# TRANSMITTING SETS RADIO, RACAL TYPE TTA.1860A AND TTA.1860S (UK/FRT-618) ALSO DRIVE UNIT TYPE M.1721S

**NOTE: SINCE PUBLICATION OF THIS A.P. THE TRANSMITTING SET RADIO TTA.1860A HAS BEEN REMOVED FROM SERVICE AND IS NOW OBSOLETE.**

## GENERAL AND TECHNICAL INFORMATION ALSO REPAIR AND RECONDITIONING INSTRUCTIONS

BY COMMAND OF THE DEFENCE COUNCIL

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# WARNINGS

CONTROL OF SUBSTANCES HAZARDOUS TO HEALTH

MAKE SURE YOU KNOW THE SAFETY PRECAUTIONS AND FIRST AID INSTRUCTIONS BEFORE YOU USE A HAZARDOUS SUBSTANCE

READ THE LABEL ON THE CONTAINER IN WHICH THE SUBSTANCE IS SUPPLIED

READ THE DATA SHEET APPLICABLE TO THE SUBSTANCE

OBEY THE LOCAL ORDERS AND REGULATIONS

WARNINGS

(1) LETHAL VOLTAGE. DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT. REFER TO JSP 375 VOL 2 AND DEF STAN 61-15 ISS 3 FOR SAFETY PRECAUTIONS

(2) IONIZING RADIATION. THIS EQUIPMENT CONTAINS CLASS 1 RADIOACTIVE VALVES. REFER TO JSP 392 CHPT 30

(3) BERYLLIUM/BERYLLIA. THIS EQUIPMENT CONTAINS COMPONENTS THAT ARE OF BERYLLIUM/BERYLLIA. REFER TO JSP F 395 100B-10 (RAF) FOR SAFETY PRECAUTIONS

(4) LIFTING/REMOVAL PRECAUTIONS

A. RACAL MA1720 DRIVE UNITS ARE NOT TO BE LIFTED OUT OF THEIR EQUIPMENT RUNNERS UNLESS THE UNIT IS BEING REMOVED FROM THE CABINET AND THEN ONLY BY TWO TRADESMEN.
AFTER EMBODIMENT OF MODIFICATION TC 0088 IT WILL BE NECESSARY TO REMOVE TWO BLANKING PLATES FROM THE RUNNERS TO FACILITATE REMOVAL OF DRIVE UNITS. (RAF LOCKING ONLY).

B. AT NO TIME ARE PERSONNEL TO BE PERMITTED TO WORK BELOW A UK/FRT 618 TRANSMITTER SUB-ASSEMBLY WHICH HAS BEEN WITHDRAWN OUT OF THE CABINET ON ITS EQUIPMENT-RUNNERS, EG. RACAL MA1720 DRIVE UNIT. THIS IS TO MINIMISE THE POSSIBILITY OF THE EXTENDED SUB-ASSEMBLY SLIPPING, FALLING AND INJURING PERSONNEL WORKING BELOW.

C. TRADESMEN ARE TO SATISFY THEMSELVES, BY PHYSICAL EXAMINATION, THAT WHEN A SUB-ASSEMBLY, EG. RACAL MA1720 DRIVE UNIT IS FULLY WITHDRAWN OUT OF ITS UK/FRT 618 TRANSMITTER CABINET, ALL LOCATING-LUGS AT THE SIDE OF THE SUB-ASSEMBLY ARE SECURELY LOCATED IN THE EQUIPMENT RUNNERS.

WARNING

BERYLLIUM/BERYLLIA. THIS EQUIPMENT CONTAINS BERYLLIUM/BERYLLIA MATERIAL AND/OR ITEMS. REFER TO THE BERYLLIUM/BERYLLIA WARNINGS IN THE PRELIMINARY PAGES OF THIS PUBLICATION.

Components in this equipment which are manufactured using beryllium oxide are as follows:-

| Assembly | Board ref. | Circuit ref. |
|---|---|---|
| MS.442 | Distribution amplifier PS.319 | TR1 to TR4 |
| MS.564 | Muting unit PS.565 | TR1, TR2 |
| MS.420 | Low-level PS.314 | TR15,16,17,20,21,22. |
| | or | |
| | Low-level PS.351 | TR15,16,17,20,21,22 |
| MM.420 | High-level PS.315 | TR1 to TR10 |
| | High-level PS.315 | Heatsink washers for TR1 to TR4 and TR7 to TR10 |

## MODIFICATION RECORD

A list of the modifications embodied in this publication is given in Topic - 1A6A, pages (vii) and (viii).

## PUBLICATION RE-CODING

This publication has been re-coded (Amdt 11) to exclude the use of 'cover' numbers; hence, any other references in the book to 'cover' numbers should be ignored.

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# CONTENTS - TOPIC 1B6B

## Preliminary material

Chapter 4-0

DESCRIPTION

# AMPLIFIER, STABILIZER 10U/5820-99-626-4730

(R.F. power module MM.420)

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## INTRODUCTION

1. The r.f. power module MM.420 is a solid-state wideband linear amplifier capable of producing an output of at least 125W over the frequency range of 1.6 MHz to 30 MHz.

## CONSTRUCTION

2. The MM.420 physically separates into an r.f. amplifier module MM.320 and a power stabilizer module MS.440. Fig. 1 shows the construction of the complete MM.420 and Table 1 lists the sub-assemblies.

TABLE 1

List of sub-assemblies: MM.420

| Sub-assembly | NATO No. | Manufacturer's ref. |
|---|---|---|
| Amplifier r.f., containing:- | 10U/5820-99-626-4732 | MM.320 |
| Low-level board | | PS.314 |
| High-level board | | PS.315 |
| Protection board | | PS.251 |
| V.S.W.R. board | | PS.316 |

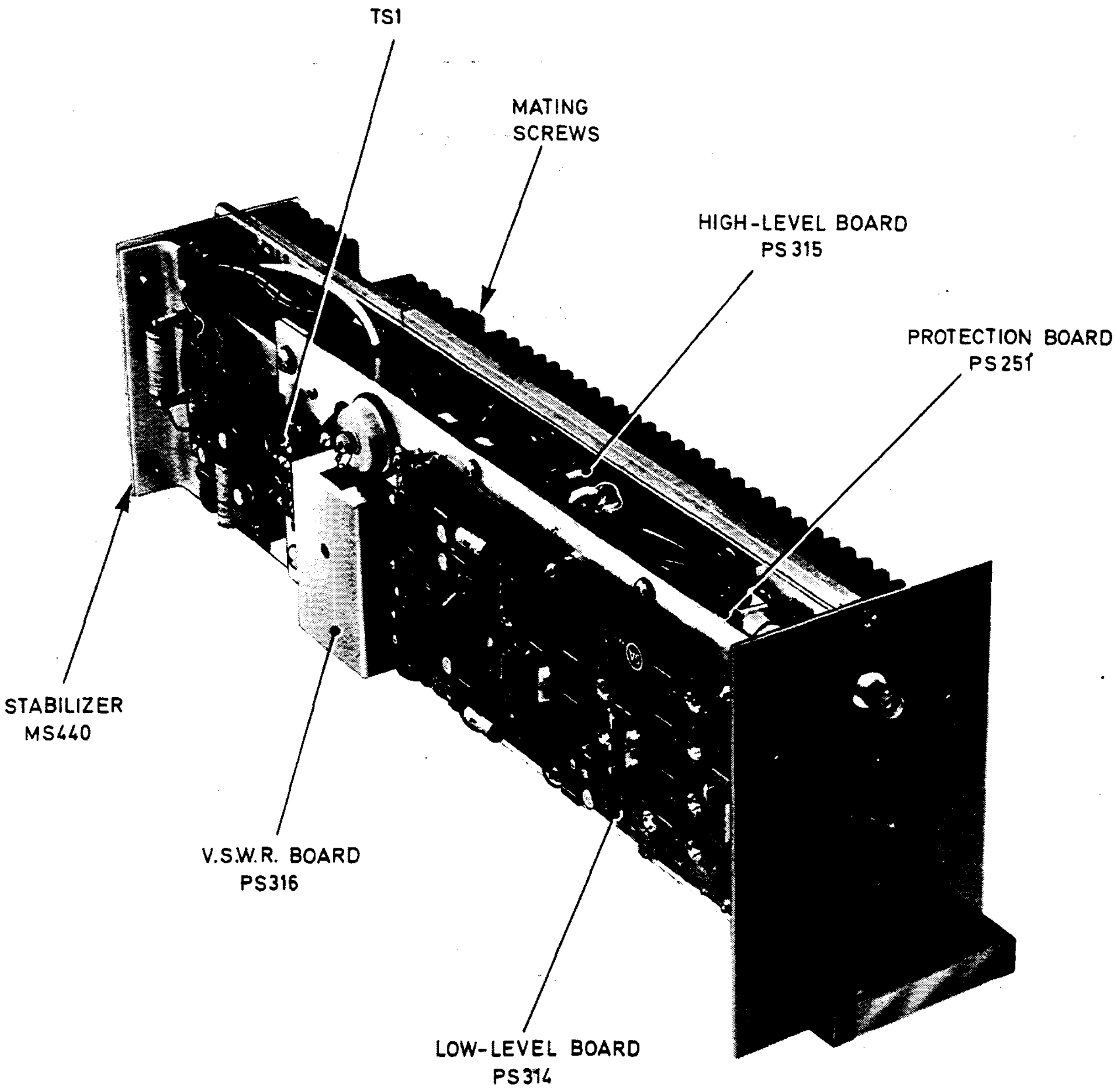


Fig.1 R.F. power module MM.420 : general view

TABLE 1 (cont.)

| Sub-assembly | NATO No. | Manufacturer's ref. |
|---|---|---|
| Stabilizer, voltage containing:- | 10D/5820-99-626-3419 | MS.440 |
| panel, electronic circuit | | PS.313 |

3. Eight of these modules fit into either a transmitter sub-assembly 10D/5820-99-624-5393 or 10D/5820-99-631-8612 to form a 1 kW linear amplifier TA.1810A (Chap.1-0) or TA.1810S (Chap.9-0) respectively.

BRIEF FUNCTIONAL DESCRIPTION

4. Fig.2 is a block diagram of the r.f. amplifier module MM.320; the stabilizer MS.440, which produces stabilized +20V and +30V d.c. supplies, is not shown but is described in detail in Chap. 4-4.

Low-level board PS.314

5. The PS.314 board amplifies a 10 mW r.f. input signal to a level of approximately 2W. The a.l.c. stage (automatic level control) is a variable-gain amplifier which maintains the r.f. output from the high-level board PS.315 constant, and reduces this output to a safe level if a load-mismatch occurs.

6. The input to the PS.314 is fed to the a.l.c. stage consisting basically of two transistors operating in class A push-pull. The gain of the stage is varied by causing two diodes (one associated with each class A transistor) to shunt part of the r.f. drive signal.

7. Following the a.l.c. stage are two class A amplifier stages. The first stage has two transistors operating in grounded-base mode and connected in push-pull. The second stage is similar to the first but employs four transistors connected in a parallel/push-pull configuration and transformer-coupled to the output.

High-level board PS.315

8. This board contains two stages of r.f. amplification. The driver stage consists of two power transistors, operating in class B push-pull with grounded-base, which are transformer-coupled to the final output stage; this consists of eight power transistors connected in a parallel push-pull arrangement and operated in the common-emitter mode. Negative feedback is applied to the output stage to ensure a flat response over the frequency range.

9. All components in the output stage, with the exception of the transistors and diodes, are mounted on the high-level board; the transistors are stud-mounted on the main casting to ensure maximum head dissipation. Replacement of a transistor can be effected without removing the board (refer to Chapter 4-2).

10. The high-level board includes diodes monitoring the r.f. collector-voltage swing of the power transistors. If this becomes too large, the diodes conduct and operate the a.l.c. stage thus reducing the drive level in order to avoid saturation (para.6).

V.S.W.R. board PS.316

11. The v.s.w.r. board monitors the forward and reflected output power from the high level board before it is fed to the output connector of the MM.420.

12. The forward-power-dètector output is fed back to the a.l.c. stage on the low-level board to control the output level under normally-matched conditions (i.e. 50 ohms). The actual forward output level is set by a potentiometer.

13. Under mis-matched conditions, the resultant output from the reflected-power-detector is also fed back to the a.l.c. stage to reduce the output level appropriate to the degree of mis-match. The level at which the reflected power takes over from normal a.l.c. control is adjustable via a second potentiometer.

CAUTION...

The potentiometers of the r.f. power module MM.420 should only be adjusted when setting-up the module as part of the adjustment procedure (Chapter 4-2). They should not be adjusted when the module is installed in the transmitter, since the protection afforded to the output transistors may be reduced with the consequent risk of transistor failure.

Protection board PS.251

14. The protection board is designed to provide protection for the r.f. amplifier against d.c. fault conditions. Depending on the actual fault, it operates in one of two ways:

(1) Firstly, if a short-circuit should occur in the stabilizer MS.440, this would apply approximately 40V to the amplifier rail, overstressing the r.f. transistors. To prevent this, a power thyristor is included which, in the event of such a fault, conducts and operates a fuse thereby open-circuiting the positive supply.

(2) Secondly,if the collector currents of the r.f. output transistors tend to exceed a prescribed maximum (approximately 7 amps for each group of four transistors), a fast acting d.c. overload signal is applied to the a.l.c. stage, on the low-level board, to ensure that this current level is not exceeded.

Note...

If reducing the r.f. drive does not control the transistor currents, then a d.c. overload trip in the stabilizer unit will operate.

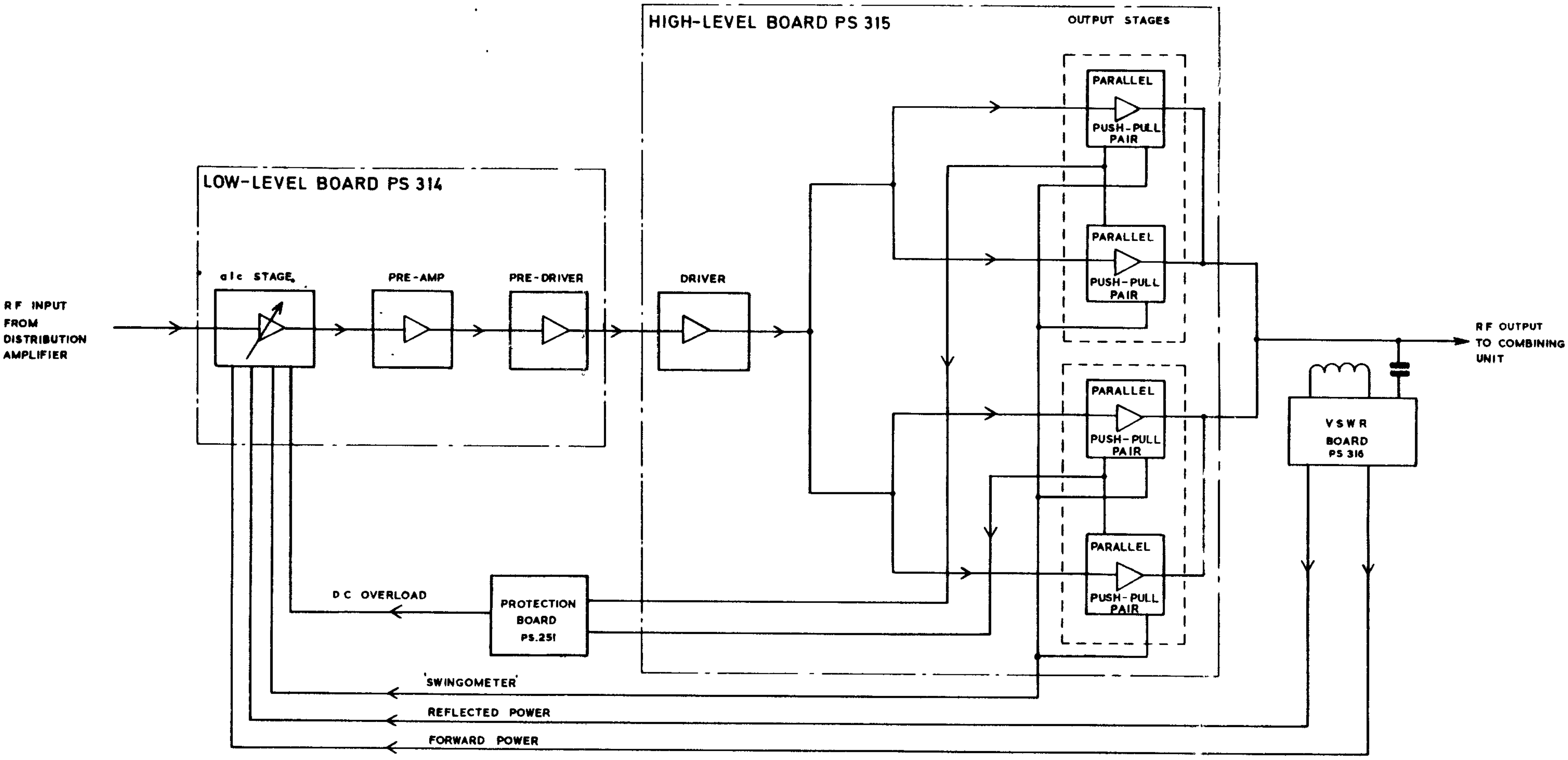


Fig. 2

# R.F. power module MM320: block diagram

Chapter 4-1

# SERVICING

## AMPLIFIER, STABILIZER 10U/5820-99-624-4730

## (R.F. power module MM.420)

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TABLES



### INTRODUCTION

1. This chapter lists the test equipment required for the 3rd-line testing of the MM.420 and also gives the fault location information. The list of test equipment is an extract from the overall list given in Chap.1-3 (TTA.1860A) and Chap.13-3 (TTA.1860S and MA.1721S).

2. A thorough understanding of Chap.4-4 is an essential aid to fault-finding and reference should be made to the relevant paragraphs.

3. The test procedures must be carried out in the order given; this ensures that the r.f. drive is not applied under conditions where damage could occur. The fault is localized to a sub-assembly and thence to component level.

4. A fault in the MS.440 stabilizer can damage the MM.320 amplifier module; hence the serviceability of the MS.440 must be established before attempting any tests involving the MM.320.

5. Access to certain components requires the partial-removal of a sub-assembly; the instructions are given in Chap.4-2.

TEST EQUIPMENT

6. The test equipment required for the 3rd-line testing of the MM.420 is as follows:-

| | | | |
|---|---|---|---|
| (1) | 5QP/6625-99-105-7049 | Multimeter set CT.498A | |
| (2) | 10S/6625-99-193-4355 | Electronic voltmeter | Marconi 2603 |
| (3) | | Signal generator, 1-30 MHz | |
| (4) | 110S/6625-99-649-5070 | Wattmeter, directional | Bird 43 |
| (5) | 110B/9542785 | Detecting element 1000W, 2-30 MHz | |
| (6) | 10S/6625-99-628-5323 | Frequency counter | Racal 9059 |
| (7) | 10K/6150-99-628-5325 | Mains power unit | |
| (8) | 10ZZ/205705 | Oscilloscope set CT.588 | Tektronix 475 |
| (9) | 10S/17198 | Dummy load 1 kW, 50 ohms | Bird 8890 |
| (10) | 10H/6625-99-631-9452 | Accessory kit CA.607 comprising:- | Racal BA 604043 |
| | | (a) Amplifier module extension lead assembly. | |
| | | (b) Combiner patch lead assembly. | |
| | | (c) Amplifier module blanking panel assembly. | |
| | | (d) Amplifier module mating connectors. | |
| (11) | 10W/5905-99-633-3089 | Rheostat 5.8 ohms, 20A | Berco SE. |

FAULT FINDING

7. The MM.420 under test is connected via the extension lead assembly (part of accessory kit CA.607) into a serviceable transmitter (TTA.1860A or TTA.1860S). The extension lead assembly may be fitted to any one of the eight MM.420 positions; it is assumed in the following paragraphs that position No.4 has been selected.

PRELIMINARIES

8. (1) Check that the right-hand circuit breaker is OFF (released).

(2) Set the SUPPLY switches on modules No.3, No.7 and No.8 to OFF.

(3) Withdraw module No.4 and fit the extension lead assembly into this position.

(4) Carefully loosen the nuts securing connectors 5SK1 and 5SK2.

(5) Noting the order in which the washers are removed, withdraw both connectors inwards and allow them to hang clear.

(6) If transmission is to continue whilst the fault-finding is in progress, connect the transmitter for 500W operation; the instructions are given in para.20 of Chap.1-2 (TTA.1860A) and para.11 of Chap.13-1 (TTA. 1860S). The dummy load and signal generator connections are omitted at this stage.

Note...

> Under these conditions, the muting circuits of the 'active' linear amplifier also control the operation of the module under test; hence testing must be synchronised to the 'transmit' periods.

(7) As required, resume transmission at the 500W power level.

9. Prior to connecting the MM.420 to the extension lead assembly:-

(1) Set the SUPPLY switch on the r.f. module to ON.

(2) Measure the d.c. resistance between terminals 3 (positive) and 1 of tagstrip TS1; this value should be at least 10Ω.

(3) Check that fuselink FS1 is serviceable; replace as necessary.

(4) Measure the resistance between terminals 2 and 1 of TS1. This should be at least 500Ω; if not carry out the procedures given in para.10.

(5) Reset the SUPPLY switch to OFF.

(6) Provide a suitable support for the module under test and connect to the extension lead assembly (connector 4PL1).

10. If a low resistance reading was obtained at operation 9(4):-

(1) Set the SUPPLY switch to OFF.

(2) Release the solder tags at T3 and T13 centre-taps (+30V inputs) on the PS.315 high-level board. Lift both leads clear.

(3) Measure the resistance to chassis of the following points:-

(a) T3 centre-tap on the PS.315 board.

(b) T13 centre-tap on the PS.315 board.

(c) Fuselink FS1.

(d) Terminal 2 of TS1.

(4) If a low-resistance reading is obtained at T3, carefully unsolder the collector leads from p.a. transistors TR1 to TR4 in turn and check the collector-to-chassis resistances. If a low-resistance is present at T13, check TR7 to TR10 in a similar manner. Identify and replace any faulty items.

(5) A low resistance reading at FS1 indicates a fault in either the PS.251 protection board, SCR1 or transistors TR5, TR6 of the PS.315 board, and is localized with the aid of fig.1 of Chap.4-4.

(6) A low resistance reading at terminal 2 of TS1 implies a fault in the stabilizer module (fig.13 of Chap.4-4).

(7) Having located and eliminated the fault, re-solder all connections disturbed during these tests.

STABILIZER TESTS

11. The MS.440 stabilizer and its associated protection circuits must be proved serviceable prior to the investigation of r.f. faults in the MM.320 amplifier module.

12. The MS.440 (fig.13 of Chap.4-4) is isolated from the r.f. stages and an external load is connected to the +30V output. The load ensures that the d.c. supply inputs from the MS.64 power supply are close to their normal values; under no-load conditions, the +36V (nominal) rail rises to about +60V.

+30V and +20V outputs

13. (1) Connect the rheostat, set for maximum resistance, between terminals 1 and 2 of tagstrip TS1.

(2) Switch the MS.64 power supply ON, i.e. set the right-hand circuit-breaker ON.

(3) Check that the +42V and +36V supply inputs are present at pins 4 and 2 respectively of the PS.313 board.

Note...

These voltages are nominal values. Under no-load conditions, the +36V supply voltage rises to about +60V.

(4) Measure the voltage at terminal 2 of TS1; this should be +30.5V. If not, adjust preset control 4AR10 to obtain this value.

(5) Measure the voltage at terminal 3 of TS1; this should be +20V. If not, adjust preset control 4AR16 to obtain this value.

(6) If the +30.5V and +20V outputs cannot be obtained after adjustment of 4AR10 and 4AR16, switch OFF and then refer to para.18.

(7) Set the SUPPLY switch on the module to ON and check that:-

(a) Relay RLA/2 operates and the SUPPLY lamp glows.

(b) The +30V and +20V supply rails are unaffected.

14. If the overload circuit tripped at operation 13(7):-

(1) Set the SUPPLY switch to OFF.

(2) Switch the MS.64 OFF.

(3) Release the solder tags at T3 and T13 centre-taps on the PS.315 board. Lift both supply leads clear.

(4) Switch the MS.64 ON again and repeat operation 13(7). If the desired results are now obtained, one of the p.a. transistors is faulty.

(5) Repeat operations (1) and (2).

(6) Measure the resistances to chassis of T3 centre-tap and T13 centre-tap.

(7) If a low-resistance reading is obtained at T3, carefully unsolder the collector leads from p.a. transistors TR1 to TR4 in turn and check the collector-to-chassis resistances. If a low-resistance is present at T13, check TR7 to TR10 in a similar manner.

(8) Identify and replace any faulty items.

(9) Re-connect all leads disturbed during the tests.

Overload protection

CAUTION...

The supply voltage at terminal 2 must not exceed +34V during the following test.

15. Over-voltage protection.

(1) Note the initial setting of preset control 4AR10.

(2) Carefully adjust 4AR10 to increase the +30V (nominal) supply voltage until the over-voltage trip circuit operates. Check that this occurs at between +32.5V and +33.5V; if not, adjust preset control 5CR1 (on the PS.251 board). If the desired condition cannot be obtained by adjustment of 5CR1, refer to para.36.

(3) Set the SUPPLY switch on the module to OFF.

(4) Re-set 4AR10 to the setting noted at operation (1).

(5) Re-set the trip circuit by switching the MS.64 OFF and then ON again.

(6) Re-adjust preset control 4AR10 to give +30.5V at terminal 2.

16. Over-current protection.

(1) Set the MODULE switches on the meter panel to measure CURRENT in No.4 position.

(2) Set preset control 4AR3 fully counter-clockwise.

(3) Slowly decrease the load resistance until the load current is between 16.5A and 17A.

(4) Adjust preset control 4AR3 until the stabilizer trip circuit operates. If the trip circuit fails to operate, refer to para.22.

(5) Switch the MS.64 OFF. Increase the load resistance by about 20 per-cent.

(6) Switch ON again and repeat operation (3). Check that the trip circuit operates at the stated load current.

(7) Switch the MS.64 OFF and disconnect the rheostat from terminal 2.

17. (1) Connect the rheostat, set for maximum resistance, in series with the multimeter between terminals 3 (positive) and 1 of TS1.

(2) Set the multimeter to the 10A d.c. range.

CAUTION...

The load current drawn from the +20V supply must not exceed 4A during the following test.

(3) Switch the MS.64 ON.

(4) Decrease the load resistance until the stabilizer trip circuit operates. Check that this occurs at a load current of between 3A and 4A; if not, refer to para.22.

Note...

The trip level is set by the circuit parameters; no adjustments are provided.

(5) Switch the MS.64 OFF.

(6) Disconnect the rheostat and the multimeter.

