B.R. 575(2)J

AUDIO FREQUENCY EQUIPMENT

A.F. 100 SERIES

BROADCAST SYSTEMS

THE 2-WATT AMPLIFIER, A.P. 32047

and

MOUNTINGS, A.P. Nos. 32048, 32049 and 32050

1956

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Electrical Engineering Department,
ADMIRALTY S.W.1

AMENDMENTS

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B.R. 575(2)J, *Audio Frequency Equipment—A.F.* 100 *Series, Broadcast Systems, The* 2-*watt Amplifier, A.P.* 32047 *and Mountings, A.P. Nos.* 32048, 32049 *and* 32050, 1956, having been approved by My Lords Commissioners of the Admiralty, is hereby promulgated.

This book should be inserted in B.R. 575, guard cover for this series of books.

Attention is directed to the notice printed below.

By Command of Their Lordships,

J. S. Long

To Flag Officers and Commanding Officers of H.M. Ships and Vessels concerned.

Suggestions for improvement of the text or illustrations which can be incorporated by way of amendment or in any future revision of this book, will be welcomed and will receive careful consideration; they should be forwarded to the Secretary of the Admiralty through the usual channels.

CONTENTS

	page
SECTION I 2-*Watt Amplifier A.P.* 32047	1
Safety warning	1
Supply voltage warning	1
General description	1
Circuit description	1
Circuit components and their functions	2
Maintenance	3
Maintenance routines	3
Location of defects at the amplifier position	3
Annual examination and test	3
Audio test in a workshop	4
Location of defects in the workshop	4
Fault location table	5
SECTION II *Mountings A.P.* 32048, 32049, *and* 32050	7
The single and dual unit mountings	7
The five unit mounting	7

Appendices:—

1. Summary of structural and electrical details. The amplifiers and mountings	8
2. Test data. The amplifier	9
3. Constructional details. Transformers and choke. The amplifier	10

ILLUSTRATIONS

Plates:—between pp. 6 *and* 7

1. The amplifier A.P. 32047
2. The amplifier A.P. 32047
   (*a*) viewed from the right
   (*b*) viewed from the left
3. The mounting A.P. 32048
   (*a*) complete with amplifier
   (*b*) showing the cabinet swung out for removal of the amplifier
   (*c*) showing the cradle carriage
4. The mounting A.P. 32049
   (*a*) complete with amplifiers
   (*b*) showing the cabinet swung out, amplifiers removed
5. The mounting A.P. 32050
   (*a*) complete with amplifiers
   (*b*) showing the cradle and terminals
6. The mounting A.P. 32050 showing the cradle withdrawn for access to the wiring

Figures (at end of text):—

1. The mounting A.P. 32048. Dimensions. Fixing particulars. Terminal arrangement. (Collingwood Drawing No. 12158).
2. The mounting A.P. 32049. Dimensions. Fixing particulars. Terminal arrangement. (Collingwood Drawing No. 12159.)
3. The mounting A.P. 32050. Dimensions. Fixing particulars. Terminal arrangement. (Collingwood Drawing No. 12160.)
4. The amplifier A.P. 32047. Circuit diagram. (Collingwood Drawing No. 12161.)
5. The amplifier A.P. 32047. Arrangement. (Collingwood Drawing No. 12162.)
6. The amplifier A.P. 32047. Pictorial wiring diagram. (Collingwood Drawing No. 12163.)

SECTION I

THE 2-WATT AMPLIFIER, A.P. 32047

SAFETY WARNING

1. The voltages employed in this amplifier are sufficiently high to endanger human life. Work on the open amplifier should be undertaken only by personnel who are aware of the danger involved and who have taken adequate steps to guard against direct contact with high voltages.

SUPPLY VOLTAGE WARNING

2. Before an amplifier is inserted into any mounting the setting of the supply voltage change-over socket should be checked to ensure that it conforms to the voltage of the supply to the mounting.

GENERAL DESCRIPTION

Use

3. The amplifier is the smallest in the range of amplifiers in four sizes of the A.F. 100 series equipment. It is used for small intercom systems where the power output is appropriate or, when coupled through a suitable transformer, will energise a group of handsets or headsets.

Input. Output

4. The amplifier operates from either of two inputs, that is, a 25 ohms impedance microphone circuit or an audio frequency signal at " line " level, i.e., approximately 1 volt r.m.s. Two or more amplifiers may be operated from a common input.

5. The audio output is at the usual loudspeaker line level of 31.6 volts (nominal) and operates one or more loudspeakers or receiver groups up to a maximum of the 2 watts power output. The output circuits of individual amplifiers must be kept electrically separate.

Dimensions

6. The dimensions and weight of the amplifier are given in Appendix 1.

Housing

7. The amplifier is designed to be housed in the cradle of any one of the mountings described in *Section II*. It is not suitable for any other form of mounting.

CIRCUIT DESCRIPTION (*Fig.* 4)

8. The amplifier comprises three stages, that is, two stages of voltage amplification and an output stage. Stages one and two employ the two parts of a double triode; the output stage uses a beam tetrode valve.

Input

9. The microphone input lines are connected to pins 5 and 6 of the plug PL2; the line level input lines are connected to pins 1 and 2 of the same plug. Attenuator resistors R1 and R2 connect, respectively, pins 2 to 6 and 1 to 5. Thenceforward the input lines are common and are connected through break contacts on an input test jack to the terminals of the primary winding of the input transformer T1. Resistor R3 is connected in parallel with the primary winding, forming a line input attenuator with R1 and R2.

10. The centre tap of the primary winding is connected through capacitor C9 to chassis earth for the reduction of cross talk in cases where two or more amplifiers are accommodated in one mounting. Another connection from the centre tap is taken to pin 4 of the plug PL1 for earthing or coupling, where necessary, to obtain a balanced input.

11. The input transformer gives a primary/secondary step up turns ratio of 1 : 40. A potentiometer RV1 is connected across the secondary winding, with one end terminal earthed to chassis. The potentiometer variable tapping is connected to the control gird of stage one in valve V1. The connections, secondary winding to potentiometer and thence to the grid, are screened, with the screen earthed. Details of the windings of the transformer may be obtained from *Appendix* 3.

The first and second stages

12. These stages are voltage amplification stages. The double triode used is C.V.492. The valve is screened by a canister type valve retainer. The output of stage one is resistance capacitance coupled to the grid of stage two. The output of stage two is similarly coupled to the grid of stage three in valve V2. Negative feedback is applied from the output transformer to the cathode of stage two.

The output stage

13. The beam tetrode valve of this stage is C.V.2136. The stage is transformer-coupled to the output.

The output transformer

14. Transformer T2 has three windings: primary, secondary and feedback. The primary winding is directly in the anode circuit of valve V2. The secondary winding, with a loading resistor R4 connected across it, is connected through break contacts of an output test jack to pins 7 and 8 of the plug PL1. The turns ratios are: Primary/Secondary, 3.53 : 1; Primary/Feedback, 1000 : 1. Other details of the transformer are given in *Appendix* 3.

Bias

15. Automatic bias is employed in stage one, provided by the cathode resistor R5. In stages two and three fixed grid bias is employed, applied from the potential divider R9, R10 and R11 in the negative return of the H.T. supply.

Gain control

16. Output level or overall gain is controlled by the setting of the potentiometer RV1. The basic scale is graduated evenly 0 to 20 over an arc of 300°.

17. A secondary scale marked " +10 dB...0...—10dB " over an arc of 120° is superimposed on the basic scale. This secondary scale is intended for use when the amplifier is operating from a line level input from a radio receiver or similar input source. If a given input signal strength drives the amplifier at full 2 watts output with the gain control set to " 0 dB ", then, to obtain the same output from a signal strength + n dB on the original, the gain control must be set to " + n dB ", and vice versa.

Valve heaters

18. The valve cathodes are indirectly heated by power at 6·3 volts from a winding on the mains transformer T3. All the heaters are in parallel. Emission temperature is maintained when the " power on " switch S1 is closed.

H.T. Supply. Smoothing. Switching

19. H.T. power is provided by the secondary winding of the mains transformer T3, and rectified by a bridge type combination of metal rectifiers. The maximum current at 250 volts is 66mA.

20. Smoothing is by the choke L1 and the capacitors C3 and C4, in the form of a capacitor input filter. The choke is connected in the negative or return side of the H.T. circuit.

21. Separate H.T. switching is not fitted. The amplifier must be switched off when not required for use.

Fuse protection

22. Fuses are fitted in the supply lines within the amplifier. The rating is varied to suit the voltage of the power supply. Details are given in the schedule to *Fig.* 4.

Pilot lamp

23. A pilot lamp ILP1, connected in parallel with the valve heaters, indicates " power on " when the switch S1 is closed.

Power supply. Voltage

24. The amplifier operates from a single phase, 50 to 60 c/s a.c. power supply at 230, 115 or 50 volts. The primary winding of the mains transformer is split. This arrangement allows the halves to be connected in series for a 230-volt supply, and in parallel for operation from a 115-volt supply. For operation from a 50-volt supply parts only of the halves are used, connected in parallel. Adjustment to conform to the supply voltage is by means of a free socket SK3 which can be fitted to any one of the three plugs, PL3 for 50 volts, PL4 for 115 volts and PL5 for 230 volts.

The controls

25. The controls mounted on the front panel of the amplifier are an " on " " off " power supply switch, fuses, and the gain control. These controls are protected by a hinged cover. Other items on the panel are the pilot lamp and the input and output test jacks. For access to the supply voltage adjustment socket the amplifier must be withdrawn from its housing.

Connections

26. The connections to the amplifier are made by means of 8-way and 10-way fixed plugs, one of each, fitted at the rear of the chassis. The plugs mate with corresponding fixed sockets fitted to the cradle of the mounting. Withdrawal of the amplifier from the cradle breaks all the connections. The correct alignment of the mating components is ensured by two fixed steel guide pins on the chassis entering holes in the cradle. The 8-way plug (PL2) carries the input connections; the 10-way plug carries the connections for the output, the power supply, the chassis earth and the primary winding centre tap of the input transformer.

Table 1. Circuit components and their functions

Capacitors	
C1	Coupling, stage 1 to stage 2
C2	Coupling, stage 2 to stage 3
C3 & C4	Smoothing
C5	Decoupling, stage 1
C6	Decoupling, stages 1 and 2
C7 & C8	Decoupling. Grid bias potential divider
C9	Capacitance earthing. Centre tap of input transformer primary winding
Resistors	
R1 & R2	Attenuators (series). Line level input
R3	Attenuator (shunt). Primary of input transformer
R4	Damping. Output transformer secondary winding
R5	Cathode bias, stage 1
R6	Anode load, stage 1
R7	Grid leak, stage 2
R8	Decoupling, stage 1
R9, R10 & R11	Potential divider. Grid bias, stages 2 and 3
R12	Anode load, stage 2
R13	Decoupling, stages 1 and 2
R14	Grid leak, stage 3
R15	Gain control balancing
Miscellaneous	
FS1 & FS2	Fuses, supply
L1	Smoothing choke
LP1	Pilot lamp
MR1 to MR4	Rectifiers, H.T.
PL1	Plug. Output, supply and earth (10 pin)
PL2	Plug, input (8 pin)
PL3 to PL5	Plugs, supply voltage adjustment
RV1	Gain control potentiometer
SK3	Socket for plugs PL3 to PL5
SW1	Switch, power on
TJI	Test jack, input
TJO	Test jack, output
T1	Transformer, input
T2	Transformer, output
T3	Transformer, mains

MAINTENANCE

27. Attention is drawn to the safety warning in *paragraph* 1.

28. SWITCH OFF WHEN NOT REQUIRED. In the interests of economy and valve life the amplifier should be switched off when not required for use.

29. THE READY USE MAINTENANCE BOX, A.P. 12685. This box, with its contents, provided for general testing work on the A.F. 100 series audio frequency amplifiers, is described in B.R. 575(2)E. The test apparatus stowed in the box, suitable for use with the 2-watt amplifier, includes a portable 25 ohms impedance microphone, a headset and a test load. The test load is A.P. 32064 and is designed for use with either the 2-watt or the 16-watt amplifier. Instructions on the use of the test load are given in the B.R. referred to above. The box also provides stowage for some expendable items such as valves, lamps and fuses.

30. DUST. The interior of the amplifier must be kept reasonably free from accumulated dust. This applies particularly to the transformer H.T. terminals and the H.T. rectifiers.

31. VENTILATION. Heat dissipation must not be impeded. Ventilating louvre openings in the casing and the vent holes in the cradle of the mounting and in the amplifier chassis must be unobstructed.

32. VALVE RETAINERS must always be replaced after removal. They should be examined as opportunity offers and efficiently maintained.

33. CONNECTIONS. When the amplifier is removed from its mounting the plug connectors should be protected from dust settling upon them. This precaution applies particularly to the input plug connector. The plug and socket connectors should not be lubricated; if left connected, or protected by a clean rag when disconnected, they need no cleaning.

34. SPARE AMPLIFIERS are allowed to ships and are usually stowed in the multiple mountings where groups of amplifiers are fitted.

35. SPARE PARTS. Spare transformers and chokes are allowed in the Establishment of Naval Stores. Other items such as valves, lamps and fuses are of Joint Service patterns.

Maintenance routines

36. The following routines should be carried out:—

(*a*) Amplifiers stowed in working positions but not in regular (weekly or more often) use:—

(i) *Daily*. Switch on power for a few hours.

(ii) *Occasional*. If possible, switch on power for a day or more before required for use.

(iii) *Monthly*. An audio test. (Reference *paragraph* 37.)

(*b*) All amplifiers. An annual inspection, cleaning and an audio test under full load in a workshop. (Reference *paragraph* 41.)

37. MONTHLY TEST. Wherever possible the monthly audio test should be made by the user, using the microphone(s) and loudspeaker(s) of the system. Where this procedure is not possible the test should be made by the maintainer, by passing a vocal test message, using a hand microphone and a portable loudspeaker, plugged respectively into the input and output test jacks. The flexible cables to the microphone and loudspeaker should be long enough to allow wide separation for the avoidance of acoustic feedback.

