B.R. 575(2)E

AUDIO FREQUENCY EQUIPMENT

A.F.100 SERIES

BROADCAST SYSTEMS

THE 16 WATT AMPLIFIERS

A.P. 32020 and 32021

THE MOUNTING

A.P. 32022

THE READY USE MAINTENANCE BOX

A.P. 12685

1954

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Director of Electrical Engineering
ADMIRALTY

AMENDMENTS

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B.R. 875(2)E, *Audio Frequency Equipment—A.P. 100 Series, Broadcast Systems, The 16 watt Amplifiers, A.P. No. 32020 and 32021, The Mounting, A.P. 32022, The Ready Use Maintenance Box, A.P. 12695, 1954*, having been approved by My Lords Commissioners of the Admiralty, is hereby promulgated for information and guidance.

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

Attention is directed to the notice printed below.

By Command of Their Lordships,

D. E. Lang

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 to any future revision of the book will be welcomed and will receive careful consideration. They should be forwarded to the Secretary of the Admiralty through the usual channels.

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← AMPLIFIER PATT 32020 MOD 1

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CHAPTER I

THE 16 WATT AMPLIFIERS, A.P. 32020 AND 32021

SAFETY WARNING

1. The voltages employed in the amplifiers are sufficiently high to endanger human life. The power supply switch should be at "off" when valves are being changed. Work on the open amplifiers 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.

GENERAL DESCRIPTION

2. The 16 watt amplifiers A.P. Nos. 32020 and 32021 are identical in their circuits and methods of amplification and reproduction of audio frequency signals. It is only in the power pack that the two differ from each other. Amplifier A.P. 32020 operates from a single phase A.C. power supply at 230, 115 or 50 volts; amplifier A.P. 32021 operates from a D.C. supply at 24 volts. References in this chapter to "the amplifier" apply to both patterns.

Uses

3. The amplifier is the third largest in the range of amplifiers in four sizes of the A.F. 100 series equipment. It is used in small broadcast and intercom systems where the power output is appropriate, and for loud hailing systems. The amplifier can be used singly, or two with inputs paralleled may share a load provided that the output circuits are kept separate.

Input. Output

4. The amplifier operates only from a 25 ohms impedance microphone. The audio output is at the usual audio frequency level of 31·6 volts (nominal), and operates loudspeakers, singly, as in the case of the loudhailer, or in a group, up to a maximum of the nominal power output.

Dimensions

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

Mounting

6. The amplifier is designed to be housed in a bulkhead mounting A.P. 32022, and is not suitable for use in any other form of mounting. The mounting is described in *Chapter II* and illustrated in *Plate* 3. The dimensions and weight are given in *Appendix* 1.

CIRCUIT DESCRIPTION

(*Fig.* 1)

7. The amplifier circuit comprises four stages, namely, two stages of voltage amplification, a phase splitter, and an output stage. These stages employ five valves.

The input

8. The input signal from the microphone enters by connections Nos. 3 and 4 of the 10 way plug PL1, and is applied to the primary of the input transformer TR1. The connecting leads are screened. The centre point of the primary winding is connected to chassis. An input test jack is connected across the transformer primary and enables a local test input to be applied by means of a plug-in microphone or test oscillator.

9. The transformer TR1 gives a step up turns ratio of 1 : 40. A loading resistor R1 is connected across the terminals of the secondary winding, of which one terminal is connected to chassis and the other to the control grid of valve V1, the connection being screened. Details of the windings of the transformer may be obtained from *Appendix* 3.

The first and second stages

10. These stages are the voltage amplification stages; each employs one pentode, C.V. 2901. The first stage, valve V1, is resistance capacitance coupled to the second stage, valve V2, through the capacitor C4, and the potentiometer RV.1. Negative feed back is applied from the output transformer to the cathode of the second stage through the resistor R12. The output of valve V2 is resistance capacitance coupled through capacitor C5 to the third stage, valve V3.

The third stage

11. This stage, valve V3, is the phase splitter for the operation of the push-pull output stage, and employs a double triode C.V. 455. The split phase output of this stage is resistance capacitance coupled through capacitors C8 and C9 to the grids of stage 4, valves V4 and V5.

The output stage

12. This stage employs balanced valve operation, working in push-pull class A.B.1. The valves, V4 and V5, are beam tetrodes, C.V. 1075.

The output transformer

13. Transformer TR2 couples the output stage to the external load, the connections being made through pins 7 and 8 of PL1. The transformer has four windings; two of these form the halves of the split primary; the two secondary windings provide (*a*) an output at 31·6 volts (nominal) for connection to the load, and (*b*) negative feed back at 9·75 volts. The capacitors C16 and C17 are fitted for the suppression of any radio frequency effects caused by the beam tetrode output valves. For further details of the transformer windings see *Appendix* 3.

14. An output test jack is connected permanently across the output lines; by this means the output may be monitored by a plugged-in headphone set or a loudspeaker.

Bias

15. Automatic bias is employed in the valves of all four stages, being provided by resistors R6 in stage 1, R11 in stage 2, R17 in the phase splitting stage, and R22 and R23 in the output stage. The value of the bias in the valve(s) of each stage is given in *Appendix* 2 in the table of voltage values.

Gain control

16. Output level or overall gain is controlled by the potentiometer RV1 in the coupling of the first and second stages. The potentiometer is screwdriver operated and gives logarithmic increase of resistance with clockwise rotation. The scale is graduated equally 0–10.

Valve heating

17. The cathodes of the amplifying valves are indirectly heated from a 24 volt supply. This supply is A.C. in the amplifier A.P. 32020, and D.C. in the amplifier A.P. 32021; The valve heaters are arranged in a series parallel circuit with the necessary resistors to give the correct voltage to each heater. In both patterns of amplifier the valves are maintained at emission temperature at all times when the switch SW1 is closed.

H.T. smoothing

18. The H.T. supply from the power pack is smoothed by the choke L1 and the capacitor C11. This combination is adequate when the H.T. supply is from the D.C. source, but for the A.C. supply an additional capacitor, C.13, is provided in the power pack, and connected so as to complete the capacitor input smoothing filter.

H.T. switching

19. With the switch SW1 closed, the A.C. pattern amplifier is ready for use, there being no H.T. switching arrangements. From considerations of economy and valve life, the amplifier must be switched off when not likely to be used. In the D.C. pattern of amplifier, for reasons which are explained later, external H.T. switching is employed and must be operated before the amplifier can be used ; this may be arranged for remote operation.

Power supply switching. Fuse protection

20. In both patterns of the amplifier power is switched on by the closing of the switch SW1. In the A.C. pattern amplifier the fuse FS1 is rated as shown in *Appendix* 1 ; in the D.C. operated amplifier the fuse rating is 15 amperes.

Pilot lamp

21. This lamp, LP1, connected in series with resistor R28, draws its power from the 24 volt valve heating supply. The lamp is arranged behind a red lens on the front panel of the amplifier. Provision is made for an external pilot lamp if needed.

22. The glowing of the lamp indicates that power is on the amplifier. In the case of the A.P. 32020 (the A.C. pattern) this means that the amplifier is ready for use ; in the case of the A.P. 32021 (the D.C. pattern) the lamp indicates only that the valve heating is on.

The controls (*Plate* 1)

23. The controls, arranged on the front panel of the amplifier, as viewed from left to right, are :—input, test jack, gain control, pilot lamp, power supply switch, output test jack, fuse. One additional control component is provided in each pattern of amplifier ; they are, in the A.P. 32020 the supply voltage change over plug, and in the A.P. 32021 an H.T. test switch. These items are mounted on the deck of the respective power packs.

Connections

24. The connections to the amplifier are made by means of a 10 way plug fixed to the back of the amplifier, mating with a corresponding socket fixed to the inside of the back of the mounting. Withdrawal of the amplifier from the mounting breaks all the connections. Steel locating pins, fixed in the mounting, matching with corresponding holes in the casing of the amplifier, ensure correct alignment of the connecting plug and socket. Full details of the connections are shown in *Fig.* 1.

Earth connections

25. The earth connections from the amplifiers are made via the plug and socket and the terminal strip in the mounting, and must be as described in *Chapter II*. The arrangement for amplifier A.P. 32021 includes a capacitance earth instead of a direct connection of chassis to ship's structure.

THE POWER PACKS

(*Fig.* 1)

26. The power pack for each pattern of amplifier is built as a unit. The components and the additional control mentioned in *para.* 23 are mounted on a platform which forms part of the deck of the amplifier. The packs are interchangeable, either being fitted as required during manufacture. It is not intended that the power packs should be changed at sea, though there is no objection to this as an emergency measure. Such an exchange of power packs converts an amplifier to the other pattern number.

27. The connections between the amplifier and the power pack are short leads soldered between corresponding tags in adjacent strips. Five connections are used for the A.C. power pack and six for the D.C. pack, the extra line for the last named pack being needed for the external H.T. switching employed.

The power pack for the amplifier A.P. 32020

28. This pack consists of a mains transformer, TR3, a rectifying valve, V6, the reservoir capacitor, C13, of the capacitor input filter, and the supply voltage change over plug.

29. The transformer terminals can be identified by their position as shown on a tally plate fixed to the transformer. On this plate the primary terminals collectively are marked 50~, and individually—230V, 115V, 50V and Com. The usual three secondary windings are employed. The first, terminals 5V, 3A, provides power for rectifying valve cathode heating. The second, terminals 25·2V, 1·4A, provides the supply for audio valve cathode heating and pilot lamps. The third, terminals 300V, CT, 300V, is the H.T. winding feeding the anodes of the rectifying valve, the centre tap is earthed. The rectifier valve V6 is a C.V. 378, providing full wave rectification. Particulars of the transformer windings may be obtained from *Appendix* 3.