STABILIZER FAULTS

18. A fault in the MS.440 is located with the aid of Table 1.

TABLE 1

Electrode potentials, stabilizer MS.440

| Transistor | Emitter | Base | Collector |
|---|---|---|---|
| TR1 | +30.5V | +31V | +36V (Note) |
| TR2 | +31.7V | +32.4V | +42V |
| TR3 | +31V | +31.7V | +36V |
| TR4 | +30.5V | +31V | +36V |
| TR5 | + 5.6V | + 6.0V | +33V |
| TR6 | +20.7V | +21.4V | +30.5V |
| TR7 | +20V | +20.7V | +30.5V |
| 4ATR1 | +36V | +36V | 0V |
| 4ATR2 | 0V | 0V | +33V |
| 4ATR3 | +30.5V | +30.5V | - |
| 4ATR4 | + 5.6V | + 6.0V | +21.4V |

Note...

Nominal value of supply input +36V; rising to +60V on no-load.

19. If zero or reduced output was obtained at operations 13(4) and (5), measure the potential at pin 3 of the PS.313 board. A significantly low voltage at pin 3 indicates a fault in the stabilizer trip circuits 4ATR1 to 4ATR3. If the potential at pin 3 is correct, the fault lies in the main regulator chain TR1 to TR4.

Note...

A faulure of the +42V input to TR2 will inhibit the conduction of TR1, TR3 and TR4.

20. If both outputs are high and adjustment of 4AR10 has no effect, check for a short-circuit in TR1 to TR4.

21. If the output at terminal 2 is correct but that at terminal 3 is not, the fault lies in regulator chain TR7, TR6 and 4ATR4.

22. A malfunction of the trip circuit at operation 16(4) implies a failure of either 4ATR1 or 4ATR2. If the circuit failed to trip at operation 17(4), 4ATR3 is probably faulty.

R.F. MODULE TESTS

23. As stated in para.4, fault-finding in the MM.320 amplifier module must not be attempted until the serviceability of the MS.440 stabilizer has been established.

Note...

The heatsinks on the MM.420 are normally cooled by the airstream in the transmitter cabinet. If the r.f. module is operated external to the cabinet, cooling is by natural convection only; this is sufficient for limited periods of operation. The MM.320 may be driven to full r.f. power output for up to 20 minutes; if the 20 minute periods are exceeded, overheating will occur resulting in operation of the thermal cut-out THE1.

P.A. bias

CAUTION...

(1) The power transistors will be damaged if their emitter studs are earthed whilst the +30V supply is present.

▶ (2) To avoid damage to output transistors on the PS315 board, the amplifier input must be muted when changing the frequency range of the signal generator. ◀

24. (1) Using a minimum length of r.f. cable, connect the dummy load via the directional wattmeter to 5PL2 (r.f. output).

(2) Set the power indicator for 150W forward power.

(3) Switch the MS.64 ON. Set the SUPPLY switch to ON.

(4) Measure the quiescent emitter potentials of the p.a. transistors TR1 to TR4 and TR7 to TR10. The emitter potentials should be in the range +5mV to +20mV, each group of four being similar.

(5) Connect the r.f. signal generator to 5PL1.

(6) Set the generator for c.w. operation at a frequency of 10 MHz. Set the signal input level to 2mW initially.

(7) Slowly increase the signal input level until the load current indicated on meter ME1 is 2.4A.

(8) Taking care not to earth the studs, measure the emitter potentials of the eight transistors. These potentials should be about +0.15V and all readings should be similar.

(9) If one particular reading is significantly different from the remainder, switch OFF and change the relevant transistor.

(10) If a group of four transistors give similar but incorrect readings, check their base potentials (+0.6V nominal).

V.S.W.R. balance

25. (1) Slowly increase the signal input level to obtain 100W r.f. output.

(2) Check that the load current does not exceed 13A and that the signal input required is less than 450mW.

(3) Check that about +5V to +7V is present at pin 11 on the low-level board.

(4) Check that the potential at pin 10 on the low-level board is between +0.4V and +0.65V.

(5) Adjust preset control 5DC3 for a minimum reading. A sharp 'null' should be obtained.

Note...

Adjustments to 5DC3 are made via the access hole in the cover of the v.s.w.r. board. Do not remove this cover whilst the MM.320 is 'live'.

(6) If the required output cannot be obtained, refer to para.29.

(7) If the d.c. levels are incorrect, refer to para.36.

Output mismatched

26. (1) Set the SUPPLY switch on the module to OFF.

(2) Set preset control 5AR6 (low-level board) fully clockwise.

(3) Disconnect the dummy load and the wattmeter from 5PL2. Switch ON again.

(4) Increase the signal input level to 10mW (700mV r.m.s.).

(5) Check that the load current does not exceed 3A.

(6) Apply a temporary short-circuit across connector 5PL2.

(7) Adjust 5AR6 to obtain a load current of 6A.

(8) Switch OFF. Remove the short-circuit from 5PL2. Re-connect the dummy load and the wattmeter.

Forward power

27. (1) Set the signal input frequency to 18 MHz. Set the signal input level to 10mW.

(2) Switch ON again and note the r.f. output level.

(3) Adjust preset control 5AR1 to obtain 135W output. If this level is not obtainable, adjust 5AR1 to the point where the a.l.c. circuit is just controlling.

(4) Measure the r.f. signal input to the high-level board; this level should not exceed 10V r.m.s.

(5) Mute the amplifier as described in para.28. Set the signal input frequency to 1.6 MHz and then de-mute the amplifier. Check that:-

(a) The r.f. power output is between 120W and 150W.

(b) The load current does not exceed 13A.

(6) With the amplifier muted during each change of frequency setting, tune ► the signal generator through the range 1.6 MHz to 30 MHz. Check that the results in operation (5)(a) and (b) are satisfied throughout the frequency range; observe the CAUTIONS in para.24. ◄

Muting

28. (1) Repeat operation 27(1).

(2) Apply a temporary short-circuit between terminal 4 of TS1 and chassis; check that the r.f. output is muted. Remove the short-circuit and check that the output is restored to its previous level.

(3) Disconnect the r.f. input from 5PL1.

## R.F. MODULE FAULTS

### Power output stages

29. If the fault-symptom is 'reduced output', check for an undistorted 10V r.m.s. signal at pins 2 and 3 of the low-level board. If satisfactory, the fault is in either the PS.315 board or the output paths to 5PL2; if not, the low-level board is probably faulty (para.31).

30. Fault-finding in the high-level board is carried out with the aid of fig.7 of Chap.4-4.

(1) Check that the +30V supplies are present at T3, T13 and T8.

(2) Check the base potentials (about +0.6V under no-drive conditions) and the collector potentials (+30V, nominal) of each transistor.

► (3) Check the emitter potentials as given in para.24; observe CAUTIONS in para.24. ◄

(4) If the d.c. potentials are correct, carry out stage-by-stage signal checks using the oscilloscope; the symmetry of the amplifier stages aids the location of the faulty item.

► 30A. If short-circuit transistors have been located and replaced, carry out the following tests before putting the transmitter back into service. It is assumed that the MM 420 has been switched off in order to carry out repairs.

30B. Test with no RF drive.

(1) Reduce the signal generator output to zero.

(2) Switch on the MM 420.

(3) Using the electronic voltmeter, check the emitter-to-chassis voltage of TR1 to TR4 and TR7 to TR10; monitor on the emitter stud of each transistor, and note that the meter reading is greater than 5 mV. If a transistor gives a zero meter indication, it must be replaced; refer to para.7, chap.4.2.

30C. Test with RF drive.

(1) Restore the signal generator output to that set up in para.24(6); observe CAUTIONS in para.24.

(2) Check that the +30V supply current to the PS315 is between 8A and 12A (dependant on drive frequency).

(3) Using the electronic voltmeter, check the emitter-to-chassis voltage of TR1 to TR4 and TR7 to TR10; note that the meter reading is typically 0.6V, and that the eight measurements are equal to within 0.1V. If a zero or significantly low meter reading is obtained, change the particular transistor. ◄

### Low-level board

31. A fault in the low-level board (PS.314 or PS.351) is located with the aid of Table 2.

32. The r.f. output from the board is isolated from the power amplifier stages and terminated into 50Ω. With the PS.315 board dormant, no a.l.c. action takes place provided that +30V is present on the high-level board; if not, the swingometer circuits will hold the a.l.c. stage at maximum attenuation.

33. To check the amplifier stages:-

(1) Switch the MS.64 OFF.

(2) Carefully unsolder the output leads from pins 2 and 3 of the board. Terminate the output into a 50Ω test resistor (rating 2W) and connect the electronic voltmeter to this point.

(3) Set the signal input level via 5PL1 to 2mW, at a frequency of 10 MHz.

(4) Switch ON again and increase the signal input level to obtain a 2W r.f. output (10V r.m.s.).

(5) Check that the signal input level required does not exceed 10 mW.

34. To check the muting action:-

(1) Connect a temporary short-circuit between pin 12 and chassis.

(2) Check that the output level falls by at least 40 dB. Also check that TR12 collector falls to less than +4V and TR13 emitter falls to 0V.

(3) Remove the short-circuit and check that the output is restored to its previous value.

TABLE 2

Electrode potentials, low-level board

| Transistor | Emitter | Base | Collector | Remarks |
|---|---|---|---|---|
| TR1 to TR4 | - | - | - | Note 1 |
| TR5 | +5.1V | +5.8V | - | Note 2 |
| TR6 | +7.2V to +10V | +7.9V to +10.7V | - | |
| TR7 | +6.5V to 9.3V | +7.2V to +10V | - | |
| TR8 | +6.8V | +7.5V | +7V | |
| TR9 | +8.5V | +9.3V | - | |
| TR10 | +19.4V | +18.6V | +19V | |
| TR11 | +9.3V | +10V | - | |
| TR12 | +20V | +19.4V | +19V | |
| TR13 | +1.9V to +2.2V | +2.6V to +2.9V | +20V | |
| TR14 | +4.8V to +8.6V | +6.8V to +9.3V | - | PS.314 only |
| TR15 | +1.2V to +1.5V | +1.9V to +2.2V | +20V | |
| TR16 | +1.2V to +1.5V | +1.9V to +2.2V | +20V | |
| TR17 | +0.7V | +1.4V | +19V | |
| TR18 | +7.8V | +8.5V | +20V | |
| TR19 | +7.8V | +8.5V | +20V | |
| TR20 | +1.2V to +1.5V | +1.9V to +2.2V | +20V | |
| TR21 | +0.7V | +1.4V | +19V | |
| TR22 | +1.2V to +1.5V | +1.9V to +2.2V | +20V | |
| TR23 | +4.8V to +8.6V | +6.8V to +9.3V | - | PS.314 only |

Notes ...

(1) Values determined by the forward and reflected power levels.

(2) Swingometer OFF condition.

35. If zero or a reduced output was obtained at operation 33(5):-

(1) Check the +20V supplies to each amplifier stage; if incorrect, check the muting network TR8 to TR13.

(2) Check the emitter potentials of TR7 and TR9. If either level is incorrect, TR18 and TR19 may be reverse-biased.

(3) Measure the remaining potentials of TR15 to TR22 and TR14, TR23 (PS.314 only).

(4) Carry out stage-by-stage signal level checks with the oscilloscope.

(5) Having rectified the fault, re-connect the input to the high-level board and then check the a.l.c. action in accordance with para.26 and 27.

Note ...

If the emitter potentials of TR15, TR16, TR20 and TR22 are incorrect check TR13 base potential and D11, D12. If either diode is replaced, a change of R32 value may be required to compensate for component tolerances. The new value - either 33, 39, 47, 56 or 68 ohms - is selected by trial to achieve the desired emitter potentials.

V.S.W.R. board

36. A fault in either the PS.316 board or the associated components 5T2 and 5C3 is located with the aid of Table 3.

TABLE 3

Signal levels, v.s.w.r. board

| Test-point | Function | Level |
|---|---|---|
| Pin 1 | Output | +5V to +7V |
| Pin 2 | Forward power | 8.8V p-p |
| Pin 3 | | 4.4V p-p |
| Pin 4 | Supply | +20V |
| Pin 5 | Reflected power | - |
| Pin 6 | Output | +0.4V to +0.65V |
| Pin 7 | | 0V |
| C6 | Ref. voltage | +1.2V (note 2) |

Notes ...

(1) Levels are nominal values for 100W r.f. output.

(2) No-signal level.

Protection board

37. A fault in the PS.251 board is located with the aid of Table 4. Should a fault develop in TR4 to TR7, check these electrode potentials under no-signal conditions.

TABLE 4

Electrode potentials, protection board

| Transistor | Emitter | Base | Collector |
|---|---|---|---|
| TR1 | +7.4V | +5.5V to +7.5V | 30V |
| TR2 | +7.4V | +8.1V | +1V |
| TR3 | +28V | +30V | 0V |
| TR4 | +30V | +30V | 0V |
| TR5 | +30V | +30V | 0V |
| TR6 | +6.5V to +9.3V | +7.2V to +10V | +30V |
| TR7 | +5.8V to +8.6V | +6.5V to +9.3V | +30V |

Chapter 4-2

REPAIR

AMPLIFIER, STABILIZER 10U/5820-99-626-4730

(R.F. power module MM.420)

CONTENTS



INTRODUCTION

1. The following instructions cover the separation of the MM.420 into the stabilizer MS.440 and the r.f. amplifier MM.320; this is followed by the dismantling of each sub-assembly.

R.F. POWER MODULE MM.420

2. To separate the stabilizer MS.440 from the r.f. power module MM.420, proceed as follows (fig.10, Chap. 4-4 and fig. 1, Chap.4-0):

(1) Slacken the four fixing screws on tag strip TS1 and remove the fanning strip.

(2) Remove the fixing nuts and washers on both r.f. connectors (5PL1 and 5PL2) on the rear panel of the MM.420, noting the order in which the washers are removed.

(3) Remove both Pozidriv screws securing the top plate of the MS.440 to the MM.320.

(4) Slacken off the two nuts and bolts connecting the mating edges of heat sink.

(5) Push 5PL1 and 2 clear of fixing holes in the MM.420 rear panel.

(6) Remove the stabilizer module by pulling it in the direction of the heat sink.

(7) Reassemble in the reverse order to above.

DISMANTLING R.F. AMPLIFIER MM.320

3. During the following procedure, where leads have to be unsoldered, a careful note should be made of lead colour-codes and tag numbers to ensure that, on reassembly, the correct connections are made. Unless otherwise stated, it is not necessary to carry out the procedure in para.2.

Low-level board PS.314 or PS.351

4. (1) Unsolder all connecting leads to the board.

(2) Unsolder all leads to transistors TR13 to TR22.

(3) Remove the six fixing screws and withdraw the board.

Low-level board : changing a transistor

5. This procedure initially entails raising the plate on which the low-level board is secured; the board does not have to be removed from the plate.

(1) Place the MM.420 so that the heat-sink is resting on a bench and the front-panel is to the right.

(2) Remove the fixing nut securing 5PL2 on the rear panel of the MM.420, and push the plug through the panel hole; note the order in which the washers behind the plug-fixing-nut are placed.

(3) Remove the two screws securing the rear of the low-level plate to pillars.

(4) Remove the four screws securing the sides of the low-level plate to pillars.

(5) Remove the two nuts, bolts and washers securing the low-level plate to the front-panel.

(6) Unsolder the three leads to the faulty transistor.

(7) Raise and tilt the plate back on its connecting leads.

(8) Remove the fixing screw (plate underside) from the affected transistor.

(9) Withdraw the transistor.

CAUTION...

If it is necessary to operate the MM.420 in this condition, care must be taken to ensure that the low-level plate does not short to ground any 'live' points.

WARNING...

THE POWER TRANSISTORS AND THEIR ASSOCIATED INSULATING WASHERS CONTAIN BERYLLIUM OXIDE, THE DUST OF WHICH IS TOXIC. BEFORE HANDLING THESE DEVICES REFER TO THE SAFETY PRECAUTIONS IN THE PRELIMINARIES OF THIS AIR PUBLICATION.

High-level board PS.315

6. This procedure initially entails raising the plate on which the low-level board is secured.

(1) Carry out operations (1) to (5) and (7) of para. 5.

(2) Unsolder, at the four corners of the high-level board, the anode lead of diodes D1, D2, D11 and D12.

(3) Unsolder all leads to TR1 to TR10.

(4) Unsolder all leads to T3, T8 and T13.

(5) Unsolder all remaining leads on the board.

(6) Remove the screw in the pillar which secures the clamp on T3 and T13.

(7) Remove the three pairs of screws securing T3, T8 and T13, through the board, into the heat-sink.

(8) Raise the high-level board vertically off the heat-sink.

High-level board : changing a transistor

7. (1) Carry out operations (1) to (5) and (7) of para. 5.

(2) Unsolder the leads to the faulty transistor.

(3) Place the assembly on its side.

(4) Fit a suitable box spanner over the transistor-securing nut and loosen the nut; as the spanner is turned, the transistor could also turn: to prevent this happening, place a screw-driver blade, through the appropriate hole on the top of the board, so that it presses against the hexagonal body of the transistor.

▶ 8. When fitting a new transistor (see CAUTION), use new insulating washers, if necessary, and coat both sides with 'Thermaflow' thermal paste Type A30/J before re-assembly (see Note). ◀

▶ CAUTION ...

If short-circuit transistors have been replaced, carry out the tests given in Chap.4-1, para. 30A. ◀

Note...

It is important to use 'Thermaflow' or a similar high-conductivity paste in preference to silicone grease to ensure adequate thermal conductivity.

Protection board PS.251

9. This procedure initially entails raising the plate on which the low-level board is secured.

(1) Carry out operations (1) to (5) and (7) of para. 5.

(2) Unsolder all leads to the board.

(3) Remove the four fixing screws.

V.S.W.R. board PS.316

10 (1) Place the MM.420 with the heat-sink resting on the bench.

(2) Remove the four screws securing the screening cover and withdraw the cover.

(3) Unsolder the lead to T2.

(4) Unsolder all leads to the board.

(5) Remove the four screws securing the board to the plate.

REASSEMBLY OF R.F. AMPLIFIER MM.420

11. The reassembly procedures are the reverse to those given in para. 3 to 10.

DISMANTLING STABILIZER MS.440

12. The printed-circuit board can be removed by unsoldering all leads and removing four fixing screws.

13. Access to the remaining components on the stabilizer heat-sink is obtained as follows:

(1) Carry out the instructions in para. 2.

(2) Remove the two screws securing the stabilizer top plate (and p.c.b.) to the rear plate.

(3) Raise and tilt the plate back on its connecting leads.

(4) Removal of components mounted on the heat-sink is self-evident.

REASSEMBLY OF STABILIZER MS.440

14. The reassembly procedures are the reverse to those given in para.12 and 13.

Chapter 4-3

# OVERALL PERFORMANCE CHECKS AND ADJUSTMENTS
# AMPLIFIER, STABILIZER 10U/5820-99-626-4730
# (R.F. power module MM.420)

CONTENTS



## INTRODUCTION

1. The performance checks are carried out, in the order given, to prove the serviceability of the MM.420 r.f. power module. Instructions are also given for the electrical adjustments required following an unsatisfactory performance check.

2. The protection circuits within the MS.440 stabilizer must be tested prior to the application of r.f. inputs to the MM.320 amplifier module since a fault in the MS.440 could cause damage to the power transistors in the high-level board.

## TEST EQUIPMENT

3. The test equipment required for the performance checks is listed in Chap.4-1.

## PRELIMINARIES

4. The MM.420 under test is connected via the extension lead assembly (part of accessory kit CA.607) into a serviceable transmitter (TTA.1860A or TTA. 1860S). The extension lead assembly may be fitted to any one of the eight MM.420 positions; it is assumed in the following operations that position No.4 has been selected.

5. (1) Check that the right-hand circuit breaker is OFF (released).

(2) Set the SUPPLY switches on modules No.3, No.7 and No.8 to OFF.

(3) Withdraw module No.4 and fit the extension lead assembly into this position.

(4) If transmission is to continue whilst the performance checks are in progress, connect the transmitter for 500W operation; the instructions

are given in para.20 of Chap.1-2 (TTA.1860A) and para.11 of Chap.13-1 (TTA.1860S). The dummy load and signal generator connections are omitted at this stage.

Note...

Under these conditions, the muting circuits of the 'active' linear amplifier also control the operation of the module under test; hence testing must be synchronized to the 'transmit' periods.

(5) As required, resume transmission at the 500W power level.

6. Prior to connecting the MM.420 to the extension lead assembly:-

(1) Set the SUPPLY switch on the r.f. module to ON.

(2) Measure the d.c. resistance between terminals 3 (positive) and 1 of tagstrip TS1; this value should be at least 10 ohms.

(3) Measure the resistance between terminals 2 and 1; this should be at least 500 ohms.

7. (1) Carefully loosen the nuts securing connectors 5SK1 and 5SK2.

(2) Noting the order in which the washers are removed, withdraw both connectors inwards and allow them to hang clear.

(3) Provide a suitable support for the module under test and connect to the extension lead assembly (connector 4PL1).

STABILIZER TESTS

8. (1) Connect the rheostat, set for maximum resistance, between terminals 1 and 2 of tagstrip TS1.

(2) Switch the MS.64 power supply ON, i.e. set the right-hand circuit breaker ON.

(3) Check that the +42V and +36V supply inputs are present at pins 4 and 2 respectively of the PS.313 board.

Note...

These voltages are nominal values. Under no-load conditions, the +36V supply voltage rises to about +60V.

(4) Measure the voltage at terminal 2 of TS1; this should be about +30.5V. Note the setting of preset control 4AR10.

(5) Measure the voltage at terminal 3 of TS1; this should be +20V. If not, adjust preset control 4AR16 to obtain this value.

(6) Set the SUPPLY switch on the module to ON and check that:-

(a) Relay RLA/2 operates (audible check) and the SUPPLY lamp glows.

(b) The +30V and +20V supply rails are unaffected.

<u>OVER-VOLTAGE TRIP</u>

CAUTION...

The supply voltage at terminal 2 must not exceed +34V during the following test.

9. (1) Carefully adjust preset control 4AR10 to increase the +30V (nominal) supply voltage until the over-voltage trip circuit operates. Check that this occurs at between +32.5V and +33.5V; if not, adjust preset control 5CR1 (on the PS.251 board) to obtain this condition.

(2) Set the SUPPLY switch on the module to OFF.

(3) Re-set 4AR10 to the setting noted at operation 8(4).

(4) Re-set the trip circuit by switching the MS.64 OFF and then ON again.

(5) Re-adjust preset control 4AR10 to give +30.5V at terminal 2.

OVERLOAD PROTECTION

10. (1) Set the MODULE switches on the meter panel to measure CURRENT in No.4 position.

(2) Set preset control 4AR3 fully counter-clockwise.

(3) Slowly decrease the load resistance until the load current is between 16.5A and 17A.

(4) Adjust preset control 4AR3 until the stabilizer trip circuit operates.

(5) Switch the MS.64 OFF. Increase the load resistance by about 20 percent.

(6) Switch ON again and repeat operation (3). Check that the trip circuit operates at the stated load current; if necessary readjust 4AR3.

(7) Switch the MS.64 OFF and disconnect the rheostat from terminal 2.

11. (1) Connect the rheostat, set for maximum resistance, in series with the multimeter between terminals 3 (positive) and 1 of TS1.

(2) Set the multimeter to the 10A d.c. range.

CAUTION...

The load current drawn from the +20V supply must not exceed 4A during the following test.

(3) Switch the MS.64 ON.

(4) Decrease the load resistance until the stabilizer trip circuit operates. Check that this occurs at a load current of between 3A and 4A.

Note...

The trip level is set by the circuit parameters; no adjustments are provided.

(5) Switch the MS.64 OFF.

(6) Disconnect the rheostat and the multimeter.

R.F. POWER TESTS

12. As stated in para.2, any test involving the MM.320 r.f. amplifier module must not be attempted until the serviceability of the MS.440 stabilizer has been established.

CAUTION...

(1) The heatsinks on the MM.420 are normally cooled by the airstream in the transmitter cabinet. If the r.f. module is operated external to the cabinet, cooling is by natural convection only; this is sufficient for limited periods of operation. The MM.320 may be driven to full r.f. power output for up to 20 minutes; if the 20 minute periods are exceeded, overheating will occur resulting in operation of the thermal cut-out THE1.

▶ (2) To avoid damage to output transistors on the PS315 high level board, the amplifier input must be muted when changing the frequency range on the signal generator. ◀

V.S.W.R. BALANCE

13. (1) Connect the dummy load via the directional wattmeter to 5PL2 (r.f. output of module). Set the power indicator for 150W forward power.

(2) Connect the r.f. signal generator to 5PL1.

(3) Set the generator for c.w. operation at a frequency of 10 MHz. Set the signal level to 2mW initially.

(4) Switch the MS.64 ON.

(5) Set the SUPPLY switch on the module to ON.

(6) Slowly increase the signal input level until the r.f. power output is 100W.

(7) Check that the load current does not exceed 13A.

(8) Using the multimeter set to the 3V d.c. range, check that the potential at pin 10 on the low-level board (PS.314 or PS.351) is between +0.4V and +0.65V. If not, adjust preset control 5DC3 for a minimum reading; a sharp 'null' should be obtained.

Note...

Adjustments to 5DC3 are made via the access hole in the cover of the v.s.w.r. board. Do not remove this cover whilst the MM.320 is 'live'.

(9) Reduce the signal input level to 2mW.

OUTPUT MISMATCHED

14. (1) Set the SUPPLY switch on the module to OFF.

(2) Set preset control 5AR6 (low-level board) fully clockwise.

(3) Disconnect the dummy load and the wattmeter from 5PL2.

(4) Switch ON again.

(5) Increase the signal input level to 10mW.

(6) Check that the load current does not exceed 3A.

(7) Apply a temporary short-circuit across connector 5PL2.

(8) Adjust 5AR6 to obtain a load current of 6A.

(9) Switch OFF. Remove the short-circuit from 5PL2.

(10) Re-connect the dummy load and the wattmeter to 5PL2. Switch ON again.



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FORWARD POWER

15. (1) Set the signal input frequency to 18 MHz. Set the signal input level to 10mW.

(2) Adjust preset control 5AR1 to obtain 135W r.f. output. If this level is not obtained, adjust 5AR1 to the point where the a.l.c. circuit is just controlling.

(3) Tune the signal generator through the frequency range from 1.6 MHz to 30 MHz and check that:-

(a) The r.f. power output is between 120W and 150W.

(b) The load current does not exceed 13A.

(4) Remove the signal input.

16. On completion of the serviceability checks:-

(1) Switch the MS.64 OFF.

(2) Disconnect the signal generator and then the dummy load.

(3) Disengage the MM.420 from the extension lead assembly.

(4) Re-fit connectors 5SK1 and 5SK2 to the extension lead assembly.

(5) Disconnect remaining test equipment.

(6) As required, re-connect the transmitter for normal operation.

# Chapter 4-4

## CIRCUIT DESCRIPTION OF SUB-ASSEMBLIES:

## AMPLIFIER, STABILIZER 10U/5820-99-626-4730

## (R.F. power module MM.420)

CONTENTS



ILLUSTRATIONS

## INTRODUCTION

1. Before proceeding to the circuit description of the sub-assemblies, the function of a number of components - not fitted on printed-circuit boards - is given with reference to the sub-assembly interconnection diagram (fig. 1).

## INTERCONNECTION OF SUB-ASSEMBLIES

2. Figure 1 shows the interconnections between all sub-assemblies in the r.f. amplifier module MM.320; figure 13 gives the circuit and interconnecting details for the stabilizer MS.440 and its sub-assembly PS.313.

