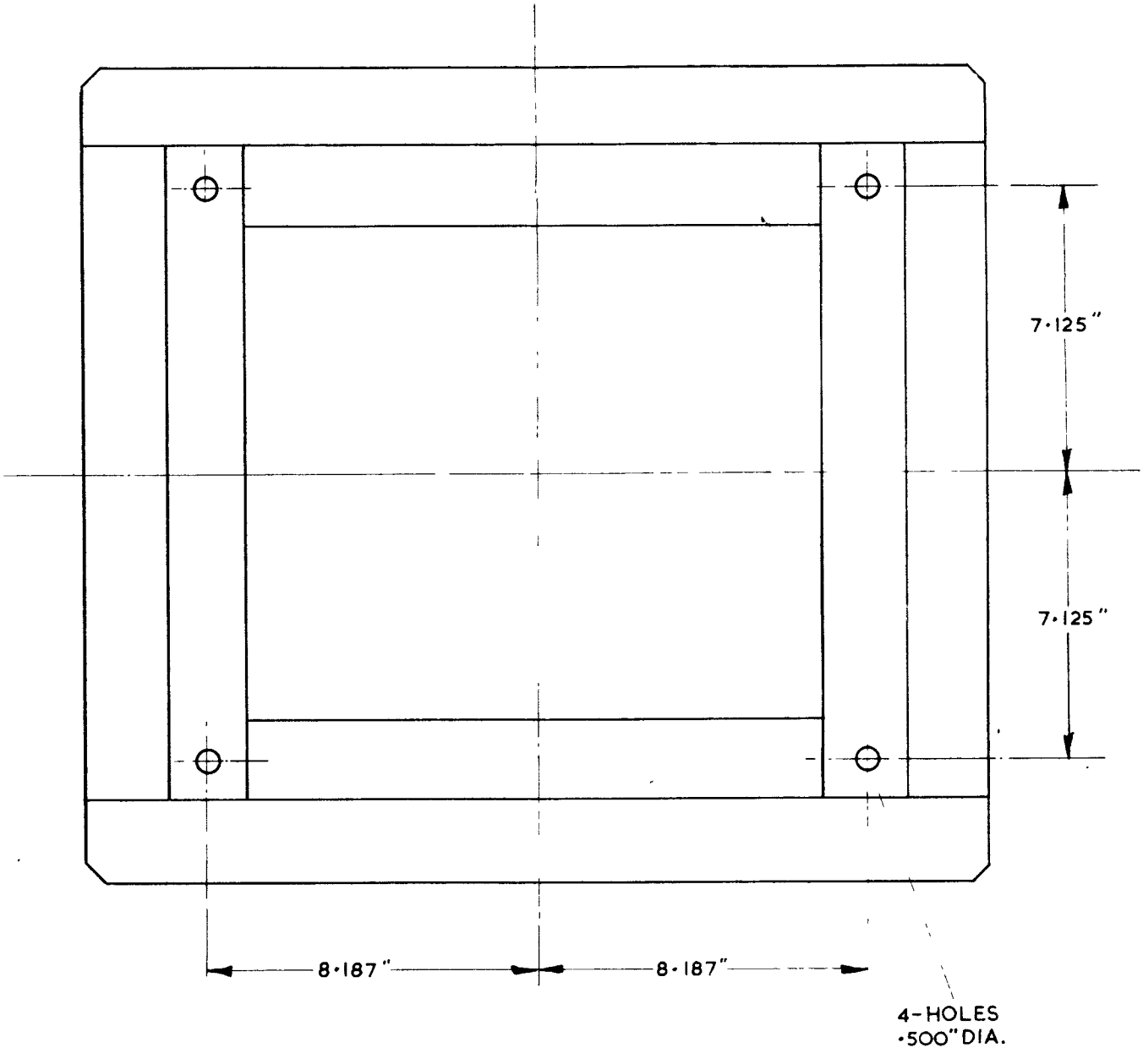


FIG.9. FIXING CENTRES FOR PLINTH.

PRINTED IN ENGLAND BY STANDARD TELEPHONES & CABLES LONDON.	CHKD.	DRN.
	APP.	ENG.

DIST. J

ISSUE 2 8-12-44
ISSUE 3. 7.1.53

1.0 PREPARATION OF CABLE.

In the following instructions where stripping of P.V.C. or polythene is called for, hot strippers should be used if available.

If hot strippers are not available, great care should be taken not to nick any wire covered by the plastic material.