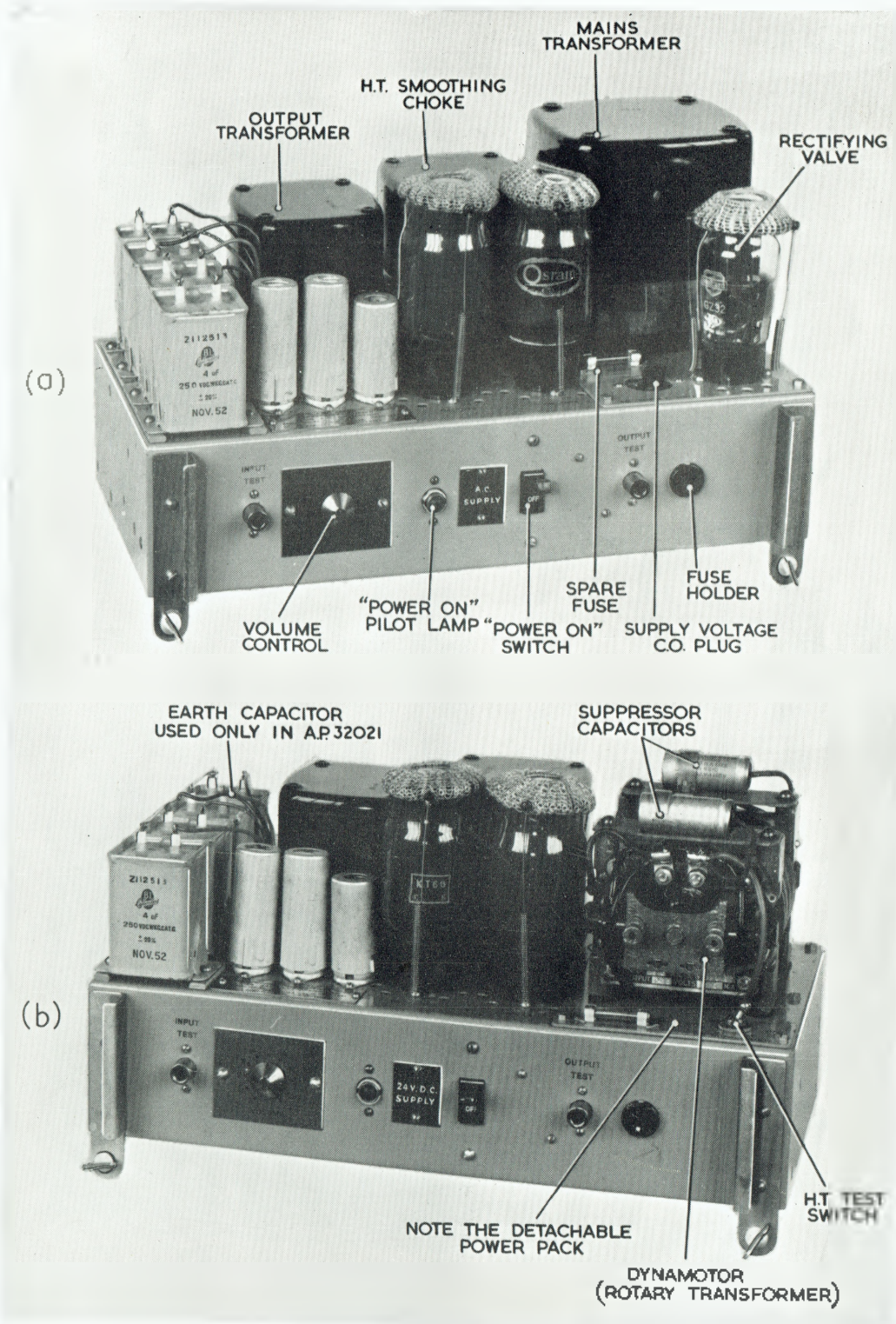


PLATE I. (*a*) THE AMPLIFIER A.P. 32020 (A.C. SUPPLY). FRONT VIEW

(*b*) THE AMPLIFIER A.P. 32021 (D.C. SUPPLY). FRONT VIEW

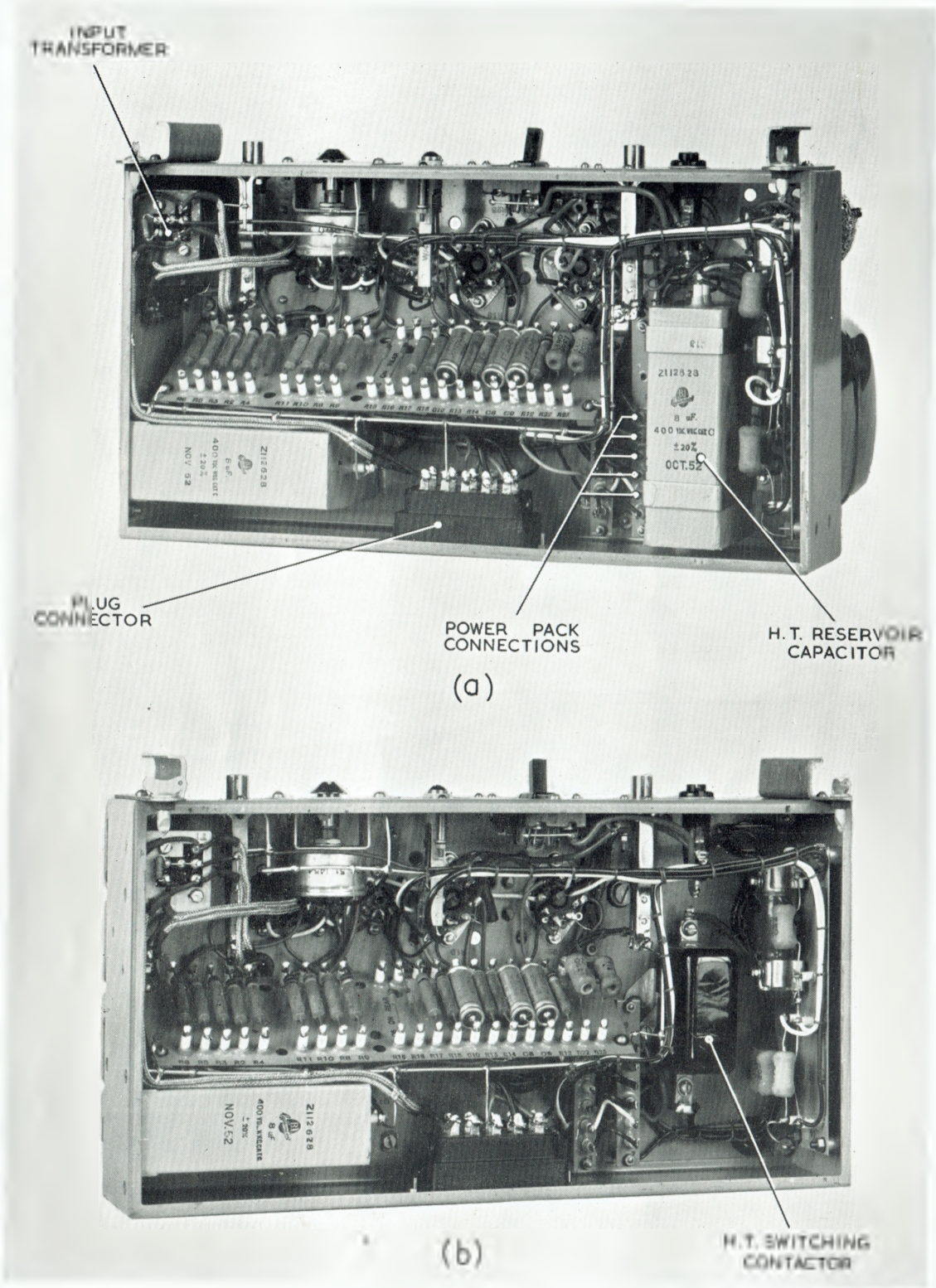


PLATE 2. (a) THE AMPLIFIER A.P. 32020. VIEW FROM BELOW
(b) THE AMPLIFIER A.P. 32021. VIEW FROM BELOW

THE 16 WATT AMPLIFIERS, AP 32020 AND 32021

The power pack for the amplifier AP 32021

30. This pack consists of a rotary transformer, RT1; a contactor, RL1; an HT test switch, SW2; and the two capacitors, C14 and C15. The rotary transformer gives a DC output of 265-280 volts, and up to a maximum of 170 milliamperes. The power supply is DC at 24 volts, and may be from the ship's LP source or from a battery. The contactor operates from the 24 volt supply and is employed to close the power circuit to the rotary transformer for HT external switching purposes. The capacitors are for the suppression of commutator interference; they are connected one across each of the motor and generator commutators, that is, in each case, between the positive brush and chassis.

The rotary transformer (Dynamotor) AP 32065

31. This machine will henceforth in this book be referred to by its alternative name, dynamotor. In the amplifier, AP 32021 the dynamotor replaces the rectifying system of the AP 32020 as the source of HT current. Two designs of the machine are in use; those bearing the serial numbers 59480K to 59567K are of the earlier design and are slightly larger than those of later manufacture, all of which bear other serial numbers. The machines of the two designs are completely interchangeable, electrically and mechanically. Full particulars of the machines are given in Appendix 4.

32. HT switching. External and test. For the reduction of brush and commutator wear on the dynamotor, and in the interests of economy of power, external HT switching is arranged so that the dynamotor is run only when the amplifier is required for use. This switching is effected by means of the contactor, RL1, and switch lines through the plug and socket connections numbers 5 and 9. The switch lines are wired to the microphone positions and are closed by the operation of "press to speak" switches. To enable the HT to be switched on locally for test or other purposes a switch, SW2, wired in parallel with the external switching is provided and fitted on the power pack deck. By this means the contactor operating coil can be energised at the amplifier and the dynamotor run up, thus making the amplifier ready for test or emergency use.

33. Valve heater and pilot lamp supply. This supply is direct from the incoming 24 volt DC supply.

Amplifier AP 32020 Mod 1 (Figs 3, 4 and Fig 5)

33A. In amplifiers AP 32020 Mod 1, changes have been made in the output stage, in the valve heater and pilot lamp circuit, and in the AC power pack, to overcome overheating of the amplifiers when they are stacked together. Serviceable amplifiers up to Serial No 2959 will be modified by the Director of Stores. In amplifiers Serial No 2960 onwards, the modification has been incorporated during manufacture.

33B. The output stage valves, V4 and V5, have been changed to CV391, making an alteration to the bias arrangement and the heater circuit necessary. The fixed bias level required is derived from the 25.2 volt AC heater secondary winding of the mains transformer, using D1, R7 and C18. Resistors, R30 and R31, are now in series across the heaters of the first two stages, and resistor R29, with its value altered is in parallel with an additional resistor R32. The power pack differs from the unmodified version in that different types of mains transformer, rectifier valve, and reservoir capacitor are used.

Table 1. CIRCUIT COMPONENTS AND THEIR FUNCTIONS

Capacitors

C1	HT decoupling, valve V1.
C2	HT decoupling, valve V1.
C3	HT decoupling, valve V2.
C4	Coupling, valves V1 to V2.
C5	Coupling, valve V2 to grid' of valve V3.
C6	Screen grid decoupling, valve V1.
C7	Screen grid decoupling, valve V2.
C8	Coupling, anode'' of valve V3 to V4.
C9	Coupling, anode' of valve V3 to V5.
C10	Phase changing, for push-pull operation, valve V3.
C11	HT smoothing.
C12	"Earthy" connection (for amplifier AP 32021 only).
C13	Reservoir capacitor for capacitance input filter (AP 32020 only).
C14 & C15	Commutation suppressors. Generator and motor, respectively.
C16 & C17	Radio frequency suppressor.

Resistors

R1	Loading, Input transformer secondary winding.
R2	Decoupling, valve V1.
R3	Decoupling, valve V1.
R4	Anode load, valve V1.
R5	Screen grid, valve V1.
R6	Bias, cathode of valve V1.
R7	
R8	Decoupling, valve V2.
R9	Anode load, valve V2.
R10	Screen grid, valve V2.
R11	Bias, cathode of valve V2.
R12	Feed back.
R13	Anode' load, valve V3.
R14	Anode'' load, valve V3.
R15	Grid leak, grid' of valve V3.
R16	Grid leak, grid'' of valve V3.
R17	Bias, cathodes of valve V3.
R18	Cathode, load, valve V3.
R19	Parasitic stopper, grid of valve V4.
R20	Grid leak, valve V4.
R21	Grid leak, valve V5.
R22	Bias, cathode of valve V4.
R23	Bias, cathode of valve V5.
R24	Parasitic stopper, grid of valve V5.
R25	Screen grid, valve V4.
R26	Screen grid, valve V5.
R27	Ballast series, External pilot lamp cct.
R28	Ballast series, External pilot lamp cct.
R29 & R32	Ballast series, audio valves heater cct.
R30 & R31	Shunt, valve heating circuit, valves V1, V2 and V3.

Miscellaneous

FS1	Fuse. Supply.
L1	HT smoothing choke.
LP1	"Power on" pilot lamp.
PL1	Plug, 10 way, input, output and supply.
RL1	Contactor, HT switching. (AP 32021 only)
RT	Dynamotor (Rotary transformer) (AP 32021 only).
RV1	Gain control potentiometer.
SW1	"Power on" switch.
SW2	HT test switch (AP 32021 only).
TJI	Input test jack.
TJO	Output test jack.
TR1	Input transformer.
TR2	Output transformer.
TR3	Mains transformer (AP 32020 only).

MAINTENANCE

Warning

34. Attention is drawn to the safety warning in *para.* 1.

General Maintenance

35. *Switch off when not required.* The nature of the service on which the amplifiers are employed will usually permit power to be switched off when not required for use. In the interests of economy of power and of valve and amplifier life, this should always be done.

36. *Maintenance Stores.* Certain maintenance stores for use with the amplifier are provided and may be stowed in the Ready Use Maintenance Box A.P. 12685 described in *Chapter III.* For the amplifiers described in this book the items are a portable hand microphone, a headphone set, and a test load. The box also provides stowage for some expendible items such as valves, pilot lamps and fuses.

37. *Early observation of defects.* The maintenance of the amplifier in good working order is largely dependent upon a close watch being kept upon its performance, and immediate attention being given to any indications of defective working. The liaison between the user and the maintainer must be sufficiently close to ensure that the latter is informed immediately any symptom of unsatisfactory working is observed.

38. *Weekly test.* Amplifiers in regular use need no periodical audio tests. Amplifiers not in regular use should be tested weekly. The test should preferably be carried out by the user and include the microphone(s) and loudspeakers fitted in the system, but if this is not possible the test may be made by the maintainer by means of a test microphone and test load as described in *Chapter III.*

39. *Dust.* If dust is allowed to accumulate in the amplifier it will cause unsatisfactory working and interfere with the normal dissipation of heat. Dust on exposed H.T. terminals will cause leakage. On every occasion of the removal of the amplifier from its mounting the opportunity must be taken to remove all dust from the surfaces and terminals in the valve compartment. Where it is found that dust accumulates in an amplifier it should be removed at intervals of not more than one month. The underdeck compartment of the amplifier should be thoroughly cleared of dust during the annual examination. The best method of dust removal is by suction cleaner, blowing, and the use of a small stiff bristle brush lightly applied.

40. *Valve retainers.* The valves fitted on octal bases, namely, the output, and in the amplifier A.P. 32020 the rectifier, valves have the usual spun glass cap and spiral spring retainers. The valves for the first three stages are fitted on B.9.A bases, and are retained by screen type retainers. During periodic inspections the valve retaining arrangements should be examined for efficacy.

41. *Connectors.* If the plug and socket connector is left disconnected for more than a few minutes the contacts must be protected from dust settling upon them. This precaution applies particularly to those contacts which carry the low level input signal currents, but since all the contacts are in one connector the whole should be protected. The plug and socket contacts should not be lubricated. If left connected, or protected by a clean rag when disconnected, they need no cleaning.

42. *Valve cooling.* Vent holes, for the circulation of air around the power and rectifying valves, are cut in the valve deck ; these holes must be kept clear.

43. *Record of employment.* Where two or more amplifiers of one pattern are fitted in a ship it is probable that one or some will get much more work than others. A record of the allocation of particular amplifiers to the various communication systems should be kept in order that the allocation may be altered when considered desirable. The serial number shown on the chassis enables an amplifier to be identified.

44. *Spare amplifiers.* Spare amplifiers up to 10 per cent. of the numbers of each pattern carried are allowed to ships.

45. *Spare parts.* Spare transformers and chokes for the amplifiers are allowed in the establishment of stores. Other items such as valves, lamps and fuses are all of joint service patterns.

Maintenance routines

46. (*a*) *Daily.* Amplifiers stowed in working positions but not in regular use. Switch on power for a few hours.

(*b*) *Weekly.* Amplifiers as at (*a*) above. An audio test (*para.* 38).

(*c*) *Monthly.* All amplifiers stowed in their working positions. A visual inspection covering the following points :—

(i) Operation of the pilot lamp.

(ii) Signs of overheating in the valve compartment.

(iii) Ventilation not obstructed.

(iv) Condition of small fixings such as valve retainers.

(*d*) *Annually.* A complete examination and test in a workshop (*para.* 50).