### Inputs

3. The power supply inputs are +20V and +30V d.c. on TS1 pins 3 and 2 respectively; these are connected directly to the associated stabilizer MS.440. The only other connection is the external muting line on TS1 pin 4; this applies a OV signal to the low-level board which operates the relevant switching transistors thereby cutting off the r.f. output. The r.f. input from the distribution amplifier (Chap. 1-0 or 13-0) is at PL1.

### Outputs

4. The r.f. output appears at PL2; it is fed from two outputs, on the high-level board, which are connected together prior to T1. The latter is a monitoring transformer feeding LP2 and an external r.f. monitor socket. T2 is the reflectometer toroid for the PS.316 v.s.w.r. unit and C3 is the associated capacitive probe.

### Protection

5. Other miscellaneous components shown on the interconnection diagram are associated with module protection.

6. SCR1 is fired under a fault condition from the PS.251 protection board, thereby short-circuiting the +30V line and blowing FS1 if the stabilizer trip does not operate. C1, L1 and C2 are r.f. decoupling components. THE1 is the thermostat on the assembly heat-sink which open-circuits the +20V supply rail if the safe working temperature (approx. $85^{\circ}$C) is exceeded. Pulse transformer T3 trigger SCR1 if there is a significant out-of-balance current between each half of the power-amplifier stage. This occurs if one p.a. transistor has failed (normally short-circuit) thereby preventing operation of the module until the faulty p.a. transistor has been replaced. Hence, overloading of the remaining p.a. transistors is prevented.

## LOW-LEVEL BOARDS PS.314 and PS.351 (fig. 3 and 5)

7. The difference between the two low-level boards PS.314 and PS.351 is in the method of a.l.c. control; para. 8 and 9 describe the respective differences.

Note...

The low-level board PS.314 is fitted to the r.f. power modules in the TTA.1860A, and the PS.351 is fitted to the modules in the TTA.1860S.

A.L.C. control stage on PS.314 (fig. 3)

8. The r.f. input is connected to pins 4 and 5 on the printed-circuit board. Transformer T4 provides a balanced push-pull signal to the automatic-level-control (a.l.c.) stage comprising TR14, TR18, TR19 and TR23. Transistors TR18 and TR19 are an r.f. amplifying stage and operate in class A grounded-base mode. The function of TR14 and TR23 is to shunt part of the drive current, thus reducing the gain of TR18 and TR19 in accordance with the signa input from TR7 (para. 12).

A.L.C. control stage on PS.351 (fig. 5)

9. The r.f. input is connected to pins 4 and 5 of the printed-circuit board. Transformer T4 provides a balanced push-pull signal to the a.l.c. stage which consists of TR18, TR19, D15, D16 and associated components. Transistors TR18 and TR19 act as an r.f. amplifying stage operating in class A grounded-base mode. Diodes D15 and D16 provide control of the stage by shunting part of the drive current, thus reducing the output of TR18 and TR19 in accordance with the signal input from TR7 (para. 12).

10. The r.f. output from the a.l.c. stage is transformer-coupled by T3 to the amplifier stage comprising TR17 and TR21 which also operates in class A push-pull grounded-base mode. Transformer T2 couples the signal to the emitters of the final stage of the low-level board comprising TR15 and TR16 in parallel, operating push-pull class A, with TR20 and TR22 in parallel. Transformer T1 combines the outputs from TR15, TR16, TR20 and TR22 and feeds the signal at a level of between 1W and 2W to pins 2 and 3 of the board.

A.L.C. detectors

11. The forward d.c. voltage derived from the PS.316 v.s.w.r. board is fed to pin 11. R1 is the 'set forward power' control which determines the threshold level at which the a.l.c. holds the output power under normal conditions. This voltage is amplified by TR1 and is gated via D1 into the a.l.c. switching circuits.

12. The direct voltage, derived from the reflected-power monitor on the v.s.w.r. board, is amplified by TR3 and is combined with a fixed fraction of the forward power (via TR2) at the paralleled collectors. The output signal, whose level is adjusted by R6, controls the level at which the a.l.c. will respond to a reflected-power signal caused by a load mismatch. This output is gated to the a.l.c. switching circuits via D2. These circuits provide current gain via TR6, TR7 and a reference level determined by R29, D20 in conjunction with TR9, TR11 and associated components.

13. The attack time is approximately 200-500 microseconds and the discharge time is determined by C3 discharging through R18.

Muting circuit

14. The external muting signal is applied to pin 12 (0V muted, +12V normal). With +12V applied, TR10 and TR12 are switched on, thereby supplying +20V to the TR17/TR18 amplifier stage. TR13 is also conducting, supplying a positive bias voltage to the final amplifying stage. Under muted conditions, transistors TR8, TR10, TR12 and TR13 are cut off thereby applying muting to both the penultimate and final stages.

15. When muting occurs, the gain of the a.l.c. stage is increased to maximum by the action of D13 and R52 which reduce the voltage on C3. However, since the action of D13 and R52 is still present, the module will operate at maximum gain, after a short delay, on de-muting.

16. TR8 and associated components form an input noise-immunity circuit. Diodes D11 and D12 provide temperature compensation for TR13 to maintain a stable bias voltage.

HIGH-LEVEL BOARD PS.315 (fig. 7)

17. The r.f. input signal from the low-level board (pin 4) is applied to an impedance-matching network T6, T7, T9, T10 and associated resistors; the purpose of this network is also to provide opposite-phase signals at the emitters of the push-pull amplifier TR5, TR6. Transistors TR5 and TR6 operate in the class B mode and function as a driver stage for the power amplifier. T8 is the driver transformer which is coupled to the parallel push-pull output stage via transformers (2 : 1 ratio) T1, T2, T4, T5, T11, T12, T14 and T15.

18. Transistors T1 to T4 and T7 to T10 form the parallel push-pull output stage, and each transistor operates in the grounded-emitter class B mode. The resistors R5, R12, R43 and R50 provide feedback over the output stage.

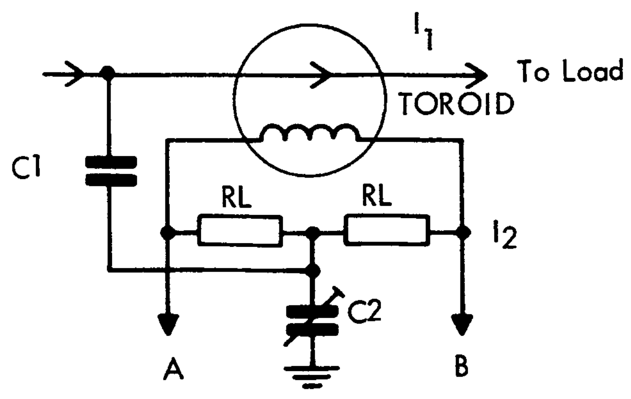
19. A reference to fig. 1 shows how the two r.f. outputs from T3 and T13 are combined across an inductor L2.

V.S.W.R. BOARD PS.316 (fig. 9)

20. Two r.f. input signals are applied to this board; the first is derived from the reflectometer toroid T2 (fig. 1) and is proportional to the r.f. output current; the second is fed via C3 (fig. 1), and is proportional to r.f. output line voltage.

21. A simplified circuit of the v.s.w.r. board is shown below. The induced voltage in the secondary winding of the feeder toroid causes a current $I_2$ to flow which is equal to $jwMI_1/(2R_L + jwL_2)$ where:

| | | |
|---|---|---|
| $I_1$ | = | primary current, |
| M | = | toroid mutual inductance, |
| $2R_L$ | = | total secondary load resistance, |
| $L_2$ | = | toroid secondary inductance, |
| w | = | angular frequency in radians/second. |



If $2R_L << jwL_2$ at the lowest frequency, then $I_2 = ML_1/L_2$ and is independent of frequency. The output voltage developed across each secondary resistor is $I_2R_L$, and they are 180° out of phase.

22. The r.f. voltage, divided down by C1 and C2, is applied between the resistor junction point and earth, and adjusted by C2 so that, with the matched line condition, the voltage across C2 is equal in amplitude to the voltage across each resistor. This voltage Vc is also independent of frequency since $Vc = \frac{V1\ C1}{C1+C2}$; it is also in phase with the voltage across one $R_L$ and out of phase with the other. The result is that under matched conditions, at terminal A, the voltage $(Vc + I_2R_L)$ appears (the forward-power output) and at terminal B the voltage $(Vc - I_2R_L) = 0$ appears (reflected-power output).

23. Under mismatched conditions, such that a short-circuit appears on the feeder, the Vc is zero and the forward and reflected outputs are equal. Similarly with an open-circuit on the line, the voltage appearing across the two resistors from the toroid are zero, and again the forward and reflected outputs are equal.

24. It can be shown that intermediate mismatched impedances produce some output from the reflected part, but that the forward output remains sensibly constant for a given linear amplifier output power.

25. R1 and R2 (fig. 9) form the resistor loads and C3 and C5, in parallel, produce the required capacitive voltage. The outputs are coupled via C2 and C7, then rectified by voltage-doubler circuits (D1, D2, C1 and D5, D6, C8). C9 and R3 boost the low-frequency power response of the module by effectively reducing the d.c. level, at the forward output terminal, at the low-frequency end (i.e. below approximately 5 MHz). This means that more power is required from the r.f. amplifier module to reach the same a.l.c. threshold voltage.

Protection board PS.251 (fig. 11)

26. The protection board has two main functions:

(1) It monitors the module positive supply voltage and, if this exceeds a safe operating level, a pulse is generated to fire a thyristor (mounted on the r.f. power module chassis) which in turn trips the stabilizer or, if this has failed, blows an associated fuse FS1.

(2) It also monitors the current taken by each group of four output transistors and operates the a.l.c. line if this exceeds a predetermined level.

27. The +30V supply is monitored on pin 1 and connected, via a chain of Zener diodes and a potentiometer R1, to the base of TR1. R1 provides an adjustable reference voltage for the operation of the long-tailed pair TR1 and TR2. The output from TR1 is amplified by TR3 the operating voltage which is determined by R10 and R13. When transistor TR3 conducts, a voltage is generated which operates the thyristor gate, SCR1, via pin 8.

28. D.C. overload sensing resistors are connected to pins 2 and 3 and to pins 2 and 4. The direct current overload inputs are fed to pins 3 and 4; as either or both of these levels increases, transistors TR4 and TR5 will start to conduct and cause TR6 and TR7, connected as emitter-followers, to conduct and provide a d.c. output to the a.l.c. circuit via pin 5 of the board. Diode D7 maintains C3 in a charged state so that TR6 will switch on quickly.

The Zener diode D5 limits the maximum voltage to approximately 12.5 volts to prevent possible damage to the transistors in the a.l.c. stage on the low-level board.

STABILIZER MS.440 (fig. 13)

29. The stabilizer MS.440 provides a stabilized +30V and +20V supply to the r.f. amplifier MM.320. It is fed from the main power supply unit MS.64 which provides a smoothed nominal 36V at full load.

Note...

In the following circuit description, the component prefix codes shown on fig. 13 are used.

30. The stabilizer also provides voltage and current-metering facilities for the +30V and +20V supply lines. A fast-acting current-overload trip circuit is also included which is reset by removing the d.c. input. All power dissipating components e.g. power transistors and resistors are mounted directly on the finned casting; the low-level stages are mounted on a printed-circuit board, PS.313.

Output ratings

31. The maximum current ratings of the two supply lines are:-

(1) +30V at 16A,

(2) +20V at 3A.

32. The +36V d.c. input to the stabilizer is connected to pins 12, 13, 14, 15 and 16 in parallel (positive) and pins 4, 5, 6, 7 and 8 in parallel (OV); pin 3 is a separate earth.

33. A 42V input provides the collector supply to 4TR2 and 4TR5; the maximum current consumption is only 50 mA. The +30V and +20V stabilized outputs appear on TS1 pins 2 and 3 respectively.

34. The stabilizer consists of three stages as follows:-

(1) +30V stabilizer,

(2) +20V stabilizer, and

(3) D.C. overload-trip.

+30V stabilizer

35. The main d.c. input is fed to 4TR1 and 4TR4, connected in parallel, which are the main series stabilizing transistors; they are controlled by a feed-back system 4TR5, 4TR2 and 4TR3. Transistor 4TR5 is the comparator stage while 4TR2 and 4TR3 provide current amplification for the feedback loop. The emitter of 4TR5 is held at 5.6V by 4AD3; the base voltage is derived from the stabilized +30V rail via an adjustable resistor 4AR10; this control determines the setting of the +30V output level.

36. As the voltage tends to rise, due to a reduction of load current, 4TR5 base voltage will also rise, causing 4TR5 to conduct more heavily, which in turn causes 4TR2, 4TR3, 4TR1 and 4TR4 to conduct less heavily. This gives a greater voltage drop across 4TR1 and 4TR4, thereby reducing the output voltage

and opposing the initial change of output level. The circuit is therefore self-compensating and, with the high loop-gain involved, relatively large input voltage variations have no affect on the output voltage.

+20V stabilizer

37. This follows the +30V stabilizer and has 4TR7 as the main series transistor, with 4TR6 as an amplifier and 4TR4 as the reference detector stage. The output level is set by R16; in principle, it functions exactly as the +30V stabilizer.

D.C. trip

38. As the load current increases, the voltage drop across 4R1 increases; this increases the voltage appearing across the base of 4ATR1 - which is adjustable via 4AP3. Under normal conditions, this voltage is insufficient to cause 4ATR1 to conduct hence, 4ATR2 is also non-conducting. The collector voltage of 4ATR2 is high and therefore isolated from the main +30V stabilizing feedback loop i.e. base of 4TR2, by 4AD2.

39. A similar trip circuit for the +20V supply is provided by 4ATR3, the trip voltage being developed across R9 and applied to pins 9 and 10 on the PS.313 board. Transistor 4ATR3 is coupled to 4ATR2 and 4ATR1 via diode 4AD1.

40. The voltage level at which 4ATR3 starts to conduct is determined by the Vbe of 4ATR3 i.e. 0.6V. Under normal operating conditions, this voltage is less than 0.6V and again 4ATR2 is non-conducting.

41. However, in the event of either 4ATR1 or 4ATR3 switching on, this being caused by an overload in current in either the main input or the +20V stabilizer input, then 4ATR2 will switch on, causing the main +30V stabilizer transistors to be switched off. Positive-feedback between 4ATR2 and 4ATR1 then causes them to 'latch' on, so that the main stabilizing transistors are held non-conducting until the unit is reset by interrupting the d.c. input, by unplugging and re-inserting the MM.420, or by operation of the appropriate circuit-breaker on the front panel of the MS.64 power unit.