Each of the operations specified below should be carried out successively as quickly as possible to avoid any tarnishing of the copper braiding or central conductor which would make soldering difficult.

1.1 Remove the P.V.C. sheath for a distance of 1/8" from the end of the cable.
1.2 Remove the copper braiding to leave 5/16" from the end of the P.V.C. sheath.
1.3 Push back the copper braiding and remove the polythene insulation to leave 1/8" from the end of the P.V.C. sheath.
1.4 Thread an LP. 180517 thimble over the central conductor and push it home over the polythene insulation and under the copper screening.
1.5 Draw forward the copper braiding so that it fits tightly over the thimble. (see Fig.1.)
1.6 Fit LP 180519 clamp as indicated in fig.2.
1.7 Solder the clamp to the braided screen, using a well tinned iron. This should be applied to the clamp and, at the same time, resin cored solder applied to the copper braid through the "window" in the clamp. Immediately the copper braid is completely "wetted" with solder, the iron should be removed and all excess solder shaken off. It is essential that this soldering should be carried out as quickly as possible to avoid melting the polythene under the copper braid.

It should be noted that, as this type of wire will not twist easily, care must be taken to solder the clamp in the correct plane, for the subsequent wiring. (see below).

1.8 Cut off any superfluous braid with a knife, care being taken not to leave any strands which might subsequently cause a short circuit.

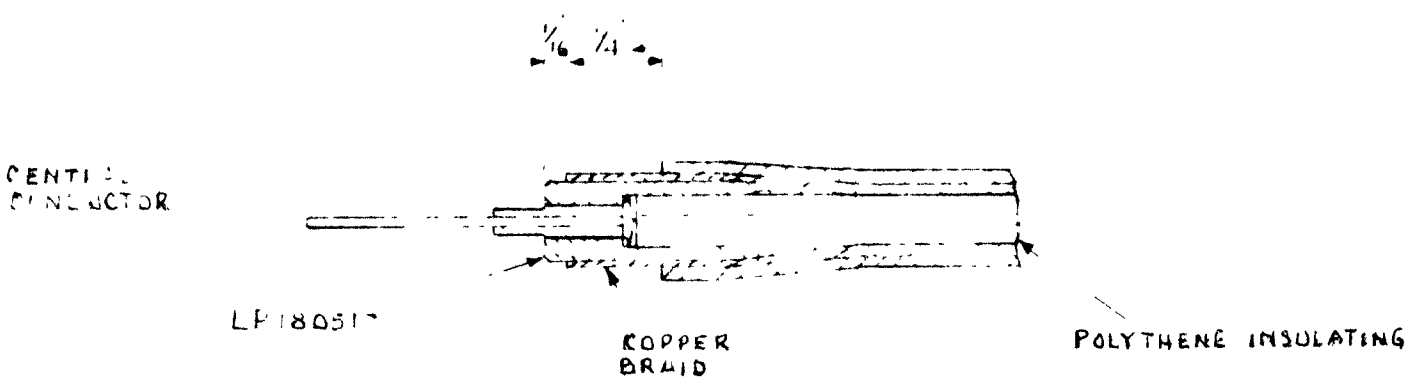


FIG. 1.

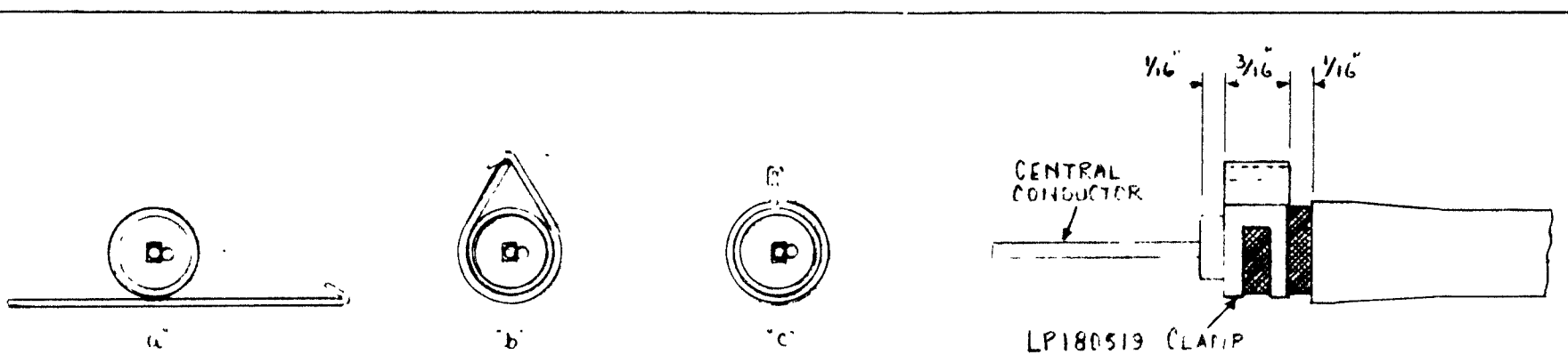


FIG 2.