Location of defects at the amplifier position

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

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

(2) Ascertain by sight or touch that all the valves are hot. (If necessary to exchange a valve open the " power on " switch while doing so.)

(3) In amplifier A.P. 32021 only, close the H.T. test switch.

(4) Check the earth connections, chassis to ship's structure. A rough check can be made by obtaining a zero reading on an Ohmmeter A.P. 5045 :—

(*a*) Amplifier A.P. 32020, between a bright part of the chassis and the ship's structure.

(*b*) Amplifier A.P. 32021, by temporarily withdrawing the amplifier from its mounting and testing between the socket connection No. 10 and the ship's structure. Replace the amplifier after test.

48. *Audio tests.* With the amplifier in place audio tests which can be made are :—

(*a*) Listen to the output by means of headphones ed into TJO.

Listen to the output as in (*a*) from a test input via nd microphone plugged into TJI.

The other practical test which can be made locally if red establishes whether the defect is in the amplifier lsewhere. The test is made by means of the amplifier t load A.P. 32064. The amplifier must be withdrawn m its mounting and the test load and a power supply nnected through the plug and socket connection. If e testing apparatus is known to be in good order and he results of the test are unsatisfactory the amplifier ust be removed to the workshop for examination.

Annual examination and test

50. The following items should be attended to :—

(*a*) Visual examination of all small components, looking for signs of overheating or other signs of deterioration.

(*b*) A complete cleaning of the amplifier internally with the removal of all dust.

(*c*) Examination of all fixings of components, tightness of screws and nuts, condition of the valve retainers, securing clips, etc.

(*d*) Examination of the dynamotor in the amplifier A.P. 32021, with any preventive or corrective maintenance work required on the commutators, brushes and bearings (*para.* 52).

(*e*) Take a number of test point readings and check by the values given in *Appendix* 2 (*para.* 51).

(*f*) Carry out an audio test on completion, using a test microphone, the test load and a portable loudspeaker.

(*g*) Make a record of any points of interest noted and of the maintenance work which has been done.

51. The number of test point readings which should be taken will depend upon the results obtained. If a representative selection of readings from test points show satisfactory results, especially those of the output stage, no further tests need be made. If doubtful results are obtained further test point readings should be taken until it has been ascertained where the differences arise.

52. The maintenance work needed on the dynamotor is similar to that for any small motor generator. The lubricant is Belmoline RB, which should be renewed at the annual overhaul. The output voltage, namely, 265 volts at 170 mA. should be checked after overhaul. The dynamotor speed and details of the brushes are given in *Appendix* 4.

Location of defects in the workshop

53. Attention is drawn to the safety warning given in *para.* 1.

54. If it has not been done carry out a test as indicated in *para.* 49. If the performance is still unsatisfactory an examination must be made on the lines indicated in *Table* 2.

Checking performance

55. *Test data. Appendix* 2 gives data to enable the amplifier performance to be checked in the workshop and to assist in the location of defective component items. The voltage values given are in each case the mean of several measurements from different amplifiers ; the readings from a single amplifier may be expected to fall within the tolerance shown.

56. *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.

57. *Internal wiring.* The internal wiring of the amplifier should 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.

58. *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.

59. *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 " 60 ohms. 16W."

60. *Overall Voltage Gain.* The input voltage of 0.45 mV for full load (referred to on page 14 Appendix 2 Test Data against (b) Overall Voltage Gain) is to be derived from Test Set Oscillator CT 373 JSC No. 6625-99-943-8385. This input voltage is to be injected with the oscillator set to the test frequency of 1000 c/s, and the specified voltage gain of not less than 97 dB is to be obtained at the amplifier output terminals.

(*Change No. 1*)

Distortion Gain and Hum Tests

61. 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

Abbreviations used in the text :—

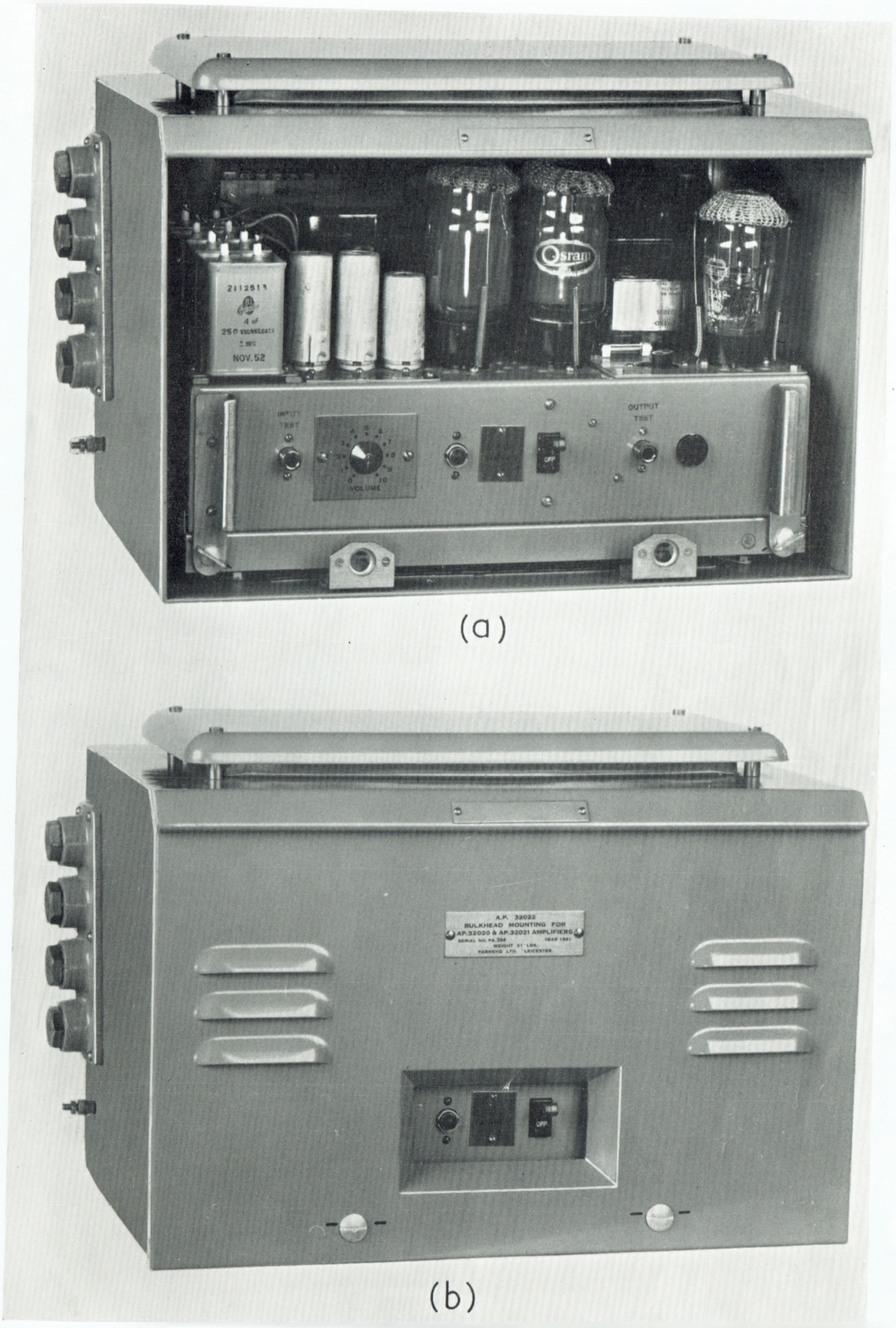
OC = Open circuited.
SC = Short circuited.
D = Defective.

Test input for use—a 25 ohms impedance microphone plugged in.

Test output load—60 ohms impedance with a headphone set or loudspeaker in parallel connected to PL1.

SYMPTOM AND PROCEDURE	POSSIBLE DEFECT	ACTION
(*a*) *No hum or noise*		
(1) See valves and pilot lamp 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) TR2 secondary OC . . .	Renew.
	Amplifier A.P. 32020 only :—	
	(vi) Rectifier valve D . . .	Renew.
	(vii) TR3 D .	Renew.
	Amplifier A.P. 32021 only :—	
	(viii) H.T. test switch open .	Close.
	(ix) Check dynamotor brushes .	Refit.
	(x) Dynamotor D	Refit or renew.
(2) Check main H.T. voltage (test point P).	*If zero :—*	
	(i) Choke L1 OC .	Renew.
	(ii) Capacitor C11 SC . . .	Renew.
	Amplifier A.P. 32020 only :—	
	(iii) Rectifier valve D . . .	Renew.
	(iv) Capacitor C13 SC . . .	Renew.
	(v) TR3 D . .	Renew.
	Amplifier A.P. 32021 only :—	
	(vi) H.T. test switch open . . .	Close.
	(vii) Contactor RL1 D . . .	Refit or renew.
	(viii) Capacitor C14 SC . . .	Renew.
	(ix) Dynamotor D	Refit or renew.
	If low :—	
	(i) Capacitor C11 SC	Renew.
	Amplifier A.P. 32020 only :—	
	(ii) Rectifier valve D . . .	Renew.
	(iii) Capacitor C13 OC . . .	Renew.
	Amplifier A.P. 32021 only :—	
	(iv) Dynamotor output low . .	Correct or renew.
	(v) Capacitor C14 D	Renew.
(*b*) *Excessive hum*		
(1) Connect a similar capacitor across C11.	Capacitor may be OC . . .	Renew.
(2) Check voltage at test point P.	Choke L1 may be SC . . .	Renew.
	Amplifier A.P. 32020 only :—	
(3) Exchange rectifier valve.	Valve may be working at half wave .	Renew.
	Amplifier A.P. 32021 only :—	
(4) Connect a similar capacitor across C14 and C15.	Capacitor may be OC or otherwise D	Renew.
(*c*) *No output signal*		
(1) Check position of gain control.	May be at zero .	Adjust.
(2) Short the grids of the valve or valves of each stage to earth in turn, starting at the output stage.	Noise and hum will get progressively greater until the grids of the faulty stage is/are earthed, when no difference will be observed . .	Check faulty stage.
(3) Check voltage at all points.	*If no anode volts :—*	
	(i) Anode or decoupling resistor OC or decoupling capacitor SC .	Renew.

SYMPTOM AND PROCEDURE	POSSIBLE DEFECT	ACTION
	(ii) Primary of TR2 OC	Renew.
	If no screen volts :—	
	Screen resistor OC or decoupling capacitor SC	Renew.
	If no bias volts :—	
	Bias or cathode resistor OC or SC	Renew.
	If low anode volts:—	
	(i) Low bias on valve	Correct.
	(ii) Coupling capacitor SC	Renew.
	If low screen volts:—	
	Decoupling capacitor D	Renew.
	If low bias volts :—	
	Bias resistor D	Renew.
(4) Check input transformer windings for continuity.	May be OC	Renew.
(5) Check output transformer windings for continuity.	Secondary winding may be OC	Renew.
(*d*) *Distorted signal*		
(1) Check anode voltage of output valves.	(i) If low	Check as in (*a*) (2).
	(ii) If high. Valve may have low emission	Renew.
	(iii) If unequal in balanced valves:—	
	(i) Valves unmatched	Renew the pair.
	(ii) Split primary of TR2 D	Renew.
(2) Renew output valves.	Characteristics may be mismatched	Renew.
(3) Check voltages of other valves.	One may be D	Renew.
(4) Check windings of input and output transformers.	SC turns in windings. Feedback winding connections may be reversed	Renew or correct.
(*e*) *Noise*		
(1) *Scratching.* Check carbon type resistors.	May be D	Renew.
(2) *Ringing.* Tap valves in the early stages.	Microphonic valves	Renew or prevent vibration.
(3) *Oscillation.* Check earth connections in the internal wiring	Earth connections broken from capacitor, transformer, wire screenings, etc.	
Check C16 and C17.	May be D	Renew.
(4) *Intermittent clicks.* Check :—		
(i) Switch contacts	May be dirty	Clean.
(ii) Valve pins in sockets.	May be dirty	Clean.
(iii) Gain control contact.	May be worn	Renew.
(iv) Capacitors	May be faulty	Renew.
(5) *Motor Boating.* Check anode decoupling capacitors and resistors.	Capacitors may be OC	Renew.
	Resistors may have altered in value	Renew.