38. A headphone set plugged into the output test jack is not an adequate test of the amplifier output, since the insertion of the plug disconnects the normal load. The use of the test load for monthly audio tests is not recommended; its use involves the removal of the amplifier from its normal housing.

Location of defects at the amplifier position

39. When a failure occurs check the following points in the order shown:—

(1) See that the amplifier supply switch is to " on ".

(2) See that the pilot lamp glows. If it does not, ascertain the cause and correct it.

(3) Check the position of the gain control. Adjust it to a higher setting if necessary.

(4) Check the earth connection, chassis to ship's structure. A rough check can be made by obtaining a zero reading on an ohmmeter AP. 5045.

(5) When the pilot lamp has been glowing for a few minutes withdraw the amplifier and ascertain by touch that the valves are hot. If not, change the cold valve(s) and test the new ones in a similar manner.

40. When the above numbered conditions are satisfactory, if the amplifier still fails to reproduce sound from its usual input and connected loudspeaker(s), carry out a local audio test as indicated in *paragraph* 37. If the results of this test are not satisfactory the fault lies in the amplifier, which must be replaced by a spare one and removed to the workshop for examination.

Annual examination and test

41. The following points should be attended to:—

(1) A complete cleaning of the amplifier internally, with the removal of all dust.

(2) a visual examination of all the small components, looking for signs of overheating.

(3) An examination of all fixing of components, tightness of screws and nuts, conditions of the valve retainers, securing clips, etc.

(4) Carry out an audio test, using the test load, as described in *paragraph* 42, from a power supply at the same voltage as the normal supply to the amplifier.

(5) Check that the amplifier operates correctly from each of the three possible supply voltages; the final test being made at the voltage of the normal supply to the amplifier.

Audio test in a workshop

42. Proceed as follows:—

(*a*) Check that the supply voltage setting in the amplifier is correct for the a.c. supply voltage it is intended to use.

(*b*) Connect the test load socket, with a power supply and an earth connection, to the 10-pin plug PL1 of the amplifier. Set the test load selector switch to " 510 ohms. 2 W."

(*c*) Connect an Avometer, set to the 120 volts a.c. range, to the test load voltmeter terminals.

(*d*) Set the gain control to zero. Switch on the amplifier.

(*e*) 25 *ohms impedance input.* With a test input of 1 mV, 1000 c/s, applied to pins 5 and 6 of the 8-pins input plug PL2, adjust the gain control until the output voltage as shown by the Avometer, is 31·6 volts. Note the setting of the gain control for future reference.

(*f*) " Line " level input:—

(i) With a test input of ·8 volts, 1000 c/s, applied to pins 1 and 2 of the input plug, and the gain control set to " 0 dB " on the scale, the amplifier should give the full output of 31·6 volts.

(ii) With the gain control set to " + 10 dB " on the scale, and the test input increased by 10 dB, full output should be obtained.

(iii) With the test input reduced by 10 dB, and the gain control set to " — 10 dB ", full output should be obtained.

43. If the results of the audio test are not satisfactory a detailed examination should be made on the lines indicated in Table 2.

Location of defects in the workshop

44. Attention is drawn to the safety warning given in *paragraph* 1.

45. TEST DATA. Appendix 2 gives data to enable a test of the amplifier performance to be made in a workshop, and to assist in the location of defective component items. The voltage values given at (*a*) in the *Appendix* are, in each case, the mean of several measurements from different amplifiers; the readings from any one amplifier may be expected to fall within the tolerance given.

46. VOLTAGE READINGS. When using an Avometer in taking test voltage readings the instrument must be of the same A.P. number as that used to obtain the test values given in *Appendix* 2. The range employed must be that shown against the test figures. For any other voltage readings select the highest range which will give a clear indication.

47. INTERNAL WIRING. The internal wiring of the amplifier must never be altered in an attempt to locate a fault. The fact that the amplifier has worked correctly is proof that the wiring scheme is correct. Defective components (resistors and capacitors) or broken or dry joints are the only circuit defects likely to be found in the wiring.

48. SYMPTOMS. Bear in mind the possibility of the existence of two or more defects which may give rise to misleading symptoms and lead to a mistaken diagnosis. If any corrective work has recently been done on the amplifier suspect a resultant defect and check thoroughly before proceeding further.

49. POWER SUPPLY CONNECTIONS. If H.T. is switched on and an input signal applied while the amplifier output is open circuited, excessive voltage, causing harm to the valves, may occur in the output stage. These undesirable conditions can be guarded against, when connecting a power supply to the amplifier in the workshop, by always making use of the test load connector, taking care to see that the load selector switch is set at " 510 ohms, 2 W."

Fault location

50

Abbreviations used in Table 2. (pages 5 and 6):—

OC = Open circuited
SC = Short circuited
D = Defective

Test inputs for use:—

Input test jack or pins Nos. 5 and 6 of plug PL2.
Pins Nos. 1 and 2 of plug PL2.
A 25 ohms impedance microphone or 1 mV, 1000 c/s, from a signal generator.
0·8 volts, 1000 c/s from a signal generator.

Test output load for use:—

(*a*) Test load A.P. 32064, set to " 510 ohms, 2W " and an Avometer set to a.c. 120-volt range, or
(*b*) A loudspeaker adjusted to 2 watts power consumption at 31·6 volts.

51. Distortion gain and hum of the amplifier may be readily checked using Distortion Test Set CT 494, see BR 1771A(2) for operating instructions.

Table 2. FAULT LOCATION

SYMPTOM AND PROCEDURE	POSSIBLE DEFECT	ACTION
(*a*) *No noise or hum*		
(1) See valves and pilot lamps are on.	(i) No supply	Provide.
	(ii) Not switched on	Switch on.
	(iii) Fuse OC	Renew.
	(iv) Valves or lamp not firmly in socket	Refit.
	(v) Output test jack contacts faulty	Make good.
	(vi) Transformer T2. Windings OC	Renew.
(2) Check main H.T. voltage (test point H).	*If zero:*—	
	(i) Rectifiers OC	Renew.
	(ii) Transformer T3, H.T. secondary winding OC	Renew T3.
	(iii) Capacitor C4 SC	Renew.
	If low:—	
	(i) Rectifiers D	Renew.
	(ii) Capacitor C3 SC	Renew.
	(iii) Supply voltage adjuster D or wrongly set	Reset or renew.
	(iv) Choke L1 D	Renew.
(*b*) *Excessive hum*		
(1) Connect a similar capacitor across C3 and C4.	Capacitors may be OC	Renew.
(2) Check voltage at test point H.	See (*a*) (2) above.	
(*c*) *No output signal*		
(1) Check position of gain control.	May be at zero	Adjust.
(2) Check contacts of input and output test jacks.	May be faulty	Clean.
(3) Short the grids of each stage to chassis in turn, commencing at the output stage.	Noise and hum will get progressively greater until the faulty stage is reached when no difference will be observed	Check the faulty stage.
(4) Check circuit voltages at all points.	*If no anode volts:*—	
	(i) Point F. Primary of T2 OC	Renew T2.
	(ii) Point E. Resistor R13 OC	Renew.
	(iii) Capacitor C6 SC	Renew.
	(iv) Point D. Resistor R12 OC	Renew.
	(v) Capacitor C2 SC	Renew.
	(vi) Point A. Resistor R6 OC	Renew.
	If low anode volts in stages 1 *and* 2:—	
	Capacitors C5 or C6 D	Renew.
	If no cathode volts in stages 1:—	
	Resistor R5 SC	Renew.
(5) Check input transformer windings for continuity.	May be OC	Renew.
(3) Check values of resistors R3 and R4.	May be D	Renew.
(*d*) *Distorted Output*		
(1) Check anode voltage of output valve.	(i) If low	Check as in (*a*) (2).
	(ii) If high. Valve may have low emission	Renew.