2.0 JOINTING TWO CABLES BY MEANS OF A 231/4005A ADAPTOR.

The ends of the wire must first be prepared as specified in Para.1. above.

2.1 Remove the cover from the 231/4004A adaptor and slip it over one of the wires, also slip one 12.5 mm x 38 P.V.C. sleeve over one wire.
2.2 Insert the tags formed by the LP 180519 clamps into the slots at each end of the adaptor using the slots located at opposite side to opening and solder in position, avoiding excess solder which would interfere with fitting of cover.
2.3 Solder together the inner conductors and cut off any superfluous wire.
2.4 Replace the cover and slip the P.V.C. sleeve over the adaptor.

3.0 JOINTING ONE CABLE TO A 219/4003A SOCKET (SCREENED).

Where connector is required for use external to unit, a special terminating sleeve, LP.718000, will be called for, this will require to be slipped on to cable before preparing to para.1.0. above.

For internal or interchassis use the terminating sleeve will be synthetic rubber (3/16" I/D X 1" Long) LP. 102096.

Prepare cable as specified in Para. 1.0 above.

3.1 Remove the outer shell of the 219/4003A Socket.
3.2 Insert the tag, formed by LP. 180519 clamp, into the slot at the end of the socket body. Bend tag flat against the socket body and solder in position. See Fig.3.
3.3 Solder the inner conductor together and cut off any superfluous wire.
3.4 Replace the outer shell of the socket and secure by means of the normal screw. Bond the outer shell to the body by means of a small spot of solder.
3.5 Fit rubber sleeve, LP.102096 or position LP. 718000 if fitted, to cover junction of cable to socket body.

Fit cable markers as required.

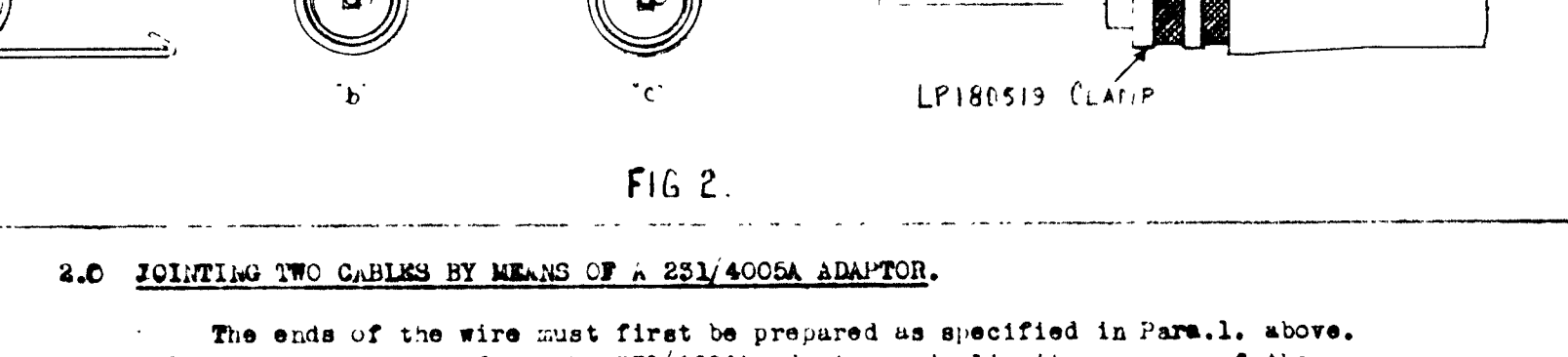


FIG 3

4.0 JOINTING ONE CABLE TO A P.O. COAXIAL PLUG No.1. BY MEANS OF A 231/4005A. ADAPTOR.

The end of the cable must first be prepared as specified in Para.1. above.

4.1 Fit the 231/4005A adaptor to the Plug and secure by means of the small screw supplied with the latter and bond with a small spot of solder as shown in fig. 4.