(a)

(b)

PLATE 3. (a) THE MOUNTING A.P. 32022 WITH AMPLIFIER A.P. 32020
(b) THE MOUNTING A.P. 32022 CLOSED, WITH AMPLIFIER A.P. 32020

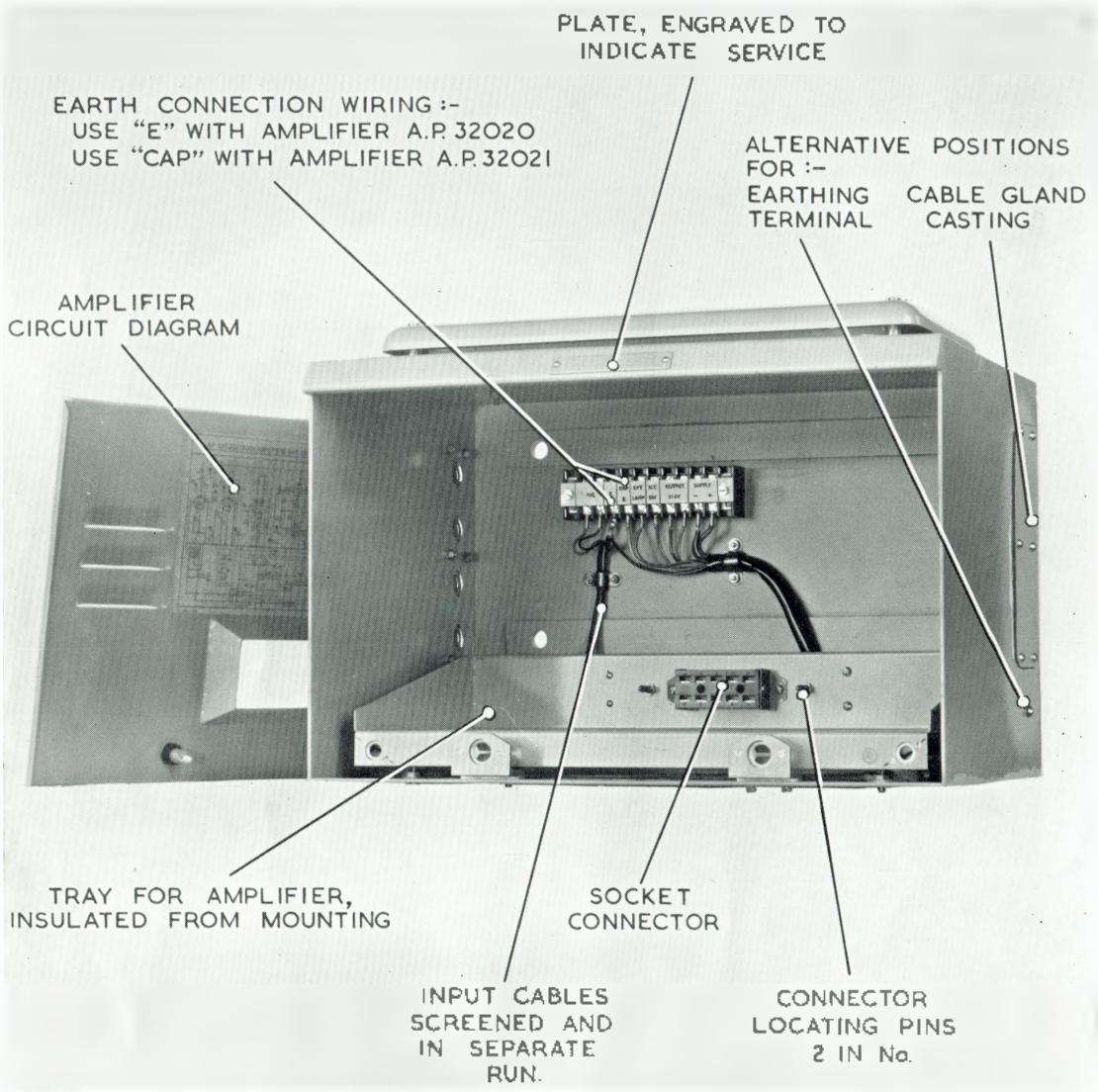


PLATE 4. THE MOUNTING A.P. 32022, SHOWING THE CONNECTIONS

CHAPTER II

THE MOUNTING, A.P. 32022

Use

1. The mounting is designed and employed to house one of either of the 16 watt amplifiers described in *Chapter I*. It is arranged for fixing to a bulkhead or other vertical support. The mounting is complementary to the amplifier and is the only means provided for mounting the latter. The dimensions, weight and fixing particulars are shown in *Appendix* 1 and *Fig.* 3.

DESCRIPTION

2. The mounting consists of a casing and an inner mounting tray. The casing is formed from sheet steel and is reinforced internally and externally at the back for fixing purposes by horizontal and vertical steel straps. The front of the mounting is closed by a detachable door secured at the bottom by Oddie clips. The door is pierced and shaped to give access to the amplifier essential controls.

3. *The mounting tray.* The tray is formed of pressed sheet steel and is supported in the casing by four resilient mounts for the protection of the amplifier from shock and vibration. The mounts also provide electrical insulation between the tray and the casing which is an important feature when the mounting houses an amplifier A.P. 32021 (the D.C. pattern). The amplifier slides into the mounting and rests on the tray, to which it is secured by Oddie clips. The chassis of the amplifier is therefore insulated from the casing.

4. *Ventilation.* Ventilation of the mounting is provided for by perforated metal plates fitted at the top and bottom of the casing. The top ventilation is made drip proof by a cowl mounted over a coaming which surrounds the top ventilation apertures. The tray is ventilated by circular holes cut in the base, and the door of the mounting by louvers.

5. *Cable entry.* Four standard A.P. glands, No. 3 size are provided in a casting of aluminium. The gland casting can be fitted to the mounting on either the left hand or the right hand side ; a closing plate covers the gland opening not in use.

6. *Earth connection.* An earth terminal is fitted on the casing and the earth connection from it to the ship's structure should be efficiently maintained. The arrangements for the earthing of the amplifier are described in paragraphs 9 and 10.

7. *Amplifier connections.* A 10 way socket connector is fixed to the vertical plate at the back of the tray. The corresponding plug on the amplifier mates with the fixed socket ; correct alignment when engaging being ensured by two steel guide pins. The connections from the socket to the mounting terminal strip are by flexible cables, sleeved and made in cableforms. The connections for the microphone input are run separate from the others, in an earthed screen.

8. *Terminal arrangements.* A terminal strip is provided inside the mounting at the back. The marking of the strip is as shown in *Fig.* 3. The outgoing lines connected to the terminals for the two patterns of amplifier differ somewhat from each other, and are as shown below :—

AMPLIFIER A.P. 32020		AMPLIFIER A.P. 32021	
Microphone. .	M.M.	Microphone. .	M.M.
Earth. . .	E.	Earth. . .	Cap.
Output . .	S.S.	H.T. switching .	H.E.
A.C. supply. .	~ ~	Output . .	S.S.
External pilot lamp . .	N.E.	L.P. supply . External pilot lamp . .	+ − N.E.

9. *Amplifier earth connections.* For the A.P. 32020 amplifier the chassis is earthed through the plug and socket connection No. 5, the terminal " E " on the strip and a direct lead thence to the ship's structure.

10. In the case of the A.P. 32021 amplifier direct earthing of the chassis is not permissible, because to do so would be to put one pole of the ship's L.P. supply to earth. In this case a capacitance earth is arranged, the capacitor for the purpose (C12 in *Fig.* 1) being accommodated in the amplifier. The connections are then made through the plug and socket connection No. 10, the terminal " Cap. Earth " on the strip and a direct lead thence to the ship's structure.

11. When a mounting houses an amplifier A.P. 32021 the terminal " E " on the strip is used for the return of the H.T. switching and the pilot lamp circuits, and MUST NOT be connected to earth.

MAINTENANCE

12. *Ventilation.* Nothing must be allowed to impede the circulation of air through the ventilation openings in the base, the top and the front cover. The normal ventilation of the compartment in which the mounting and amplifier are situated should be maintained.

13. *Earth connections.* These connections should be tested annually as part of the yearly examination and test of the amplifier which the mounting accommodates, and always, as appropriate, early in any process of defect location. The resistance of the earth connections should be negligible. The connections are direct to the ship's structure :—

(*a*) When housing an amplifier A.P. 32020—From the terminal " E."

(*b*) When housing an amplifier A.P. 32021—From the terminal " Cap."

(*c*) In both (*a*) and (*b*) above—From the mounting case earth terminal.

14. *Insulation test, tray from casing.* When the mounting houses an amplifier A.P. 32021 nothing must be allowed to make electrical contact between the tray and the casing. The insulation of the tray from the casing should be tested annually when the amplifier is given its yearly examination. The insulation resistance should be at least one megohm.

CHAPTER III

THE READY USE MAINTENANCE BOX, A.P. 12685

1. The reason for including the information on the Ready Use Maintenance Box in this book is that it is likely that in every ship equipped with any of the A.F. 100 gear or systems, one or more 16 watt amplifiers will be employed.

LIST OF GEAR

2. The following items are provided :—

	A.P. NO.	ITEM	ALLOWANCE PER SHIP
(1)	12685	Box, ready use (without contents)	1
(2)	12657	Test load for amplifiers 50 watt A.P. 12647 and 300 watt A.P. 12649 . .	2
(3)	32063	Test load for Microgram A.P. 32018	1
(4)	32064	Test load for amplifiers 2 watt A.P. 32047 and 16 watt A.P. 32020 and 32021 .	1
(5)	6057	Mains cable (6 ft.) with socket J.S. cat. No. Z560119 and end entry cover . .	1
(6)	12599	Microphone, hand, with plug A.P. 651 and cord . .	1
(7)	3662	Headphone set, with plug A.P. 651 and cord . .	1

Items (2) to (7) should be stowed and carried in the box, item (1).

3. Stowage is also provided in the box for the following stores :—

	J.S. CAT. NO.	STORES	STOWAGE FOR
(1)		Handbooks, one each of B.R. 575 and B.R. 472 series .	2
(2)	Z590123	Fuses, 15 amp. . . .	2
(3)	Z590107 to Z590113	Fuses, $\frac{1}{4}$ amp. to 7 amp. (as required)	12
(4)	X959101	Lamps, 6V (grey end) . .	2
(5)	X959213	Lamps, 24V (yellow end) .	2
(6)	X959220	Lamps, 50V (white end) .	2
(7)	—	Valves, spare, as required .	—

USE

4. The purpose for which the box and gear are provided is to enable all the apparatus likely to be required for ready use maintenance of the A.F. 100 series of amplifiers to be immediately to hand for the expeditious location and remedy of minor defects.

DESCRIPTION

5. The box is made of sheet aluminium and is readily portable by one man. The dimensions are, length 20½ in. breadth 15½ in., depth 9 in. An interior tray is fitted to facilitate the stowage of the contents, and a metal label inside the lid shows a list of the intended contents.

The test loads

6. The use of a test load with any amplifier enables an audio test to be applied :—

(*a*) For the performance to be observed under conditions of full and stable output.

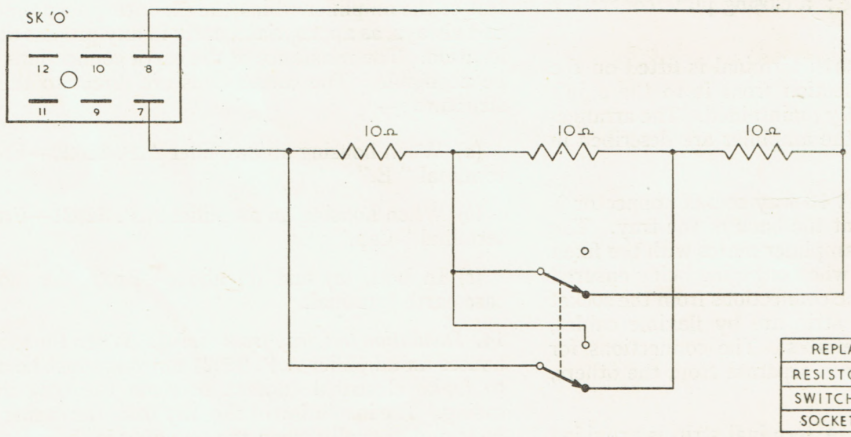
(*b*) Without loudspeaker reproduction of the test.

(*c*) In a workshop or other space where the normal loudspeaker load is not available.

7. The three types of test load provided in the outfit are designed to be applicable to all the amplifiers of the A.F. 100 series, a total of five. Two of the test loads are of the double purpose type, switching being provided in each of these two cases for selection of the load. The third test load has a single application, that is, for the Microgram employed in the Type A.F. 155 (S.R.E. Minor) and in public address equipment.

The test load A.P. 12657 (50/300 watt)

8. The general appearance of this apparatus is shown in *Plate* 5 (*c*). The circuit is shown in *Diagram* 1. Three resistors, each of 10 ohms and of 100 watts rating, are mounted on an iron framework and protected by a perforated metal cover. A double pole two way switch at one end of the casing provides the means of grouping the resistors so as to form a load suitable for either of the



REPLACEMENT COMPONENTS	
RESISTORS	Z 241006
SWITCH	Z 510304
SOCKET	A.P. 60066

DIAGRAM 1. TEST LOAD. A.P. 12657. CIRCUIT DIAGRAM. SWITCH SHOWN IN POSITION FOR TESTING THE 300w AMPLIFIER.

CHAPTER III

THE READY USE MAINTENANCE BOX, A.P. 12685

1. The reason for including the information on the Ready Use Maintenance Box in this book is that it is likely that in every ship equipped with any of the A.F. 100 gear or systems, one or more 16 watt amplifiers will be employed.