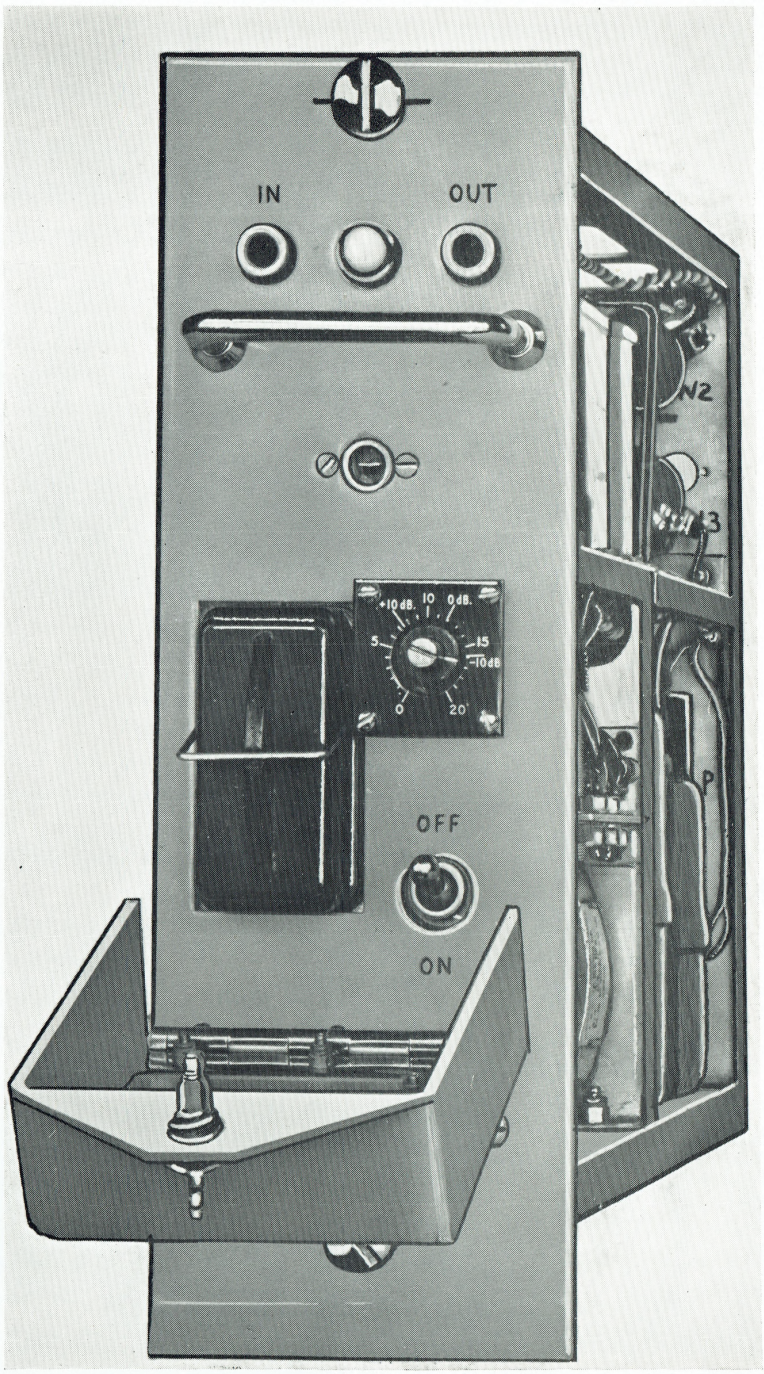


PLATE I. THE AMPLIFIER A.P. 32047

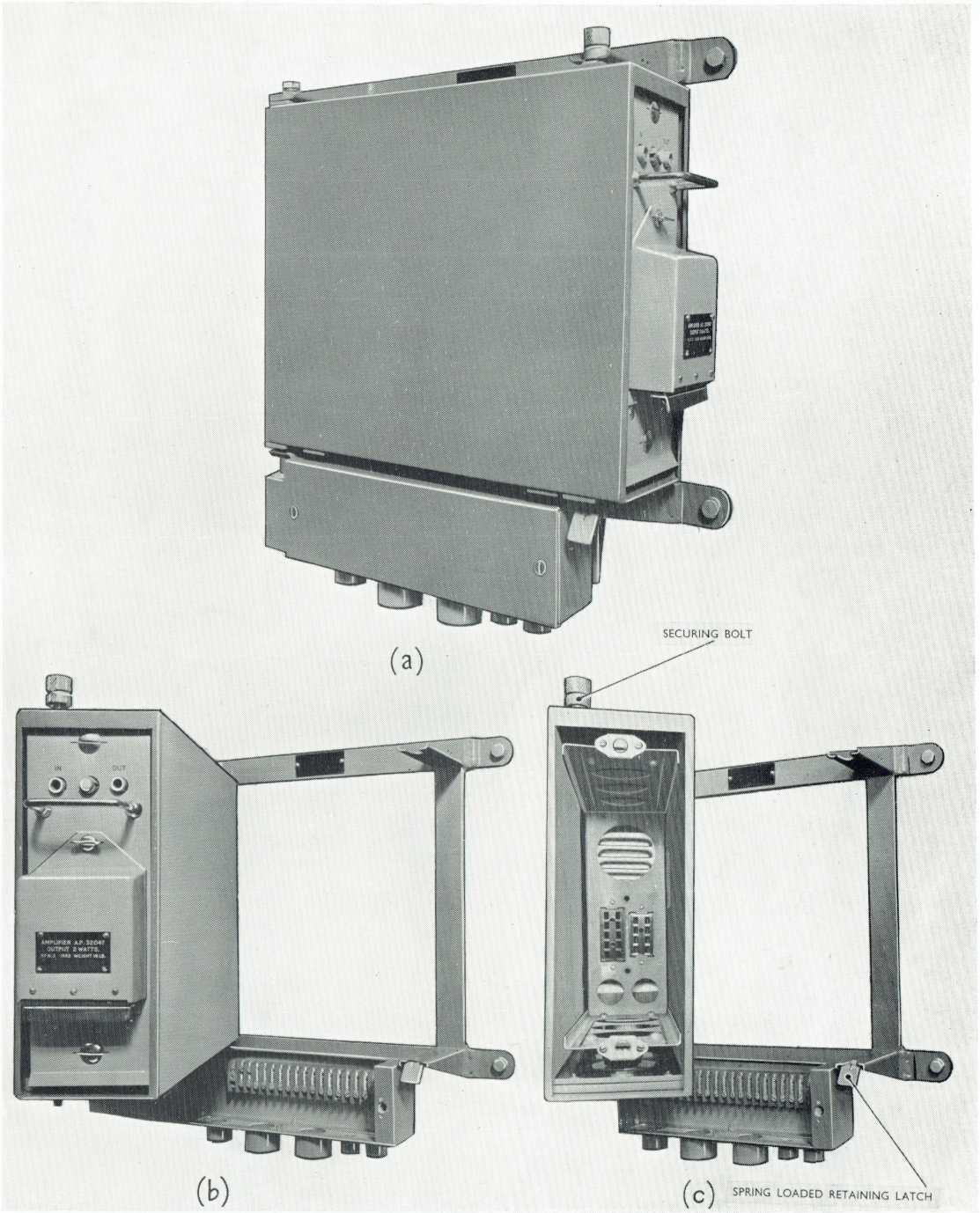


PLATE 3. THE MOUNTING A.P. 32048

(*a*) COMPLETE WITH AMPLIFIER

(*b*) SHOWING THE CABINET SWUNG OUT FOR THE REMOVAL OF THE AMPLIFIER

(*c*) SHOWING THE CRADLE CARRIAGE

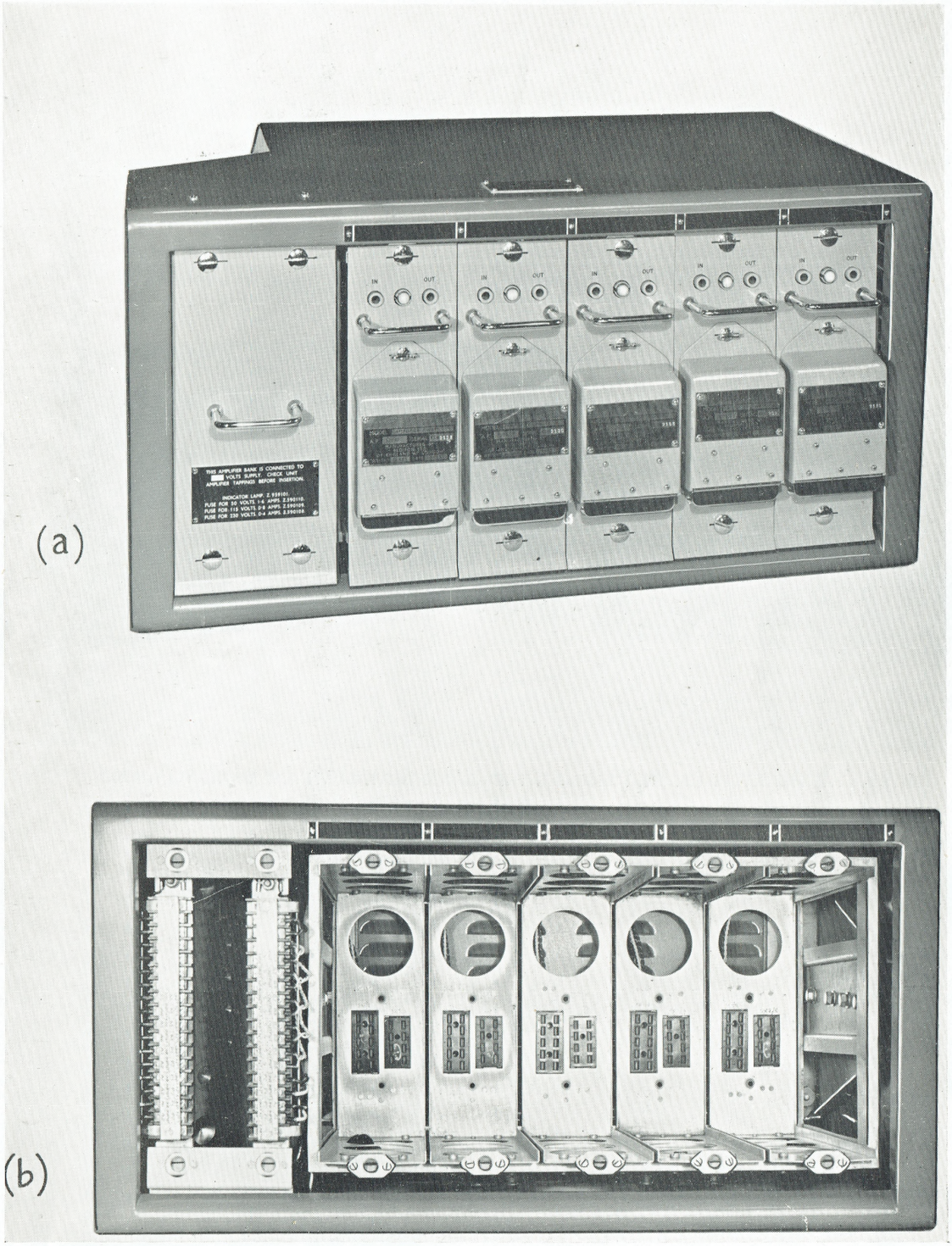


PLATE 5. THE MOUNTING A.P. 32050
(*a*) COMPLETE WITH AMPLIFIERS
(*b*) SHOWING THE CRADLE AND TERMINALS

Table 2 (*continued.*)

SYMPTOM AND PROCEDURE	POSSIBLE DEFECT	ACTION
(2) Check feedback winding of transformer T2.	May be SC or connections reversed .	Renew transformer or correct the corrections.
(3) Check voltages in stages 1 and 2.	May be incorrect	
(4) Check windings of input and output transformers for inductance.	SC turns in windings . . .	Renew transformer.
(*e*) *Noise*		
(1) *Scratching.* Check carbon type resistors.	May be D	Renew.
(2) *Ringing.* Tap valve V1.	Microphonic valve	Renew or prevent vibration.
(3) *Oscillation* Check earth connections in internal wiring.	Earth connection broken from capacitor, transformer, wire screening, etc. .	Renew.
(4) *Intermittent clicks.* Check:—		
(i) Test jack contacts.	May be dirty	Clean.
(ii) Valve pins in sockets.	May be dirty	Clean.
(iii) Gain control contacts.	May be worn	Renew.
(iv) Capacitors.	May be D.	Renew.
(5) *Motor boating*		
Check anode decoupling capacitors and resistors.	Capacitors may be OC . . .	Renew.
	Resistors may have altered in value .	Renew.

SECTION II

THE MOUNTINGS A.P. 32048, 32049 AND 32050

1. Three sizes of mountings are provided for the amplifier A.P. 32047; mounting A.P. 32048 houses one, A.P. 32049 two, and A.P. 32050 five amplifier(s).

2. All three patterns of mounting are arranged for fixing to a bulkhead or similar structure.

3. The amplifiers in the two and five-unit mountings may be employed singly for separate communication systems, or two or more may be operated from a common source. In the last named method the output circuits of individual amplifiers must be kept electrically separate.

THE SINGLE AND DUAL UNIT MOUNTINGS A.P. Nos. 32048 and 32049

(*Figures* 1 and 2. *Plates* 3 and 4)

4. *Figures* 1 and 2 show respectively the construction and fixing arrangements of the mountings, the gland particulars and position, the terminal arrangements and a statement of connections between the terminal strip and the amplifier plug and socket connectors. The weights of the mountings are given in *Appendix* 1.

5. Each of the mountings comprises a framework with a terminal chamber, a casing and inner cradle(s). The framework is made of steel straps and brackets welded together. The mounting complete is drip-proof.

6. The terminal chamber, situated at the bottom of the framework, is made of pressed aluminium alloy, with a detachable cover secured by turn button clips. Cast aluminium alloy cable glands are formed in a gland plate, fixed by screws to the bottom of the terminal chamber. The connections between the terminal strip and the socket connectors in the cradle are made by a flexible cable form.

7. The casing is made of aluminium alloy pressings welded together, and reinforced by steel at the points of support. The cabinet is pivoted at the left side of the mounting in order that it may be swung out for the insertion and removal of the amplifier(s). The cable-form leading to the terminal strip below, passes through a tubular extension of the bottom pivot into the terminal chamber. Access to the socket connections at the rear of the cradle is by means of a removable plate at the left side of the casing. The housing is held in the stowed, or working, position by a steel spring latch at the bottom and a securing bolt with a knurled nut at the top.

8. Ventilation of the housing is through gauze protected holes in the bottom plate, by louvres in the left hand side, and by clearance around the front plate of the amplifier(s).

9. The cradle (two in the two-unit mounting) is of skeleton construction, made of mild steel pressings. It is fixed in the casing by resilient mounts, two at the top and two at the bottom. The amplifier slides into the cradle runway and is secured by turn button spring clips. The rear of the cradle carries the socket connectors which mate with the plugs on the amplifier, correct alignment being ensured by steel locating pins fixed to the amplifier chassis entering holes cut in the cradle.

10. *Earthing arrangements.* The chassis of each amplifier is earthed through pin No. 5 of its 10-way plug and socket connector SK1, whence a line is run to the earth terminal on the terminal strip. The cradle is earthed by an earth connection to the same line from one of the securing screws of the 8-way socket(s) SK2. From the earth terminal on the strip a line is run to an earth terminal on the casing; from this terminal a permanent earth connection is made to the ship's structure. (See Note following *paragraph* 18.)

THE FIVE UNIT MOUNTING A.P. 32050

(*Figure* 3. *Plates* 5 and 6)

11. *Figure* 3 shows the construction and fixing arrangements of the mounting, the gland particulars and position, the terminal arrangement, and a statement of connections between the terminal strips and the amplifier plug and socket connectors. The weight of the mounting is given in *Appendix* 1.

12. The mounting comprises a casing and an inner cradle. The cradle is supported in the casing by resilient rubber mounts fixed to a bracket framework supported directly by the mounting fixing straps. By this means, the weight of the amplifiers and cradle is supported by the framework and not by the casing.

13. *The casing* is made of aluminium alloy pressings welded together, reinforced at the rearmost corners, and supported on steel fixing straps. Ventilation is by louvres in the rear face and the sides and by clearances around the closing plates at the front. The whole is drip-proof.

14. The cable glands are fixed in a steel plate which closes the rear of a terminal chamber forming part of the casing on the left, as viewed from the front.

15. The termination of the fixed incoming cables is on terminal strips in the terminal chamber. The connections between the terminal strips and the amplifier connectors are by flexible cable forms.

16. *The cradle* is of skeleton construction, is built up of mild steel pressings, and is fixed to the supporting framework with a tilt backwards of $2\frac{1}{2}°$. The amplifiers slide into runways in the cradle and are secured by turn button spring clips. The rear of the cradle carries the socket connectors which mate with the plugs on the amplifiers, correct alignment being ensured by steel locating pins on the amplifier chassis entering holes cut in the cradle.

17. For access to the wiring connections from the terminal strips to the sockets the cradle can be withdrawn from the cabinet (see *Plate* 6) after the removal of 12 securing bolts.

18. *Earthing.* The chassis of each amplifier is earthed through pin No. 5 of its 10-way plug and socket connector SK1, whence an earth line is run to an earth bus-bar near the terminals strips. The cradle is earthed by an earth connection to the same line from one of the securing screws of each of the 8-way sockets SK2. Near the terminal strips an earth line runs from the earth bus-bars to an earth terminal on the casing at the rear of the terminal chamber. From this terminal a permanent earth connection is made to the ship's structure.

Note: In some early production mountings of all three patterns the earthing arrangements may differ slightly from those described. The standard method described above should be adopted if found necessary.

APPENDIX 1

Summary of Structural and Electrical Details

STRUCTURAL DETAILS

AMPLIFIERS AND MOUNTINGS

	AMPLIFIER	MOUNTINGS		
	A.P. 32047	A.P. 32048 (SINGLE UNIT)	A.P. 32049 (TWO UNIT)	A.P. 32050 (FIVE UNIT)
Dimensions (inches):				
Height	10½	17¼	17¼	13
Width overall	3½	17⅞	17⅞	28
Depth, front to back	14¾	4¾	8½	16¾
Withdrawal clearance	—	—	—	15
Weight (lb)	16	14½	19¾	38
Cable entry:				
Type	Sockets, one of each:	Glands	Glands	Glands
	8 way, A.P. W7339	2 No. 2	2 No. 2	8 No. 2
	10 way, A.P. 57907	1 No. 3 2 No. 4	1 No. 3 2 No. 4	1 No. 3 2 No. 4
Position	Rear	Bottom	Bottom	Left side
Casing material		Aluminium alloy and mild steel		

ELECTRICAL DETAILS

THE AMPLIFIER

Power supply:—	
Type	a.c. single phase
Voltage	50, 115 or 230 volts
Frequency	50 to 60 c/s
Power consumption	26 VA
H.T. (Max.)	250 volts
Fuses:—	
Capacity and J.S. Cat. No.	for 50 volt supply—2A. Z590110 (2 off) for 115-volt supply—1A. Z590109 (2 off) for 230-volt supply—·5A. Z590108 (2 off)
Valves	V.1, double triode. C.V.492 V.2, beam tetrode. C.V.2136
Pilot lamp	X959101 (1 off)
Inputs. Type	25 ohms impedance microphone, or " line " level from radio set, recorder, etc.
Power output	2 watts at 31·6 volts