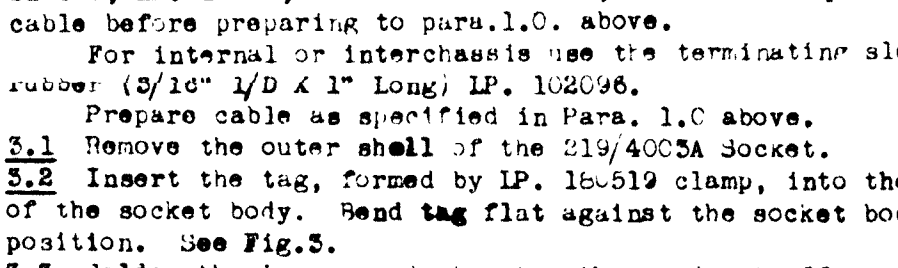


FIG. 4.

4.2 Slip the cover of the adaptor over the cable.
4.3 Connect the cable to the adaptor-plug combination by inserting the tag formed by LP 180519 clamp into the slot at the end of the adaptor using the slot at opposite side to opening, and solder in position avoiding excess solder. Solder the inner conductors together and cut off all superfluous wire.
4.4 Slip the cover of the adaptor back into position.

5.0 JOINTING A CABLE TO A P.O. COAXIAL PLUG NO.1. BY MEANS OF A 231/4005B OR D ADAPTOR ("T" CONNECTION).

The ends of the cables should first be prepared as specified in Para-1.0 above.

5.1 Remove the cover plate.
5.2 Insert the tag formed by the LP 180519 clamp of each cable into the slots of the adaptors and solder in position.
5.3 Solder the central conductors together and cut off any superfluous wires.
5.4 Replace the cover plate.

6.0 JOINTING A CABLE TO A P.O. COAXIAL PLUG NO.1. BY MEANS OF A 231/4005C ADAPTOR. ("L" CONNECTION).

The instructions are identical with those given in 5.0-5.4 above except that only one LC 11185 cable is connected.

FIG.10

JOINTING OF LC11185 (UNIRADIO 32) TO P.O. TYPE COAXIAL FITTINGS

E S. 7968 SHT. 1.

DRN	ENG.	DIST. J	ISSUE 2 8-12-44 ISSUE 3. 7.1.53
CHKD.	APP.		

PRINTED IN ENGLAND BY STANDARD TELEPHONES & CABLES LONDON.

1.0 PREPARATION OF CABLE.

In the following instructions where stripping of P.V.C. or polythene is called for, hot strippers should be used if available.

If hot strippers are not available, great care should be taken not to nick any wire covered by the plastic material.

Each of the operations specified below should be carried out successively as quickly as possible to avoid any tarnishing of the copper braiding or central conductor which would make soldering difficult.

1.1 Remove the P.V.C. sheath for a distance of 1" from the end of the cable.
1.2 Remove the copper braiding to leave 5/16" from the end of the P.V.C. sheath.
1.3 Push back the copper braiding and remove the polythene insulation to leave 1/8" from the end of the P.V.C. sheath.
1.4 Thread an LP. 180517 thimble over the central conductor and push it home over the polythene insulation and under the copper screening.
1.5 Draw forward the copper braiding so that it fits tightly over the thimble. (see Fig.1.)
1.6 Fit LP 180519 clamp as indicated in fig.2.
1.7 Solder the clamp to the braided screen, using a well tinned iron. This should be applied to the clamp and, at the same time, resin cored solder applied to the copper braid through the "window" in the clamp. Immediately the copper braid is completely "wetted" with solder, the iron should be removed and all excess solder shaken off. It is essential that this soldering should be carried out as quickly as possible to avoid melting the polythene under the copper braid.

It should be noted that, as this type of wire will not twist easily, care must be taken to solder the clamp in the correct plane, for the subsequent wiring. (see below).

1.8 Cut off any superfluous braid with a knife, care being taken not to leave any strands which might subsequently cause a short circuit.