LIST OF GEAR

USE

4. The purpose for which the box and gear are provided is to enable all the apparatus likely to be required for ready use maintenance of the A.F. 100 series of amplifiers to be immediately to hand for the expeditious location

Page 10. LIST OF GEAR. *Delete* paragraph 2 and *insert* new paragraph 2 as follows:-

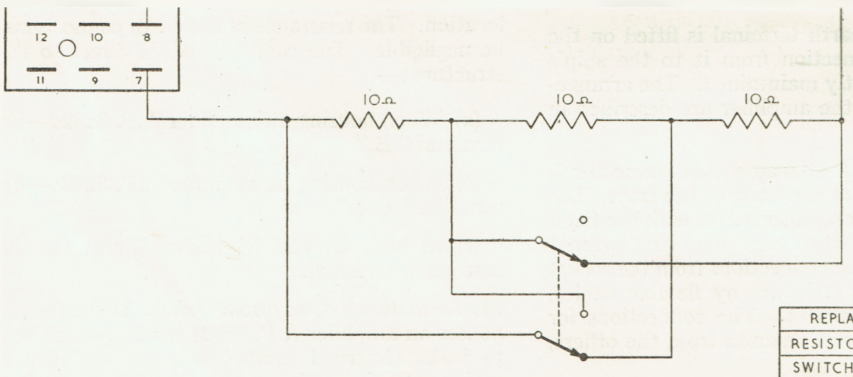
LIST OF GEAR

The following items are provided:-

A.P. NO.	ITEM	ALLOWANCE PER SHIP
(1) 0512/12685	Box, ready use containing:-	1
(2) 0557/12657	Test load for amplifiers 50-watt A.P.12647 and 12647A, and 300-watt A.P.12649 and 12649A	2
(3) 0557/32063	Test load for Micrograms A.P.32018, 32112 and 198346	1
(4) 0557/32064	Test load for amplifiers 2-watt A.P.32047 and 16-watt A.P.32020 and 32021	1
(5) 0561/6057	Mains cable (6 ft.) fitted at one end with socket A.P.0568/972-6820 and end entry cover	1
(6) 0512/972-6181	Microphone, hand	1
(7) 0611/3662	Headphone set (complete with plug A.P.651 and cord)	1

Items (2) to (7) are provided *with* the box item (1).

(Change No. a.)



REPLACEMENT COMPONENTS	
RESISTORS	Z 241006
SWITCH	Z 510304
SOCKET	A.P. 60066

DIAGRAM 1. TEST LOAD. A.P. 12657. CIRCUIT DIAGRAM. SWITCH SHOWN IN POSITION FOR TESTING THE 300w AMPLIFIER.

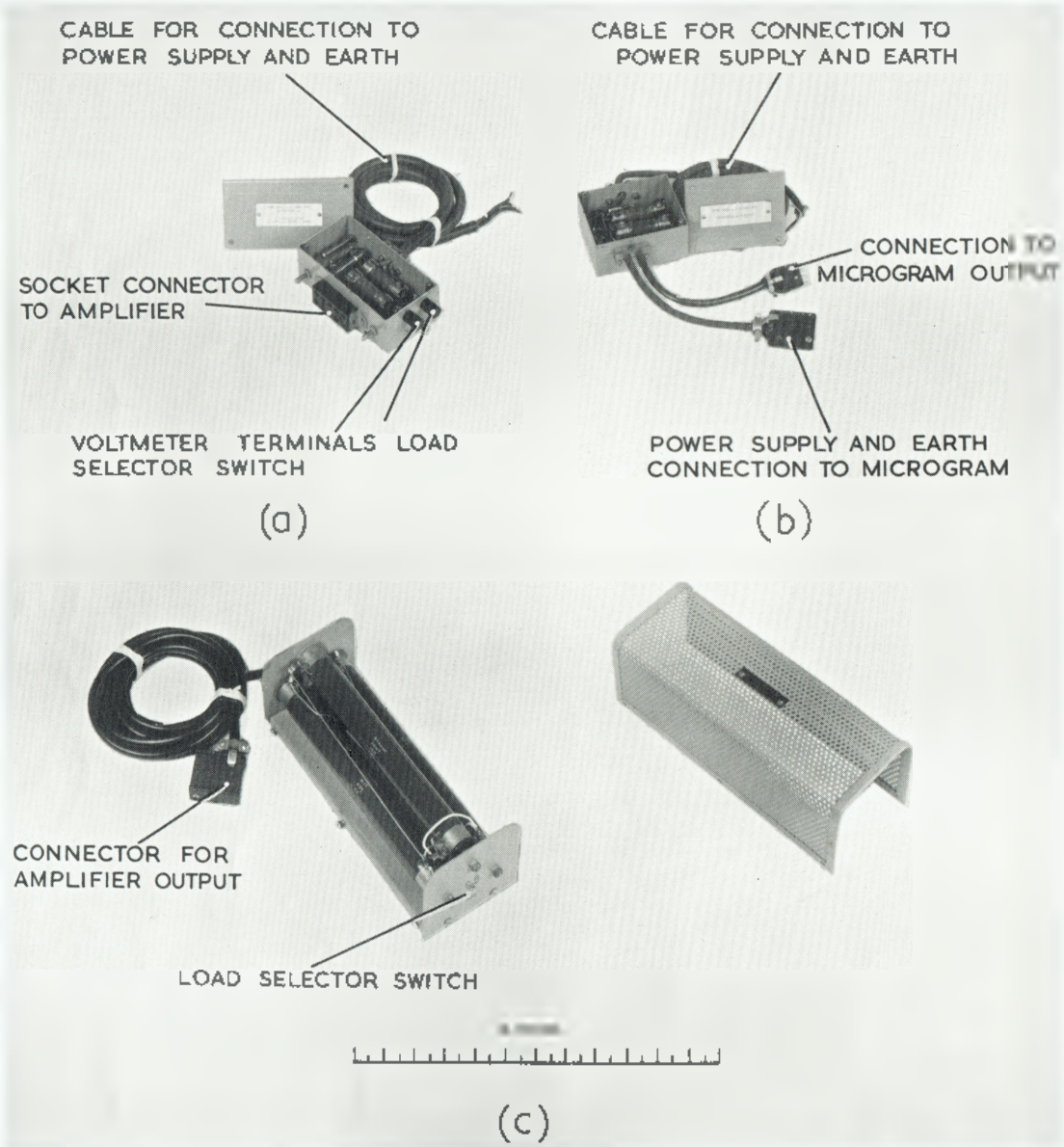


PLATE 5. (a) THE TEST LOAD A.P. 32064
(b) THE TEST LOAD A.P. 32063
(c) THE TEST LOAD A.P. 12657

300 watt or the 50 watt amplifiers. A short flexible cable from the test load to a six way socket connector provides a connection for the amplifier output plug. The plug connections used are numbers 7 and 8.

9. As a load for the 300 watt amplifier the resistors are grouped three in parallel, an arrangement which provides a full output load of 3·3 ohms. As a load for the 50 watt amplifier two only of the resistors are used, connected in series, the third not being used; this arrangement provides a full output load of 20 ohms. The test load is not intended for use in testing the higher voltage output of the 50 watt amplifier employed as a driver for a larger amplifier.

10. *To use the test load.* The test may be made with the amplifier in place in the rack or removed from it, but in the latter case a separate power supply and earth connection must be provided and connected to PLC. Disconnect the amplifier sockets SKI and SKO. Connect the test load and set the load selector switch to the appropriate load setting. Set the amplifier meter selector switch to the position for registering the output voltage. Plug a headphone set or portable loudspeaker into the amplifier TJO. Provide a test input; for the 50 watt amplifier a portable microphone or test oscillator plugged into TJI; for the 300 watt amplifier a driver amplifier or a test oscillator connected to PL1. Close the amplifier H.T. test switch and operate the input. Adjusting the gain control(s) as necessary check the output voltage by the meter and the audio output by the headphones or loudspeaker.

The test load A.P. 32063 (Microgram)

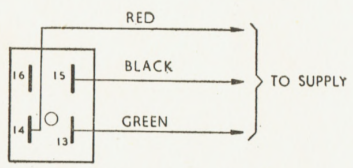
11. As may be seen from *Plate* 5 (*b*) this apparatus consists of a small metal box with three connected flexible cables. Two of the cables are fitted with connectors for mating with the associated connections on the Microgram; one, a six way plug, makes connection to the amplifier output, and the other, a four way socket, carries the supply and the earth connection. The third cable must be connected to the A.C. supply of a voltage 230V, 115V or 50V, for which the Microgram supply voltage selector is adjusted; a third core (green) being connected to earth. The circuit is shown in *Diagram* 2.

12. The load resistors are three in number, two, each of 30 ohms and rated at 10 watts, are connected in series and form the load for the 16 watts 31·6V (loudspeaker) output of the Microgram. The third resistor, R3 in *Diagram* 2, forms the load for the high impedance (recorder) output of the Microgram and must be of a value of between 560 ohms and 600 ohms. R3 may be found to consist of two resistors in parallel, for example, 700 ohms and 3,500 ohms, which give a value, allowing for tolerances, between the limits stated. The J.S. Cat. No. of a replacement resistor for R3 if required is shown in *Diagram* 2. Both output loads are connected simultaneously through the six way plug connector, two pins being spare.

13. *To use the test load.* Connect the supply and earth lines and the supply and output connectors. The output volts as indicated by the meter may be checked by means of an Avometer plugged into TJO.

The test load A.P. 32064 (2/16 watt)

14. *Plate* 5 (*a*) shows the general appearance of this apparatus. It consists of a small metal box containing the load resistors, with a fixed ten-way socket connector, a pair of terminals, a switch and a short length of three core flexible cable. The socket connector mates with the plug of the amplifier, correct alignment being ensured by steel locating pins and correct engagement by dowel pins in the connector. The terminals enable an A.C. (rectifier type) voltmeter to be connected. The switch is for selection of the load. The cable provides lines for the power supply and earth connection; care must be taken when connecting an amplifier A.P. 32020 (the A.C. type) that the supply voltage is at the value for which the



REPLACEMENT COMPONENTS	
R1 & R2	Z 241067
R3	Z 221242
SOCKET 4 POLE	Z 560113
COVER FOR SOCKET	Z 970169
PLUG 6 POLE *	

* PAINTON CAT. No. 500198

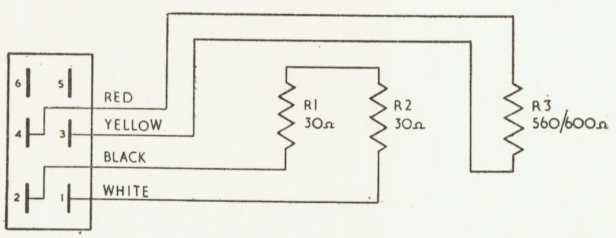


DIAGRAM 2. TEST LOAD. A.P. 32063 FOR MICROGRAM A.P. 32018 CIRCUIT DIAGRAM AND SUPPLY CONNECTIONS

amplifier supply selector is adjusted. The circuit is shown in *Diagram* 3.

15. The load resistors are three in number, two of these being each of 30 ohms and 10 watts rating ; the value of the third is between the limits of 430 to 450 ohms and it is of 3 watts rating. The switch is of the single pole toggle operated type and marked for the selection of loads, either 60 ohms 16 watts or 510 ohms 2 watts according to the type of amplifier under test. Joint-Service reference numbers of resistors and switch suitable for replacement when necessary are shown in *Diagram* 3.

16. The two 30 ohms resistors (R1 and R2) are permanently connected in series and are used alone for the 16 watt amplifier output load. The third resistor (R3) is used in series with R1 and R2 to provide a load of 490 to 510 ohms as load for the 2 watt amplifier. R3 may be found to be made up of two resistors in parallel but when renewal becomes necessary a single resistor of the reference number quoted may be used as a replacement.

17. *To use the test load with a 16 watt amplifier.* With the amplifier withdrawn from its mounting proceed :—

(1) Plug the socket connector to the amplifier plug.

(2) Set the load selector switch to "60 ohms, 16W."

(3) Connect the supply and earth connections (note the caution given in *para.* 14).

(4) Connect an Avometer set to the 120V A.C. range to the test load voltmeter terminals.

18. When testing an amplifier A.P. 32021 under the above conditions one pole of the 24V supply will be earthed. If this earthing is not acceptable (*e.g.*, if the supply is from the ship's L.P. supply) the capacitance earth of the amplifier can be brought into use by taking a line from the socket connection No. 10 to earth and at the same time disconnect the line from connection No. 5 to earth.

19. *To test a* 2 *watt amplifier.* Proceed as instructed above for the 16 watt amplifier except that the load selector switch should be set to "510 ohms, 2W."

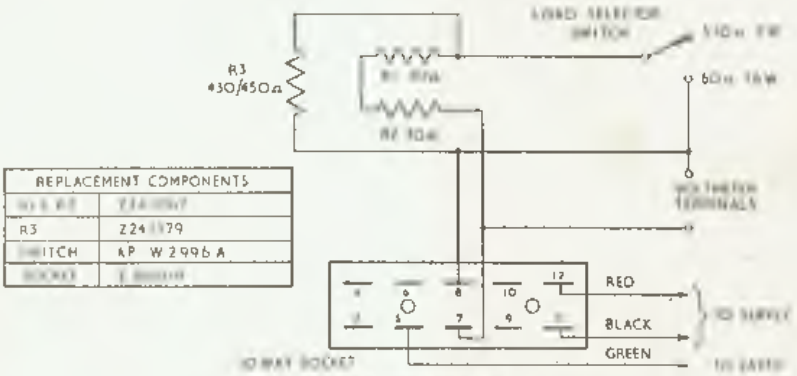


DIAGRAM 3. TEST LOAD. A.P. 32064 FOR AMPLIFIERS 2 WATT A.P. 32047 AND 16 WATT A.P. 32020 AND 32021. CIRCUIT DIAGRAM.

APPENDIX 1

Summary of Structural and Electrical Details

STRUCTURAL

	AMPLIFIERS	MOUNTING A.P. 32022
Dimensions :—		
Height	9 in.	11¾ in.
Width overall	14½ in.	17½ in.
Depth, front to back	8½ in.	11 in.
Withdrawal clearance	12 in.	—
Weight	28 lb., 29 lb.	21 lb.
Mounting :—		
Type	Bulkhead A.P. 32022	On bulkhead or other vertical support.
Fixing particulars	Tray, Oddie clips	See *Figure* 3.
Cable entry :—		
Type	10 way plug and socket J.S. Cat. No. Z560119 from terminal strip.	4 in No. No. 3 glands and terminal strip.
Position	Rear.	Either side.
Casing material	Mild steel sheet	Mild steel sheet.
Type of enclosure	The mounting.	Drip proof.