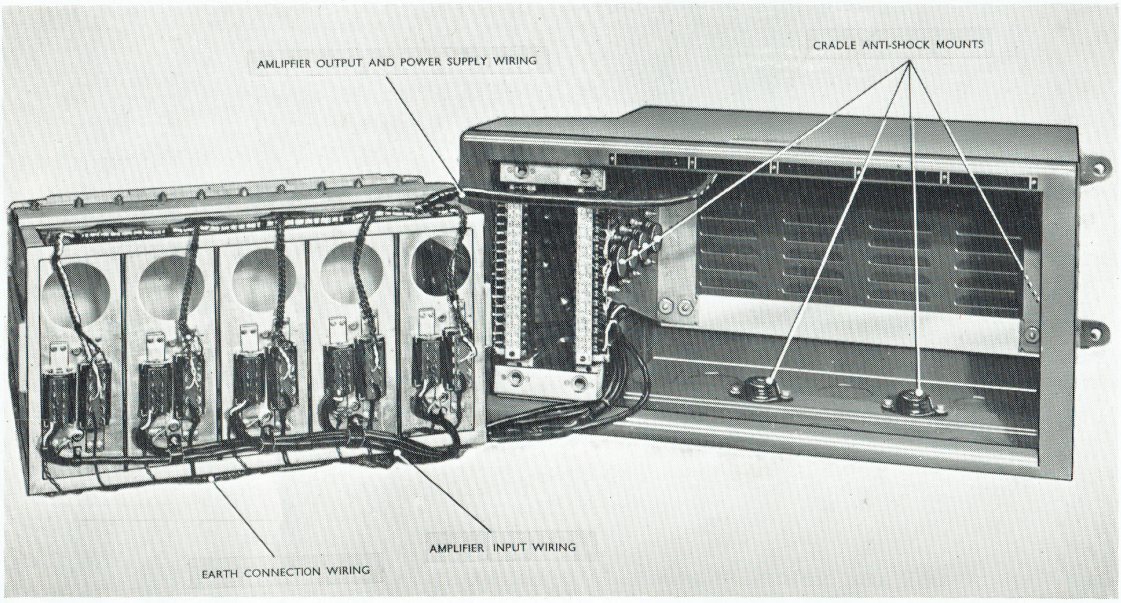


PLATE 6. THE MOUNTING A.P. 32050 SHOWING THE CRADLE WITHDRAWN FOR ACCESS TO WIRING

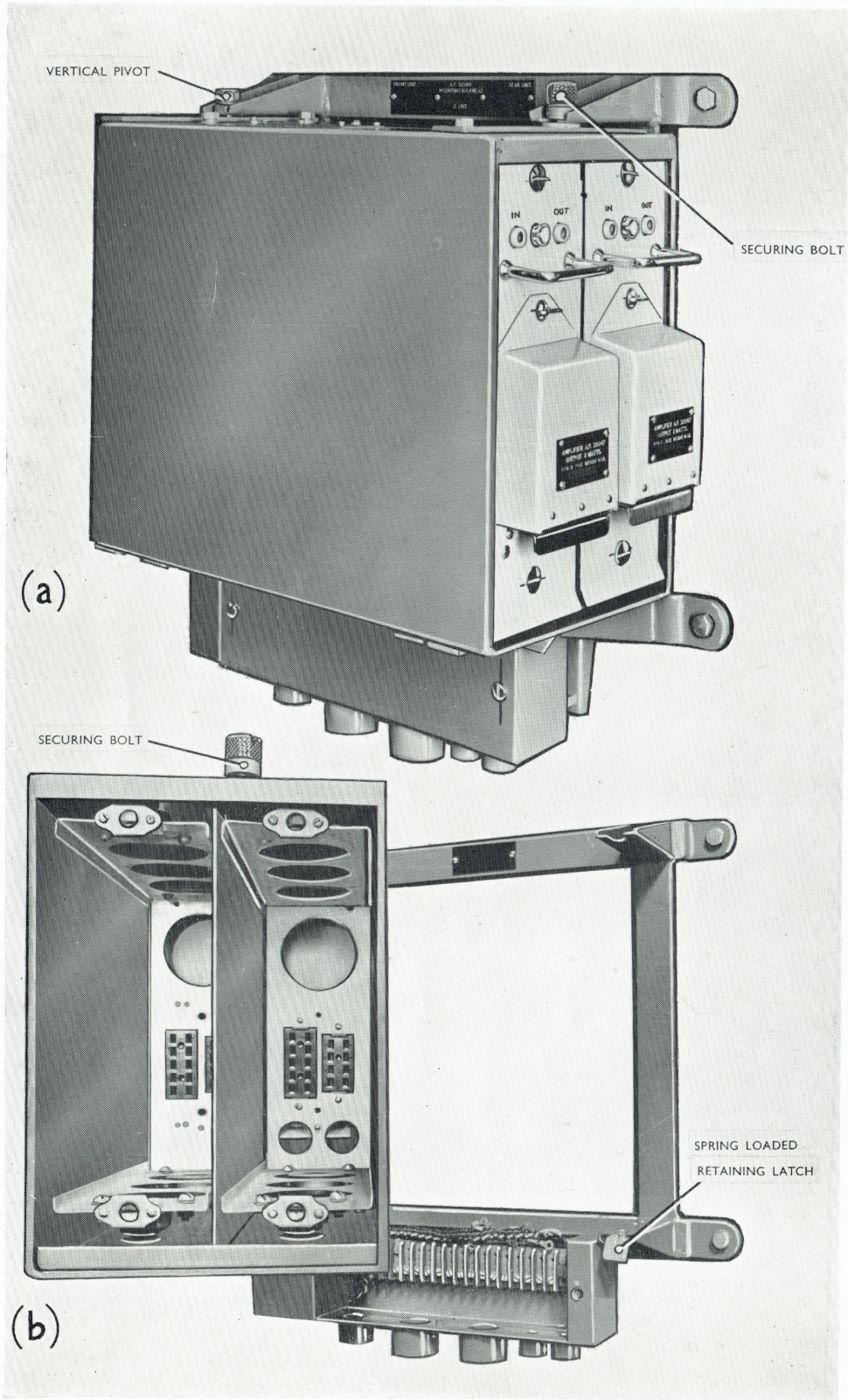


PLATE 4. THE MOUNTING A.P. 32049
(*a*) COMPLETE WITH AMPLIFIERS
(*b*) SHOWING THE CABINET SWUNG OUT, AMPLIFIERS REMOVED

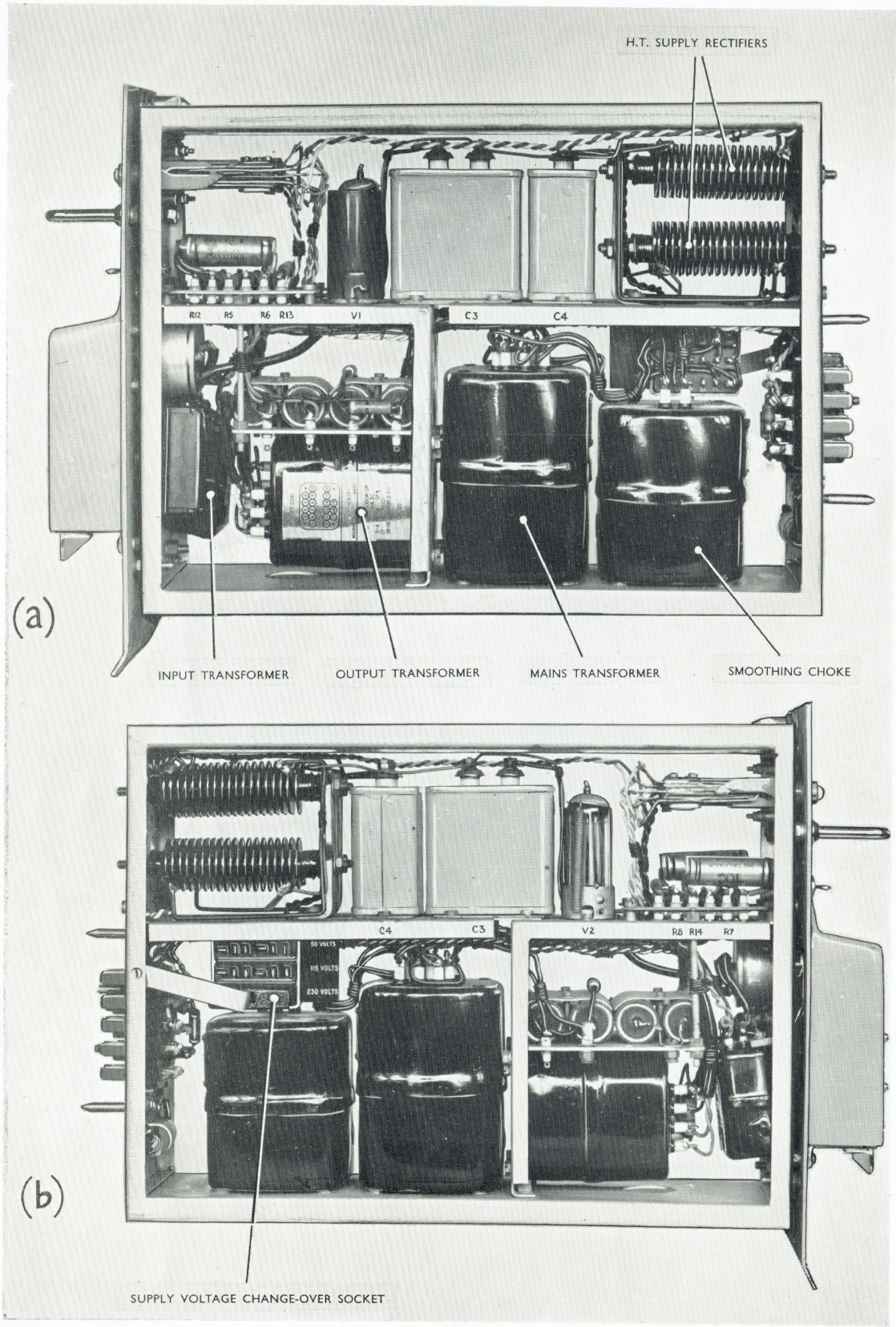


PLATE 2. THE AMPLIFIER A.P. 32047

(*a*) VIEWED FROM THE RIGHT

(*b*) VIEWED FROM THE LEFT

APPENDIX 2

Test Data

THE AMPLIFIER

(a) *Voltages.* Between test point and chassis, taken with Avometer A.P. 47A. (Test point letter references are to *Plate* 1.) Reference *paragraph* 46 of *Section I.*

TEST POINT LETTER	CIRCUIT POINT	METER RANGE USED D.C.	VOLTAGE (VOLTS)	ACCEPTABLE TOLERANCE + or − %
A	Anode of valve V1. Stage 1 . . .	480	21	*
B	Across capacitor C5	480	34	*
C	Cathode of valve V1. Stage 1 . . .	12	0·44	*
D	Anode of valve V1. Stage 2 . . .	480	38·5	25
E	Across capacitor C6	480	54·5	25
F	Anode of valve V2	480	238	10
G	Choke L1 Rectifier end	120	− 13·5	10
H	Across capacitor C3	480	248	10

Note: * Tolerances undefinable due to manufacturing tolerances in valve and resistors.

(b) *Distortion.* With a 2 watts output into a 500 ohms load the distortion at 400 c/s is less than 3 per cent.

(c) *Frequency response:*— (Relative to that at 1.000 c/s)
(i) at 100 c/s = 0 ± 2 dB
(ii) at 5,000 c/s = −1 ± dB

(d) *Input voltage* for full load output:—
(i) 25 ohms microphone = 1 mV
(ii) "line" level input = 0·8 volts with gain control set to 0 dB.

APPENDIX 3

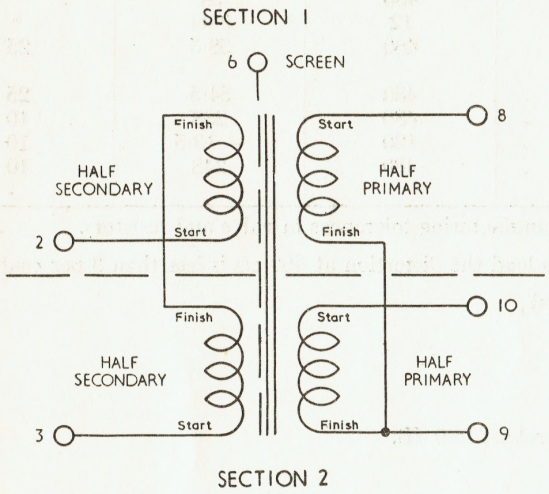
Constructional Details

TRANSFORMER A.P. 32007

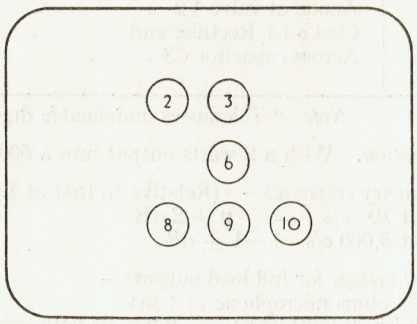
TYPE: Microphone Input. (25 ohms).

USED IN : 16-watt amplifiers A.P. Nos. 32020 and 32021.
2-watt amplifier A.P. 32047.
Microphone pre-amplifier A.P. 12949
Microgram A.P. 32018

CIRCUIT DIAGRAM



TERMINAL PLAN



COIL WINDING DATA
Two bobbins, one for each section.

WINDING ORDER	WINDING	NO. OF TURNS ON SECT. 1	NO. OF TURNS ON SECT. 2	SIZE OF WIRE (S.W.G.)	D.C. RES. (OHMS) ALL ± 20 PER CENT.	INDUCTANCE (1V AT 50 C.P.S.) HENRYS
1	Secondary . .	2525	2525	44	700	—
2	Screen . . .	1	1	(Copper foil 1 mil thick)		
3	Primary . .	63	63	32	2	0·126

WIRE: Copper. Double enamel covered.

INSIDE INSULATION: Bakelite tube.

INTERWINDING INSULATION : Between secondary and screen and between screen and primary—one turn of silk.

CORE LAMINATIONS: TYPE L, MATERIAL Mumetal, J.S. REF. NO. 529, STACK 0·4 in.

NOMINAL IMPEDANCE OF PRIMARY: 25 ohms.

PRIMARY/SECONDARY TURNS RATIO: 1/40.

HIGH POTENTIAL TEST VOLTAGE: 500 volts d.c.

TERMINALS: Z560093 (6 off).