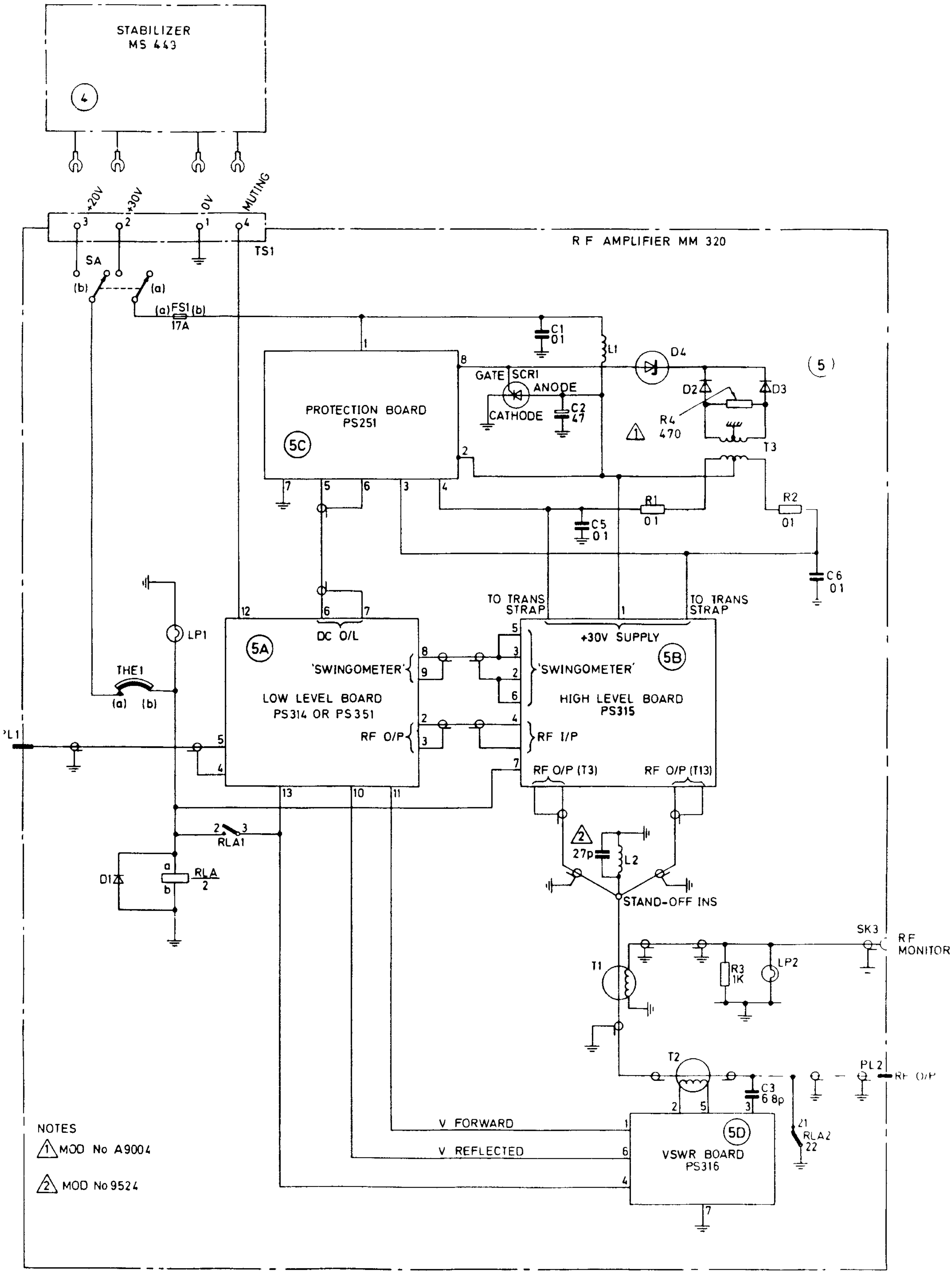



Fig. 1 RF power module MM 420 : interconnections Fig 1

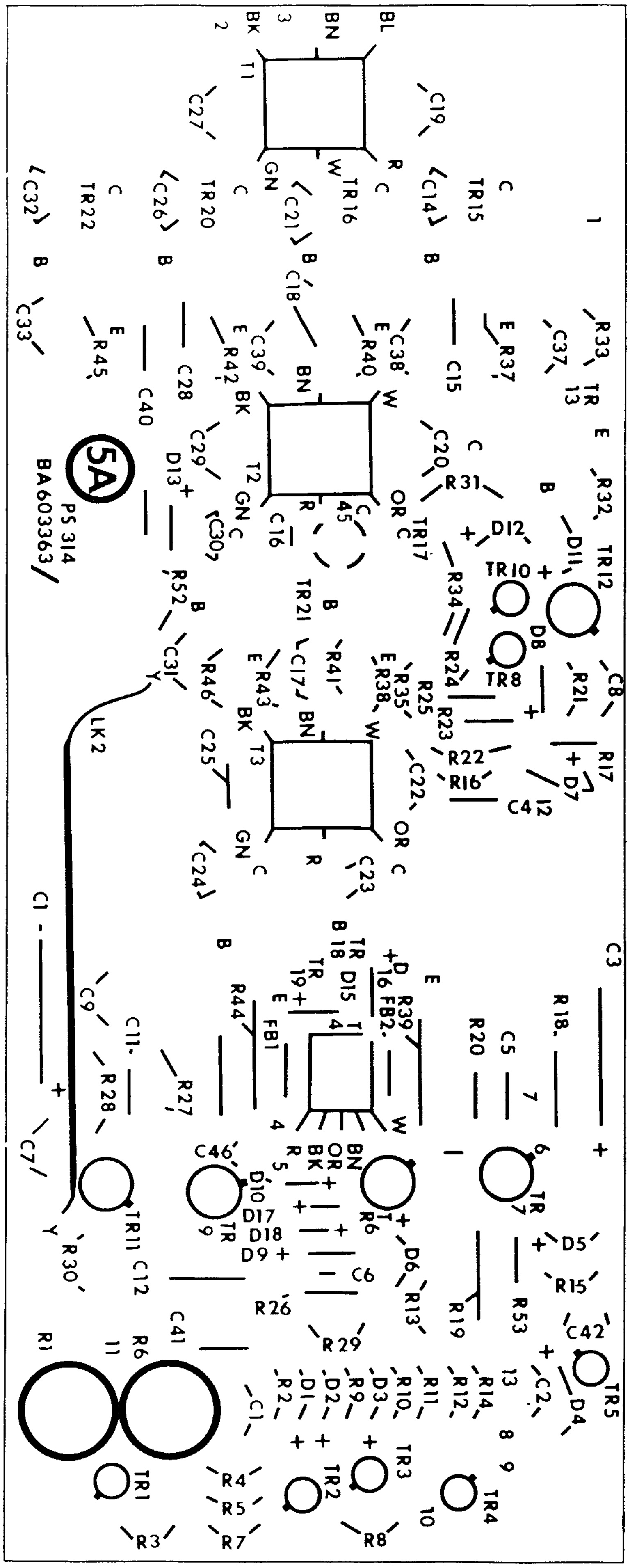


Fig.2 Low-level board PS 314: component layout



Issued Nov.74

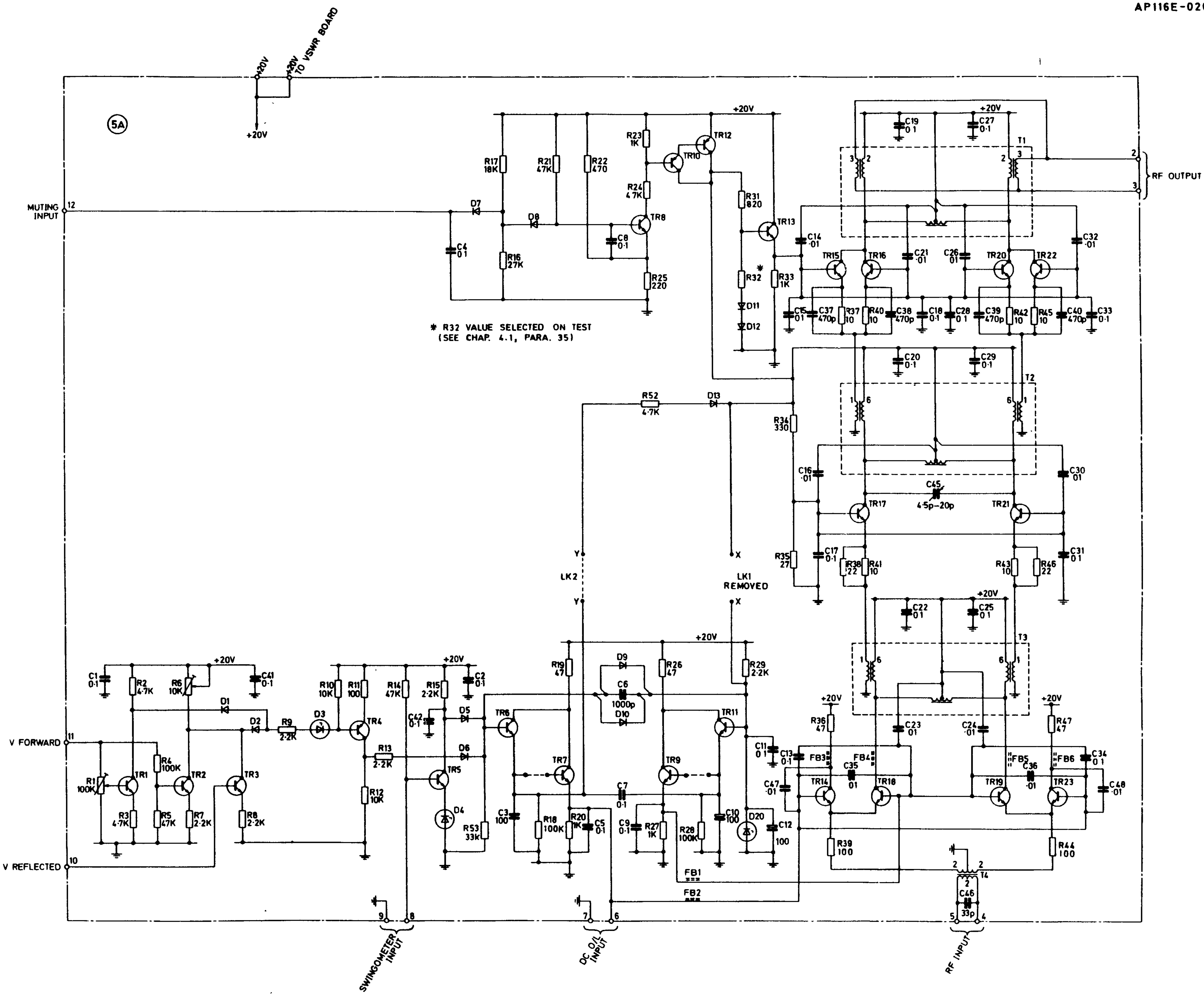



Fig 3

## Low-level board PS. 314: circuit

R56 ADDED BY
MOD No B0231

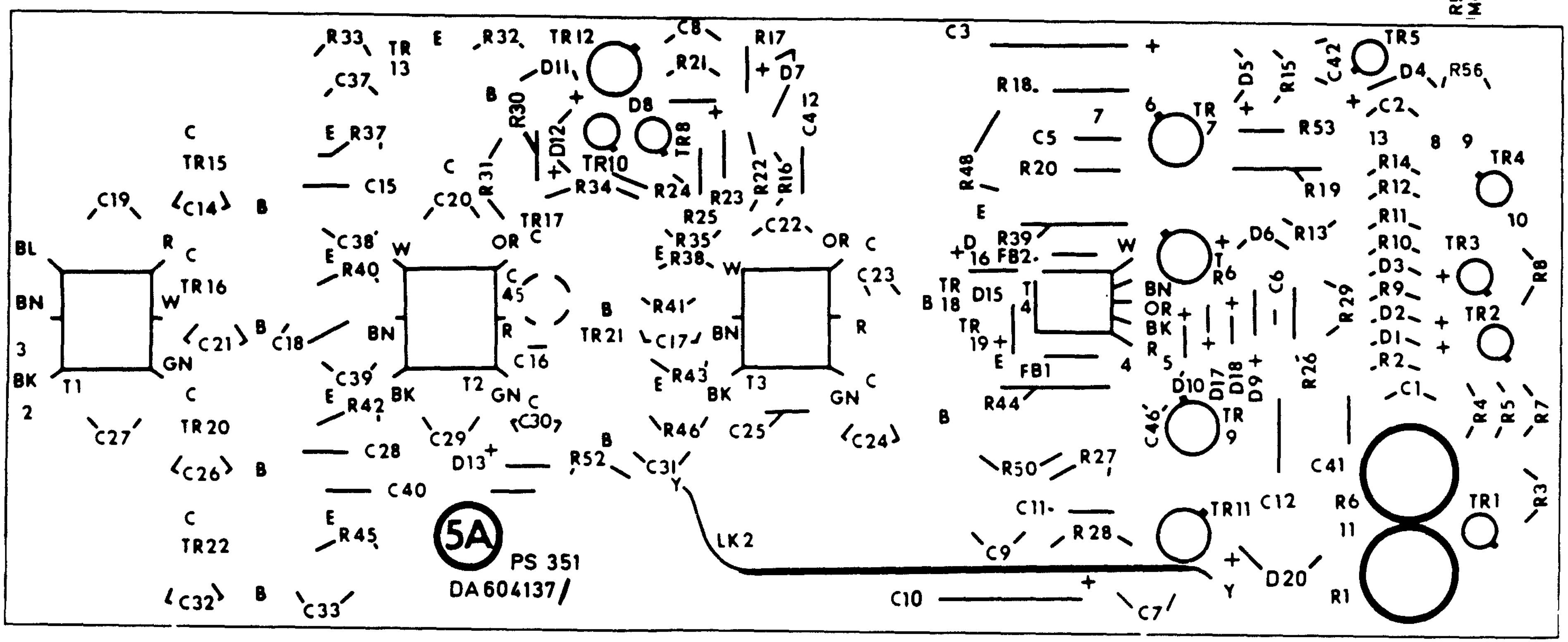



Fig.4 Low-level board PS351: component layout

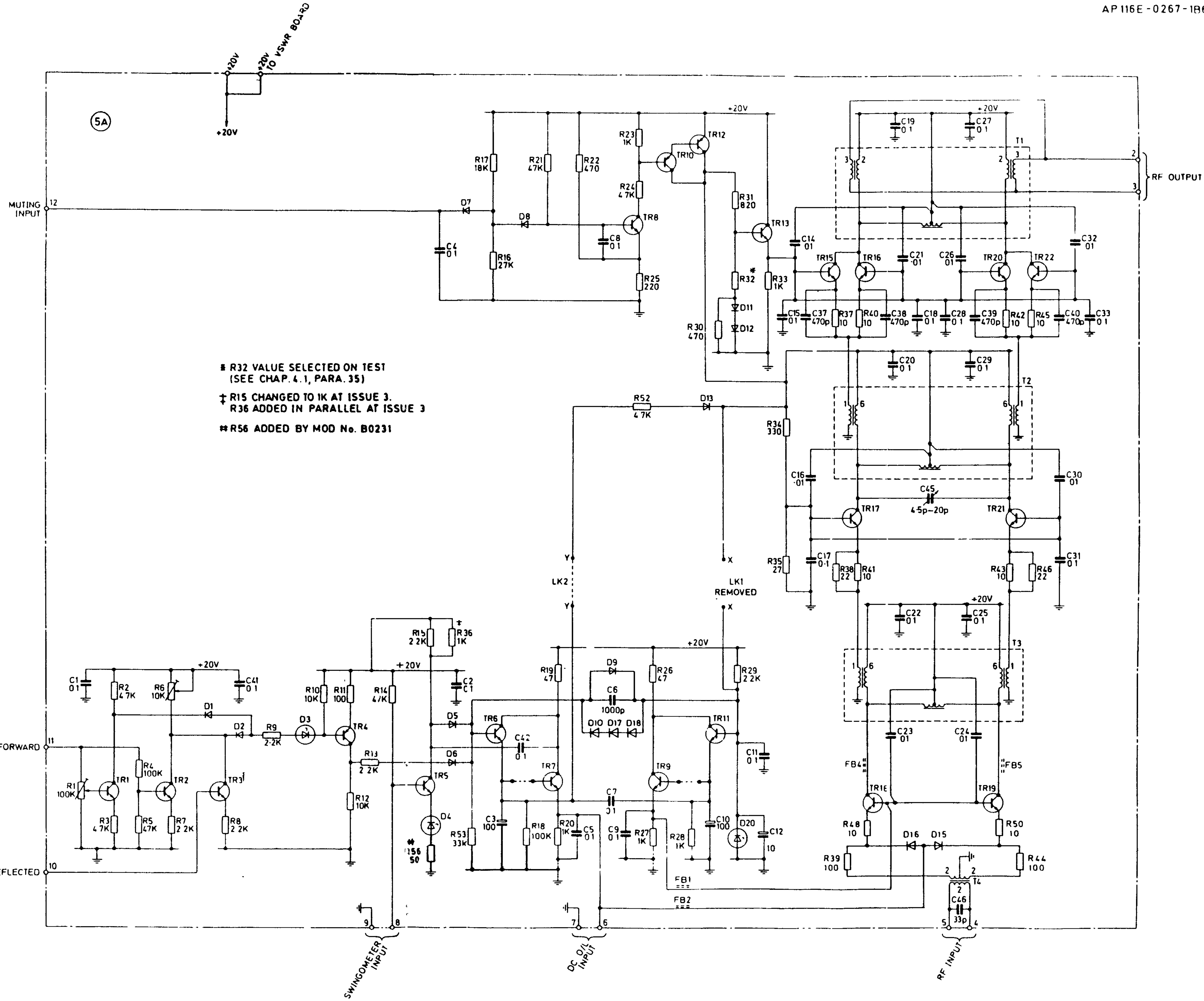
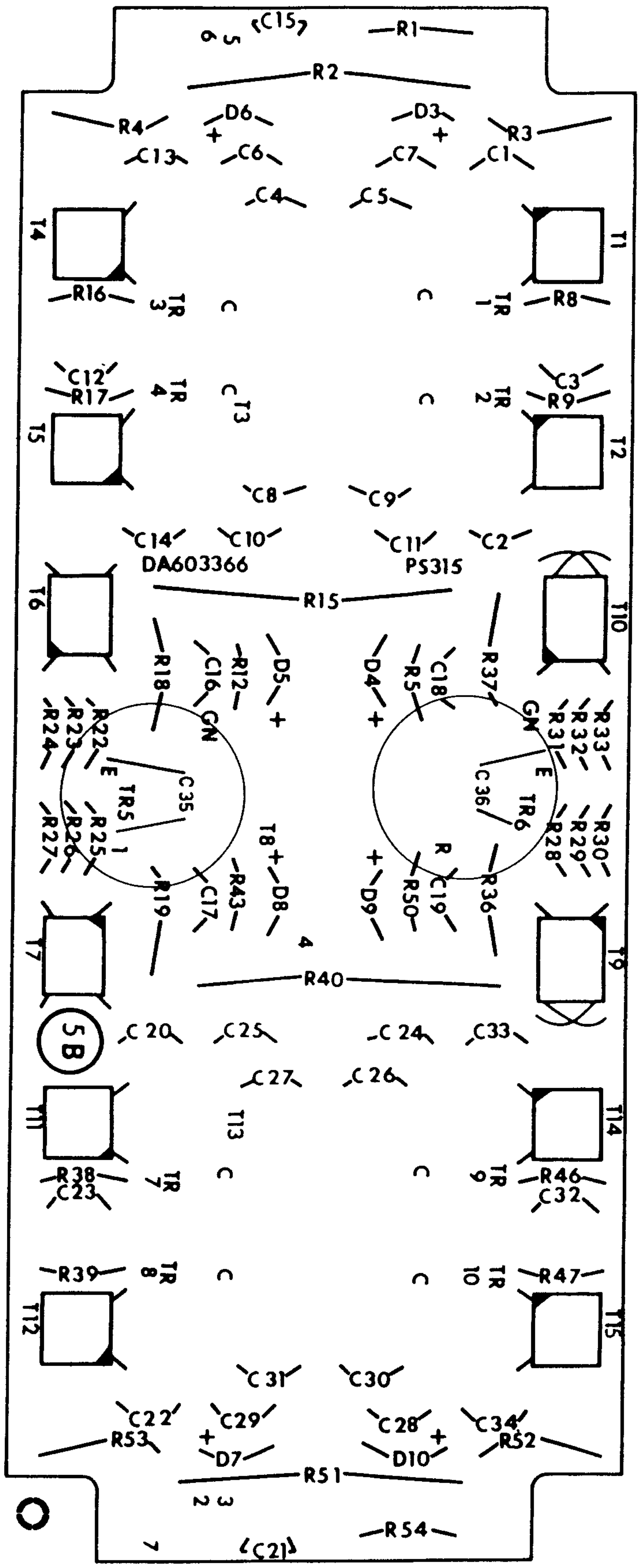
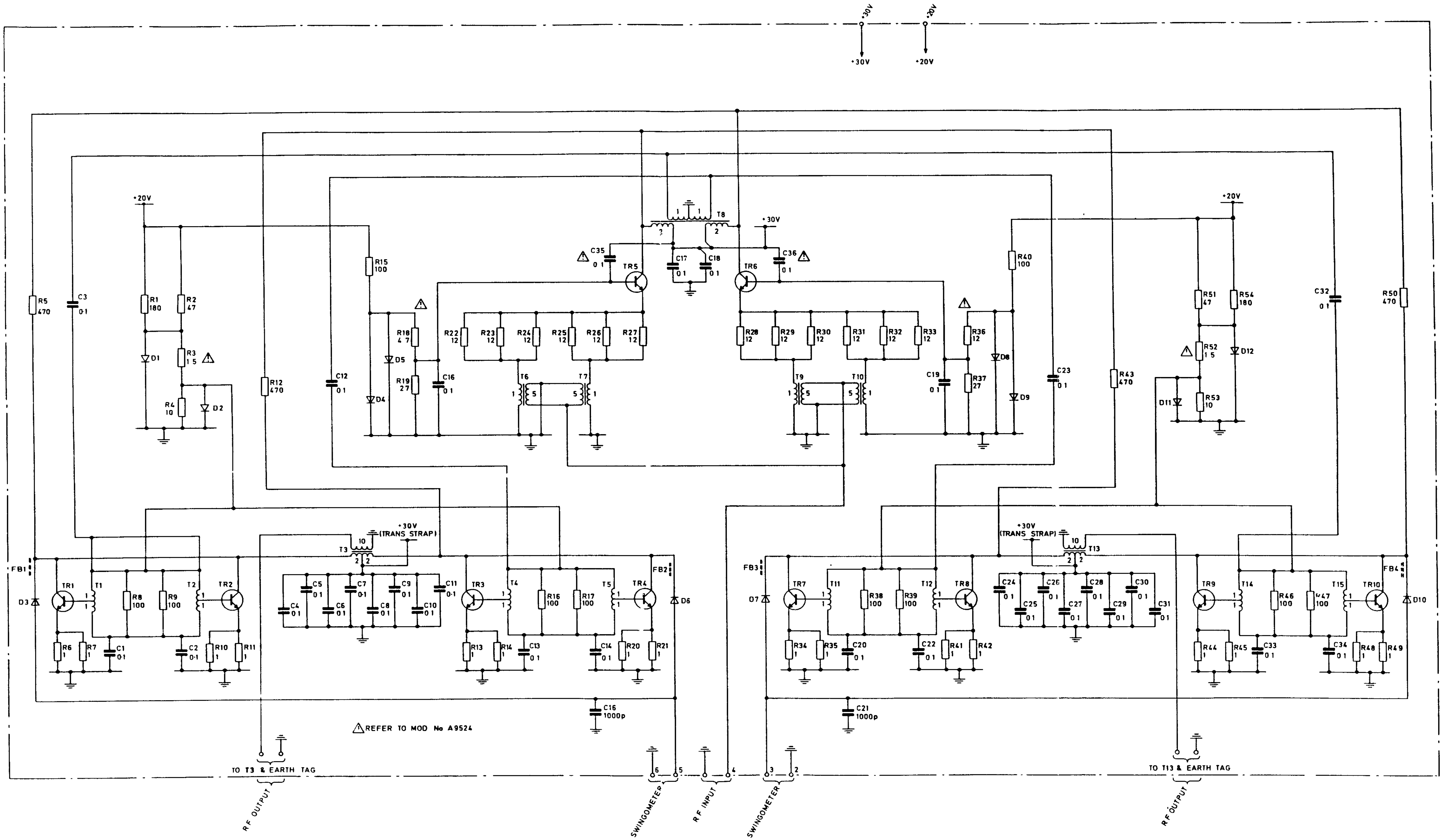



Fig 5

# Low-level board PS.351: circuit




# Fig. 6 High-level board PS 315: component layout



High-level board PS.315 : circuit

Fig 7

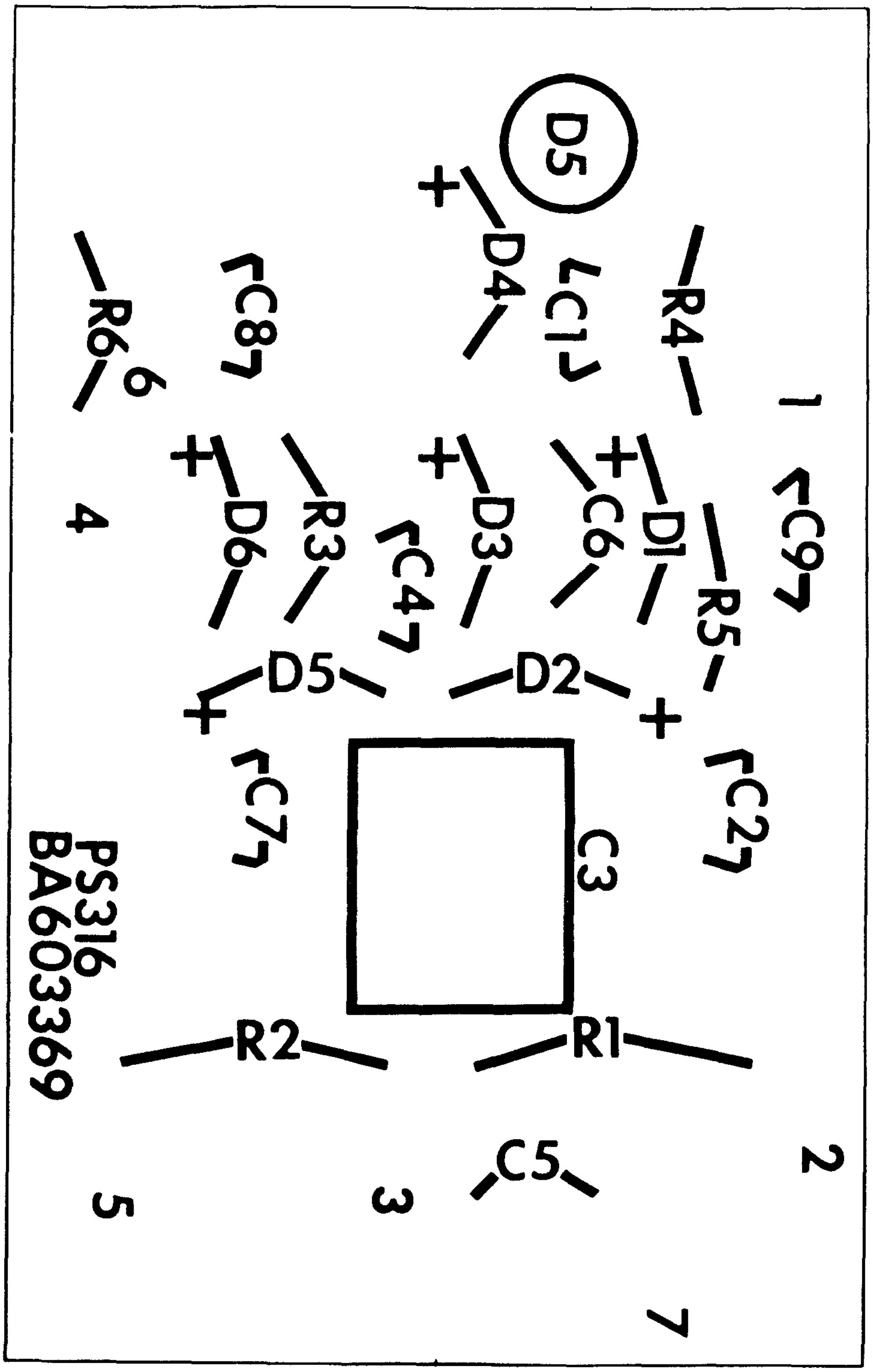
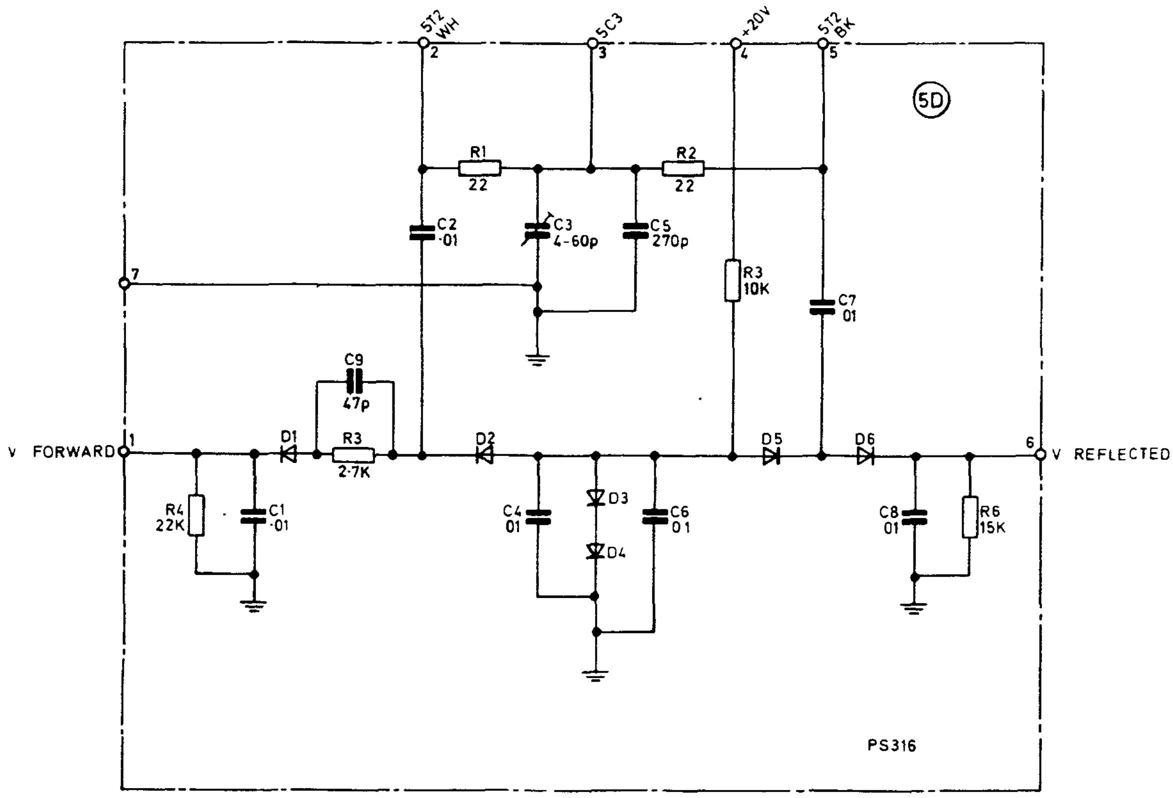