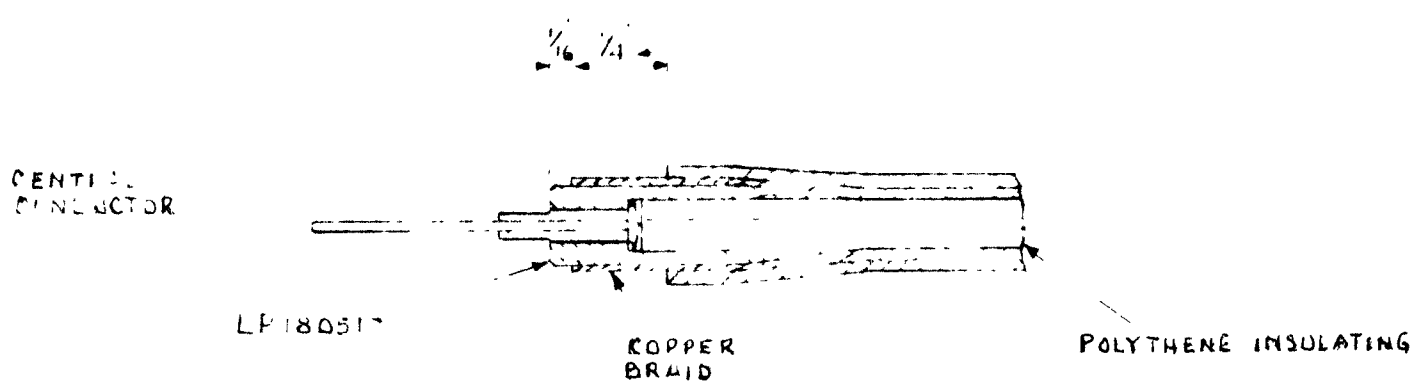


FIG. 1.

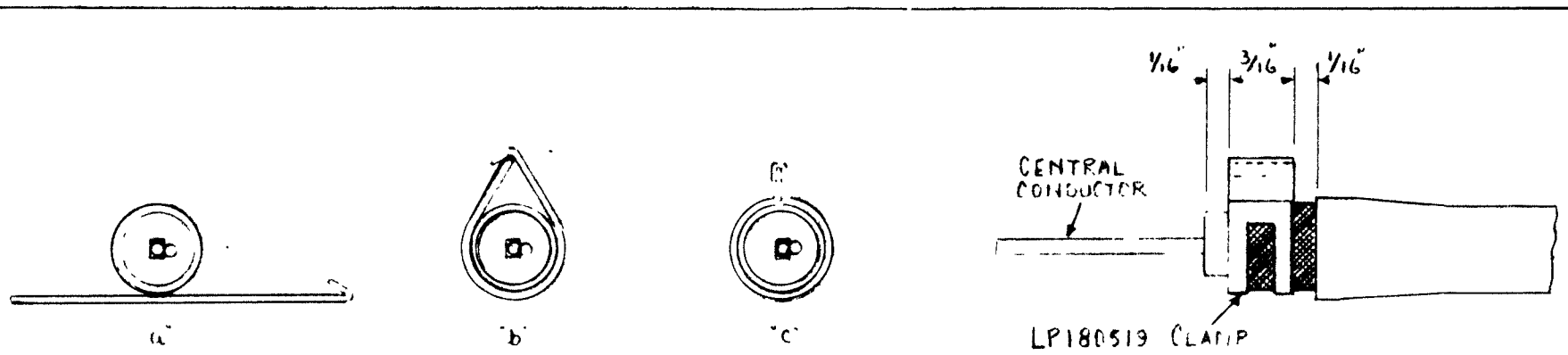


FIG 2.

2.0 JOINTING TWO CABLES BY MEANS OF A 231/4005A ADAPTOR.

The ends of the wire must first be prepared as specified in Para.1. above.

2.1 Remove the cover from the 231/4004A adaptor and slip it over one of the wires, also slip one 12.5 mm x 38 P.V.C. sleeve over one wire.
2.2 Insert the tags formed by the LP 180519 clamps into the slots at each end of the adaptor using the slots located at opposite side to opening and solder in position, avoiding excess solder which would interfere with fitting of cover.
2.3 Solder together the inner conductors and cut off any superfluous wire.
2.4 Replace the cover and slip the P.V.C. sleeve over the adaptor.

3.0 JOINTING ONE CABLE TO A 219/4003A SOCKET (SCREENED).

Where connector is required for use external to unit, a special terminating sleeve, LP.718000, will be called for, this will require to be slipped on to cable before preparing to para.1.0. above.

For internal or interchassis use the terminating sleeve will be synthetic

FIG. 1.

2.0 JOINTING OF CONNECTION TO SCREEN OF LC.11185

THE END OF THE LC 11185 MUST FIRST BE PREPARED AS SPECIFIED ON 1.0-1.5 ABOVE.