APPENDIX 3

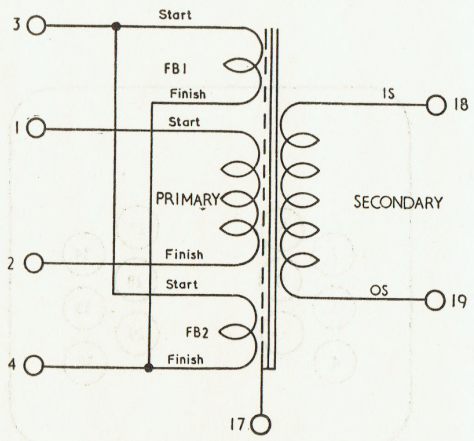
Constructional Details

TRANSFORMER A.P. 32116

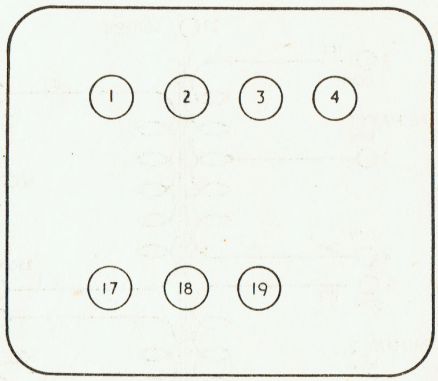
TYPE: Output.

USED IN: 2-watt amplifier A.P. 32047.
Monitor Selector Panel A.P. 32000 (S.R.E.).

CIRCUIT DIAGRAM



TERMINAL PLAN



COIL WINDING DATA

WINDING ORDER	WINDING	NO. OF TURNS	SIZE OF WIRE (S.W.G.)	NO. OF LAYERS	D.C. RES. (ALL ± 20 PER CENT.) (OHMS)	INTERLAYER PAPER INSULATION	
						NO. OF TURNS	THICKNESS
1	F.B. 1 . . .	3	28 × 2	1	—	—	—
2	Primary . .	3000	36	23	200	1	1·5 mil
3	F.B. 2 . . .	3	28 × 2	1	—	—	—
4	Screen . . .	1	(Copper foil 1 mil thick)			—	—
5	Secondary . .	850	33	9	38	1	1·5 mil

WIRE: Copper. Enamel covered.
INSIDE INSULATION: Bakelite tube.
INTERWINDING INSULATION: 5 layers of 3 mil thick paper.
COIL OUTSIDE INSULATION: 5 layers of 3 mil thick paper.
CORE: Z371020 (1 off).
CORE GAP: 0·005 in.
GAP MATERIAL: Paper.
PRIMARY—IMPEDANCE: 5,000 ohms.
INDUCTANCE: 8 H (min) 45 mA d.c. Tested at 10V 50 c/s.
SECONDARY IMPEDANCE: 400 ohms, at 2·5 watts.
PRIMARY/FEEDBACK TURNS RATIO: 1,000/1.
PRIMARY/SEC. TURNS RATIO: 3·53/1.
FREQUENCY RESPONSE: ± 1 dB 200 to 5,000 c/s.
HIGH POTENTIAL TEST VOLTAGE: 2 kV.
TERMINALS: Z560087 (7 off).

APPENDIX 3

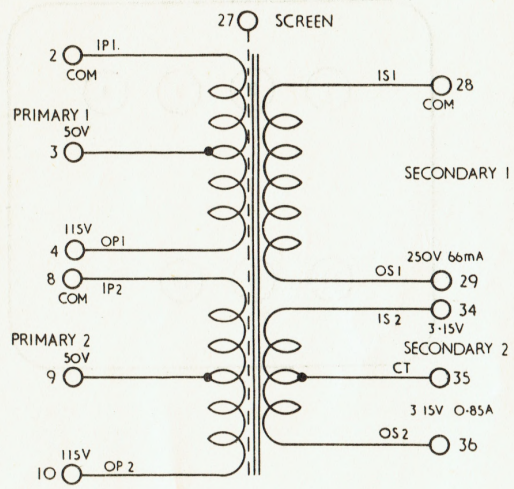
Constructional Details

TRANSFORMER A.P. 32117

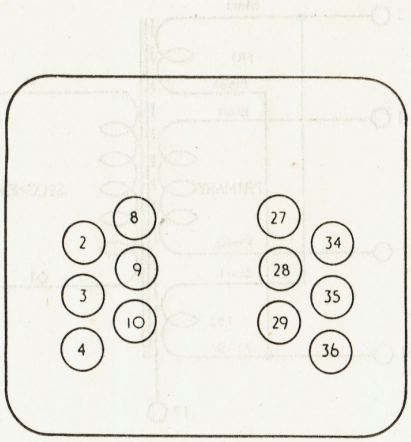
TYPE: Mains.

USED IN: 2-watt amplifier A.P. 32047.

CIRCUIT DIAGRAM



TERMINAL PLAN



COIL WINDING DATA

WINDING ORDER	WINDING	NO. OF TURNS	SIZE OF WIRE (S.W.G.)	NO. OF LAYERS	D.C. RES. (ALL ± 20 PER CENT.) (OHMS)	INTERLAYER PAPER INSULATION	
						NO. OF TURNS	THICKNESS
1	Primary No. 1 .	221	28	4	5	1	2·5 mil
		299	33	3	14	1	1·5 mil
2	Primary No. 2 .	221	28	4	5	1	2·5 mil
		299	33	3	17	1	1·5 mil
3	Screen . . .	1	(Copper foil 1 mil thick)			—	—
4	Secondary No. 1 .	1185	37	9	165	1	1·5 mil
5	Secondary No. 2 .	15 + 15	23	1	0·36	—	—

WIRE: Copper. Enamel covered.

INSIDE INSULATION: Bakelite tube.

INTERWINDING INSULATION: 3 turns of 5 mils thick paper.

COIL OUTSIDE INSULATION: 3 turns of 5 mils thick paper.

CORE: Z371002 (2 off).

INPUT TO PRIMARY: 50, 115 or 230 volts. 50 to 60 c/s. (Series parallel winding.)

OUTPUT FROM: Secondary 1 250 volts. 66mA.
Secondary 2 6·3 volts. 0·85 amperes.

HIGH POTENTIAL TEST VOLTAGE: 2 kV.

TERMINALS: Z560087 (12 off).

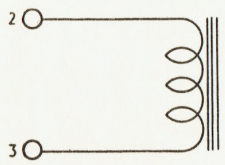
APPENDIX 3

Constructional Details

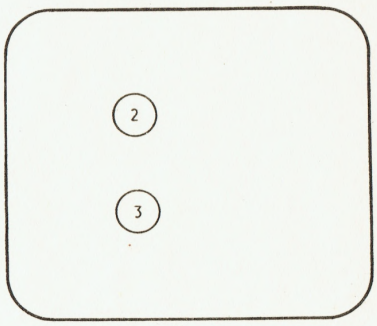
SMOOTHING CHOKE A.P. 32115

USED IN: 2-watt amplifier A.P. 32047.
Monitor Selector Panel A.P. 32000 (S.R.E.)

CIRCUIT DIAGRAM



TERMINAL PLAN



COIL WINDING DATA

NO. OF TURNS	SIZE OF WIRE (S.W.G.)	NO. OF LAYERS	D.C. RES. (OHMS)	INTERLAYER PAPER INSULATION THICKNESS
3,600	36	32	275 ± 20 PER CENT	1 mil

WIRE: Copper. Enamel covered.

INSIDE INSULATION: Bakelite tube.

COIL OUTSIDE INSULATION: 3 turns of 5 mils thick paper.

CORE: Z371001 (2 off).

CORE GAP: 0·01 in.

GAP MATERIAL: Paper.

INDUCTANCE: 20 H ± 25 per cent. Tested at 10V, 50 c/s.

HIGH POTENTIAL TEST VOLTAGE: 2 kV.

TERMINALS: Z560087 (2 off).

A2181. 40975/102. 875. 9/56. McC. 557/2

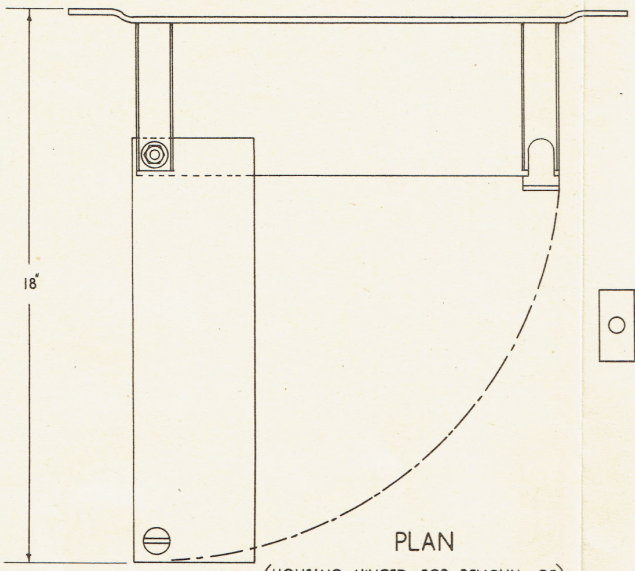
THE MOUNTING A.P.32048

FIG. 1

DIMENSIONS, FIXING PARTICULARS, TERMINAL ARRANGEMENT

RUNNING LIST

TERMINAL STRIP NUMBERED FROM LEFT TO RIGHT	(SOCKET A) PIN Nos	(SOCKET B) PIN Nos
T 1	5 MIC INPUT	
T 2	6 MIC INPUT	
T 3	1 LINE INPUT	
T 4	2 LINE INPUT	
5 SPARE		
6 SPARE		
T 7		7 OUTPUT
T 8		8 OUTPUT
9 SPARE		
S 10		5 EARTH (SEE NOTE 2)
11 SPARE		
12 SPARE		
13 SPARE		
14 SPARE		
P 15		12 A C SUPPLY
P 16		11 A C SUPPLY



PLAN

(HOUSING HINGED FOR REMOVAL OF AMPLIFIER

TERMINAL STRIP MARKING

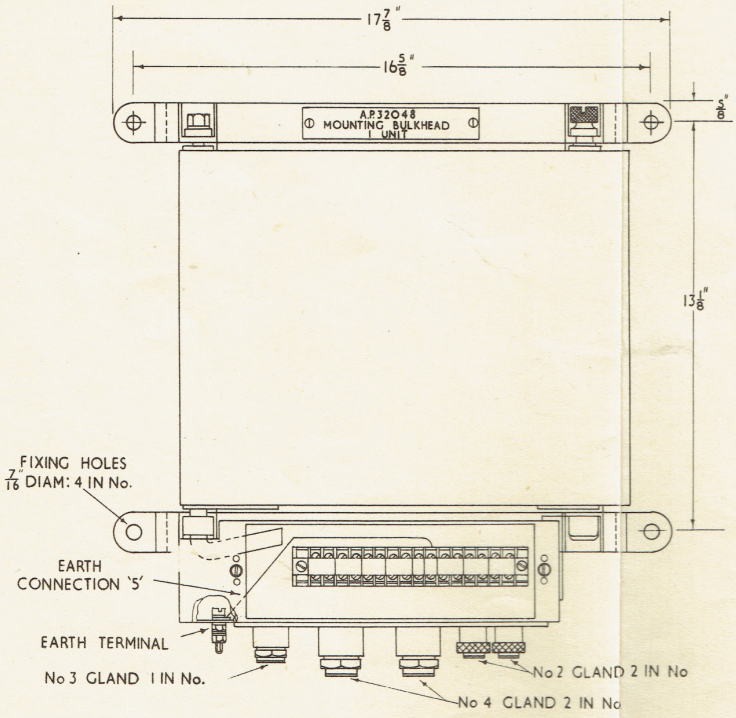
A5	A6	A1	A2		B7	B8		B5					B12	B11
MIC. INPUT		LINE INPUT			OUTPUT			EARTH					SUPPLY	
M	M	P1	P2		S	S		E					~	~

NOTES:-

1 ALL CABLES IN ACCORDANCE WITH D.E.F. 12 (EQUIPMENT WIRE)
T – TWISTED PAIR 7/0·0076 P.V.C. TYPE 2
S – SINGLE CORE 14/0·0076 P.V.C. TYPE 2
P – TWISTED PAIR 14/0·0076 P.V.C. TYPE 3

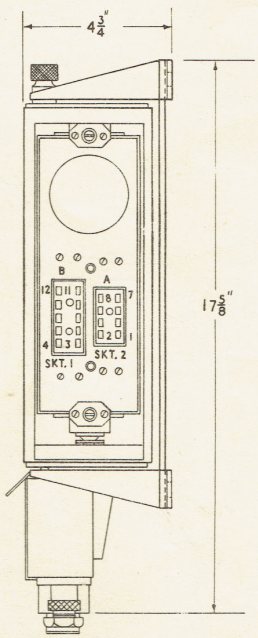
2 THE EARTH CONNECTION TO PIN 5 OF SOCKET (B) IS EXTENDED TO THE CRADLE AND SECURED VIA SUITABLE TAG TO ONE SECURING SCREW OF SOCKET (A)

WEIGHT:-
14½ LBS (MOUNTING ONLY)
30½ LBS (COMPLETE WITH AMPLIFIER)



FRONT ELEVATION

(TERMINAL COVER REMOVED AND PART SECTIONED)



END ELEVATION

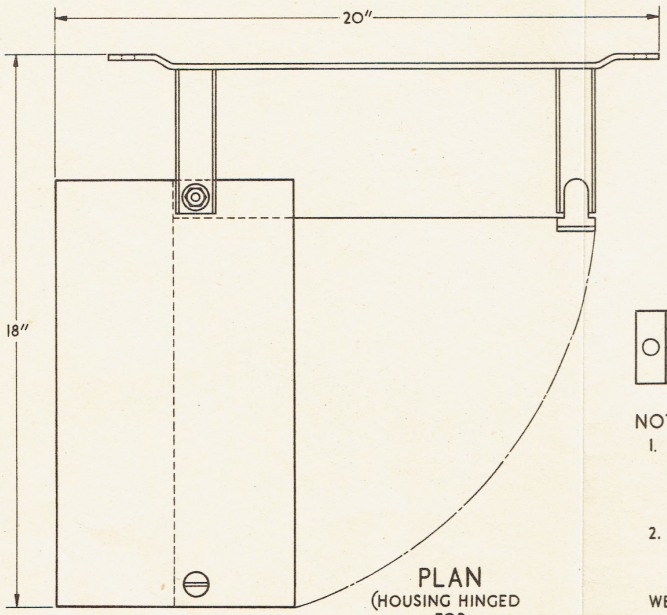
H.M.S. COLLINGWOOD DRG. No 12158
BASED ON D.E.E. DRG. No C 19942