ELECTRICAL

	AMPLIFIER A.P. 32020	AMPLIFIER A.P. 32021
Supply :—		
A.C. or D.C.	A.C.	D.C.
Voltage	230/115/50V	24V
Frequency	50 to 60 c.p.s.	—
Power consumption	150VA	155W
H.T. (max.)	300V	280V
Fuses :—		
Number fitted	1	1
Capacity	50V 10A 115V 5A 230V 2A	15A
J.S. Cat. No.	50V L1055/10* 115V Z590112 230V Z590110	L1055/15*
Valves	V1 and V2 C.V. 2901 V3 C.V. 455 V4 and V5 C.V. 1075 V6 C.V. 378	V1 and V2 C.V. 2901 V3 C.V. 455 V4 and V5 C.V. 1075
Pilot lamp	X959213	X959213
Power output	16W at 31·6V	16W at 31·6V

* Belling Lee Catalogue number.

APPENDIX 2

Test Data

Amplifiers 16 watts. A.P. 32020 and 32021

(a) **Voltages.** Between test point and chassis. (Taken with Avometer A.P. 47A.)

DRAWING TEST POINT	CIRCUIT POINT	METER RANGE USED	VOLTAGE (VOLTS)		TOLERANCE + OR — PERCENTAGE
			A.P. 32020	A.P. 32021	
A	Anode of valve V1	1200 D.C.	35	30	*
B	Across capacitor C6	1200 D.C.	35	25	*
C	Cathode of valve V1	12 D.C.	0·8	0·7	*
D	Across capacitor C1	1200 D.C.	70	60	*
E	Across capacitor C2	1200 D.C.	112	100	± 25 per cent.
F	Anode of valve V2	1200 D.C.	45	35	
G	Across capacitor C7	1200 D.C.	50	40	
H	Cathode of valve V2	12 D.C.	1·2	1·1	
J	Across capacitor C3	1200 D.C.	185	170	
K	Anode ′ of valve V3	1200 D.C.	182	180	
L	Anode ″ of valve V3	1200 D.C.	182	180	
M	Cathodes of valve V3	480 D.C.	45	40	
NA	Anode of valve V4	1200 D.C.	290	260	± 10 per cent.
NB	Anode of valve V5	1200 D.C.	290	260	
OA	Cathode of valve V4	120 D.C.	14·5	13	
OB	Cathode of valve V5	120 D.C.	14·5	13	
P	Across capacitor C11	1200 D.C.	298	260	
Q	Unsmoothed H.T.	1200 D.C.	320	280	
S	Heater and pilot lamp supplies	120 A.C.	25	24	
TA and TB	Anodes of rectifier valve	1200 A.C.	300	—	

* Tolerances undefinable owing to manufacturing tolerances.

(b) **Overall Voltage Gain.**

"see paragraph 6o page 6"

At 1000 c.p.s. . . . = 97 dB
Input voltage for full load . = 0·45 mV

(c) **Frequency Response**

(i) At 50 c.p.s. . . . = −2 dB ± 2 dB
(ii) At 1000 c.p.s. . . . = zero ± 2 dB
(iii) At 10,000 c.p.s. . . . = −1 dB ± 2 dB

(d) **Total Harmonic Distortion.** With 16 watts output at 31·6 volts into a 60 ohm load = 3 per cent.

(e) **Mains Transformer Secondary Voltages** (Amplifier A.P. 32020 only).

(i) H.T. winding . . . 300–0–300 volts
(ii) Rectifier heater winding . 5 volts
(iii) Audio valve heater winding 25·2 volts

(f) **Power Consumption (max.)**

(i) A.P. 32020 . . . = 150 VA
(ii) A.P. 32021 . . . = 155W

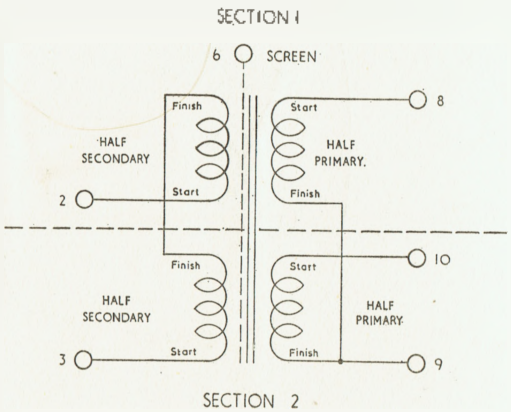
APPENDIX 3

Transformer A.P. 32007. Constructional Details

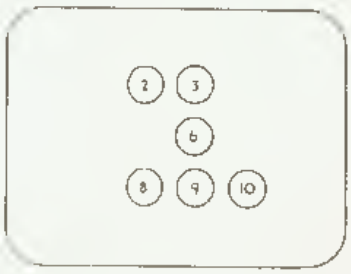
TYPE : Microphone Input. (25 ohms.)

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		WIRE (S.W.G.)	D.C. RES. (OHMS) ALL ± 20 PER CENT.	INDUCTANCE (1V AT 50 C.P.S.) HENRYS
		SECT. 1	SECT. 2			
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.

COIL OUTSIDE INSULATION : 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).

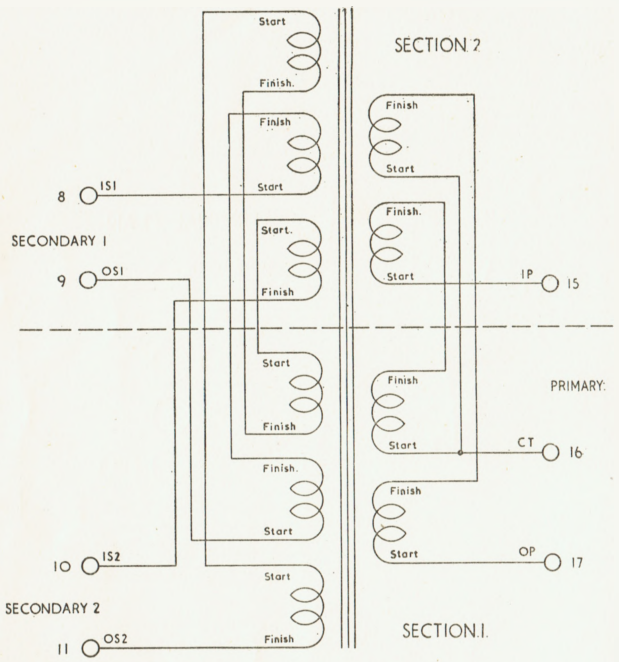
APPENDIX 3

Transformer A.P. 32056. Constructional Details

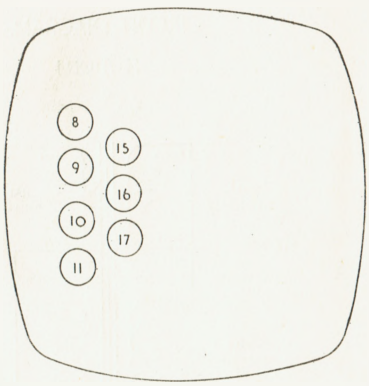
TYPE : Output.

USED IN : 16 watt amplifiers A.P. Nos. 32020 and 32021.

CIRCUIT DIAGRAM



TERMINAL PLAN



Coil winding data

One bobbin (no flanges). Section 1 wound first, bobbin reversed and section 2 wound.

WINDING ORDER	WINDING	NO. OF TURNS ON SECT. 1	NO. OF TURNS ON SECT. 2	SIZE OF WIRE (S.W.G.)	NO. OF LAYERS	INTERLAYER PAPER INSULATION NO. OF TURNS	INTERLAYER PAPER INSULATION THICKNESS
1	½ Sec. 2	12	13	32	1	—	—
2	½ Pri.	500	500	44	6	1	½ mil
3	Sec. 1	90	90	39	5	1	5 mil
4	½ Pri.	500	500	39	6	1	½ mil
5	½ Sec. 2	12	13	32	1	—	—

D.C. Res. (ohms) (all ± 20 per cent.) :

PRIMARY	SECONDARY 1	SECONDARY 2
22	1	0·1

WIRE : Copper. Enamel covered.

INSIDE INSULATION : Bakelite tube.

INTERWINDING INSULATION : Between adjacent windings—5 turns of 3 mils thick paper.

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

CORE : Z371004 (2 off).

OUTPUTS FROM :—Secondary 1 31·6V, 15·5W.
Secondary 2 9·75V (feed back). HIGH POTENTIAL TEST VOLTAGE : 2kV.

INDUCTANCE OF PRIMARY : 15H (at 25 volts, 50 c.p.s.). TERMINALS : Z560087 (7 off).

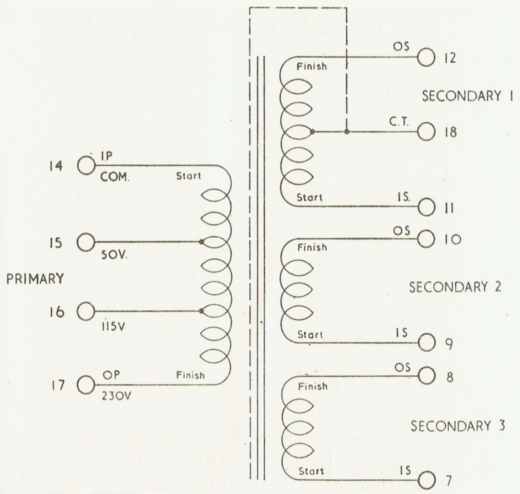
APPENDIX 3

Transformer A.P. 32055. Constructional Details

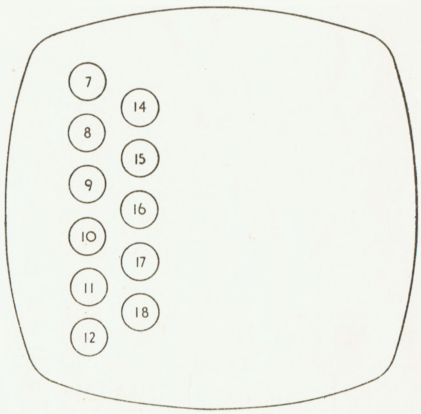
TYPE : Mains.

USED IN : 16 watt amplifier A.P. 32020.

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 .	114	18	3	7·5	1	10 mil
		148	22	3		1	5 mil
		262	25	3		1	5 mil
2	Screen . . .	1	(Copper foil 1mil thick)			—	—
3	Sec. 1 . . .	710 + 710	21	9	50–0–50	1	2 mil
4	Sec. 2 . . .	60	20	2	0·1	1	10 mil
5	Sec. 3 . . .	12	18	1	0·1	—	—

WIRE : Copper. Enamel covered.

INSIDE INSULATION : Bakelite tube.

INTERWINDING INSULATION : Between primary and screen, between screen and secondary 1 and between adjacent secondaries—3 turns of 5 mils thick paper.

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

CORE : Z371011 (2 off).

INPUT TO PRIMARY : 50/115/230 volts. 50 c.p.s. to 60 c.p.s.

OUTPUTS FROM —Secondary 1, 300V–0–300V. 170 mA.
Secondary 2, 25·2V., 1·4 amperes.
Secondary 3, 5V, 3 amperes.

HIGH POTENTIAL TEST VOLTAGE : 2 kV.

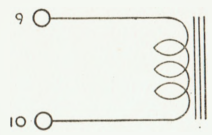
TERMINALS : Z560087 (11 off).

APPENDIX 3

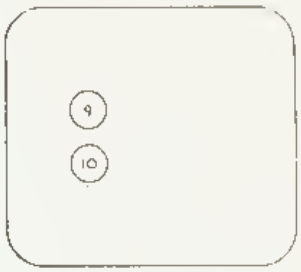
Smoothing Choke A.P. 32067. Constructional Details

USED IN : Microgram A.P. 32018.
Amplifiers, 16 watts, A.P. Nos. 32020 and 32021.

CIRCUIT DIAGRAM



TERMINAL PLAN



Coil winding data

	NO. OF TURNS	SIZE OF WIRE (S.W.G.)	NO. OF LAYERS	D.C. RESISTANCE (OHMS)	INTERLAYER PAPER INSULATION (THICKNESS)	
	3000	30	28	100 ± 10%	1½ mil	

WIRE : Copper. Enamel covered.

INSIDE INSULATION : Bakelite tube.

COIL OUTSIDE INSULATION : 10 turns of 1½ mil thick paper.

CORE : Z371005 (2 off).

CORE GAPS : 0·01 in.

GAP SPACER MATERIAL : Paper.

INDUCTANCE : 10H ± 10% at 170 mA. Tested at 25V, 50 c.p.s.

HIGH POTENTIAL TEST VOLTAGE : 2 kV.

TERMINALS : Z560087 (2 off).

APPENDIX 4

The Dynamotor (Rotary Transformer) A.P. 32068

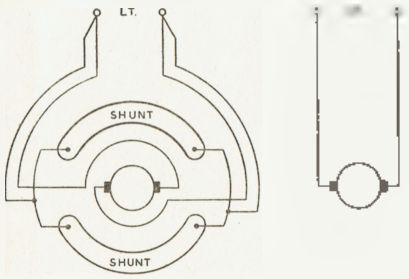
Electrical and Constructional Details

In this Appendix the earlier design of dynamotor (serial numbers 480K to 59567K) is referred to as " Type ' A ' ", the later design (other serial numbers) is referred to as " Type ' B ' ".