Fig.8 VSWR board PS316: component layout




# Fig.9 V.S.W.R. board PS316: circuit

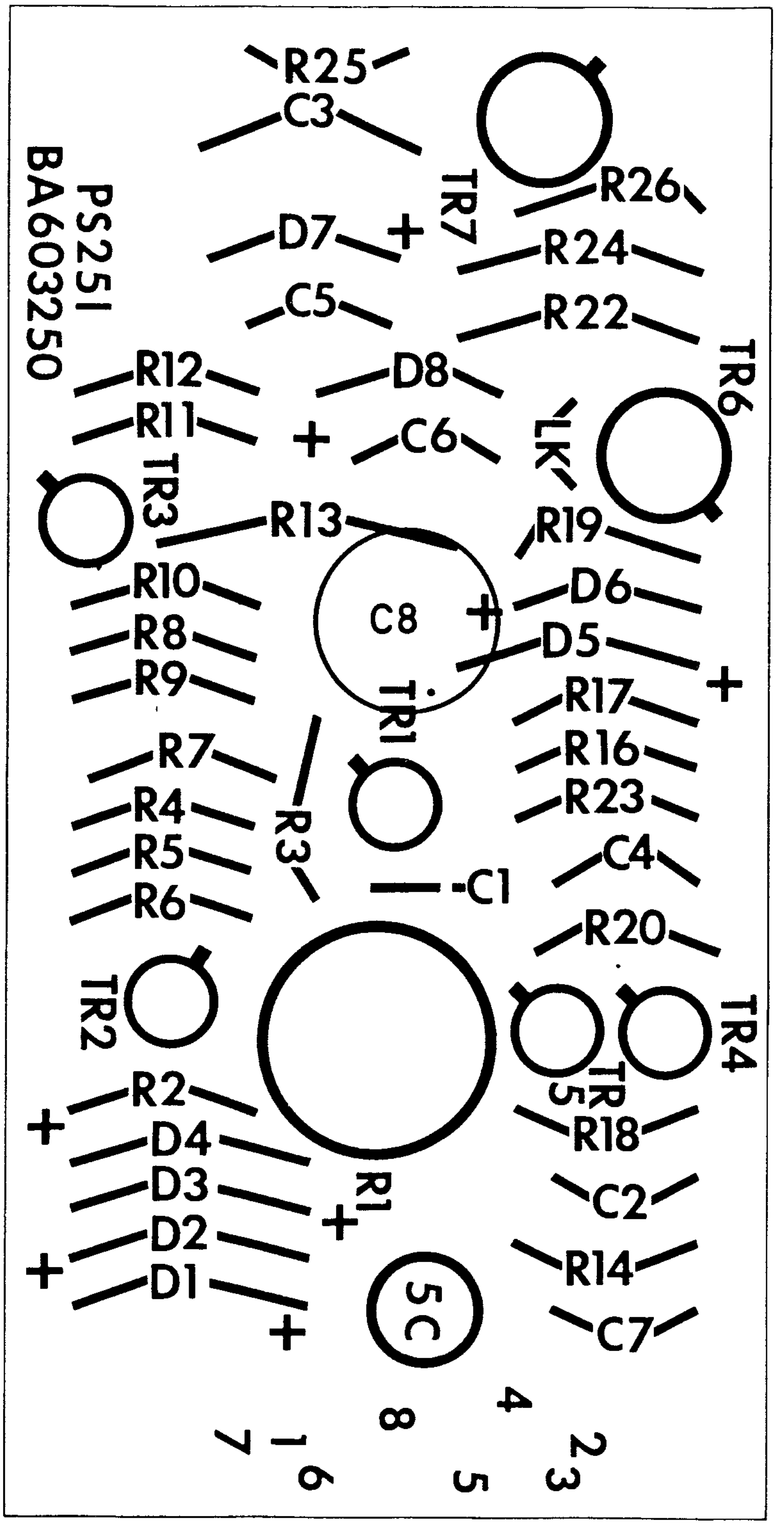



Fig. 10 Protection board PS 251: component layout

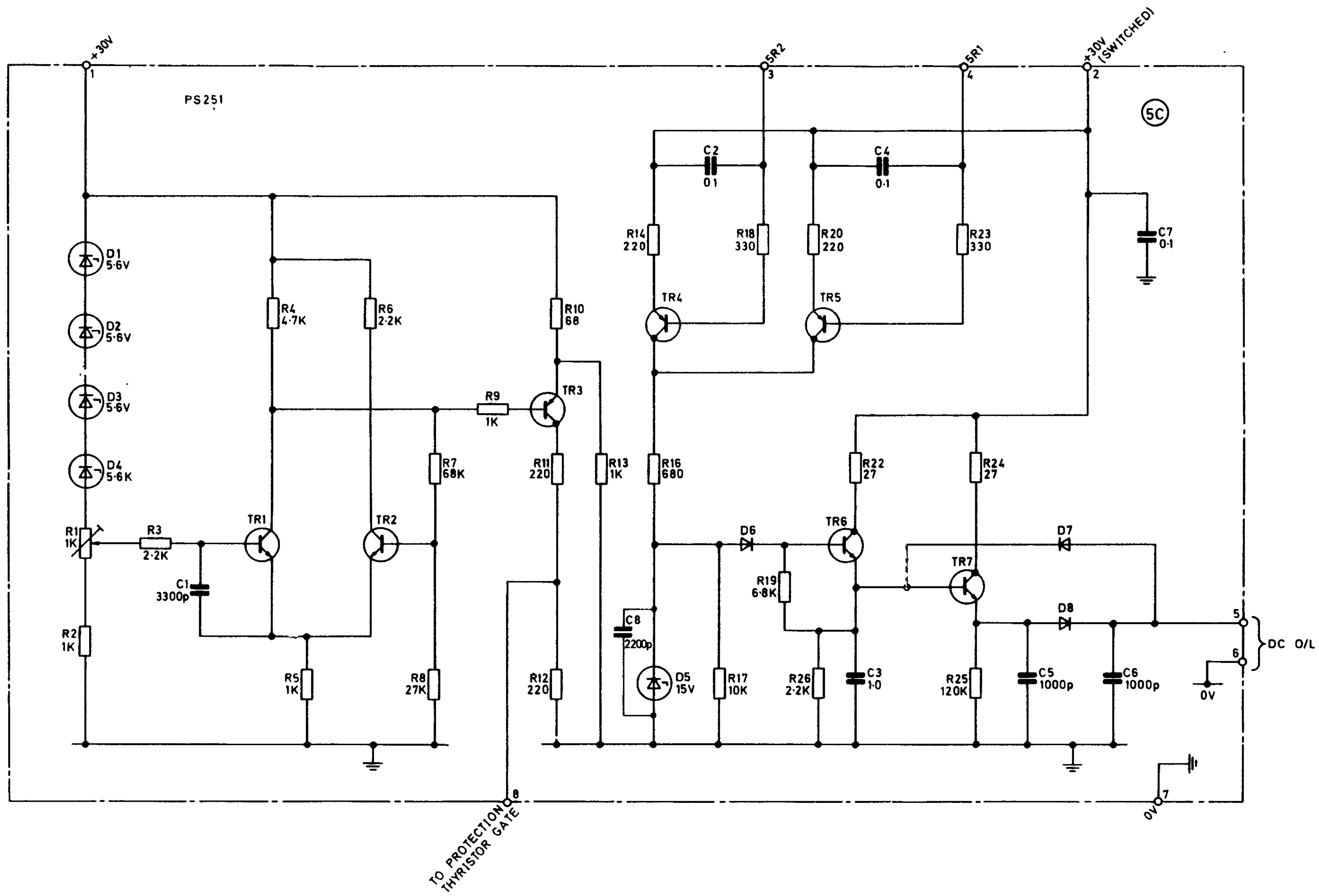



Fig. 11

Protection board PS.251: circuit

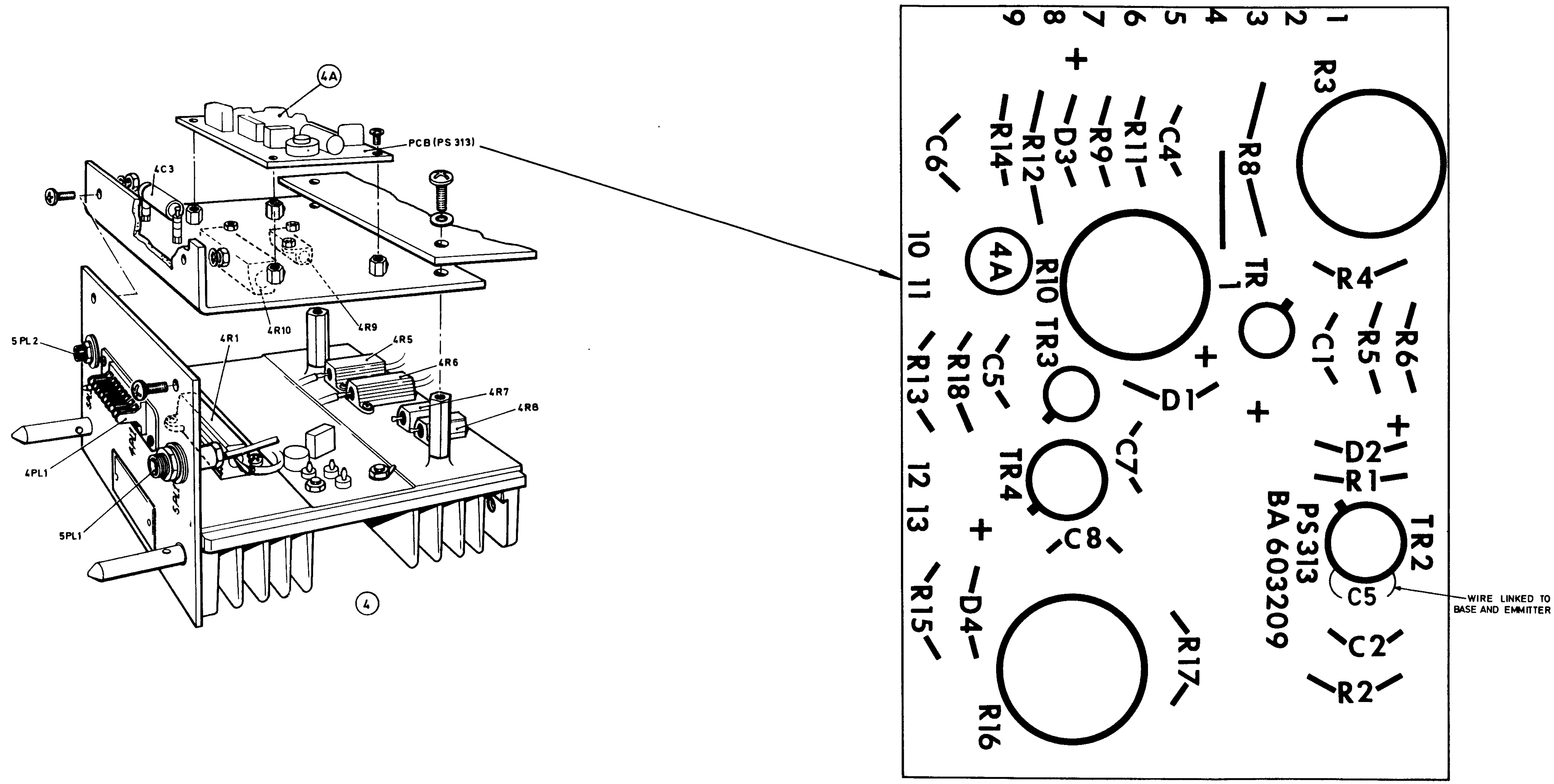



Fig. 12 — Stabilizer MS. 440 : component layout — Fig. 12

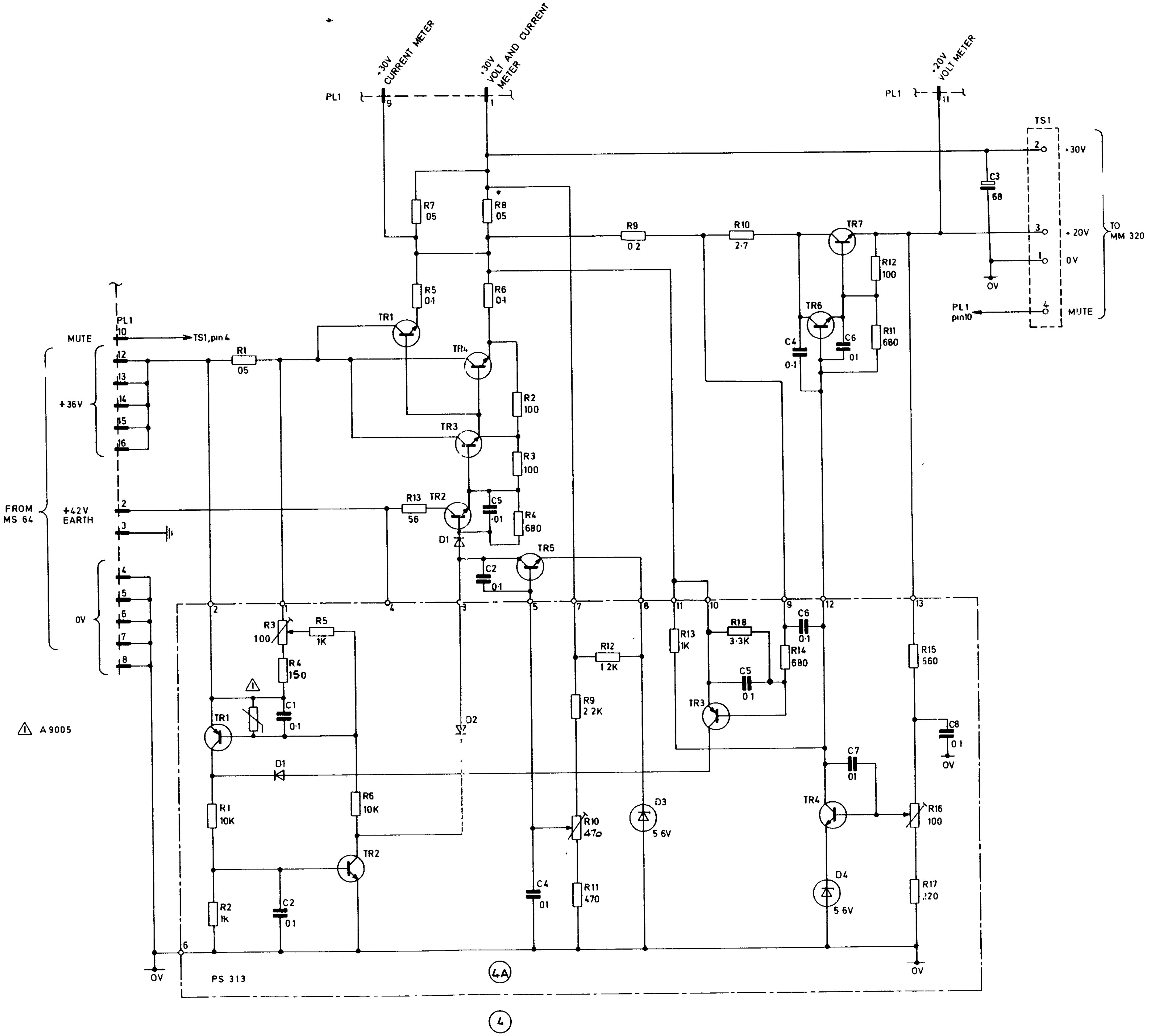



Fig.13

# Stabilizer MS. 440:circuit

Fig.13
Chap. 4-4



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Chapter 5-0

# FUNCTIONAL DESCRIPTION

## ADAPTOR, ANTENNA-TO-TRANSMITTER 10AD/5820-99-624-5394

## (Feeder matching unit MA.1004)

CONTENTS



TABLES



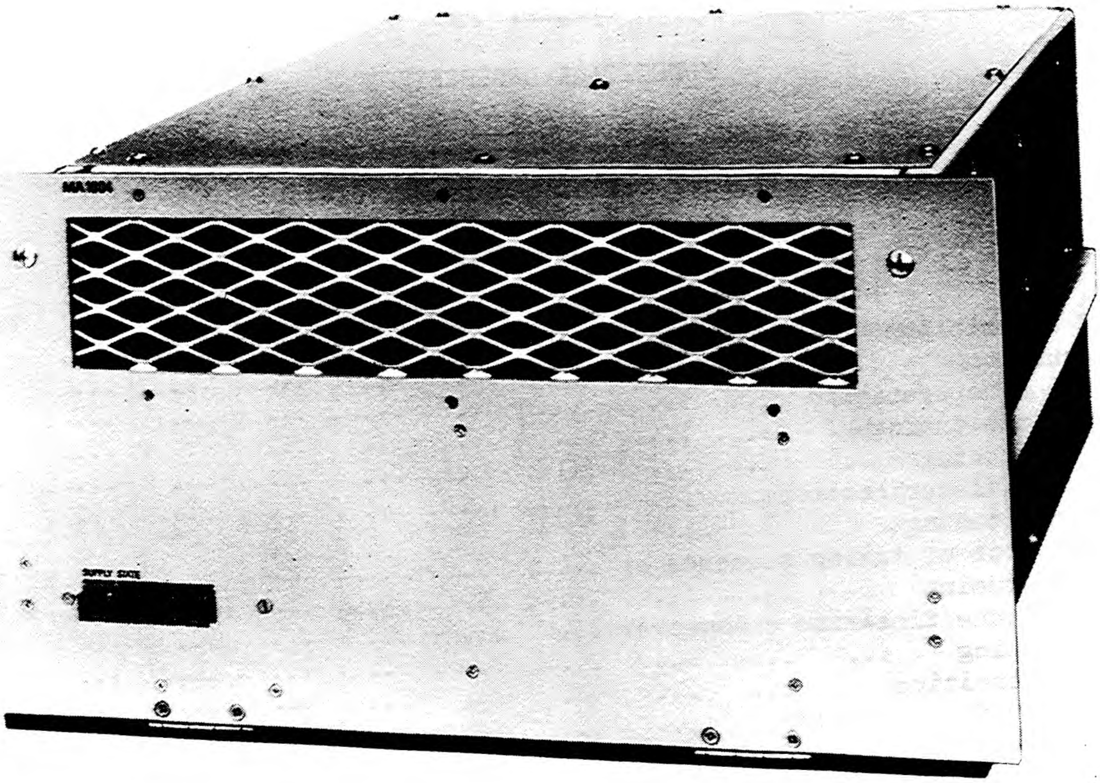
ILLUSTRATIONS



## BRIEF DESCRIPTION

1. The adaptor, antenna-to-transmitter 10AD/5820-99-624-5394 (MA.1004) matches the 50-ohm output from the 1 kW linear amplifier to the antenna, and is self-powered.

2. A power output of 1 kW can be accepted, in the range 1.6 to 30 MHz. Tuning is carried out automatically; the maximum time required for a frequency change is eight seconds and the average time is three to four seconds. Manual tuning facilities are provided for emergency of maintenance purposes.



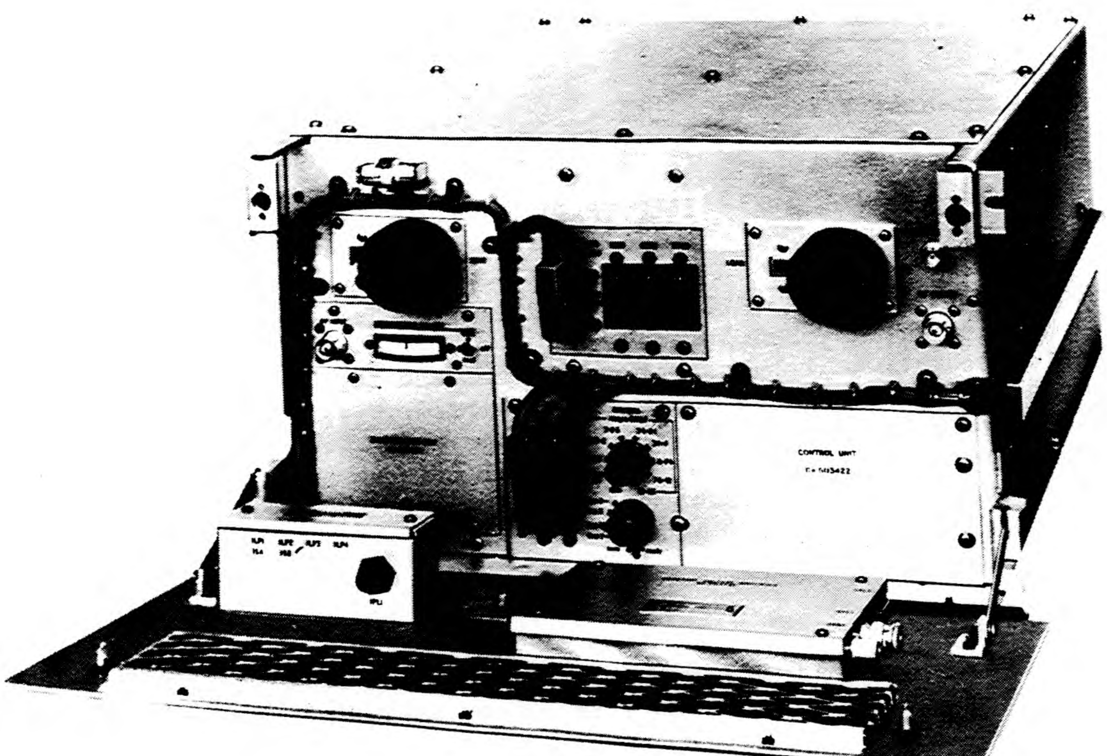


Fig.1 Feeder matching unit MA.1004 : general view

3. The matching network consists of two variable inductors and a switched bank of ceramic capacitors arranged in a 'T' configuration; this network also forms a low-pass filter which attenuates harmonics of the wanted frequency.

4. The unit is servo-tuned in two sequences, an initial coarse-tune sequence followed by a fine-tune sequence. A low level (25 mW into 50 Ω) drive is required for coarse-tuning, followed by a high power (50 W minimum) input. The low-level drive is the normal output from the drive unit to the linear amplifier, the high-power signal is the output from the linear amplifier to the antenna.

CONSTRUCTION

5. The MA.1004 is mounted on angle supports within the main transmitter cabinet; it can be withdraw from the front of the cabinet but cannot be operated in the withdrawn position.

6. The unit is constructed of sheet metal and embodies a main chassis upon which is mounted the sub-assemblies. A prefix coding system is used to provide a unique identification of units and boards as listed in Table 1; the location of sub-assemblies is shown in fig. 3 and 4.

TABLE 1

List of sub-assemblies : MA.1004

| Sub-assembly | Manufacturer's ref. | Prefix code no. |
|---|---|---|
| Main assembly (chassis) | | 1 |
| Power supply, including: | MS.448 | 2 |
| Power supply board | PS.57 | 2A |
| Control unit, including | MS.450 | 3 |
| Motherboard | PW.178 | 3A |
| Range board | PS.60 | 3B |
| Tune board | PS.59 | 3C |
| Tune servo pre-amplifier board | PS.108 | PS.108 (tune) |
| Load servo pre-amplifier board | PS.108 | PS.108 (load) |
| Fine-tune discriminator, including: | MS.449 | 4 |
| Discriminator board | PS.56 | 4A |
| Constant-voltage amplifier (c.v.a.), including: | MS.454 | 5 |
| C.V.A. board | PS.58 | 5A |
| Coil, motor and gearbox assembly (two), including: | MS.451 | 6 (coils are identified as 1L1 and 1L2) |
| Coarse-tune discriminator | PS.106 | 6A |
| Microswitch bank assembly | | 7 |
| Tune servo power amplifier, including: | MS.265 | 9 |
| printed-circuit board | PS.201 | |

TABLE 1 (cont.)

| Sub-assembly | Manufacturer's ref. | Prefix code no. |
|---|---|---|
| Load servo power amplifier, including: | MS.265 | 9 |
| printed-circuit board | PS.201 | |

OUTLINE OF OPERATION

7. The r.f. network is a 'T' section filter comprising two continuously variable inductors and a bank of fixed ceramic capacitors, combinations of which are selected in eight ranges appropriate to the operating frequency. The wipers of the variable inductors are each positioned by an integral motor and gearbox which is driven by associated power and pre-amplifier forming two independent servo systems. The appropriate ceramic capacitors are connected by spring contacts, each operated by a solenoid and selected by the control unit. A section of each variable inductor is shorted out on the two highest frequency ranges by a similar mechanism. A simplified block diagram is given in fig.5.

Automatic tuning

8. The sequence of automatic tuning is as follows:-

(1) Coarse tuning

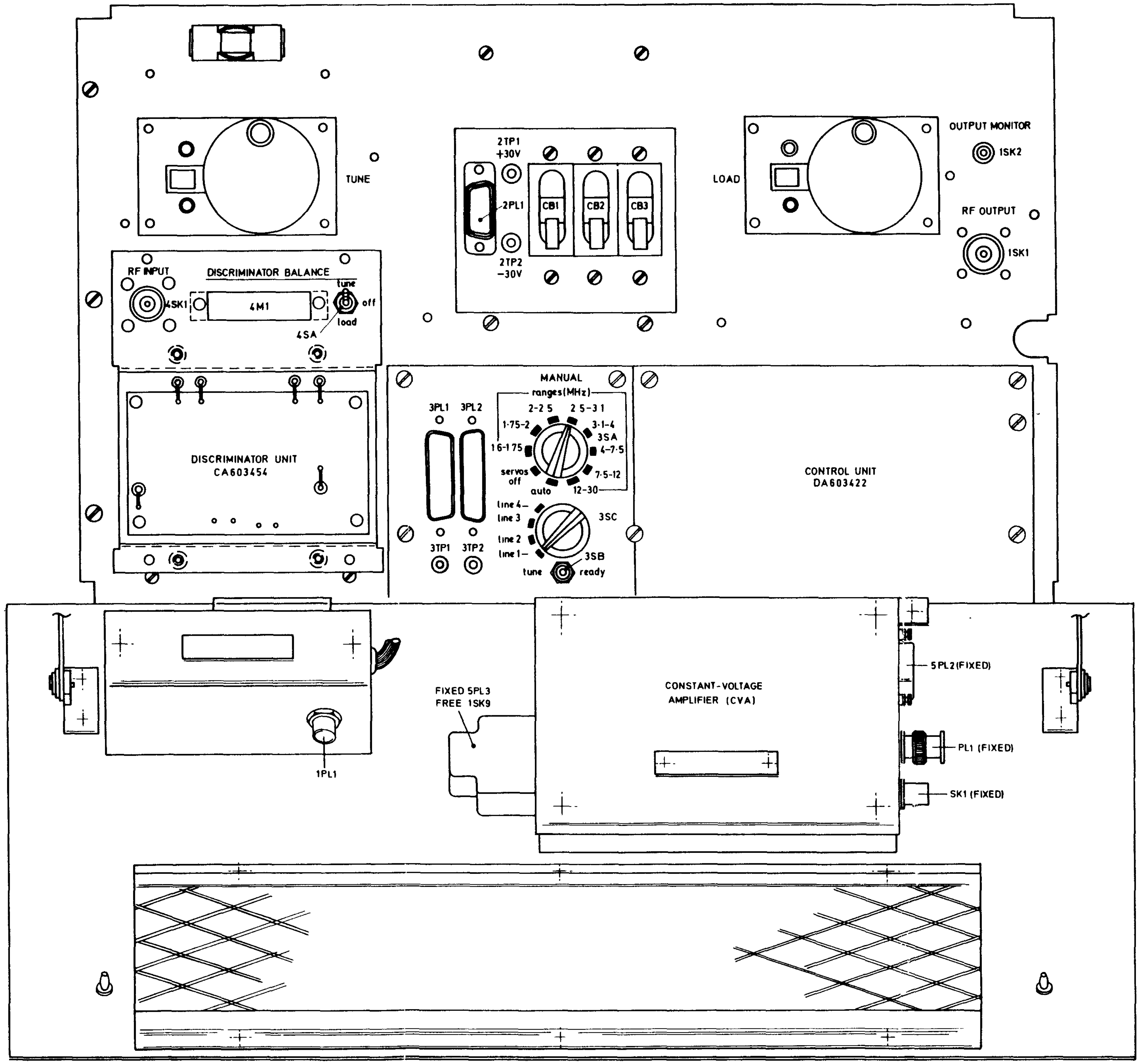
The low-level r.f. drive to the linear amplifier from the drive unit is removed and re-routed, via a constant-voltage amplifier (c.v.a.), to the two coarse-tune discriminators. The outputs of the coarse-tune discriminators are switched to the two servo amplifiers. The capacitor bank is then reset to neutral (i.e. no capacitors selected). The servo motors drive the wipers of the coils to the correct position to obtain zero output from the discriminators, i.e. the coarse-tuned condition.

(2) Coarse-tune/fine-tune changeover

When the servo motors have completed coarse tuning and a detector has sensed that the servo amplifier outputs have fallen to a sufficiently low level (i.e. servo motors stopped), the control circuit allows the unit to change over to fine-tune. At this time, using information from the motor-driven microswitch bank, the correct combination of ceramic capacitors appropriate to the coil position (and hence frequency range) is selected. The r.f. drive is then removed from the coarse-tune discriminators and reconnected to the linear amplifier, and the servo amplifier inputs are switched to the fine-tune discriminator output.

(3) Fine tuning

The fine-tune discriminators sample the amplitude and phase of the input signal to the 'T' network and provide zero outputs when the nominal 50-ohm resistive condition is obtained. The phase discriminator drives the 'tuning' coil wiper, and the amplitude discriminator drives the 'loading' coil wiper. The servos are allowed to fine-tune for a short period (about 1½ seconds) and then a large time-constant (integrator) is switched into each servo pre-amplifier feedback loop to prevent hunting. This has the effect of severely reducing the a.c. loop gain, but maintaining a high d.c. loop gain and hence high accuracy.




VIEW WITH FRONT PANEL LOWERED

Fig. 2 MA1004 with front panel lowered

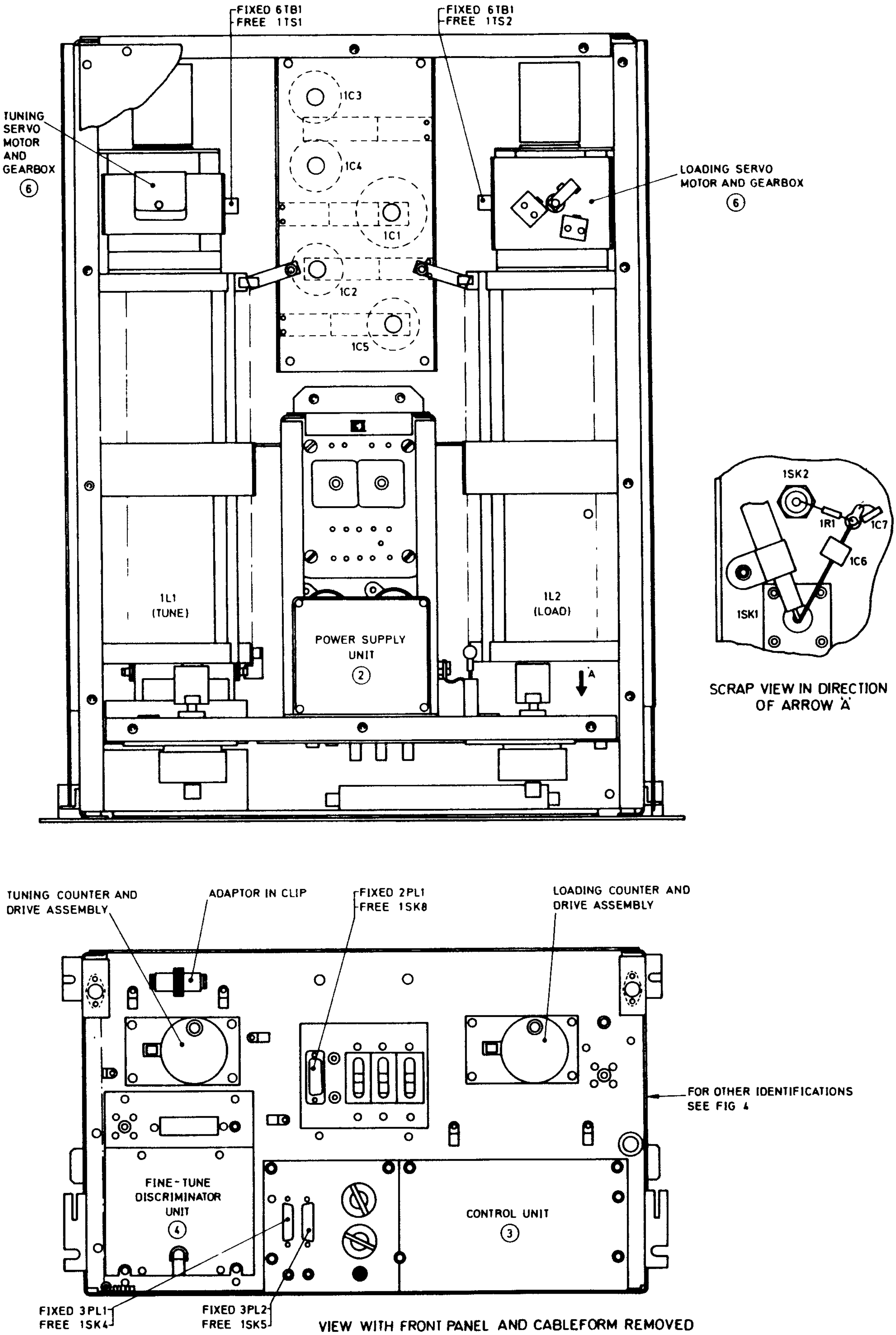



**Fig.3 MA.1004 location of sub-assemblies: front and top**

(4) Ready condition

After a period of about three seconds from the coarse-tune/fine-tune changeover, the control circuits provide a 'ready' signal output. The servos can then be inhibited, via a link on the tune board, or can be left energized, dependent upon the transmitter system requirements.

Manual tuning

9. During manual tuning, the servo system is inhibited and the selection of frequency-range is made at a rotary switch situated on the control unit. This unit also contains two other switches associated with manual tuning (1) the line switch, used to select any one of four coaxial line lengths between the linear amplifier output and the MA.1004 input (the lines are situated in the cabinet and in automatic operation are selected by external means) and (2)the manual TUNE/READY switch, which is used to override the 'unready' output signal.

10. Both the manual range switch and the manual line switch operate via the range board PS.60 to generate the necessary timing sequence so that arcing due to r.f. cannot occur at the capacitor or inductor contacts as they open and close. The variable inductors are positioned manually using the front-panel controls in conjunction with the coarse-tuning graph and the fine-tune discriminator output meter.

FUNCTIONAL DESCRIPTION

11. The following paragraphs describe the operation of the unit during a tuning sequence to suit a change of frequency. Reference should be made to the functional diagram fig. 6.

AUTOMATIC TUNING

Initiation of a tuning sequence

12. A tuning sequence is initiated by a +12V or open-circuit input at 5PL2-8 or, alternatively, by a 0V input at 5PL2-2. The front-panel TUNE button may also be used in local applications. All three tune signals are commoned and fed to the tune board 3C pin 23, then, via 3CTR5 and 3CTR6 to the bistable 3CTR12, 3CTR13, which is reset. This removes the 0V fine-tune signal from 3C pin 16 and de-energizes 3CRLA (para. 14). At the same time 3CTR14, 3CTR15 and their associated delays are reset, de-energizing 3CRLC, removing the 'ready' output (pin 28) and illuminating the TUNE indication lamp via 3CTR17 and pin 29.