C.B.H. 28004

THE MOUNTING A.P.32049

DIMENSIONS, FIXING PARTICULARS, TERMINAL ARRANGEMENT

FIG. 2



PLAN
(HOUSING HINGED FOR REMOVAL OF AMPLIFIER)

RUNNING LIST

TERMINAL STRIP NUMBERED FROM LEFT TO RIGHT		FRONT UNIT SOCKET(A) PIN Nos.	FRONT UNIT SOCKET(B) PIN Nos.	REAR UNIT SOCKET(A) PIN Nos.	REAR UNIT SOCKET(B) PIN Nos.
S	1		5 (SEE NOTE 2)		5 EARTH (SEE NOTE 2)
S	2 SPARE				
T	3	5 MIC. INPUT			
T	4	6 MIC. INPUT			
T	5			5 MIC. INPUT	
T	6			6 MIC. INPUT	
T	7	1 LINE INPUT			
T	8	2 LINE INPUT			
T	9			1 LINE INPUT	
T	10			2 LINE INPUT	
T	11		7 OUTPUT		
T	12		8 OUTPUT		
T	13				7
T	14				8 OUTPUT
P	15		12		12 A.C.
P	16		11		11 SUPPLY

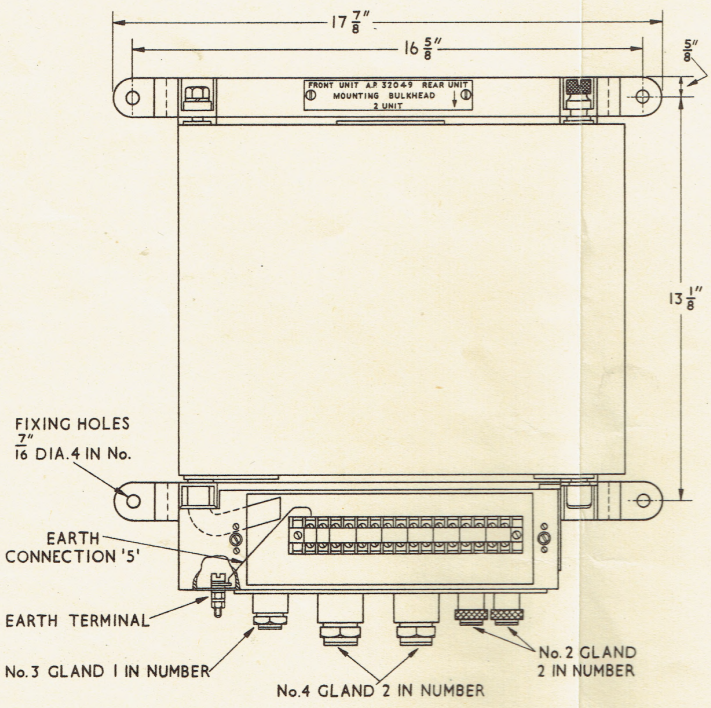
TERMINAL STRIP MARKING

	B5		A5	A6	A5	A6	A1	A2	A1	A2	B7	B8	B7	B8	B12	B11	
	EARTH		MIC. INPUT		MIC. INPUT		LINE INPUT		LINE INPUT		OUTPUT		OUTPUT		SUPPLY		
	E		M	M	M	M	P1	P2	P1	P2	S	S	S	S	~	~	
			FRONT UNIT		REAR UNIT		FRONT UNIT		REAR UNIT		FRONT UNIT		REAR UNIT				

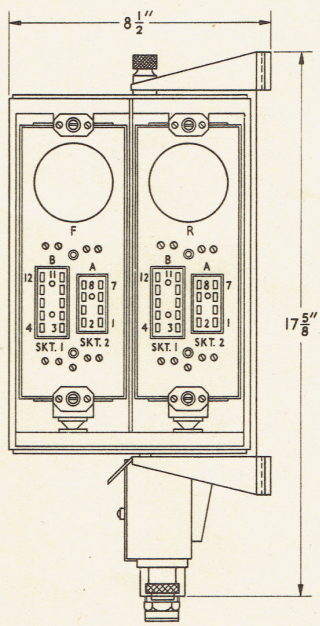
NOTES:–

1. ALL CABLES IN ACCORDANCE WITH D.E.F. 12 (EQUIPMENT WIRE)
   T - TWISTED PAIR 7/0·0076 P.V.C. TYPE 2
   S - SINGLE CORE 14/0·0076 P.V.C. TYPE 2
   P - TWISTED PAIR 14/0·0076 P.V.C. TYPE 3
2. THE EARTH CONNECTION TO PIN 5 OF EACH SOCKET (B) IS EXTENDED TO THE CRADLE AND SECURED VIA SUITABLE TAG TO ONE SECURING SCREW OF SOCKET (A)

WEIGHT:–
19 3/4 LBS. (MOUNTING ONLY)
51 3/4 LBS. (COMPLETE WITH 2 UNITS)



FRONT ELEVATION
(TERMINAL COVER REMOVED AND PART SECTIONED)



END ELEVATION

H.M.S. COLLINGWOOD DWG. No. 12159
BASED ON D.E.E. DWG. No. C19943

C.B.H. 28004

THE

DIMENSIONS, FIXING

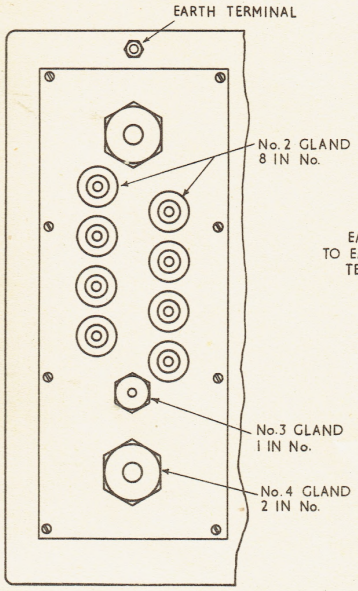
TOP / RIGHT																
	B12	B11	B7	B8	B7	B8	B7	B8	B7	B8	B7	B8	A2	A1	A2	A1
	SUPPLY		OUTPUT		OUTPUT		OUTPUT		OUTPUT		OUTPUT		LINE INPUT		LINE INPUT	
	~	~	S	S	S	S	S	S	S	S	S	S	P2	P1	P2	P1
			UNIT No. 5		UNIT No. 4		UNIT No. 3		UNIT No. 2		UNIT No. 1		UNIT No. 1		UNIT No. 2	

2

TOP / LEFT																
	UNIT No. 1		UNIT No. 2		UNIT No. 3		UNIT No. 4		UNIT No. 5		UNIT No. 5		UNIT No. 4		UNIT No. 3	
	M	M	M	M	M	M	M	M	M	M	P1	P2	P1	P2	P1	P2
	MIC. INPUT		MIC. INPUT		MIC. INPUT		MIC. INPUT		MIC. INPUT		LINE INPUT		LINE INPUT		LINE INPUT	
	A5	A6	A5	A6	A5	A6	A5	A6	A5	A6	A1	A2	A1	A2	A1	A2

1

TERMINAL STRIP MARKING



GLAND PLATE (ELEVATION)

RUNNING LIST

FOR CABLES BETWEEN TERMINAL STRIPS AND SOCKETS.

TERMINAL STRIP NUMBERING FROM TOP TO BOTTOM	UNIT No.1		UNIT No.2		UNIT No.3		UNIT No.4		UNIT No.5	
	SOCKET (A) PIN Nos.	SOCKET (B) PIN Nos.	SOCKET (A) PIN Nos.	SOCKET (B) PIN Nos.	SOCKET (A) PIN Nos.	SOCKET (B) PIN Nos.	SOCKET (A) PIN Nos.	SOCKET (B) PIN Nos.	SOCKET (A) PIN Nos.	SOCKET (B) PIN Nos.
TERMINAL STRIP No.1										
T 1, 2	5, 6 MIC INPUT									
T 3, 4			5, 6 MIC INPUT							
T 5, 6					5, 6 MIC INPUT					
T 7, 8							5, 6 MIC INPUT			
T 9, 10									5, 6 MIC INPUT	
SC 11, 12									1, 2 LINE INPUT	
SC 13, 14							1, 2 LINE INPUT			
SC 15, 16					1, 2 LINE INPUT					
TERMINAL STRIP No 2										
P 1, 2		12, 11		12, 11		12, 11		12, 11		12, 11 A.C. SUPPLY
T 3, 4										7, 8 OUTPUT
T 5, 6								7, 8 OUTPUT		
T 7, 8						7, 8 OUTPUT				
T 9, 10				7, 8 OUTPUT						
T 11, 12	7, 8 OUTPUT									
SC 13, 14	1, 2 LINE INPUT									
SC 15, 16			1, 2 LINE INPUT							
S EARTH		5		5		5		5		5

NOTE:—

1 ALL CABLES IN ACCORDANCE WITH D.E.F.12 (EQUIPMENT WIRE) EXCEPT SCREENED TWISTED PAIRS WHICH ARE TO BE D.E.F. 10 MINIATURE ELECTRIC CABLE No. 2C (LESS OUTER SHEATH)
- SC SCREENED TWISTED PAIR 14/0·0076
- T TWISTED PAIR 7/0·0076 PVC. TYPE 2
- S SINGLE CORE 14/0·0076 TYPE 2
- P TWISTED PAIR 14/0·0076 TYPE 3

2 THE EARTH LEAD FROM THE REAR TAG OF THIS EARTHING SCREW IS CONNECTED TO THE EARTH BUS BAR ARRANGEMENT OF THE TERMINAL STRIP ASSEMBLY AND THENCE VIA INTERNAL CABLE FORMS TO PIN 5 OF EACH SOCKET (B) AND THEN EXTENDED AT THE REAR OF EACH CRADLE VIA A SUITABLE TAG TO ONE SECURING SCREW OF SOCKET (A)

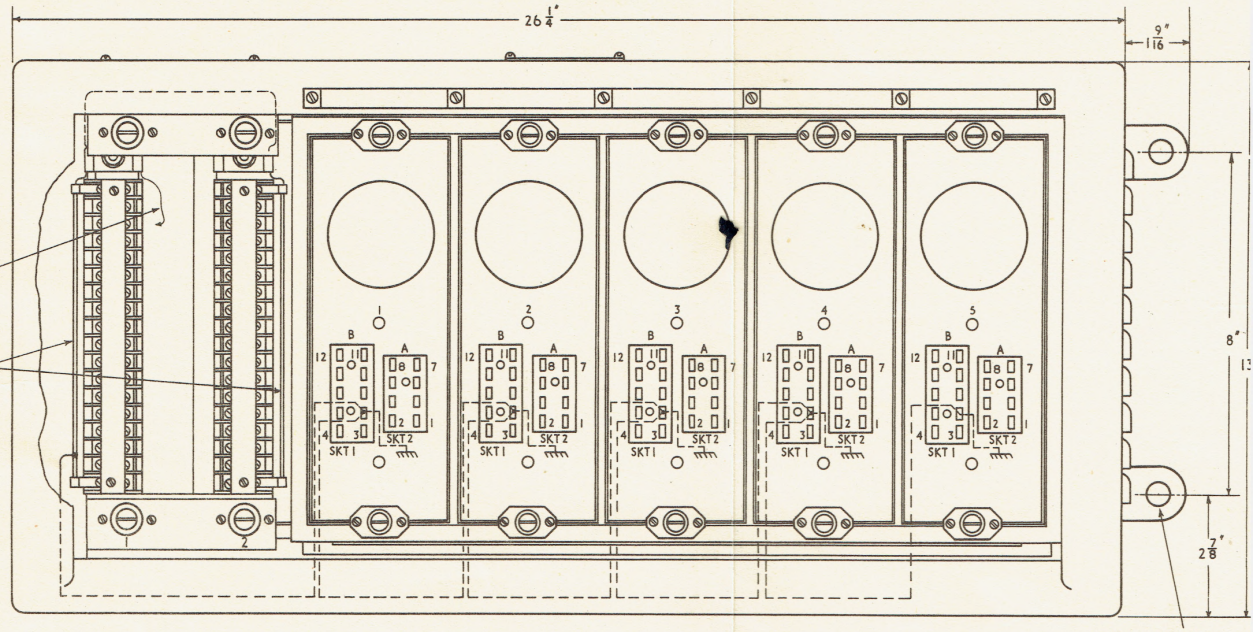
WEIGHT:— 38 LBS (MOUNTING ONLY)
118 LBS (COMPLETE WITH 5 UNITS)

C.B.H. 28004 - Wt. 40975 - Dd. P.102 - 900 - 7/56

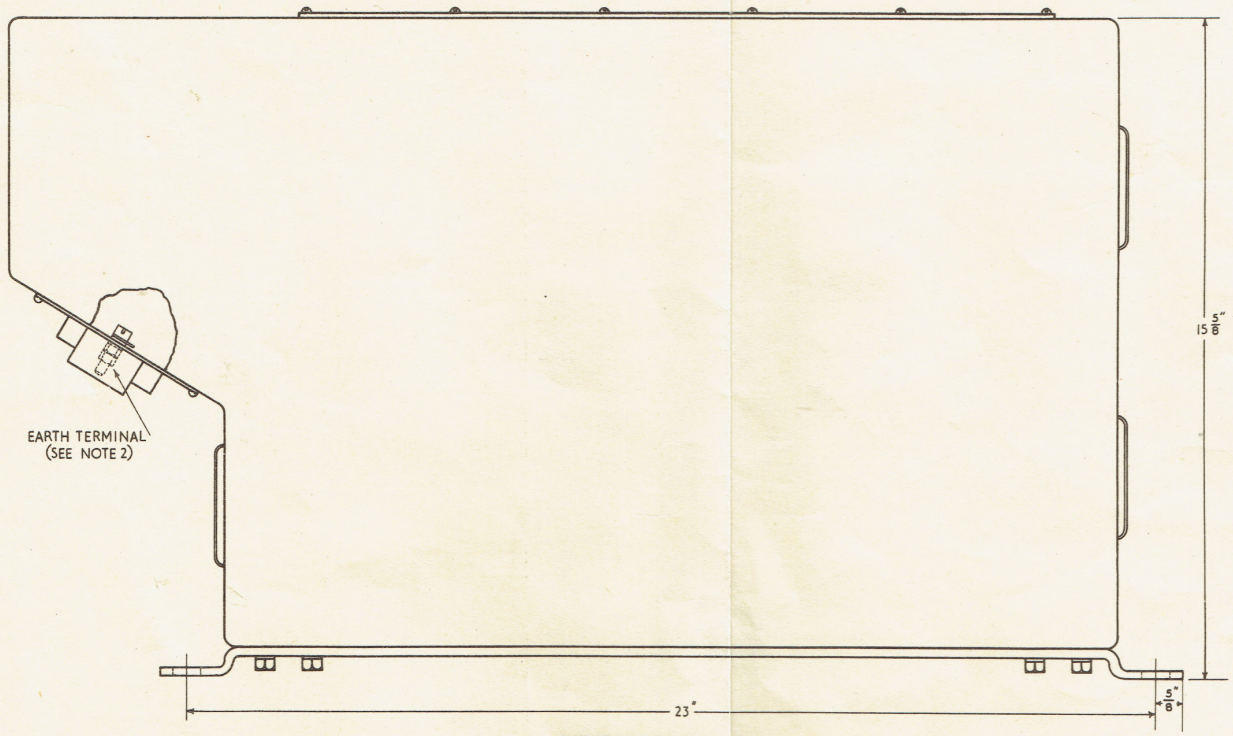
THE MOUNTING A.P. 32050

, FIXING PARTICULARS, TERMINAL ARRANGEMENT

FIG.