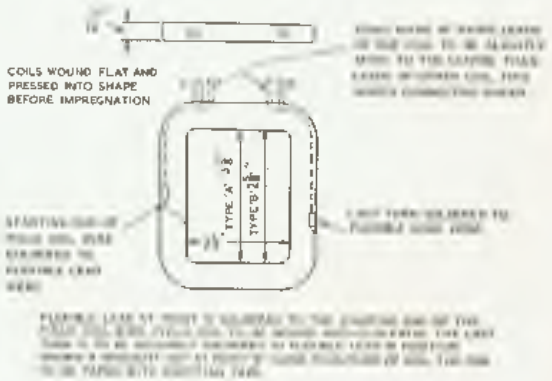
Table 1. Electrical data

Input L.T.	Types ' A ' and ' B ' . .	23·5 volts D.C.
Output H.T.	Types ' A ' and ' B ' . .	[illegible] volts D.C.
Rating period	Types ' A ' and ' B ' . .	Continuous
Power consumption . . .	Types ' A ' and ' B ' . .	[illegible] watts
Speed	Type ' A '	4,000 r.p.m.
	Type ' B '	4,200 r.p.m.

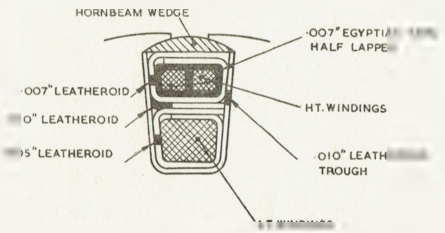
Circuit Diagram
Types ' A ' and ' B '



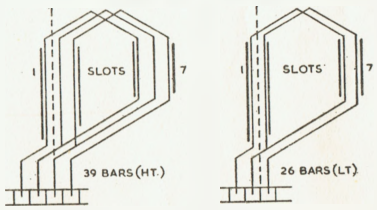
Field Coil Winding
Types ' A ' and ' B '



Armature Slot Insulation
Types ' A ' and ' B '



Armature Winding Diagram
Types ' A ' and ' B '



Brushes. Types ' A ' and ' B '

	H.T.	L.T.
Number	2	2
Size	(5/32 in. × 7/32 in.)	
Grade	EG14	CM3H

Bearings. Types ' A ' and ' B '

Lubricant	Belmoline R.B.
Number	2
Type	Hoffman 106 (L.S.)
Size	6 mm.

NS CAT NOS
EG 14 0559/200884
CM3H 0559/200678

Table 2. Windings

	Type 'A'			Type 'B'		
	ARMATURE L.T.	ARMATURE H.T.	FIELD	ARMATURE L.T.	ARMATURE H.T.	FIELD
No. of coils	2 × 13	3 × 13	2	2 × 13	3 × 13	2
Turns per coil	4	35	1,000	5	45	900
Connected in	Series	Series	Parallel	Series	Series	Parallel
Method of winding	Former	Former	Former	Former	Former	Former
Wire —Size, S.W.G.	22	38	31	22	38	31
A.P. No.	2007D	19342	18403	2007D	19342	18403
Covering	D.C.C.	Enamel	Enamel	D.C.C.	Enamel	Enamel

R	R1. R6.R5.R3. R2.R4. R11. R10.R8.R9. R15. R16. R20. R17. R18. R19. R13. R25. R14. R21 R12 R24. R22. R23. R26. R31. R29. R28. R30. R27.	R
C	C4. C12.C2. C3.C1. C11. C7. C6. C5. C10. C8.C9. C16. C17. C13. C14. C15.	C
MISC.	TR1 TJ'I' V1. V2. RV1. TR2. V3. LP. V4. RL1. L1. SW1. V5. TJ'O' FS1. V6. TR3. RT.1. RL1. SW.2.	MISC.

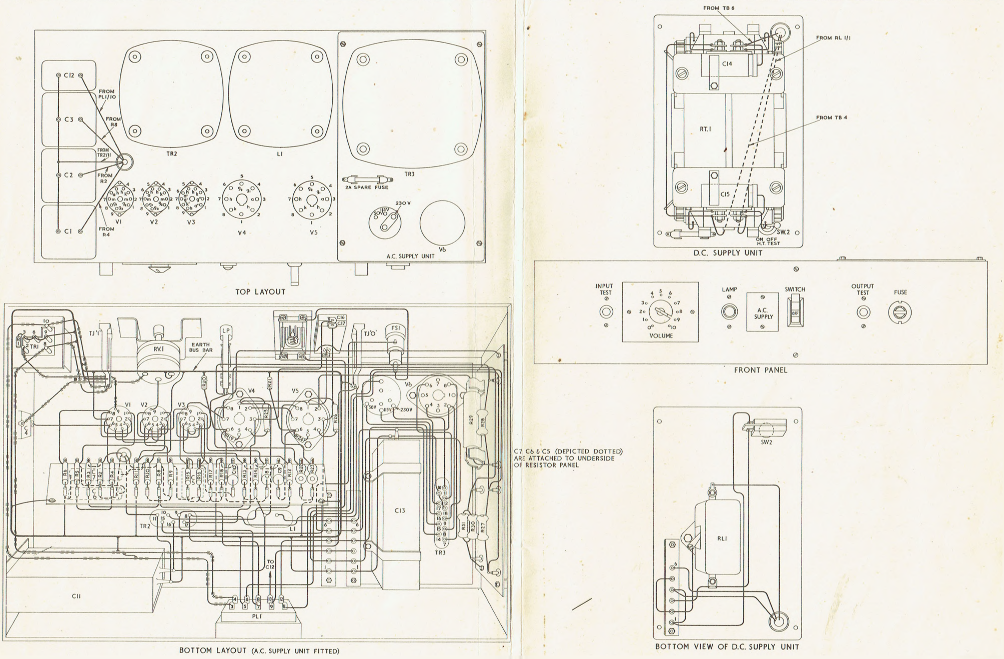
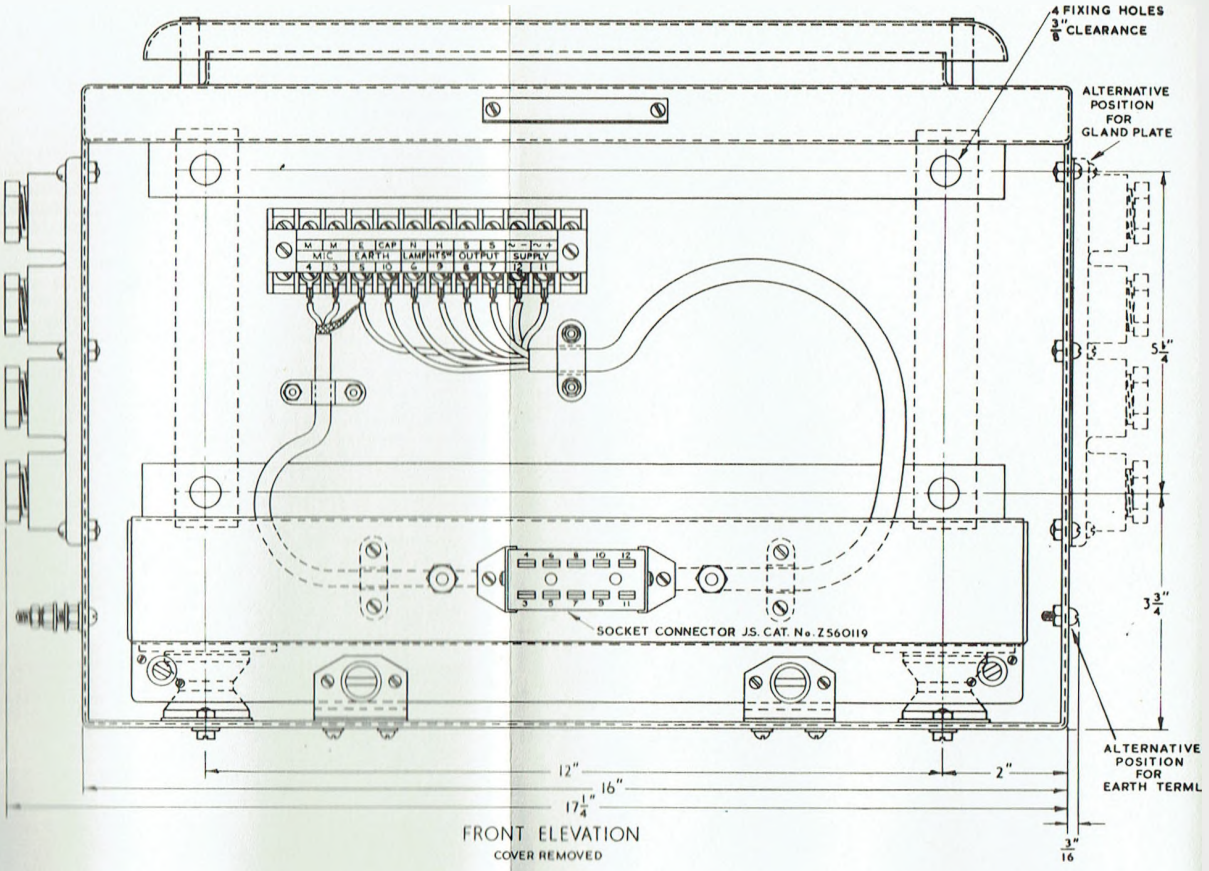
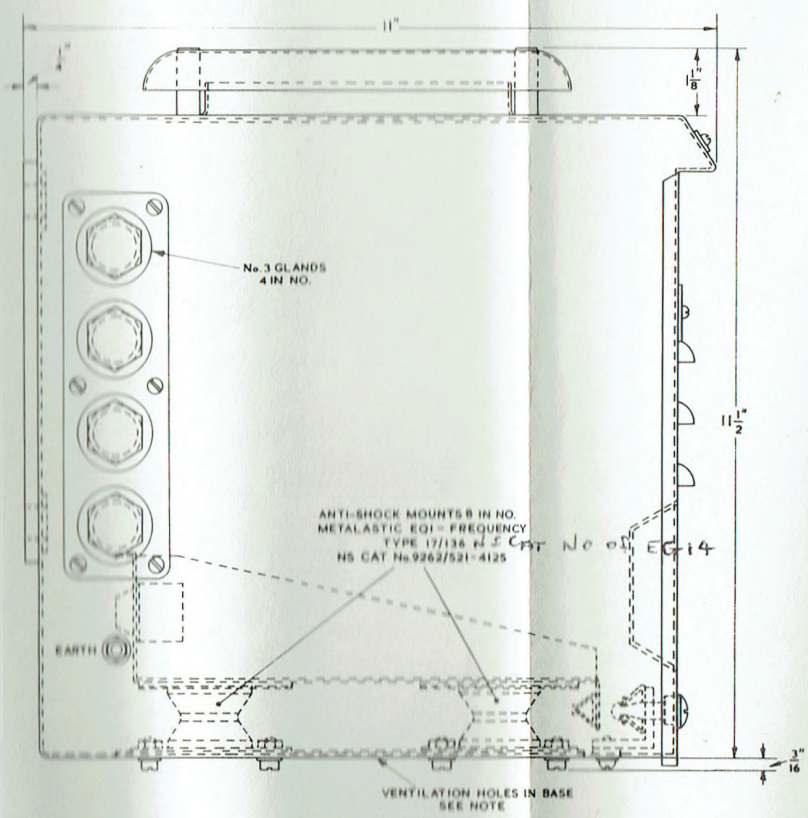


FIG. 2 16 WATT AMPLIFIERS A.P. 32020 & A.P. 32021 – PICTORIAL WIRING DIAGRAM & STRUCTURAL ARRANGEMENT.



FRONT ELEVATION
COVER REMOVED



SIDE ELEVATION

NOTE:-

1 WHEN MOUNTING ABOVE OTHER EQUIPMENT ALLOW AT LEAST 2" CLEARANCE FOR VENTILATION.

2 THE FOLLOWING TERMINAL CONNECTIONS ARE ARRANGED FOR

AMPLIFIER A.P 32020

MIC.	M.M.
EARTH	E
OUTPUT	S.S
A.C. SUPPLY	∿∿
EXT. LAMP	N.E

AMPLIFIER A.P. 32021

MIC	M.M.
CAPACITY EARTH	CAP (DIRECT CABLE TO SHIPS STRUCTURE)
HT. SW.	H.E.
OUTPUT	S.S
L.P. SUPPLY	+ −
EXT. LAMP	N.E.

3 MOUNTING ITSELF TO BE EFFICIENTLY EARTHED TO SHIPS STRUCTURE VIA EARTH TERMINAL ON CASE EXTERIOR

4 EACH SHOCK MOUNTING ASSEMBLY COMPRISES 2 IN No. ANTI-SHOCK MOUNTS 0262/521-4125 PLACED BACK-TO-BACK SEPERATED BY A 1/8" THICK STEEL WASHER. THE ASSEMBLY IS THEN RIVETED TOGETHER.