2.1 REMOVE THE INSULATION FROM A LENGTH OF 7/012 20MIL PVC. RED WIRE FOR A DISTANCE OF 3".

2.2 BIND THE BARED CONDUCTOR OF THE 7/012 3 OR 4 TURNS ROUND THE EXPOSED COPPER BRAIDING OF THE LC.11185 AND SOLDER IMMEDIATELY THE JOINT IS COMPLETELY "WETTED" WITH SOLDER. THE IRON SHOULD BE REMOVED AND ALL EXCESS SOLDER SHAKEN OFF. IT IS ESSENTIAL THAT THIS SOLDERING SHOULD BE CARRIED OUT AS QUICKLY AS POSSIBLE TO AVOID MELTING THE POLYTHENE UNDER THE COPPER BRAID.

2.3 TWIST THE SUPERFLUOUS BRAID ETC. CARE BEING TAKEN NOT TO LEAVE ANY STRAND WHICH MIGHT SUBSEQUENTLY CAUSE A SHORT CIRCUIT.

2.4 COVER COMPLETED JOINT WITH SLEEVE LP.94924 (SEE FIG 2.)

2.5 TO MAKE CONNECTION TO TAG OF APPARATUS:- PLACE INSERT ON TAG OF APPARATUS, BIND CENTRE CONDUCTOR ROUND INSERT AND TAG AND SOLDER ALL TOGETHER.

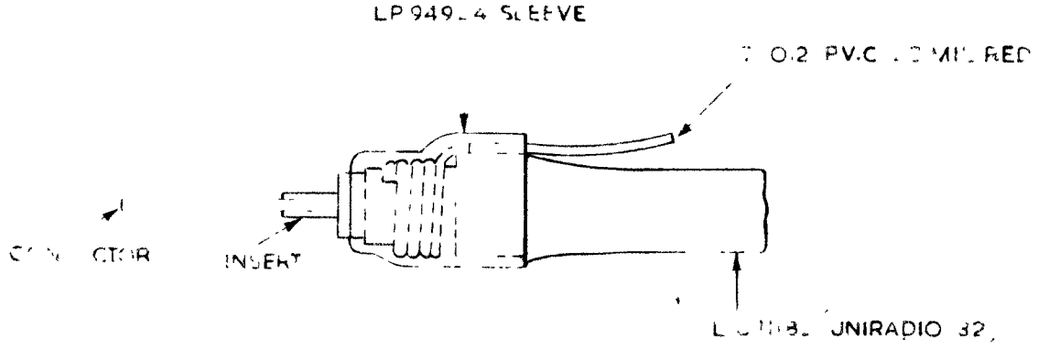


FIG.2.

3 JOINTING CONNECTION TO SCREENS OF LC.11185'S THAT ARE COMMONED TOGETHER IN CIRCUIT

THE END OF THE LC 11185 MUST FIRST BE PREPARED AS SPECIFIED IN 1.0-1.5 ABOVE.

3.1 REMOVE THE INSULATION FROM ENDS OF A LENGTH OF 7/012 PVC 20MIL RED WIRE

3.2 BIND THE BARE ENDS 3 OR 4 TURNS ROUND THE EXPOSED COPPER BRAIDING OF THE LC 11185's AND PROCEED AS SPECIFIED IN 2.2-2.3

3.3 INSULATE FREE END OF 7/012 WITH 1m/m BORE RED PVC SLEEVING.

3.4 COVER COMPLETED JOINTS WITH SLEEVE LP.94924 TAKING CARE THAT THE RED PVC SLEEVING IS WELL IN POSITION BY THE SLEEVE (SEE FIG 3)

1.5 TO MAKE CONNECTION TO TAG OF APPARATUS:- PLACE INSERT ON TAG OF APPARATUS BIND CENTRE CONDUCTOR ROUND INSERT AND TAG AND SOLDER ALL TOGETHER