FRONT ELEVATION



INVERTED PLAN

H.M.S. COLLINGWOOD DRG. No.
BASED ON D.E.E. DRG. No. D19

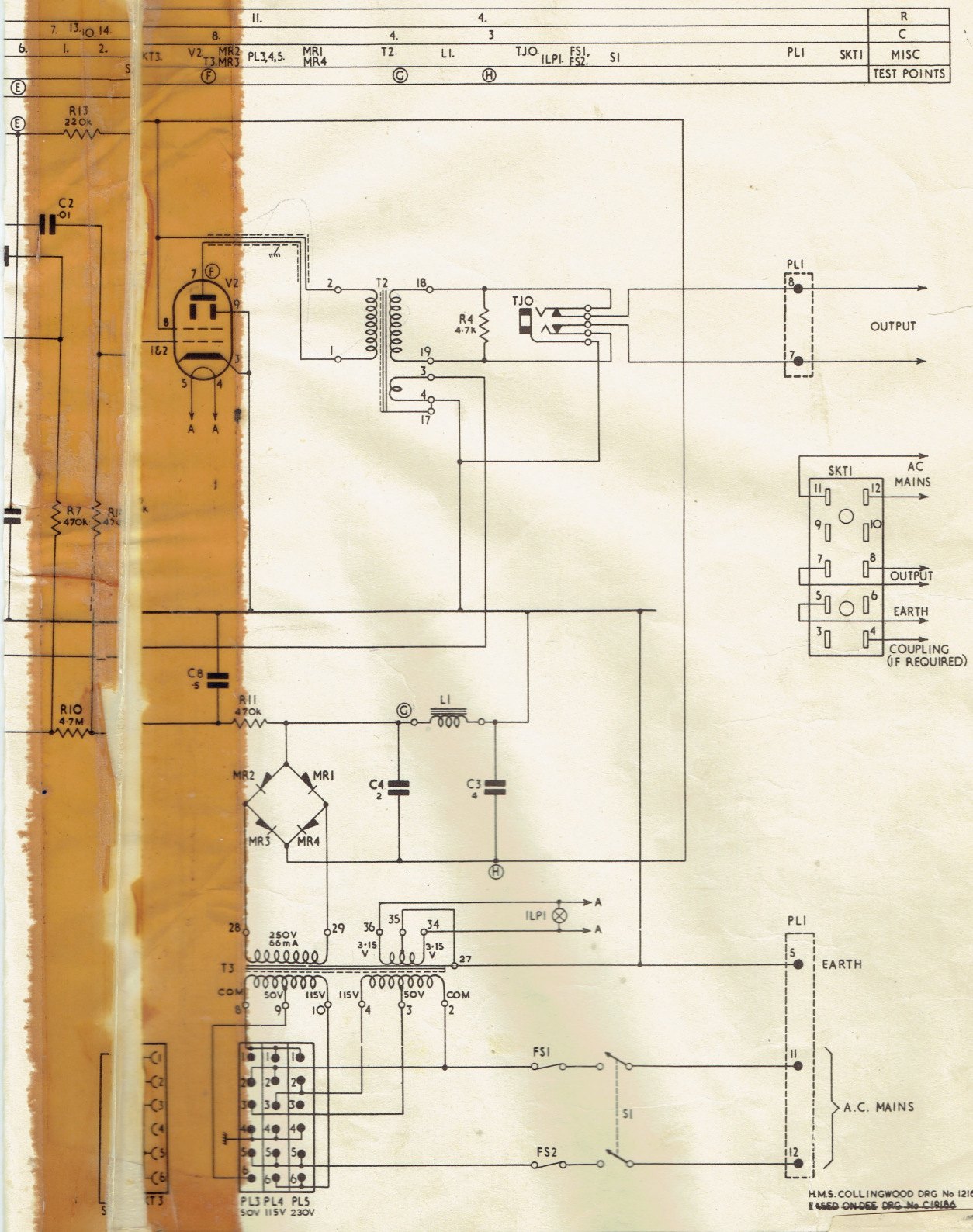
THE AMPLIFIER A.P.32047.

| | | |

47.

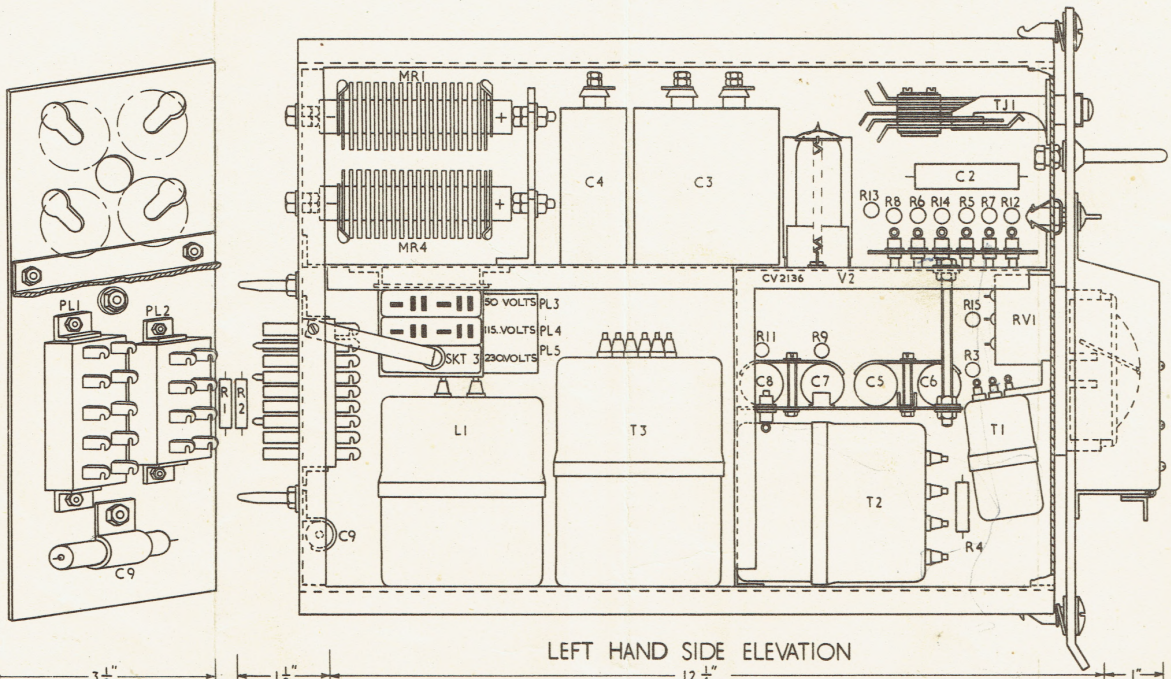
CIRCUIT DIAGRAM

FIG. 4

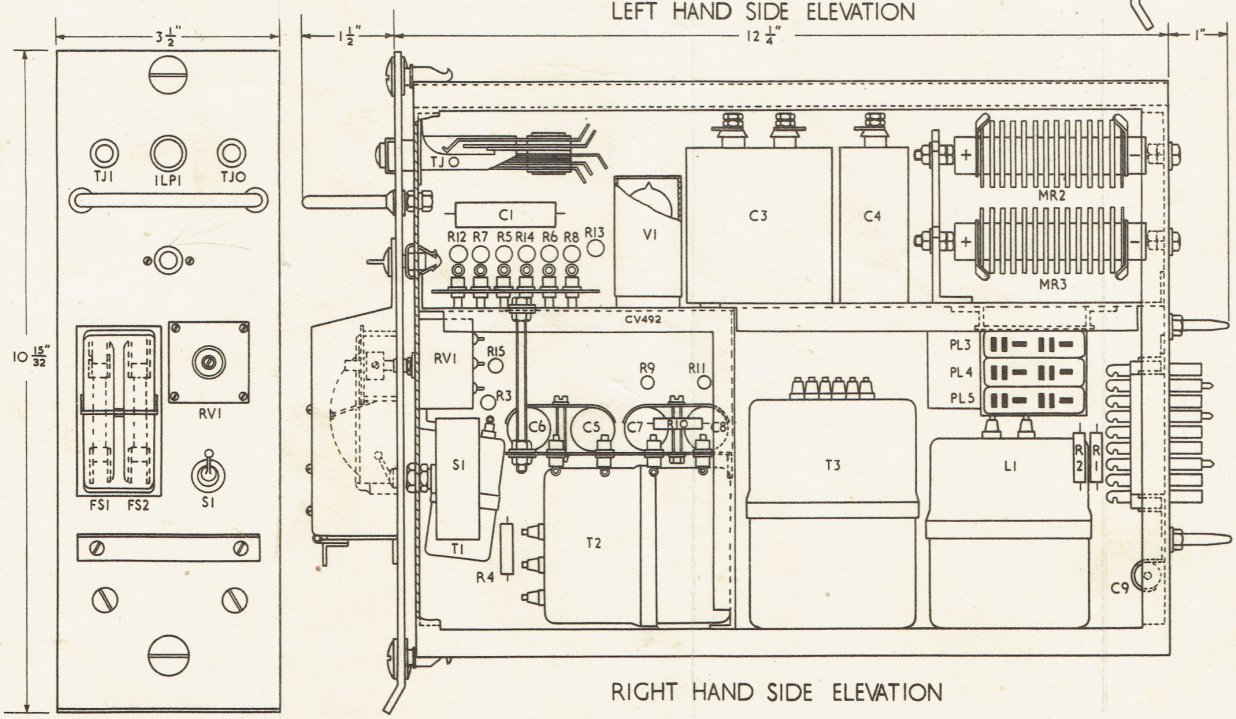


THE AMPLIFIER A.P.32047. AR

LEFT HAND ELEVATION	R	1 2 11 9 13 8 6 14 5 4 3 15 7 12
	C	9 9 4 3 8 7 5 6 2
	MISC	PL1 PL2 MR1 MR4 SKT3 L1 PL3,4 & 5 T3 V2 T2 TJ1 T1 RV1
RIGHT HAND ELEVATION	R	12 4 7 3 15 5 14 6 8 13 9 10 11 2 1
	C	1 6 5 7 8 3 4 9
	MISC	TJ FS1 FS2 ILPI RV1 TJO S1 TJO RV1 S1 T1 T2 V1 T3 PL3,4 & 5 L1 MR2 MR3



LEFT HAND SIDE ELEVATION



FRONT ELEVATION
(WITH COVER REMOVED)