WEIGHTS

MOUNTING ONLY - 21 LB
MOUNTING AND AMPLIFIER AP 32020-48 LB
MOUNTING AND AMPLIFIER AP 32021-49 LB

FIG. 3 THE MOUNTING A.P 32022 FOR AMPLIFIERS A.P 32020 & A.P 32021 - DIMENSIONS, FIXING PARTICULARS, TERMINAL ARRANGEMENTS

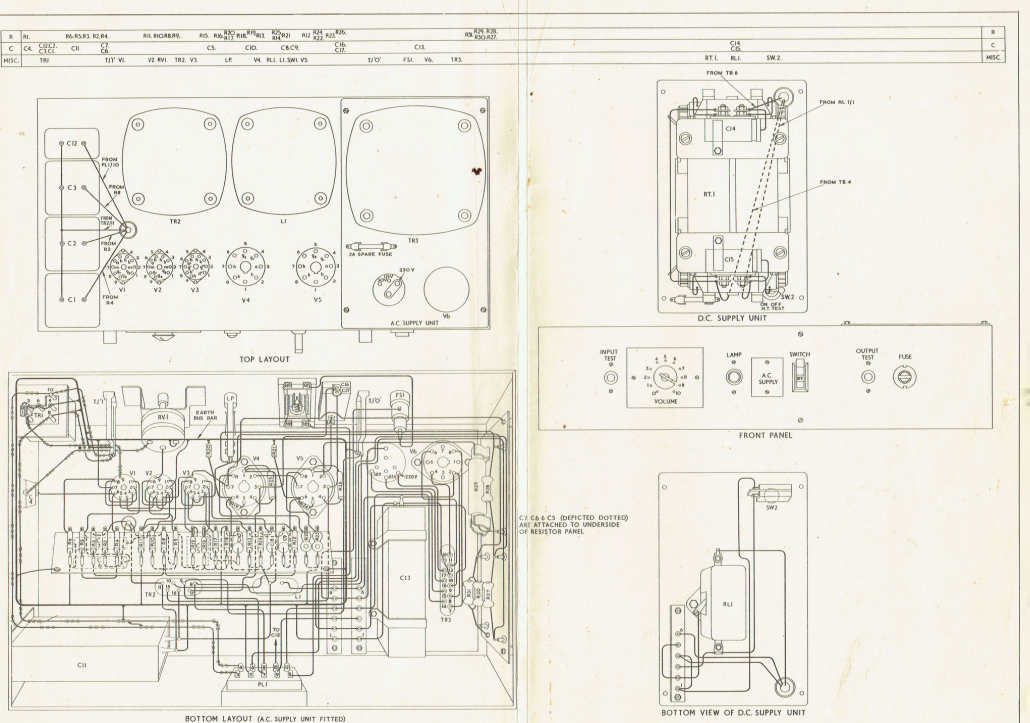
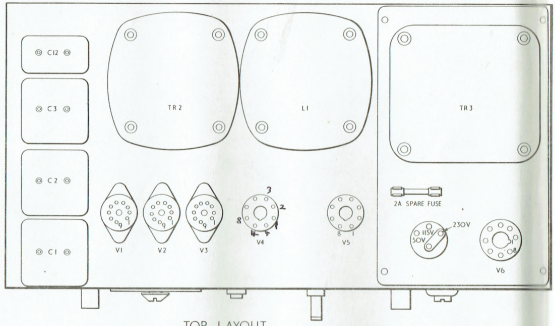
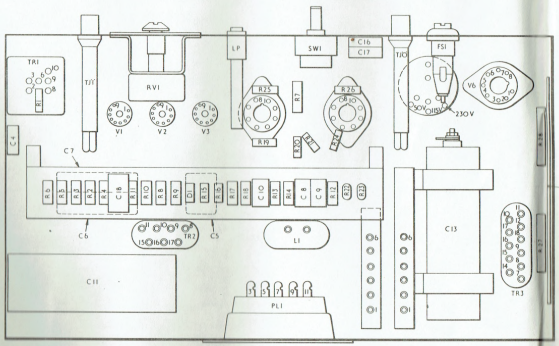


FIG.2 16 WATT AMPLIFIERS A.P. 32020 & A.P. 32021 – PICTORIAL WIRING DIAGRAM & STRUCTURAL ARRANGEMENT.

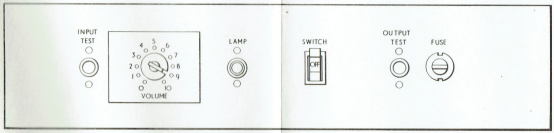
H.M.S. COLLINGWOOD DWG. No. 11873



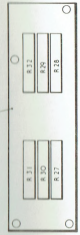
TOP LAYOUT



BOTTOM LAYOUT

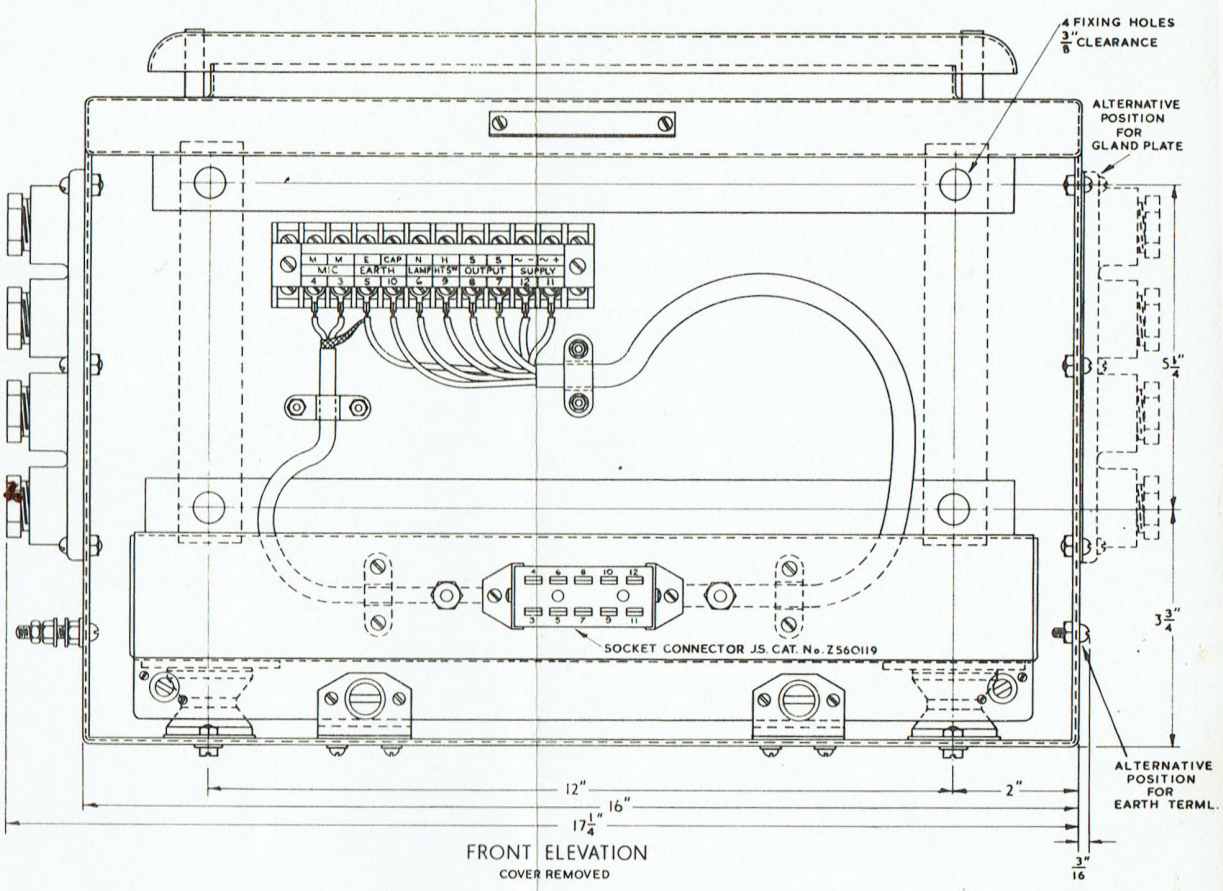


FRONT PANEL

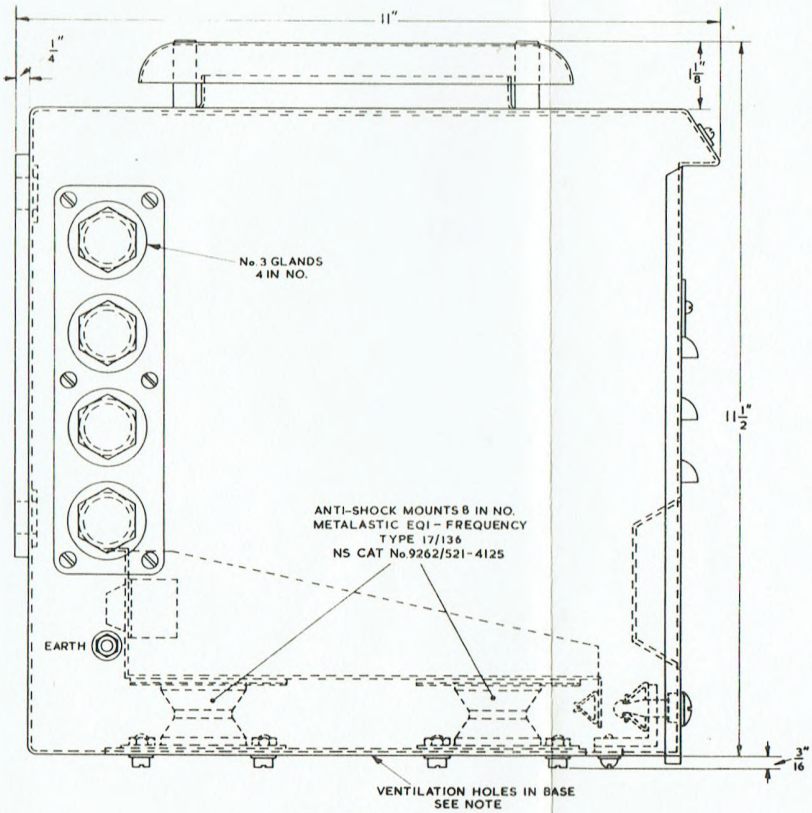


FILAMENT AND LAMP RESISTANCE PANEL

FIG. 5 16 WATT AMPLIFIER PATT 0558/32020 MOD 1– COMPONENT LAYOUT



FRONT ELEVATION
COVER REMOVED



SIDE ELEVATION

NOTE:-

1 WHEN MOUNTING ABOVE OTHER EQUIPMENT ALLOW AT LEAST 2" CLEARANCE FOR VENTILATION.

2 THE FOLLOWING TERMINAL CONNECTIONS ARE ARRANGED FOR

AMPLIFIER A.P 32020

MIC.	M.M.
EARTH	E
OUTPUT	S.S
A.C. SUPPLY	∿∿
EXT. LAMP	N.E

AMPLIFIER A.P. 32021

MIC	M.M.
CAPACITY EARTH	CAP. (DIRECT CABLE TO SHIPS STRUCTURE)
HT. SW.	H.E.
OUTPUT	S.S
L.P. SUPPLY	+ −
EXT. LAMP	N.E.

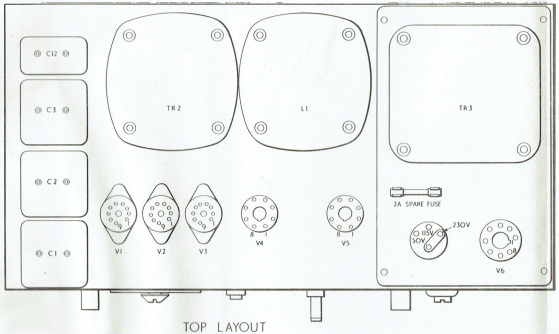
3 MOUNTING ITSELF TO BE EFFICIENTLY EARTHED TO SHIPS STRUCTURE VIA EARTH TERMINAL ON CASE EXTERIOR

4 EACH SHOCK MOUNTING ASSEMBLY COMPRISES 2 IN No. ANTI-SHOCK MOUNTS 0262/521-4125 PLACED BACK-TO-BACK SEPERATED BY A 1/8" THICK STEEL WASHER. THE ASSEMBLY IS THEN RIVETED TOGETHER.

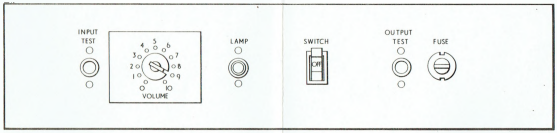
WEIGHTS

MOUNTING ONLY - 21 LB
MOUNTING AND AMPLIFIER AP 32020 - 48 LB
MOUNTING AND AMPLIFIER AP 32021 - 49 LB

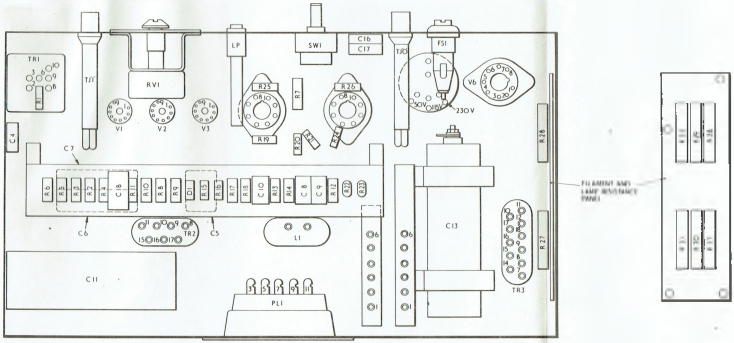
FIG. 3 THE MOUNTING A.P. 32022 FOR AMPLIFIERS A.P. 32020 & A.P. 32021 - DIMENSIONS, FIXING PARTICULARS, TERMINAL ARRANGEMENTS



TOP LAYOUT



FRONT PANEL



BOTTOM LAYOUT

FIG. 5 16 WATT AMPLIFIER PATT 0558/32020 MOD 1- COMPONENT LAYOUT

BR 575(2)E
AMDT 2 2.79