FIG.10a

CONNECTION OF LC.11185 UNIRADIO 32 TO MISC APPARATUS

ES. 7968 SHT. 2

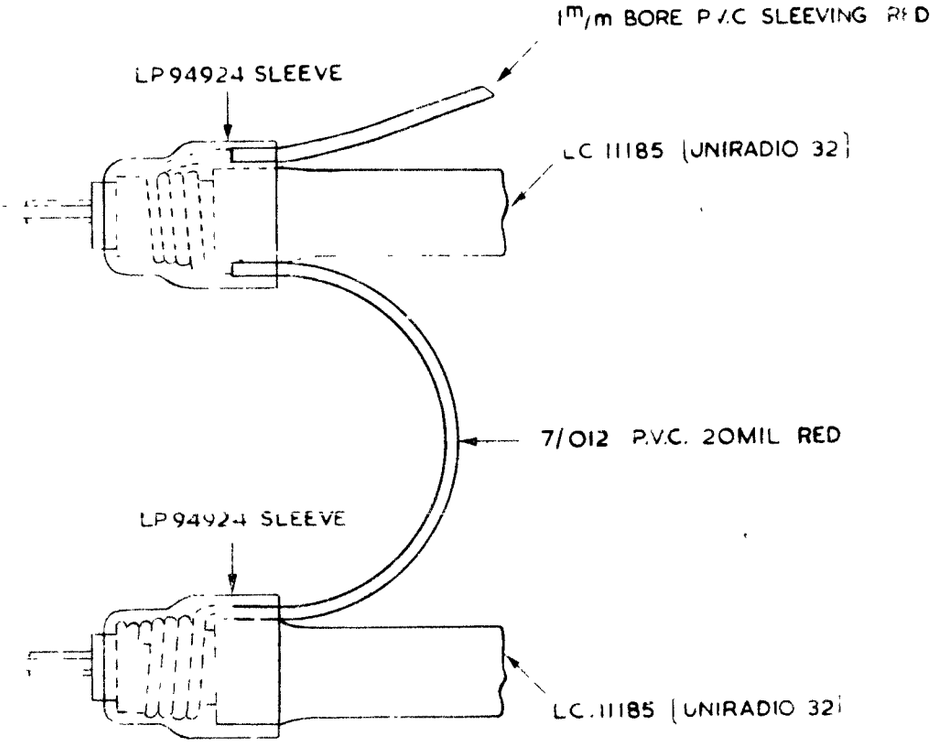


FIG 3.

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1.0 PREPARATION OF WIRE

IN THE FOLLOWING INSTRUCTIONS WHERE STRIPPING OF P.V.C. OR POLYTHENE IS REQUIRED SPECIAL STRIPPERS SHOULD BE USED IF AVAILABLE.

IF SUCH STRIPPERS ARE NOT AVAILABLE GREAT CARE SHOULD BE TAKEN NOT TO NICK OR WEAKEN THE CONDUCTOR WHEN REMOVING INSULATION.

EACH OF THE OPERATIONS DESCRIBED BELOW SHOULD BE CARRIED OUT SUCCESSIVELY AND IMMEDIATELY AFTER POSSIBLE THE PREPARATION OF COPPER BRAIDING OR CENTRAL CONDUCTOR TO WHICH SOLDER MAY SUBSEQUENTLY BE APPLIED.

1.1 BARE THE CENTRE CONDUCTOR FOR A LENGTH OF 1".

1.2 REMOVE THE COPPER BRAIDING FOR A DISTANCE OF 3/4" FROM THE END OF THE CABLE.

1.3 CUT BACK THE COPPER BRAIDING FOR A FURTHER 1/4" AND REMOVE THE POLYTHENE INSULATION FOR A DISTANCE OF 3/4" FROM THE END OF THE CABLE.

1.4 THREAD THIMBLE LP180517 OVER THE CENTRAL CONDUCTOR AND PUSH IT HOME OVER THE POLYTHENE INSULATION AND UNDER THE COPPER SCREENING