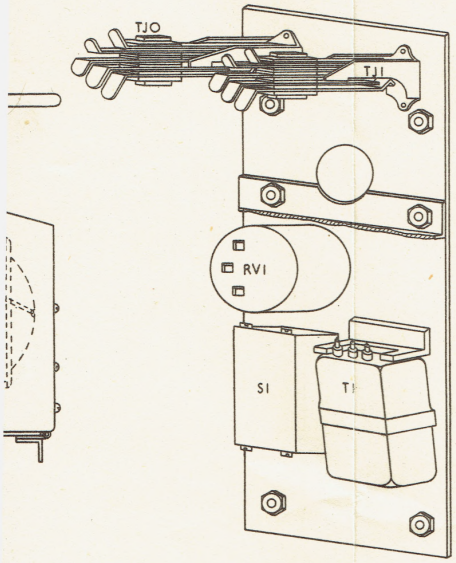
RIGHT HAND SIDE ELEVATION

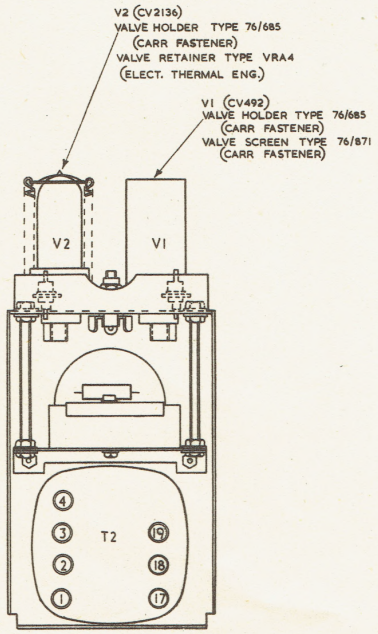
C.B.H. 28004

ARRANGEMENT

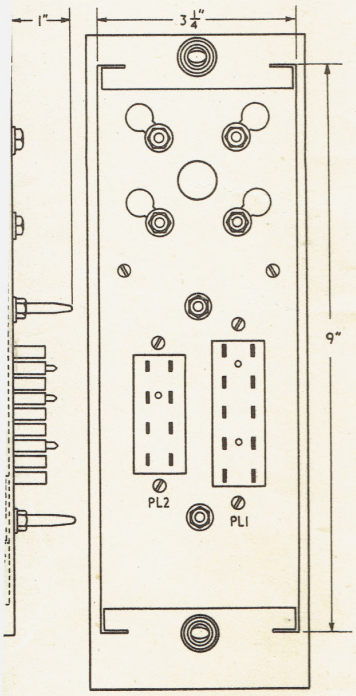
FIG. 5

						R
						C
	TJO		S1	RV1	T1	TJ1	MISC
						R
						C
	PL2		PL1			MISC

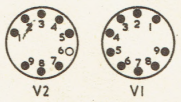




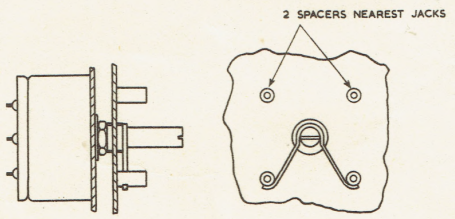
VALVE BRACKET ASSEMBLY



REAR ELEVATION



VALVE BASES
VIEW FROM UNDERSIDE

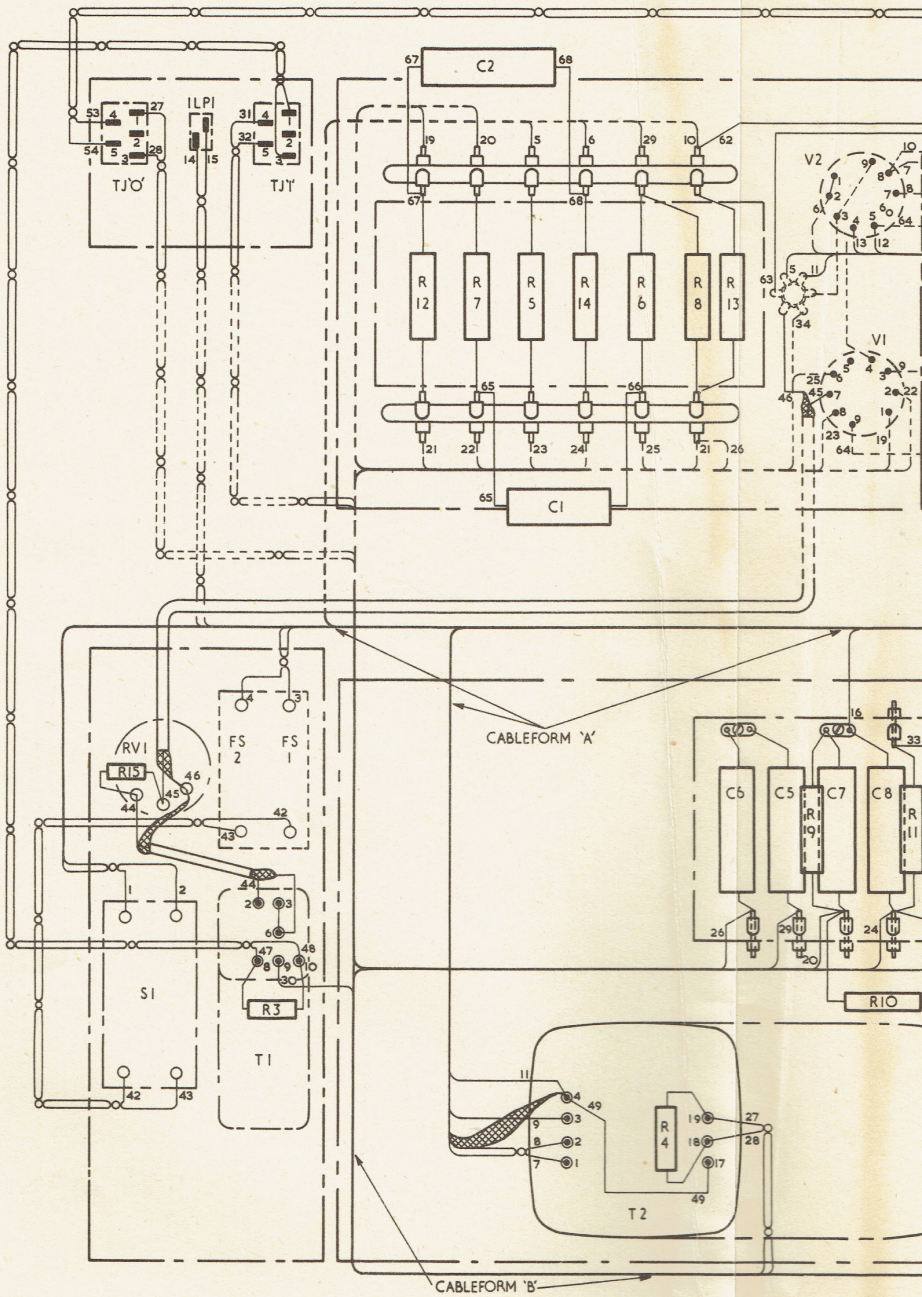


POTENTIOMETER ASSEMBLY
WITH LABEL & MARKER SLEEVE REMOVED

H.M.S. COLLINGWOOD
DWG. No. 12162

THE AMPLIFIER A.P. 32047. PICTORIAL V

No.	FROM	TO	COLOUR
CABLEFORM 'A'			
1	PL1-11	S1-TOP-LH	BROWN
2	PL1-12	S1-TOP-RH	TWISTED PR.
3	FS1-TOP	PL3-2	BROWN
4	FS2-TOP	PL3-5	TWISTED PR.
5	R5-TOP	EARTH	BLACK
6	R14-TOP	V2-2	GREEN
7	T2-2	V2-8	RED-GREY *
8	T2-1	V2-7	SCREENED PR.
9	T2-3	V1-3	BLACK
10	R13-TOP	V2-8	RED
11	T2-4	EARTH	BLACK
12	T3-34	V2-5	BROWN
13	T3-36	V2-4	TWISTED PR.
14	T3-34	ILP1-LH	BROWN
15	T3-36	ILP1-RH	TWISTED PR.
16	T3-27	EARTH	BLACK
17	T3-28	MR2-LH	BROWN
18	T3-29	MR1-LH	TWISTED PR.
CABLEFORM 'B'			
19	R12-TOP	V1-1	RED
20	R7-TOP	C7-B	GREEN
21	R12-B	R8-B	RED
22	R7-B	V1-2	GREEN
23	R5-B	V1-B	BLACK
24	R14-B	C8-B	GREEN
25	R6-B	V1-6	RED
26	R8-B	C6-2	RED
27	TJ'O'-1	T2-19	BLUE-WHITE
28	TJ'O'-3	T2-18	TWISTED PR.
29	C5-B	R6-TOP	RED
30	T1-9	C9-LH	BLACK
31	TJ'I'-4	PL2-5	YELLOW
32	TJ'I'-5	PL2-6	TWISTED PR.
33	R11-TOP	L1-2	BLACK
34	L1-3	EARTH	BLACK
35	L1-3	EARTH	BLACK
CABLEFORM 'C'			
36	T3-2	PL3-2	BROWN
37	T3-3	PL3-3	BROWN
38	T3-4	PL5-2	BROWN
39	T3-8	PL5-1	BROWN
40	T3-9	PL3-6	BROWN
41	T3-10	PL5-6	BROWN
MISCELLANEOUS			
42	S1-B-LH	FS1-B	BROWN
43	S1-B-RH	FS2-B	TWISTED PR.
44	RV1-LH	T1-2	SCREENED
45	RV1-C	V1-7	SCREENED
46	RV1-RH	EARTH	VIA SCRN'G
47	T1-8	TJ'I'-1	YELLOW
48	T1-10	TJ'I'-3	TWISTED PR.
49	T2-4	T2-17	BLACK
50	C9-RH	EARTH	BLACK
51	L1-2	C4-B	BLACK
52	PL1-5	EARTH	BLACK
53	PL1-7	TJ'O'-4	BLUE-WHITE
54	PL1-8	TJ'O'-5	TWISTED PR.
55	MR1-RH	MR2-RH	BLACK
56	MR1-LH	MR4-RH	BROWN
57	MR4-LH	MR3-LH	RED
58	MR3-RH	MR2-LH	BROWN
59	MR4-LH	C4-TOP	RED
60	MR2-RH	C4-B	BLACK
61	C4-TOP	C3-RH	RED
62	C3-RH	R13-TOP	RED
63	C3-LH	EARTH	BLACK
64	V1-9	V2-5	RED
65	C1-LH	R7-B	GREEN
66	C1-RH	R6-B	RED
67	C2-LH	R12-TOP	RED
68	C2-RH	R14-TOP	GREEN



* RED GREY TWISTED PAIR SCREENED AT TRANSFORMER END AND SCREENING TAKEN TO T2-4

THE FOLLOWING CONNECTIONS ARE NOT NUMBERED OR LISTED :-

PL3-1 TO PL4-1	PL4-6 TO PL5-6	T3-27 TO T3-35
PL4-1 " PL5-1	V1-4 " V1-5	R15-LH " RV1-LH
PL3-2 " PL4-2	V2-3 " EARTH	R15-RH " RV1-C
PL4-3 " PL5-2	V1-4 " V2-4	R3-LH " T1-8
PL3-5 " PL4-5	V2-1 " V2-2	R3-RH " T1-10
PL4-5 " PL5-5	V2-3 " V2-9	R4-TOP " T2-19
	T1-3 " T1-6	R4-B " T2-18

LH; RH; B; C ARE ABBREVIATIONS FOR LEFT HAND, RIGHT HAND, BOTTOM AND CENTRE RESPECTIVELY

WIRING SHOWN DOTTED INDICATES THAT AND RESISTOR PANEL ASSE

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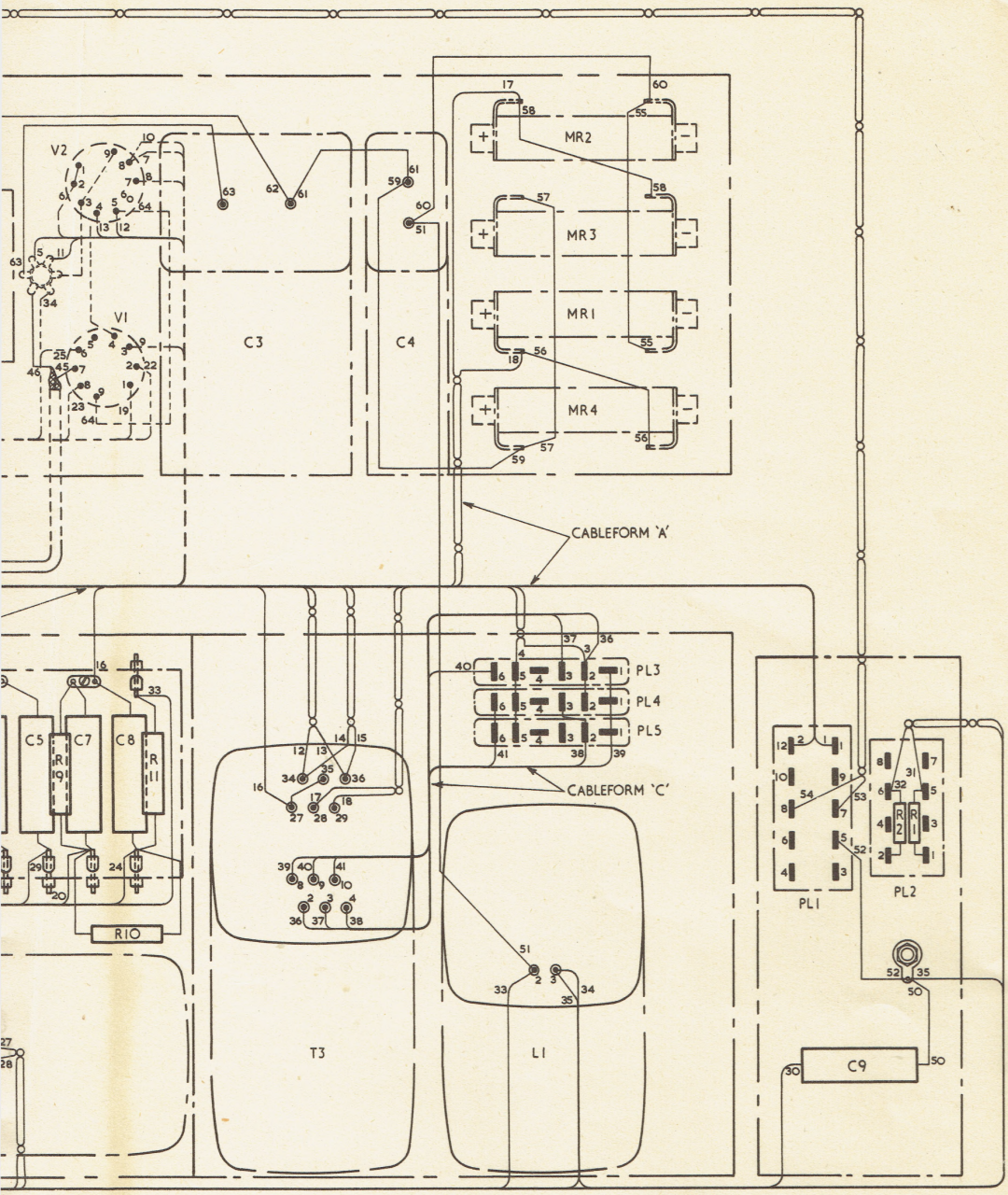
TORIAL WIRING DIAGRAM

FIG. 6



OTTED INDICATES THAT BENEATH VALVE BASE
D RESISTOR PANEL ASSEMBLY

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