13. The removal of the 0V 'fine-tune' signal from 3C pin 16 (which is connected to 3B pin 30), results in an open-circuit at 3B pin 29 (via 3BTR1 to 3BTR5). The relay 5RLA is, therefore, de-energized (para. 15). The open-circuit at 3B pin 29 also removes the +30V output from 3B pin 27 (via 3BTR1, 3BTR6 to 3BTR13), de-energizing the solenoids 1RLA to 1RLF and relay 3RLA.

14. Relay 3RLA switches the servo pre-amplifier inputs to the outputs of the coarse-tune discriminators. Relays 3CRLA and 3CRLC set the gain of the servo pre-amplifiers to the coarse-tune state.

15. Relay 5RLA removes the low-level r.f. drive from the linear amplifier input and re-routes it, via the constant-voltage amplifier (5TR1, 5TR3, 5TR4, 5TR6, 5TR8, 5TR10), to the coarse-tune discriminator inputs.

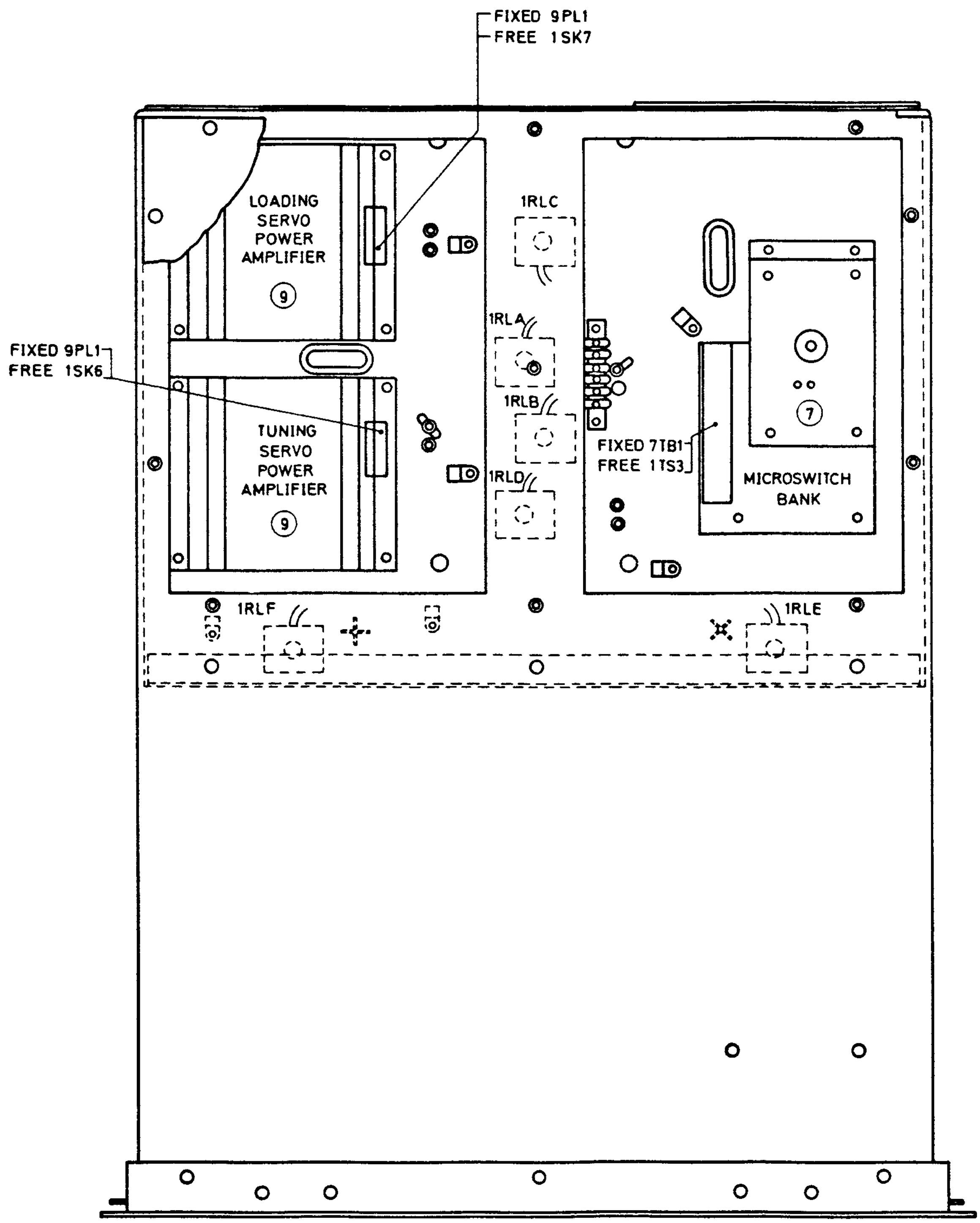



Fig.4 MA.1004 location of sub-assemblies : underside

Coarse tuning

16. The drive signal (low-level r.f. input) is fed to the coarse-tune discriminators which provide d.c. outputs. The outputs are amplified by the servo pre- and power amplifiers and cause the motors to drive the coil wipers to new coarse-tune positions.

17. The outputs from the servo pre-amplifiers are also applied (via 3CTR1 to 3CTR4) to gate 3CTR7, and inhibit its output until both pre-amplifier outputs have fallen below a reference level, i.e. until both servos have stopped.

Coarse tune/fine tune changeover

18. When all three input conditions of gate 3CTR7 i.e., the two servo pre-amplifier outputs (para.17) and the 'correct r.f.' condition (para.26), are satisfied, bistable 3CTR10, 3CTR12, 3CTR13 changes state (i.e. latches) and can only be reset by a coarse-tune initiate signal as described in para. 2.

19. The change of state results in:-

(1) a 0V fine-tune output at 3C pin 16.

(2) RLA being energized, reducing the gain of servo pre-amplifiers.

(3) Delays 3CR27, 3CC10, 3CTR14 and 3CR28, 3CC11, 3CTR15 commence.

20. The 0V fine-tune signal at 3C pin 16 and 3B pin 30 causes the output at 3B pin 27 to rise to 30V via 3BTR6 to 3BTR12 and, after a short delay, 3B pin 29 to be grounded via 3BTR2 to 3BTR5, thus energizing 5RLA (para. 22).

21. When the output at 3B pin 27 rises to +30V, a trigger pulse is generated at 3B pin 26 by 3BTR13, and is routed via switch 3SA1 and the microswitch bank (unit 7) to the appropriate range input on the range board. The pulse is then encoded by diodes and used to select the appropriate combination of capacitors and coil connections in the main r.f. network by means of solenoids 1RLA to 1RLF. At the same time, relay 3RLA is energized, connecting the output of the fine-tune discriminators to the servo pre-amplifiers (para.20).

22. When relay 5RLA changes over, (para. 20), the low-level r.f. drive is removed from the c.v.a. (and coarse-tune discriminators) and re-applied to the linear amplifier input, thus providing a high-power input at 4SK1.

Fine tuning

23. The outputs of the fine-tune discriminator (unit 4) cause the servos to drive the coil wipers to the fine-tune position, giving a nominal 50-ohm resistive condition at 4SK1.

24. When delay 3CR27, 3CC10, 3CTR14 elapses, relay 3CRLC is energized, switching a large time-constant into the servo pre-amplifiers. This drastically reduces the a.c. loop gain to prevent hunting, but maintains a high d.c. gain, giving high accuracy.

Ready condition

25. When delay 3CR28, 3CC11, 3CTR15 has elapsed, the READY lamp is illuminated via TR16, and the TUNE lamp extinguished, via TR17. At this stage the servos are normally inhibited via the servo pre-amplifier supply gate (3CTR20 to 3CTR23) and link 3LK1. If required, however, the servos may be left energized by the removal of link 3LK1.

'CORRECT RF' DETECTED

26. If the low-level r.f. input is removed during any stage of the tuning procedure, (or during the 'ready' condition when servos are active), the servos are inhibited after a short delay via the r.f. detector 5TR15, 5TR16, 5TR17 and 3TR18 to 3TR23. This ensures that the servos cannot 'drift' away from the correctly tuned position in the absence of a compensating output from either the coarse or fine-tune discriminators. If this condition occurs in coarse-tune, the coarse-tune/fine-tune changeover is inhibited via 3CTR7 until the r.f. is re-applied and coarse tuning is correctly completed. (para. 18).

SERVO PROTECTION

27. Current limit detector circuits are fitted to prevent the servo motors drawing excessive starting currents. The power amplifier output current is sensed by 9R1 which provides a control voltage via 9D1 to 9D6, to the pre-amplifiers, thus reducing the gain of the system and limiting the output current.

SERVOS 'OFF'

28. At any stage of tuning, or afterwards, the servos may be switched off by two methods. The first is by operation of the manual range switch to the SERVOS OFF position. The second is by application of an external servos off (OV) signal to 5PL2-9. In either case, +30V is applied to 3C pin 30 which opens the servo pre-amplifier supply gate 3CTR20 to 3CTR23.

FAULT SIGNALLING

29. Both positive and negative stabilized supplies are monitored, and, in the event of either supply failing, 5TR11-14 produce a fault output (OV) on 5PL2-1 provided that an external earth is applied on 5PL2-4. This earth is routed via the cabinet contactor, so that a fault output is not produced when the cabinet is switched off. If either servo runs to its limit position, it operates a microswitch which is used to disconnect the motor drive and to illuminate the front-panel SERVO LIMIT indicator. The servo limit condition also produces a fault output on 5PL2-1.

MANUAL TUNING

30. During manual operation, the servo systems are completely inhibited and the selection of frequency range and line must be made by the operator (Chap. 1-2).

31. When switch 3SA is set to any of the manual range positions, +30V is applied to 3C pin 25, via 3SA3 and 3SC1, causing 3CTR8 to 'pull down' the input to TR5, thus providing a 'tune' signal. The fine-tune output on 3C pin 16 is therefore removed but, after delay 3CR22, 3CC8 has expired, is reapplied through 3CTR8, 3CTR9. The trigger pulse from 3B pin 26 (para. 19) is now routed through 3SA1 to the appropriate range input on the range board and through 3SA2, 3SC2 to the appropriate line input (a) on the range board.

32. The range board operates normally to select appropriate capacitor combinations and coil connections; in addition it selects line lengths, at the transmitter, as the normal selection method is overridden by the manual signal.

33. If either 3SA or 3SC is moved to another position, the +30V signal on 3C pin 25 is briefly interrupted as the switch passes between positions, therefore the OV fine-tune output from 3C pin 16 is momentarily lost. This causes the solenoids 1RLA to 1RLF to be unlatched. When the +30V re-appears, a trigger

pulse is generated to re-select the combination appropriate to the new switch position. There is no necessity to remove the drive because the normal protective time sequencing operates during manual conditions.

34. Selection of a manual range applies a tune signal to 3C pin 23, therefore the 'ready' output must be provided manually. This is achieved by operation of switch 3SB which grounds 3CTR15 output via 3CTR8 (in 'manual' only), removes the TUNE output, and provides a READY output.

## OPERATING INSTRUCTIONS

35. Operating instructions for the MA.1004 are included with the system operating procedures in Chapter 1-2 of this publication.

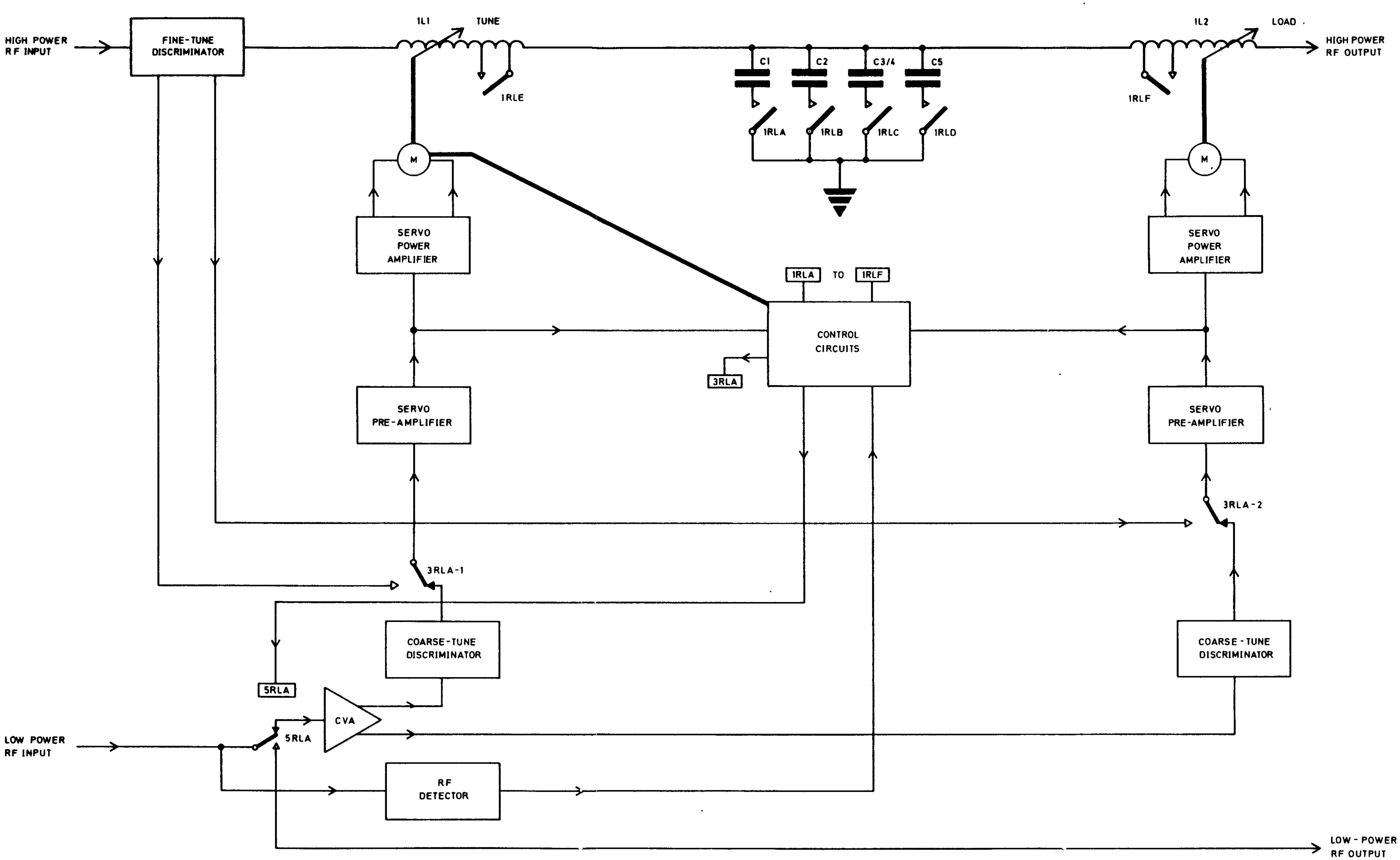



Fig. 5

Feeder matching unit MA1004: block diagram

Fig. 5

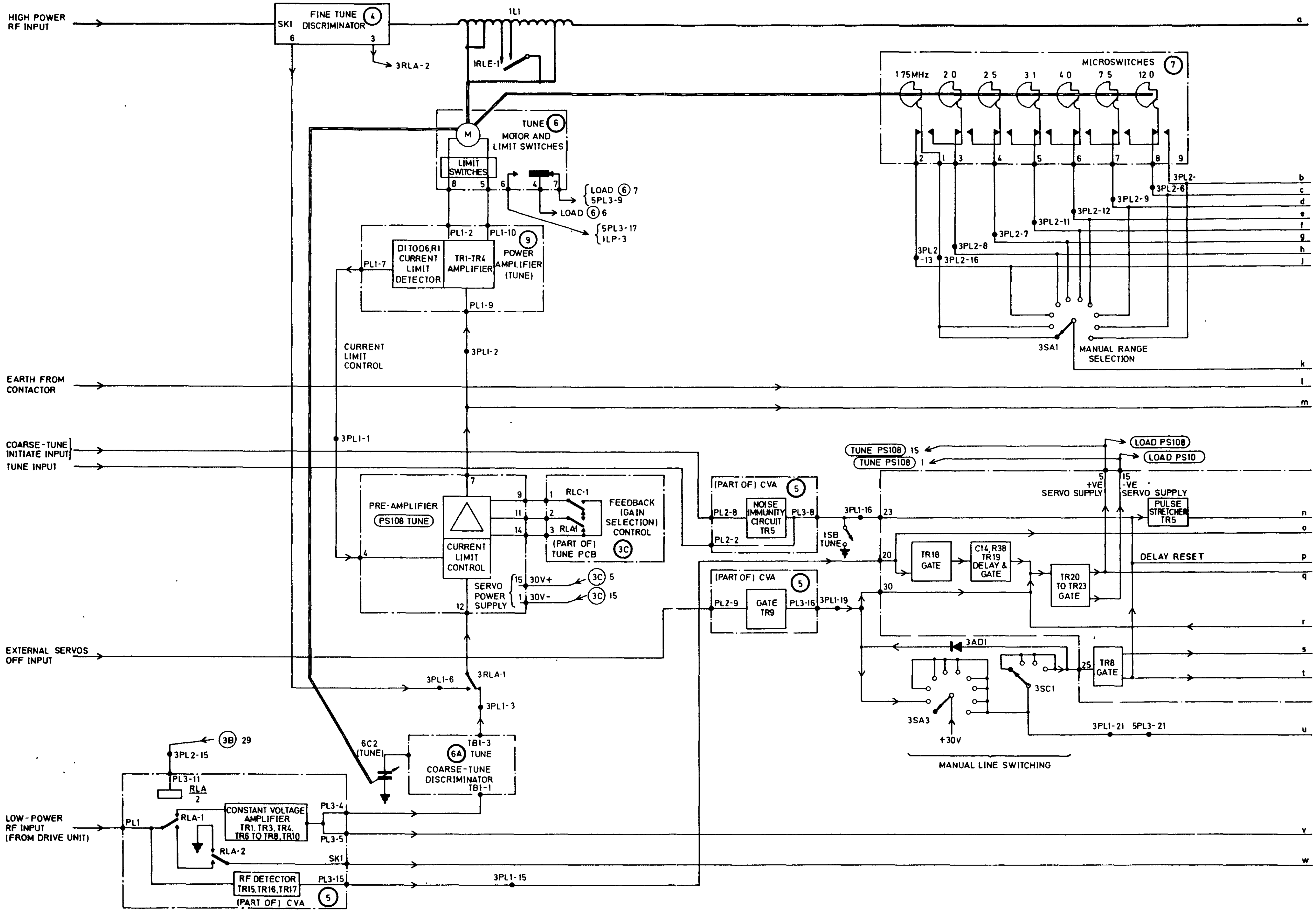



Fig.6a

**Feeder matching unit MA.1004: functional diagram (Sheet 1 of 2)**

Fig.6a

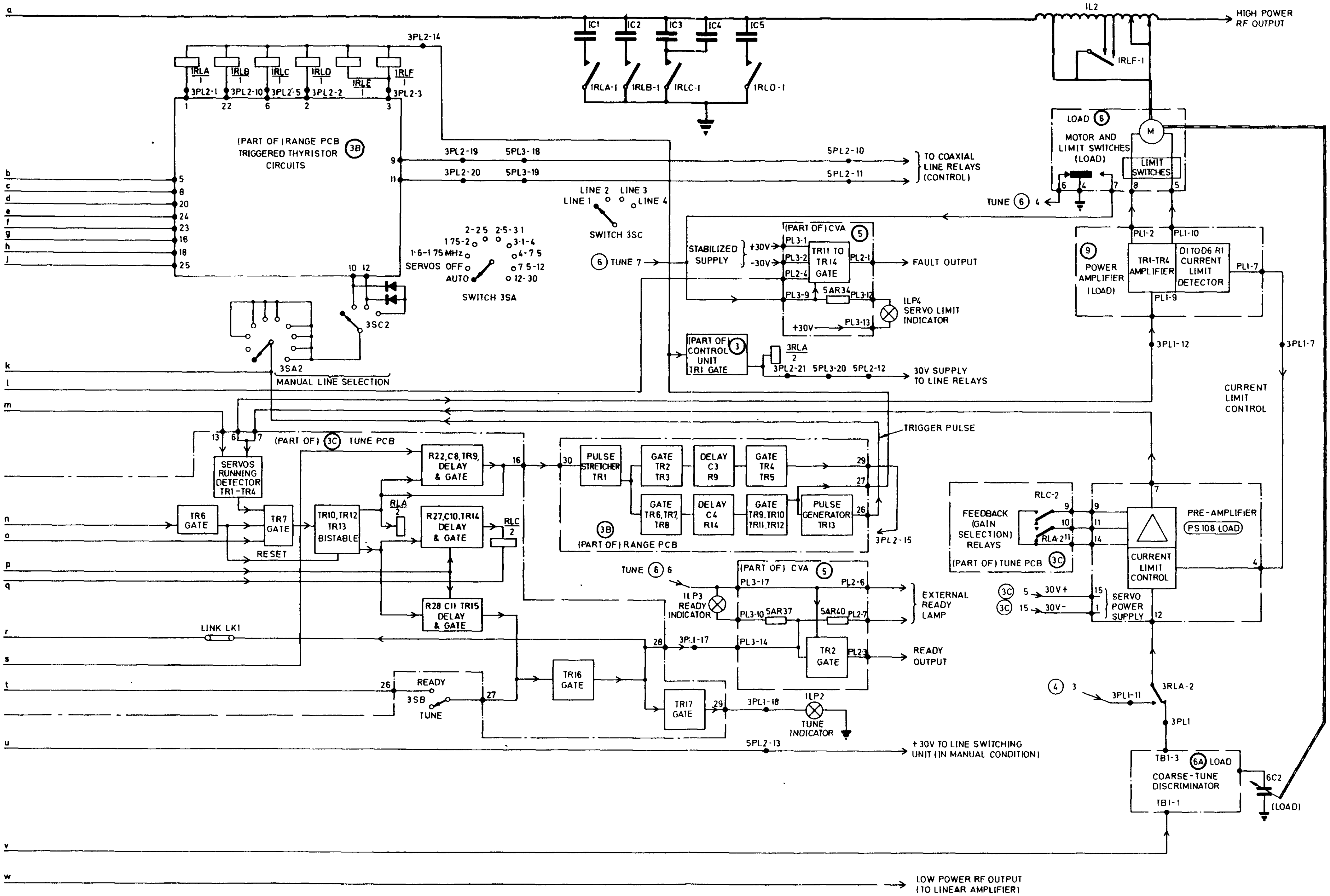



Fig.6b

**Feeder matching unit MA.1004: functional diagram (Sheet 2 of 2)**

Chapter 5-1

SERVICING

# ADAPTOR, ANTENNA TO TRANSMITTER 10AD/5820-99-624-5394

(Feeder matching unit MA.1004)

CONTENTS



TABLES



ILLUSTRATIONS



## INTRODUCTION

1. This chapter lists the test equipment required for 3rd-line testing and repair, and also gives the appropriate fault location information. The list of test equipment is an extract from the main overall list given in Chap. 1-3 (TTA.1860A) and Chap.13-3 (TTA.1860S and MA.1712S). Dismantling and post-repair adjustments are given in Chap.5-2.

WARNING...

> DURING OPERATION, HIGH LEVEL R.F. VOLTAGES ARE PRESENT AT THE R.F. INPUT AND R.F. OUTPUT CONNECTIONS; MAINS SUPPLY VOLTAGES ARE ALSO PRESENT. THESE CONNECTIONS ARE ACCESSIBLE WHEN THE HINGED FRONT PANEL IS LOWERED. ENSURE THAT POWER IS REMOVED BEFORE BREAKING THESE CONNECTIONS.

TEST EQUIPMENT

2. The test equipment required for 3rd-line testing of the feeder matching unit is as follows:-

(1) Voltmeter, electronic r.f. 10S/6625-99-193-4355.

(2) Multimeter, CT498A.

(3) H.F. signal generator.

(4) Directional wattmeter 110S/6625-00-649-5070.

(5) Detecting element 110B/9542785.

(6) 1kW, 50 Ω dummy load 10S/17198.

(7) Special potentiometer adjusting tool (Plessey Type G).

(8) Accessory kit 10H/6625-99-631-9453.

INITIAL PROCEDURE

3. The feeder matching unit cannot be operated or re-aligned - following repair - on a bench and separated from the main transmitter; hence, the procedures in this chapter and Chap. 5-2 assume that it is installed in the 3rd-line transmitter test rig. Extender boards, contained in the necessary kit may be required for certain adjustment or fault-finding procedures; the accessory kit contains extender boards for the tune and range boards (CA604130) and for the servo pre-amplifier board (CA604163).

4. The location and function of all controls and indicators is given in Chap. 1-2 (TTA.1860A) and Chap.13-2 (TTA.1860S and MA.1721S).

(1) Check that the complete transmitter is in a switched-off state.

(2) Lower the MA.1004 front panel and check that the circuit-breakers CB1, CB2 and CB3 are set to ON; raise and secure the panel.

(3) Connect items (4), (5) and (6) of para.2 to the antenna connector on top of the transmitter cabinet.

(4) On the MA.1720 drive unit, set the TUNE/MUTE/OPERATE switch to MUTE.

(5) Carry out the initial-switching-on and automatic tuning procedures given in Chap.1-2 (TTA.1860A) or Chap.13-2 (TTA.1860S and MA.1721S).

5. When the fault has been located and the necessary repair work carried out, the manual tuning procedure for the MA.1004 should be carried out; refer to Chap.1-2 (TTA.1860A) or Chap.13-2 (TTA.1860S and MA.1721S).

FAULT DIAGNOSIS

6. Chap.1-3 (TTA.1860A) or Chap.13-3 (TTA.1860S and MA.1721S) contains the 1st and 2nd-line fault-finding procedures which result in one or more of the following boards being replaced:

(1) Constant-voltage amplifier assembly MS.452.

(2) Servo power amplifier assemblies (2) MS.265.

(3) Servo pre-amplifier board PS.108.

(4) Range board PS.60.

(5) Tune board PS.59.

(6) Power supply unit MS.448.

7. In the event of it not being possible for the fault located at user level, the complete MA.1004 is returned for 3rd-line servicing. Tables 1 to 4 give information which is an aid to fault-finding to sub-assembly level. Having located the faulty sub-assembly, either conventional fault-finding techniques are applied or the adjustment checks given in Chap.5-2 must be carried out. The interconnection diagram (fig.1) and the illustrations of the chassis layout given in Chap.5-0 must be referred to when necessary.