1.5 DRAW THE COPPER BRAIDING SO THAT IT FITS TIGHTLY OVER THE THIMBLE. SEE FIG 1.

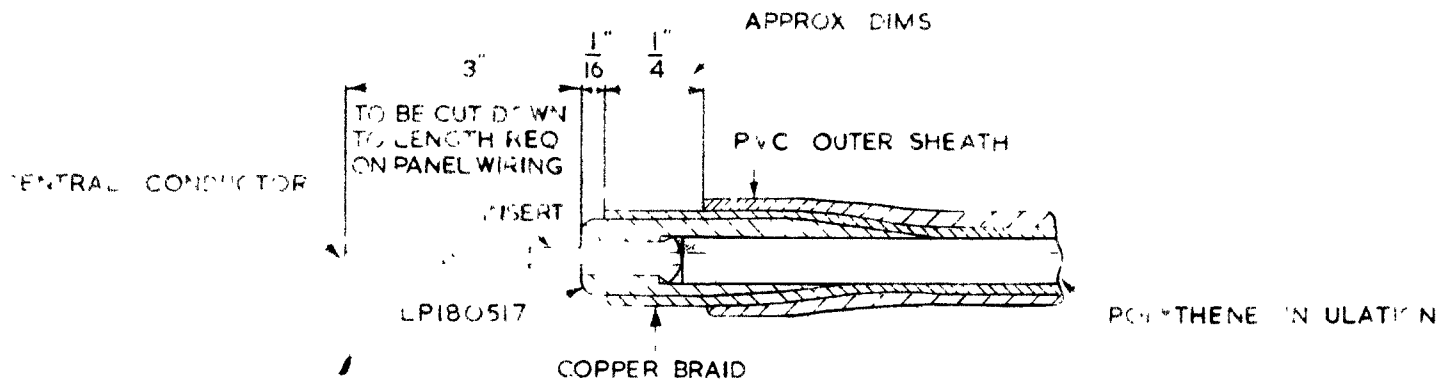

FIG 1.

2.0 JOINTING OF CONNECTION TO SCREEN OF L.C.11185

THE END OF THE L.C.11185 MUST FIRST BE PREPARED AS SPECIFIED ON 1.0-1.5 ABOVE.

2.1 REMOVE THE INSULATION FROM A LENGTH OF 7/012, 20MIL P.V.C. RED WIRE FOR A DISTANCE OF 3".

2.2 BIND THE BARED CONDUCTORS OF THE 7/012 3 OR 4 TURNS ROUND THE EXPOSED COPPER BRAIDING OF THE L.C.11185 AND SOLDER. IMMEDIATELY THE JOINT IS COMPLETELY "WETTED" WITH SOLDER THE IRON SHOULD BE REMOVED AND ALL EXCESS SOLDER SHAKEN OFF. IT IS ESSENTIAL THAT THIS SOLDERING SHOULD BE CARRIED OUT AS QUICKLY AS POSSIBLE TO AVOID MELTING THE POLYTHENE UNDER THE COPPER BRAID.

2.3 TRIM OFF ANY SUPERFLUOUS BRAID ETC CARE BEING TAKEN NOT TO LEAVE ANY STRAND WHICH MIGHT SUBSEQUENTLY CAUSE A SHORT CIRCUIT.

2.4 COVER COMPLETED JOINT WITH SLEEVE LP.94924 (SEE FIG 2.)

2.5 TO MAKE CONNECTION TO TAG OF APPARATUS:- PLACE INSERT ON TAG OF APPARATUS, BIND CENTRE CONDUCTOR ROUND INSERT AND TAG AND SOLDER ALL TOGETHER.

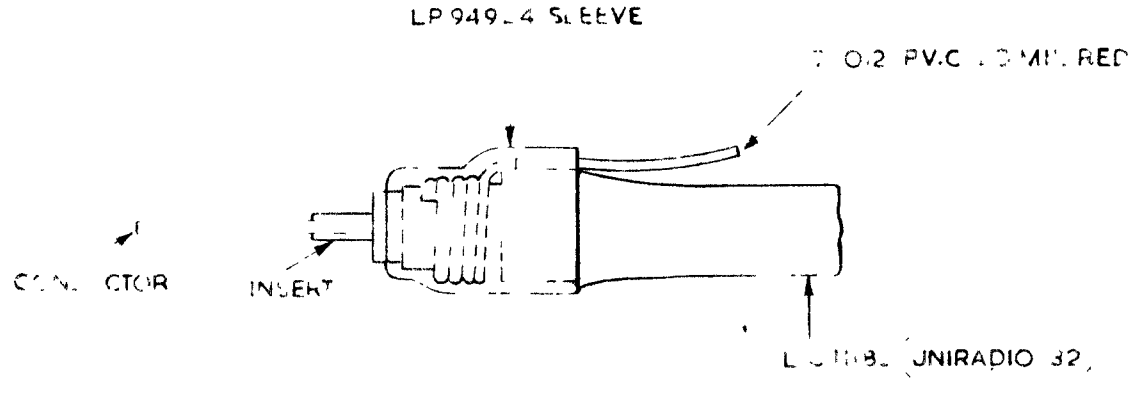

FIG.2.

3.0 JOINTING CONNECTION TO SCREENS OF L.C.11185'S THAT ARE TO BE JOINED TOGETHER IN CIRCUIT

THE END OF THE L.C.11185 MUST FIRST BE PREPARED AS SPECIFIED IN 1.0-1.5 ABOVE.

3.1 REMOVE THE INSULATION FROM ENDS OF A LENGTH OF 7/012 P.V.C. 20MIL RED WIRE

3.2 BIND BARED CONDUCTOR 3 OR 4 TURNS ROUND EXPOSED COPPER BRAIDING OF THE