TABLE 1

Signal data : feeder matching unit

| Plug | Pin No. | Function | Input or Output | Signal data |
|---|---|---|---|---|
| 1PL1 | (a)<br>(b)<br>(c) | Line<br>Neutral<br>Earth | Input | 210-250V, +6% -10%<br>47-65 Hz |
| 5PL1 | Coax. | Low-level (50Ω) r.f. signal from drive unit | Input | 25-200 mW, 1.6-30 MHz |
| 5SK1 | Coax. | Low-level (50Ω) r.f. signal to linear amplifier | Output | As for 5PL1 |
| 5PL2 | 1 | Fault | Output | 0V = fault condition<br>+12V = normal |
| | 2 | Tune | Input | 0V = tune condition<br>+12V = normal |
| | 3 | Ready | Output | 0V = ready condition<br>+12V = not ready |
| | 4 | Earth from contactor | Input | 0V = normal<br>Open-circuit = otherwise |
| | 5 | Earth | | |
| | 6 & 7 | External ready lamp | Output | 30V from 120Ω source-resistance of 24V, 55 mA lamp |
| | 8 | Coarse-tune initiate | Input | Open-circuit or +12V = coarse-tune initiate;<br>0V = normal |
| | 9 | Servos off | Input | 0V = servos off<br>Open-circuit or +12V = normal |
| | 10 | Line 2 | Output | 0V to energize line 2 selection relay in cabinet;<br>open-circuit = relay not energized. |
| | 11 | Line 3 | Output | 0V to energize line 3 selection relay in cabinet;<br>open-circuit = relay not energized |

TABLE 1 (cont.)

| Plug | Pin No. | Function | Input or Output | Signal data |
|---|---|---|---|---|
| 5PL2 (cont.) | 12 | +30V switched | Output | +30V supply to line selection relays in fine-tune condition; otherwise open-circuit. |
| | 13 | Manual | Output | +30V for manual output to line-switching-unit MS.139; open-circuit in 'auto'. |
| | 14 | +30V unstabilized | Output | +30V nom. = 30V unstabilized supply available; open-circuit = 30V supply not available. |
| | 15 | +30V stabilized | Output | +30V = stabilized supply to line-switching-unit MS.139 available; open-circuit for other conditions. |
| 4SK1 | Coax. | High-power (50Ω) r.f. signal from linear amplifier | Input | 1.25 kW (max.), 1.6 to 30 MHz. |
| 1SK1 | Coax. | High-power (50Ω) r.f. signal from MA.1004 | Output | 1.25 kW (max.), 1.6 to 30 MHz. |

8. The only fault indicator fitted to the MA.1004 is the SERVO LIMIT indicator lamp which glows if either inductor is driven to the limit of its travel. If this occurs, initiate another tuning sequence by depressing the TUNE push-button. If the fault persists, refer to para. 12.

Initial fault-location procedure

9. Proceed as follows:-

(1) Check that all connectors are firmly made.

(2) Check that the circuit-breaker 2CB1 is set to ON and that the front-panel SUPPLY lamp is glowing.

(3) Check that circuit-breakers 2CB2 and 2CB3 are set to ON.

(4) Check that +30V is available at 2TP1 and that -30V is available at 2TP2; both these test points are on the power unit (Chap. 5-3).

Fault-location during manual operation

10. In the manual-operation condition, the servo stages are inoperative, hence, if a fault persists for both automatic and manual operation, this must exclude all stages concerned with automatic tuning.

11. The range board functions in the same manner as for automatic operation except that, in the manual condition, it also controls the coaxial line-switching relays. The descriptions and diagrams of Chap. 5-3 provide an

essential aid to fault-location, and the extender boards in the accessory kit are necessary when testing the range, tune and servo pre-amplifier boards.

Fault-location during automatic operation

12. In the automatic-operation condition, fault-location is attempted assuming one of four fault symptoms.

(1) Servo motors will not rotate (Table 2).

(2) Servo motors will not coarse-tune correctly (Table 3).

(3) Servo motors will not rotate in fine-tune condition (Table 4)

(4) Servo motors will not fine-tune correctly (Table 5).

- Is the initial procedure (para. 4) satisfactory ?
  - No: Check power supply unit
  - Yes: Is MANUAL range switch set to AUTO
    - No: Set to AUTO
    - Yes: Is MA.1004 receiving a 'servos off' signal at 5PL2-9 ?
      - Yes: Remove the signal
      - No: Is r.f. drive of 25 mW in the range 1.6 MHz to 30 MHz present at 5PL1 ?
        - No: Apply correct drive input
        - Yes: Is the TUNE lamp glowing ?
          - No: Depress the TUNE button
          - Yes: Is there an output at 3TP1 and/or 3TP2
            - Yes: Is there an output from the servo power amplifier(s)
              - Yes: Check gearbox(es) and motor(s)
              - No: Check servo Power amplifier(s)
            - No: Are the servo pre-amplifier supplies present ?
              - No: Check tune board
              - Yes: Is an error voltage being developed by the coarse-tune discriminators ?
                - Yes: Check servo pre-amplifiers
                - No: Is r.f. reaching the coarse-tune discriminators ?
                  - Yes: Check coarse-tune discriminator(s)
                  - No: Check C.V.A.

## TABLE 3

Servos will not coarse-tune correctly

---

Check that the low-power drive input is between 1.6 MHz to 30 MHz (at 25 mW to 200 mW).
If drive is correct, check the coarse-tune tracking (Chap. 5-2)

---

## TABLE 4

Servo motors will not rotate in 'fine' tune condition

---

Has coarse-tuning been carried out correctly ?

- No: <u>See Tables 2 and 3</u>
- Yes: Is the MA.1004 changing over to fine-tune i.e. is an output of 25-200 mW available at 5SK1
  - Yes: Is LK1 on the tune board connected ?
    - Yes: Temporarily remove the link (→ next question)
    - No: Is r.f. signal of at least 50W present at the high power r.f. input ?
      - No: <u>Check linear Amplifier</u>
      - Yes: Is the discriminator balance meter showing an error when set to tune and/or load ?
        - No: <u>Check the discriminator</u>
        - Yes: Is there an output on 3TP1 and/or 3TP2 ?
          - Yes: <u>Check servo power amplifiers</u>
          - No: Are the servo pre-amplifier supplies present ?
            - No: <u>Check the tune board</u>
            - Yes: <u>Check the servo pre-amplifiers</u>
  - No: Is r.f. drive of between 25 mW and 200 mW at 1.6 MHz to 30 MHz present at 5PL1 ?
    - No: <u>Apply r.f. drive</u>
    - Yes: Is the MA.1004 receiving a 'tune' signal ?
      - Yes: <u>Remove the 'tune' signal</u>
      - No: Is there an output on 3TP1 and/or 3TP2 ?
        - Yes: <u>Check servo motors for stiffness</u>
        - No: <u>Check tune board</u>

---

TABLE 5

Servos will not fine-tune correctly

- Is the drive frequency between 1.6 MHz and 30 MHz ?
  - No → Correct drive frequency
  - Yes → Is the unit coarse-tuning correctly ?
    - No → See Table 3
    - Yes → Is the high-power r.f. output terminated in a suitable load i.e., up to 3:1 v.s.w.r. at 50 ohm ?
      - No → Terminate the r.f. output
      - Yes → Is the combination of capacitors selected appropriate to the frequency of operation ?
        - Yes → Are the amplitude and phase discriminator set up correctly ?
          - Yes → Inspect the components of the high-power network for damage
          - No → Reset the discriminators (Chap. 5-2)
        - No → Is the microswitch bank correctly set up ?
          - Yes → Check the range board
          - No → Reset microswitch bank (Chap. 5-2)

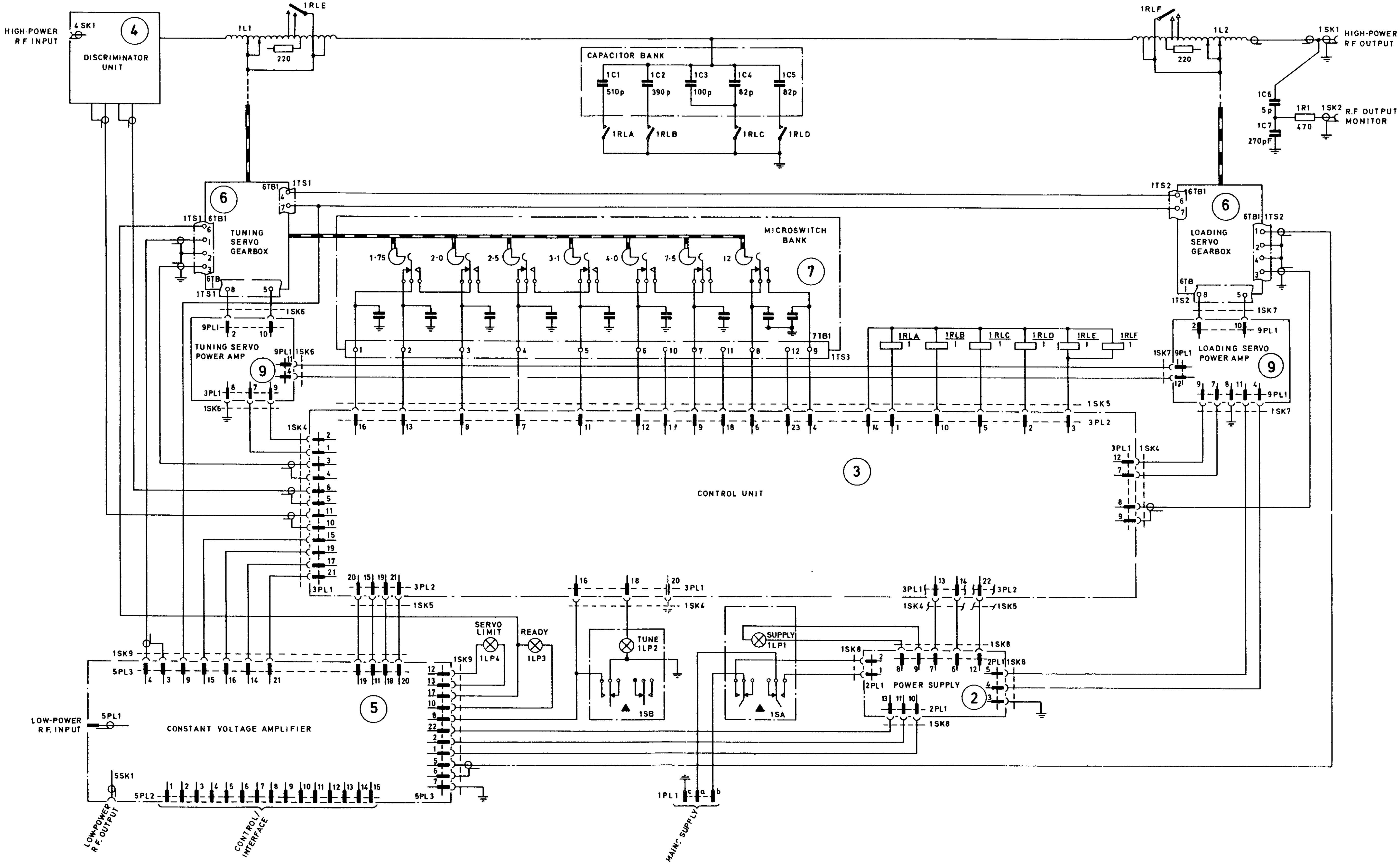



Fig 1 **MA.1004 Feeder matching unit: interconnection diagram** Fig 1

Chapter 5-2

# OVERALL PERFORMANCE TESTS AND REPAIR

# ADAPTOR, ANTENNA TO TRANSMITTER 10AD/5820-99-624-5394

# (MA.1004 FEEDER MATCHING UNIT)

CONTENTS

## INTRODUCTION

1. This chapter gives instructions for the removal and refitting of sub-assemblies, mechanical re-alignment procedures and electrical re-alignment procedures required for 3rd-line repair of the unit. A list of test equipment is given in para. 2 of Chap. 5-1.

WARNING...

DURING OPERATION, HIGH LEVEL RF VOLTAGES ARE PRESENT AT THE RF INPUT AND RF OUTPUT CONNECTIONS; MAINS SUPPLY VOLTAGES ARE ALSO PRESENT. THESE CONNECTIONS ARE ACCESSIBLE WHEN THE HINGED FRONT PANEL IS LOWERED. ENSURE THAT POWER IS REMOVED BEFORE BREAKING THESE CONNECTIONS.

## SETTING-UP PROCEDURE

2. Following any 3rd-line repairs, the setting-up procedure given in Chap. 1-1 (TTA.1860A) or Chap. 13-1 (TTA.1860S and MA.1721S) must be carried out.

## TRANSMITTER PERFORMANCE CHECK

3. Following any 3rd-line repairs, the relevant performance checks given in Chap.1-4 (TTA.1860A) or Chap. 13-4 (TTA.1860S and MA.1721S) must be carried out.

## REMOVAL AND REPLACEMENT OF SUB-ASSEMBLIES

4. The dismantling and reassembly instructions detailed in the following paragraphs assume that the feeder matching unit has been isolated from all electrical supplies and removed from the transmitter cabinet to a suitable bench, as described in Chap. 1-3 (TTA.1860A) or Chap. 13-3 (TTA.1860S and MA.1721S). The following boards and sub-assemblies can be removed while the MA.1004 is still installed in the transmitter cabinet:-

(1) Constant-voltage amplifier assembly MS.452.

(2) Servo pre-amplifier board PS.108.

(3) Range board PS.60.

(4) Tune board PS.59.

### Control unit MS.450 : removal

5. (1) Place the feeder Matching Unit on its side.

(2) Remove the four control unit fixing screws from the bottom panel.

(3) Place the MA.1004 on its base and lower the main front panel.

(4) Remove the sockets mating with plugs 3PL1 and 3PL2.

(5) Remove the two fixing screws at the top of the control unit cover.

(6) Remove the two fixing screws at the top of the AUTO/MANUAL switch mounting plate.

(7) Release the retaining arms at each side of the MA.1004 panel and lower the front panel to its fullest extent.

(8) Remove the control unit by sliding it forward and tilting it slightly to clear the lower flange of the MA.1004.

Control unit : replacement

6. (1) Refit the control unit in the MA.1004.

(2) Replace, but do not tighten, the four front panel fixing screws.

(3) Place the unit on its side and replace, but do not tighten, the four fixing screws on the bottom panel.

(4) Tighten the front panel fixing screws.

(5) Tighten the bottom panel fixing screws.

Control unit MS.450 : removal of boards PS.108, PS.60 and PS.59

7. (1) Lower the hinged front panel of the MA.1004.

(2) Remove the five screws securing the right-hand front panel of the control unit.

(3) Carefully withdraw the required board (fig. 5, Chap. 5-3).

(4) Refit in the reverse order.

Servo power amplifier MS.265 : removal

8. (1) Remove the MA.1004 from the cabinet.

(2) Remove the bottom cover (eleven screws) from the MA.1004.

(3) Disengage the relevant multi-way connector (fig. 12, Chap.5-3).

(4) Release the four captive screws painted green.

(5) Remove the servo power amplifier assembly.

Servo power amplifier : replacement

9. Replace the sub-assembly by reversing the procedure of para. 8.

Constant-voltage amplifier MS.452 : removal

10. (1) Lower the hinged front panel of the MA.1004.

(2) Disconnect the cables from 5PL1 and 5SK1.

(3) Release the slide-locks and disconnect the multi-way connectors.

(4) Remove the cover from the MS.452 (fig. 2, Chap. 5-0 and fig. 18, Chap. 5-3).

(5) Remove the four hexagon-shaped pillars.

(6) Withdraw the sub-assembly.

Constant-voltage amplifier : replacement

11. Replace the sub-assembly by reversing the procedure of para. 10.

Counter and drive assemblies : removal

WARNING...

A COUNTER AND DRIVE ASSEMBLY MUST NOT BE REMOVED WHEN AN R.F. INPUT IS APPLIED TO THE MA.1004.

12. (1) Remove the top cover of the feeder matching unit.

(2) Lower the front panel and remove the four fixing screws securing the appropriate assembly (fig.3, Chap. 5-0).

(3) Remove the counter and drive assembly ensuring that the drive coupling does not fall down inside the unit.

Counter and drive assemblies : replacement

13. Replacement of a counter and drive assembly is effected by reversing the procedure detailed in para. 12. Before replacing an assembly, refer to the re-alignment procedure detailed in para. 34.

Power supply MS.448 : removal

14. (1) Remove the top cover of the MA.1004.

(2) Lower the front panel and disconnect the socket mating with 2PL1.

(3) Remove the four power supply fixing screws located near each corner of the aperture for the circuit-breakers 2CB1, 2CB2 and 2CB3.

(4) Remove the two screws at the bottom rear of the power supply unit, and disconnect the r.f. output cable braid from the right-hand side of the unit.

(5) Slide the power supply back to its fullest extent and lift it out, front first, from the MA.1004.

(6) To obtain access to the power supply components (including board PS.57), place the unit on a bench, remove the five cover securing screws on each side and lift off the cover.

Power supply : replacement

15. Replace the power supply by reversing the procedures in para. 14.

Loading coil and gearbox assembly : removal

16. (1) Remove the power supply unit (para. 14).

(2) Remove counter and drive assembly (para. 12).

(3) Disconnect the r.f. output cable.

(4) Slacken off the fanning strip securing screws and remove the fanning strip.

(5) At the capacitor bank, disconnect the strap connected between the capacitor bank and the loading coil.

(6) Support the coil and remove the six screws securing the assembly to the side member.

(7) Lift the assembly clear from the feeder matching unit.

Loading coil and gearbox assembly : replacement

17. (1) Return the loading coil and gearbox assembly to its position in the MA.1004.

(2) Support the coil and replace, but do not tighten, the six screws securing the assembly to the side member.

(3) Replace the counter and drive assembly.

(4) Slide the coil and gearbox forward to its fullest extent to engage the coupling, and tighten the six screws securing the assembly to the side member.

(5) Replace the strap connector between the capacitor bank and the loading coil.

(6) Replace the fanning strip.

(7) Replace the r.f. output cable and the silver plated fixings.

(8) Replace the power supply unit (para. 15).

(9) Re-align the counter and drive assembly (para. 34).

(10) Carry out the coarse-tune tracking procedure (para. 39).

Tuning coil and gearbox assembly : removal

18. (1) Remove the power supply unit (para. 14).

(2) Disconnect the coil end of the strap from the discriminator unit.

(3) Remove the strap connected to the capacitor bank.

(4) Slacken off the fanning strip securing screws and remove the fanning strip.

(5) Remove the access cover on the rear panel of the MA.1004.

(6) Look through the access hole in the rear panel to locate the coupling to the microswitch bank.

(7) Loosen the two bottom 6-32 UNC grub screws on the coupling, rotating the tune control to locate the screws.

(8) Remove the counter and drive assembly (para. 12).

(9) Support the coil and remove the six screws securing the assembly to the side member.

(10) Lift the assembly from the feeder matching unit.

Tuning coil and gearbox assembly : replacement

19. (1) Return the tuning coil and gearbox assembly to its position in the MA.1004, and ensure that the coupling mates with the microswitch bank shaft. Do not tighten the grub screws.

(2) Replace, but do not tighten, the six screws securing the assembly to the side member.

(3) Replace the counter and drive assembly.

(4) Slide the coil and gearbox forward to its fullest extent and tighten the six screws securing the assembly to the side member.

(5) Re-align the counter and drive assembly (para. 34).

(6) If necessary, re-align the microswitch bank coupling (para. 35).

(7) Replace the straps and fanning strip removed in operations (3), (4) and (5) of para. 18.

(8) Replace the power supply unit (para. 15).

(9) Carry out the coarse-tune tracking procedure (para. 39).

(10) Carry out the electrical microswitch bank alignment procedure (para. 40).

(11) Switch off and replace covers.

Discriminator unit MS.449 : removal

20. (1) Remove the top cover of the MA.1004.

(2) Remove the power supply unit (para. 14).

(3) Disconnect the strap between the discriminator and the tuning coil.

(4) Lower the front panel and remove the discriminator unit cover.

(5) Use a soldering iron to remove the connections to pins 3, 4, 6 and 7 of the board, noting their positions for replacement.

(6) Release the retaining arm on the left-hand side of the front panel, and lower the panel to its fullest extent.

(7) Remove the fixing screws securing the unit and withdraw it from the MA.1004.

Discriminator unit : replacement

21. Replacement of the discriminator unit is effected by reversing the procedures detailed in para. 20.

Capacitor bank : removal

22. (1) Remove the top cover of the MA.1004.

(2) Remove the strap connecting the capacitor bank to the tuning coil.

(3) At the capacitor bank, disconnect the strap to the loading coil.

(4) Remove the four corner fixing screws and lift the capacitor bank out from the MA.1004.

Capacitor bank : replacement

23. To replace the capacitor bank reverse the procedures detailed in para.22.

Microswitch bank : removal

24. (1) Remove the access cover on the rear panel.

(2) Rotate the tune control to locate the screws in the coupling and slacken only the bottom two 6-32 UNC grub screws in the coupling.

(3) Place the MA.1004 on its right-hand side (as viewed from front).

(4) Remove the bottom panel.

(5) Disconnect the fanning strip from the microswitch bank.

(6) Remove the four fixing screws and remove the microswitch bank.

Microswitch bank : replacement

25. Replacement of the microswitch bank is effected by reversing the procedures detailed in para. 24. Before tightening the grub screws in the coupling, refer to the mechanical and electrical re-alignment procedures detailed in para. 35 and 40.

Capacitor bank solenoids 1RLA to 1RLD : removal

26. (1) Remove the capacitor bank (para. 22).

(2) Remove the bottom cover and disconnect the two wires to the appropriate solenoid.

(3) Remove the two screws securing the solenoid to the platform and remove the solenoid.

Capacitor bank solenoids 1RLA to 1RLD : replacement

27. Replacement of a capacitor bank solenoid is effected by reversing the procedures detailed in para. 26.

Coil solenoids 1RLE and 1RLF : removal

28. (1) Remove the appropriate coil and gearbox assembly (para. 16 or 18).

(2) Remove the bottom cover and disconnect the two wires to the solenoid.

(3) Remove the two fixing screws and remove the solenoid.

Note...

Solenoids 1RLE and 1RLF carry insulating caps at the end of the plungers; solenoids 1RL2 to 1RLD do not. All solenoids are otherwise identical.

Coil solenoids 1 RLE and 1RLF : replacement

29. Replacement of a coil solenoid is effected by reversing the procedures detailed in para. 28 (2) and (3) and referring to the replacement procedure for the appropriate coil and gearbox assembly.

ADJUSTMENTS AFTER REMOVAL/REPLACEMENT

30. The following paragraphs cover the mechanical and electrical alignment procedures, the relevant parts of which should be carried out when sub-assemblies are replaced after repair, or if the fault location procedure (Chap. 5-1) indicates a mis-aligned component.

MECHANICAL RE-ALIGNMENT

31. Whenever a coil and gearbox is removed, it is necessary to re-align the counter and drive assembly (para. 34) and to reset the coarse tune tracking (para. 39). In addition, when the 'tune' coil (IL1) and gearbox is removed, it is necessary to re-align the microswitch bank coupling and operating cams.

32. The mechanical re-alignment procedure is carried out with all power removed from the MA.1004.

Note...

Refer to Chap. 1-3 (TTA.1860A) or Chap.13-3 (TTA.1860S and MA.1721S) for the routine servicing checks and lubrication details for the gears within the gearboxes.

Coil and gearbox

33. The following procedure is applicable to each inductor and gearbox, and is carried out with the assembly on the bench.

(1) Slacken the grub screw securing the gearbox microswitch-striker-arm, and ensure that the arm is free to move on its shaft.

(2) Rotate the coil shaft manually until the rotor reaches the mechanical stop at the gearbox end of the shaft, ensuring that the air-spaced variable capacitor does not reach the limit of its travel.

(3) Check that the tips of vanes of the air-spaced variable capacitor are approximately 3 mm from complete engagement. If positioning is incorrect, remove the terminal block from the gearbox assembly to gain access to the solid coupling between the capacitor and gearbox. Slacken the two grub screws securing the capacitor shaft and rotate the capacitor to achieve the above condition. Tighten the two grub screws to lock the capacitor.

(4) Rotate the coil until the rotor is equi-distant from the two mechanical end stops (total mechanical travel is approximately 36 turns), then move the microswitch-striker-arm until it lies midway between the two microswitches. Tighten the grub screw to lock the striker-arm in position.

(5) Rotate the coil shaft until the rotor reaches a quarter-turn from the mechanical stop at the opposite end of the coil from the gearbox. Adjust the striker screw for microswitch SA so that the switch just operates, and lock the screw.

(6) Rotate the coil shaft until the rotor reaches a quarter-turn from the mechanical stop at the gearbox end of the coil. Adjust the striker-screw for microswitch SB so that the switch just operates, and lock the screw.

(7) The coil and gearbox assembly is now mechanically aligned and ready for fitting into the unit.

Counter and drive assembly

34. The counter and drive assembly should be aligned, in conjunction with its associated coil and gearbox, as follows.

(1) Wind the appropriate drive handle counter-clockwise until the rotor reaches the mechanical end-stop.

(2) Rotate the handle clockwise until the rotor contacts are adjacent to the fixed shorting-link on the coil assembly. If the counter indicates 100, it is correctly aligned.

(3) If the reading is not 100, proceed as follows:-

(4) Remove the four screws fixing the counter and drive assembly to the sub-front-panel and withdraw the counter and drive, taking care to support the drive coupling block.

(5) Remove the block.

(6) Wind the handle until the counter reads 100, and check that the rectangular metal drive-block then lies with its main axis at $90^{\circ}$ to the axis of the driven block.

(7) If the drive-block position is incorrect, slacken the grub screw securing the large bevel gear and rotate the gear relative to the shaft to achieve this condition; take care not to overmesh the gear. Tighten the grub screw to lock the gear.

(8) Replace the drive coupling block and the counter and drive assembly and then re-check that the counter reads 100.

Microswitch bank coupling

35. Re-alignment of the coupling between the coil and gearbox and the microswitch bank should only be necessary when either unit has been removed and the relationship between the gearbox shaft and the coupling has been disturbed.

(1) Before re-fitting the coil and gearbox, slacken the grub screws in the coupling and slide the coupling to the bottom of the microswitch bank shaft.

(2) When the coil and gearbox assembly has been refitted, remove the rear and side access covers and slide the coupling up the shaft until it is fitted to an equal distance on both shafts.

(3) Rotate the coupling until it lies in such a position that when the coil rotor is moved from end to end, all four grub screws will be accessible through the rear cover. Tighten the two grub screws on to the coil and gearbox shaft.

(4) Remove the side access cover and rotate the microswitch bank shaft so that all the cam securing grub screws will be accessible when the coil rotor is rotated throughout its complete range. Tighten the remainder of the grub screws in the coupling.

(5) Replace the rear access cover.

Note...

Whenever the microswitch bank coupling is disturbed, the electrical re-alignment procedure (para. 40) must be carried out.

ELECTRICAL RE-ALIGNMENT

Power supplies

36. Re-alignment of the power supplies consists of adjusting the voltage of the positive and negative stabilized 30V outputs. The supplies can be monitored at 2TP1 and 2TP2 on the sub-panel and are adjusted by 2AR23 and 2AR26 respectively. Access may be gained to these components by removing the top cover of the MA.1004.

WARNING...

REMOVAL OF THE TOP COVER EXPOSES MAINS AND R.F. VOLTAGES.

Coarse-tune discriminator input level adjustment

37. The input to the coarse-tune discriminators is adjusted as follows, with the MA.1004 on a bench and the front panel lowered.

(1) Connect the MA.1004 to a mains power supply, and select AUTO on the range switch.

(2) Remove the cover from the constant-voltage amplifier (c.v.a.) and connect an electronic multimeter to pins 22 and 24 (earth) of the PS.58 board in the c.v.a.

(3) Connect a signal generator to 5PL1, and set its output to 100 mW r.m.s. at 10 MHz.

(4) Switch on the MA.1004 and check that the output indicated on the electronic multimeter is 1.8V r.m.s. If the reading is incorrect adjust 5AR2 to suit.

(5) Switch off, remove test gear and replace covers unless further tests are to be carried out.

Servo pre-amplifier adjustment

38. The balance of the servo pre-amplifiers is adjusted as follows, with the MA.1004 on a bench and with the front panel lowered.

(1) Connect the MA.1004 to a mains supply and select AUTO on the MANUAL range switch. Do not apply an r.f. input

(2) Remove the control unit cover and unplug the tune board. Make a link between 3CTR19 collector and emitter. Replace the tune board and unplug the tune servo pre-amplifier board. Replace the servo pre-amplifier using the appropriate test extension board in the accessory kit (Chap. 5-1, para.3).

(3) Switch on the MA.1004.

(4) Connect a multimeter (+10V d.c. range) to the R10, R14, R15 junction (negative lead to earth) and check that a zero voltage is indicated. If incorrect, adjust R4 to suit, increasing meter sensitivity as necessary.

(5) Connect the positive lead of the multimeter to TP1; connect the negative lead to TP2 and check that the indication is zero. If incorrect adjust R19, increasing sensitivity as necessary.

(6) Switch off, remove test gear and replace covers unless further tests are to be carried out.

Coarse-tune tracking

39. The coarse-tune tracking is adjusted as follows.

(1) Check the coarse-tune discriminator input level; if there is any doubt about its accuracy refer to para. 37.

(2) With the MA.1004 on the bench, set the range switch to AUTO, and connect 1 PL1 to a power supply.

(3) Connect an r.f. signal generator to 5PL1 and adjust it to give between 25 and 200 mW at 1.6 MHz.

(4) If the readings are other than 125, use the special Type G potentiometer adjusting tool, and adjust the appropriate potentiometer 6AR7, via the access hole in the left side of the unit for 'tune' and the right side for 'load', to give counter indications of 125 in both cases.

(5) Adjust the signal generator frequency to 30 MHz. The two servo systems should run until the counters read 200. If the readings are other than 200, adjust the appropriate trimmer capacitor(s) 6AC1 via the same side access holes to bring both indicators to 200.

(6) Repeat operations (4) and (5).

Microswitch cam alignment

40. Before adjusting the microswitch cams, the coarse-tune tracking should be checked (para. 39).

(1) Carry out operations 39 (2) and (3), but adjust the signal generator frequency to 1.75 MHz. Allow the servo system to coarse-tune.

(2) Remove the side access cover, slacken the grub screw in the bottom cam and adjust its position so that the appropriate microswitch is just operated (listen for click). Ensure that this cam cannot operate the adjacent microswitch. Lock the cam.

(3) Adjust the signal generator frequency above and below 1.75 MHz and check that the switch makes and breaks either side of 1.75 MHz.

(4) Repeat operation (3) at 2.0 MHz adjusting the second cam.

(5) Repeat operation (3) at 2.5 MHz adjusting the third cam.

(6) Repeat operation (3) at 3.1 MHz adjusting the fourth cam.

(7) Repeat operation (3) at 4.0 MHz adjusting the fifth cam.

(8) Repeat operation (3) at 7.5 MHz adjusting the sixth cam.

(9) Repeat operation (3) at 12.0 MHz adjusting the seventh cam.

Alignment of fine-tune discriminators

41. The fine-tune discriminators can only be aligned when the MA.1004 is installed in the transmitter cabinet.

(1) Ensure that the transmitter is switched off. Remove the fine-tune discriminator unit cover. Set potentiometer 4AR16 to the fully counter-clockwise position.

(2) Connect the directional wattmeter and detecting element (Chap. 5-1, para.2) in the coaxial cable connected to the input of the MA.1004.

Note...

The additional cable used to connect the wattmeter must be kept as short as possible.

(3) Terminate the transmitter antenna output in the 50-ohm, 1 kW dummy load (Chap. 5-1, para. 2).

(4) Disconnect the coaxial cable to 5PL1 on the constant-voltage amplifier assembly. Connect an h.f. signal generator to 5PL1 and adjust its output to 10 MHz and output level to between 25 and 200 mW.

(5) Set the MA.1004 range switch to 7.5 - 12 MHz and the LINE switch to LINE 1.

(6) Refer to the coarse-tune graph (Chap. 1-2 or 13-2) and set the TUNE and LOAD controls to the 10 MHz position.

(7) Switch on the transmitter and manually tune (Chap. 1-2 or 13-2) the MA.1004 for minimum reflected power; note the output (forward) power.

(8) Switch to LINE 2, re-tune the MA.1004 and note the output power.

(9) Repeat operation (8) for LINES 3 and 4.

(10) Select the line which gave maximum output power and re-tune the MA.1004 for minimum reflected power.

(11) Set the switch on the discriminator unit to TUNE and adjust 4AR4 on the discriminator board to obtain a centre-zero indication on the meter.

(12) Set the switch on the discriminator unit to LOAD and adjust 4AR10 on the discriminator board to obtain a centre-zero indication on the meter.

(13) Set the MANUAL switch to AUTO.

(14) Disconnect the signal generator.

(15) Press the TUNE button.

(16) Adjust the signal generator frequency to 3 MHz, and re-connect it.

(17) Allow the MA.1004 to tune (READY lamp glowing), then set the MANUAL switch to SERVOS OFF.

(18) If the power output of the transmitter is 820W or above, no further action is required.

(19) If the power output is below 820W, adjust the TUNE manual control to give 820W output.

(20) Set the METER switch on the discriminator to OFF and carefully note the needle position (which may not be exactly central).

(21) Set the METER switch to TUNE and adjust the preset control 4AR16 until the needle is at the same position as noted in operation (20).

(22) Set the MANUAL switch to AUTO.

(23) Switch off the transmitter.

(24) Remove the test equipment.

(25) Refit the coaxial cable to 5PL1.

# Chapter 5-3

## CIRCUIT DESCRIPTION OF SUB-ASSEMBLIES

## ADAPTOR, ANTENNA-TO-TRANSMITTER 10AD/5820-99-624-5394

## (Feeder matching unit MA.1004)

CONTENTS



TABLES

## ILLUSTRATIONS



INTRODUCTION

1. The overall function of the unit is given in Chap.5-0; this chapter gives a detailed circuit description of the sub-assemblies, the majority of which are printed circuit boards.

2. Each board carries a prefix code, as given in Chap.5-0, para.7; the prefix codes are, generally, omitted from component references in this chapter unless the omission can cause ambiguity.

OVERALL CIRCUIT (prefix code 1)

3. The overall circuit connections are mainly self-evident, or have been discussed in Chap. 5-0. Capacitors 1C6 and 1C7 form a potential divider which provides a sample of the r.f. output at 1SK2 (via 1R1) for monitoring purposes (Chap.5-1, fig.1).

POWER SUPPLY MS.448 (prefix codes 2 and 2A)

4. Components of the PS.57 board within the power supply are prefix coded 2A; other components are coded 2. All input and output connections to the unit are made via a fifteen-way connector to the front of the unit. The circuit diagram is given in fig.4 and component layouts in figs. 2 and 3.

5. The unit provides the following outputs:-

(1) +30V (nominal) unstabilized d.c. at 1.5A.

(2) -30V (nominal) unstabilized d.c. at 1.5A.

(3) +30V stabilized d.c. at 1.5A.

(4) -30V stabilized d.c. at 0.2A.

6. The circuit utilizes a single-phase transformer with two secondary windings each feeding a bridge rectifier and reservoir capacitor. The supply input is fed via a circuit-breaker CB1; the rectified outputs are protected by damped circuit-breakers in each supply rail. If a circuit breaker trips, both the stabilized and unstabilized outputs of the appropriate polarity are interrupted (para. 10, Note); the stabilized outputs are also individually protected by electronic trip circuits (para. 8).

7. The positive stabilizer circuit operates as follows. Zener diode 2AD3 and resistor 2AR20 provide a stable reference voltage which is applied to the emitter of 2ATR6. A sample of the output voltage is fed via the potential divider chain 2AR22, 2AR23 and 2AR24 to the base of 2ATR6 and is compared with the reference voltage; if the output voltage tends to be high the conduction of 2ATR6 is increased, reducing the voltage at 2ATR5 base. Transistors 2ATR5 and 2TR1 are emitter-followers which provide current gain, therefore the reduced voltage at 2ATR5 provides a reduced output voltage. The output level, which may be set by adjusting 2AR23, is therefore maintained at a sensibly constant level.

8. The positive current-trip circuit operates as follows. The output current is fed via 2AR10 and a proportion of the voltage developed across 2AR10 (determined by the potential divider 2AR8, 2AR12) is applied across the base and emitter of 2ATR1. When this voltage reaches the trip level, 2ATR1 conducts, driving 2ATR3 into conduction. A rapid change of state then occurs because, as 2ATR3 conducts, 2ATR1 is also driven more fully thus causing both transistors to 'latch' in the fully conducting condition.

9. The voltage at the collector of 2ATR3 drops to about 0.5V causing the voltage at 2ATR6 collector to drop to about +1.2V (via D1). The output voltage is, therefore, effectively reduced to zero and can only be reset by switching off the mains supply, allowing time for capacitor 2C1 to discharge (about 10 seconds), then switching on again.

10. The negative stabilizer and trip circuit operates in a similar manner to that described for the positive circuit.

Note...

On some units the +30V supply to the stabilizer stages is not routed via circuit-breaker 2CB2.

<u>CONTROL UNIT MS.450</u> (prefix code 3)

11. The control unit is an aluminium box containing the logic circuits, capacitor switching and timing circuits and servo pre-amplifiers. These stages are mounted on four plug-in boards which mate with a motherboard inside the unit. Also contained in the unit are switches for manual control, a power transistor to provide a switched supply to the cabinet line-switching relays during fine-tuning and a relay used to switch the servo pre-amplifier inputs to either the coarse-tune or fine-tune discriminators. The control unit prefix code is 3 and the individual boards within the unit carry the following codes.

(1) Code 3A : motherboard PW.178.

(2) Code 3B : range board PS.60

(3) Code 3C : tune board PS.59

(4) Code PS.108 (tune) : tune pre-amplifier PS.108

(5) Code PS.108 (load) : load pre-amplifier PS.108

The circuit diagram is given in fig.6 and component layout in fig.5.

12. The motherboard provides interconnections between the boards plugged into it, and includes r.f. filtering components for the servo pre-amplifier inputs. The main function of the range board is to select the appropriate capacitors from the capacitor bank to suit the selected frequency. The tune board performs most of the logic and timing functions associated with the tuning sequence. The two servo pre-amplifiers provide the high d.c. voltage gains necessary to raise the outputs from the discriminators to a level sufficient to drive the servo power amplifiers and motors. Transistor TR1 provides a supply for relay 3RLA and the line switching relays mounted in the transmitter cabinet, and is controlled from pin 27 of the range board (para. 23).

RANGE BOARD PS60 (prefix code 3B)

13. The range board encodes the range (frequency band) information from the microswitch bank or the manual range switch, and switches into the high-power circuit the correct combination of capacitors. It also switches the inductor solenoids and provides the necessary delays to prevent the capacitor and inductor solenoid-contacts making and breaking whilst r.f. drive is applied to the linear amplifier. During manual operation the circuits also switch the coaxial relays in the transmitter cabinet to provide one of four coaxial line lengths between the linear amplifier output and the MA.1004 input. The operation of these relays is also sequenced to prevent arcing at the contacts. The circuit diagram is given in fig.8 and component layout in fig.7.

14. A stabilized +30V supply is applied to pin 31 of the board; the earth connection is at pin 32.

Delay circuits

15. At the completion of coarse tuning, the input at pin 30 (normally at +30V) changes to approximately +2V, cutting-off TR1. After a delay, caused by C2 discharging to approximately 6V, TR6 is cut-off causing TR7 and TR8 to conduct and C4 to be rapidly charged via R13. The Darlington pair TR9 and TR11 are then driven into conduction, causing TR10 and TR12 to conduct and provide a +30V supply to the solenoids (via pin 27).

16. At the same time as TR6 turns off, TR2 and TR3 are also cut-off, allowing C3 to charge via R9 and R10. When the voltage across C3 rises to approximately 24V, transistor TR4 is cut off and TR5 is driven into conduction, providing an output to relay 5RLA (c.v.a.) which removes the low-level r.f. drive from the coarse-tune discriminator and routes it to the linear amplifier.

17. When changing from fine to coarse-tune, pin 30 is open-circuited and TR1 conducts, rapidly charging C2 through R4. TR2 and TR3 conduct, rapidly discharging C3 via R8; TR4 conducts and TR5 is cut-off. The relay 5RLA is thus de-energized and the r.f. input removed from the linear amplifier. At the same time as TR2-to-TR5 conduct, TR6 also conducts, cutting-off TR7 and TR8 and causing C4 to discharge through R14, R15 until, at approximately 6V, TR9, TR11, TR10, TR12 cut-off, de-energizing the solenoids.

18. In manual operation, the input to pin 30 is only briefly interrupted between manual ranges, therefore, TR1 acts as a pulse stretcher to ensure that the delays have sufficient time to operate.

Thyristor circuits

19. The thyristors CSR1 to CSR7 energize solenoids 1RLA to 1RLF to select the correct capacitor/inductor combination for the frequency range in use (Table 1).

20. The selected thyristors are triggered by a single pulse, which is generated at the same time as the solenoid supply is energized (para.23), and are reset by removing the supply. The +5V triggering pulse is generated by TR13 and returned, either via the microswitch bank (automatic operation) or via the range switch SA1 (manual operation), to the appropriate range input of the board (pin 25, 18, 16, 23, 24, 20, 8 or 5). The pulse is then steered to the appropriate thyristor(s) via diodes D8 to D11, D15 to D18 or D20, and applied to the gates of the thyristor(s) CSR1 to CSR 7.

21. Thyristors CSR1 to CSR5 control solenoids IRLA to IRLF which, in turn, switch capacitors IC1 to IC5 and the selected turns of IL1 and IL2. Thyristors CSR6 and CSR7 are used, in manual conditions only, to energise the line selector relays of the transmitter cabinet.

22. The solenoid IRLA to IRLF, and relay 3RLA (which switches the servo pre-amplifier inputs between coarse-tune and fine-tune discriminators) are energized by a slave transistor 3TR1 fed from pin 27.

Trigger pulse circuit

23. Transistor TR13 generates a single trigger pulse each time the voltage at pin 27 rises from 0 to 30V. When pin 27 is at 0V, C5 is discharged to approximately 11V via D23 and D6. When TR12 conducts (para.16) and pin 27 rises to +30V, capacitor C5 charges via D22, R19 and T13 base-emitter junction, thus driving TR13 into conduction. The collector voltage rises to approximately +30V and this is limited by R20, D7 to give a +5V pulse at pin 26. When C5 is almost fully charged the voltage across R18 falls to below 0.6V, cutting-off TR13 and causing the completion of the output pulse at pin 26.

TUNE BOARD PS.59 (prefix code 3C)

24. The tune board PS.59 contains circuits which:-

(1) control the coarse-tune, fine-tune, ready sequence

(2) detect when the servo motors are running

(3) switch the gain of the servo pre-amplifiers during tuning

(4) signal the state of the feeder matching unit.

25. The operation of the circuit is described, assuming a start from the 'in-coarse-tune' state and progressing through 'fine tune' to 'ready', and reverting to the 'in-coarse-tune' state due to a 'tune' signal. The circuit diagram is given in fig.10 and component layout fig.9.

Servo condition detector

26. The output of the two servo pre-amplifiers (para.45) are fed via pins 13 and 7 of the tune board, to transistors TR1 and TR2, which are non-inverting for positive inputs and inverting for negative inputs. The transistors provide approximately unity gain. The output at TR1 and TR2 collectors are,

TABLE 1

Selected capacitors and shorted-turns

| Range | Range board | | Solenoids energized | Capacitors in circuit | Total capacitance | IL1 and IL2 turns |
|---|---|---|---|---|---|---|
| | Input pulse | Outputs (low) | | | | |
| 1.6 to 1.75 MHz | Pin 25 | Pins 1 & 22 | 1RLA,1RLB | IC1,IC2 | 900 pF + strays | Not shorted |
| 1.75 to 2 MHz | Pin 18 | Pins 1,2,6 | 1RLA,1RLD,1RLC | IC1,IC5,IC3,IC4 | 774 pF + strays | Not shorted |
| 2 to 2.5 MHz | Pin 16 | Pins 1 & 2 | 1RLA,1RLD | IC1,IC5 | 592 pF + strays | Not shorted |
| 2.5 to 3.1 MHz | Pin 23 | Pin 1 | 1RLA | IC1 | 510 pF + strays | Not shorted |
| 3.1 to 4 MHz | Pin 24 | Pin 22 | 1RLB | IC2 | 390 pF + strays | Not shorted |
| 4 to 7.5 MHz | Pin 20 | Pin 6 | 1RLC | IC3,IC4 | 182 pF + stays | Not shorted |
| 7.5 to 12 MHz | Pin 8 | Pins 2 & 3 | 1RLD,1RLE,1RLF | IC5 | 82 pF + stays | Shorted |
| 12 to 30 MHz | Pin 5 | Pin 3 | 1RLE,1RLF | NONE | Strays only | Shorted |

therefore, equal to the magnitude of the corresponding pre-amplifier outputs, and are combined in the OR gate D1, D2. The greater of the two outputs is compared, by the long-tailed pair TR3, TR4, with a reference voltage of approximately 12V developed by R10 and R11.

27. When either output is greater than approximately +12V (which is less than the pre-amplifier output required to drive a motor against 'stiction') the 'servo running' condition is detected, and the collector of TR4 rises to approximately 27V. During'servo stopped' conditions, TR4 collector is at approximately 18V.

AND gate D3, D6

28. The output of TR4 (servo(s) running) and the r.f. detector (para.65) are combined in diodes D3, D6 which form an AND gate; the gate therefore gives a 0 volt output when:-

(1) the servo motors are not running, and

(2) r.f. drive is present at the detector.

29. Resistor R14 and capacitor C5 give a delay on the output of the gate so that, should r.f. drive be removed during coarse tuning and then re-applied, the servo pre-amplifier outputs will have time to recover and prevent TR7 from being spuriously turned on (para. 30).

Gate TR6, TR7

30. The output of AND gate D3, D6 is applied to TR7, and the output of pulse-stretcher TR5 (para. 39) is applied to TR6; TR6 and TR7 form gates which give approximately +20V on TR7 collector when:-

(1) both servos are stopped, and

(2) r.f. drive is present at the detector, and

(3) there is no 'tune' output from TR5.

These are the three conditions for coarse-tune/fine-tune changeover.

Bistable TR10, TR12 and TR13

31. When these three conditions (para. 30) are satisfied, the outputs of gates TR6 and TR7 cause the bistable TR10, TR12 and TR13 to changeover and latch; this is achieved by the 20V at TR7 collector which drives TR10 and TR12 into conduction and cuts-off TR13.

Relay and time-delay circuits

32. The conduction of TR10 and TR12 reduces the output at pin 16 to +2V (normally at approximately +6.5V) via D13, and energizes relay RLA via D16. Relay RLA contacts switch the gain of the pre-amplifiers (para.45). The cutting-off of TR13 causes the two delay circuits R27, C10 and R28, C11 to commence timing.

33. After approximately 1.5 seconds i.e. when C10 has charged to approximately 9V, TR14 turns on and operates RLC, provided that the +30V servo supply is available (para.35). The contacts of relay RLC are also used to switch the gain of the servo pre-amplifiers (para.45).

34. After a further delay of approximately 1.5 seconds capacitor C11 has charged to about 9V, driving TR15 and TR16 into conduction and producing a 'ready' (+30V) signal at pin 28; TR17 is therefore cut off, removing the 'tune' signal from pin 29.

## Servo supply switching circuit

35. The servos are switched off by removing the ± 30V supplies to the servo pre-amplifiers; this can be achieved by one of four methods.

(1) an external 'servos off' signal, routed via the c.v.a. (unit 5),

(2) an internal 'servos off' signal from switch 3SA (manual range switch),

(3) link LK1 on the tune board is normally connected to switch-off the servos when the 'ready' state is achieved,

(4) absence of the 'correct r.f.' signal (OV) at pin 20.

36. The first three signals are connected together and operate instantaneously; when any of these are present, approximately +30V is applied at pin 30 and this cuts off TR20 thus overriding TR19. TR20 to TR23 are therefore cut-off, removing the ± 30V supplies to the servo pre-amplifiers. The last signal operates via a delay so that, during keying, the servos will not be switched at the keying rate. During longer periods of 'no drive', however, the servos are inhibited to prevent long-term d.c. drift from driving the servos in the absence of a compensating discriminator output.

37. The incorrect r.f. signal (+30V) at pin 20 cuts off TR18 and, when C14 has discharged via R37, R38 to about 36V, TR19 is cut off. This cuts off TR20 to 23 as given previously and removes the servo supplies.

## Coarse-tune initiate circuit

38. A tuning sequence is initiated by a OV input to pin 23 which performs the following functions:-

(1) it resets the two delays R27, C10 and R28, C11 via R29, D21 and D24, thus de-energizing RLC and removing the 'ready' signal (para. 34).

(2) it resets the bistable TR10, TR12, TR13 via TR5 and TR6 by removing the supply to TR13 collector and removing the input to TR10 base.

39. TR5 is a pulse-stretcher which turns off for about 200 ms when a short (minimum 2 ms) OV 'tune' input is applied at pin 23; this ensures that the bistable has sufficient time to reset.

40. The reset bistable allows pin 16 to rise to about +6.5V (limited on the range board) and de-energizes relay RLA.

41. The control circuits are now reverted to the coarse-tune state and the unit is ready to retune to a new frequency.

## 'Manual'circuit

42. When manual operation is selected, a +30V input is applied to pin 25 via switches SA3 and SC1 (fig.4); this input drives TR8 into conduction, causing a 'tune' input to TR5; this causes an open-circuit output at pin 16 (para.27). Capacitor C8 charges via the coil of relay RLA, R21 and R22; when the voltage at C8 reaches approximately 2.5V, transistor TR9 is driven into conduction and the open-circuit at pin 16 is changed to a OV output, via D12, TR9, D11, TR8

and D9, thus giving a 'fine-tune' output to the range board.

43. During switch SA3 or SC1 selection, the input at pin 25 is momentarily interrupted; transistor TR9 is maintained in the conducting condition however, as C3 has insufficient time to charge via R47, preventing TR5 from conducting. After manual tuning, the switch SB must be set at the READY position to drive TR16 into conduction and indicate the 'ready' condition (para.38).

THE SERVO SYSTEMS

44. The MA.1004 contains two identical servo systems; one drives the input (tune) variable inductor, the other drives the output (load) variable inductor; each system consists of:

(1) a servo pre-amplifier (circuit diagram and component layout fig. 11)

(2) a servo power amplifier (circuit diagram and component layout fig. 12)

(3) a servo gearbox including coarse-tune discriminator (circuit diagrams fig. 13 and 14: component layouts fig. 13 and 15).

The inputs to the servo systems are derived from discriminators; the coarse-tune discriminators are part of the gearbox units (unit 9) and the fine-tune discriminators are unit 4.

SERVO PRE-AMPLIFIERS PS.108 (prefix code PS.108)

45. The two servo pre-amplifier circuits are identical, both being used to amplify the d.c. signals from the discriminators (fig. 11). The first stage is an operational amplifier IC1 whose gain is controlled by external relays 3ARLA and 3ARLC mounted on the tune board. The operational amplifier uses supply rails of +12V and -6V which are obtained by Zener stabilization from the ± 30V supplies to the remainder of the board. The offset in the input to the operational amplifier is countered by the potentiometer R4 which is adjusted to give zero output in the balanced state. The output from the operational amplifier is fed to a long-tailed pair, TR1 and TR2, and then to a second long-tailed pair TR3 and TR4; these two stages provide voltage amplification whilst minimizing any temperature drift.

46. The output from the second long-tailed pair is fed to the output transistors TR5 and TR6 which provide a relatively low output impedance to the servo power amplifier. The gain of the second stage of the amplifier is controlled by the feedback path, from the output of TR5 and TR6 to the output of the operational amplifier, through R16. The d.c. balance of the output stage is adjusted by setting R19 to give equal voltages at TP1 and TP2.

47. The gain of the servo pre-amplifier is controlled by external relays. In 'coarse-tune', the feedback is via R10 (1Mohm), and pin 11 is connected to pin 14 to discharge C2 if necessary. This condition gives the maximum loop gain.

48. During fine-tuning, pin 11 is externally connected to pin 9, placing R2 in parallel with R10. The gain given in this condition is sufficient to bring the system to almost the correct position but there may be a tendency to 'hunt' about the final position. When the 'ready' condition is obtained, pin 9 is connected to pin 14, switching C2 in parallel with R10 and providing a high d.c. gain and a slow a.c. response to give stability. The amplifier gain is approximately 1500 during coarse-tuning (pins 11 and 14 connected) and approximately 225 during fine-tuning (pins 9 and 11 connected).

49. The motor current feedback (current limit) signal is used to restrict stall-current levels in conjunction with the servo power amplifier board. When the output current from the servo power amplifier board reaches the current limit, a voltage is fed back to pin 4 on the servo pre-amplifier board.

50. When this signal is present, dominant negative feedback is applied to the long-tailed pairs on the servo pre-amplifier board via R17. This reduces the voltage gain of the pre-amplifier circuit and limits the current to a safe level during the normal tuning period. If however the high current persists for about 10 seconds, the appropriate circuit-breaker in the power supply trips, thereby protecting the servo motor(s).

SERVO POWER AMPLIFIERS MS.265 (prefix codes 9 and 9A)

51. Components on the PS.201 board are prefix coded 9A; other components are coded 9. The servo power amplifier (fig. 12) provides the current gain necessary to drive the servo motor, with a voltage gain slightly less than unity. Transistors TR1 and TR2 form a complex n.p.n. high-gain high-current transistor, and TR3, TR4 form a complex p.n.p. high-gain high-current transistor. The two complex transistors are arranged as a push-pull complementary pair. The diodes D1 to D6 provide the current-limit delay, so that the voltage developed across R1 must exceed ±3V approximately before an output to the servo pre-amplifier is given at pin 7.

COIL, MOTOR AND GEARBOX ASSEMBLY MS.451 (prefix codes 6 & 6A)

52. Components on the coarse-tune discriminator board are prefix-coded 6A, coils are coded IL1 and IL2, other components are coded 6.

Motor and limit switches (prefix code 6)

53. The motor M1 (fig. 14) is used to drive a variable inductor (IL1 'tune' or IL2 'load') through reduction gears. Limit switches SA1 and SB1 are used to electrically disconnect the motor before mechanical end-stops are reached. When the motor is driving towards the l.f. position, a positive voltage is applied at the input pin 8. If the microswitch SB1 is operated, the return path through the motor is opened and diode D2 places a short-circuit across the motor to give rapid braking. When the motor is required to retune the inductor to a higher frequency, a negative voltage is applied at pin 8, D2 is reverse-biased but D4 conducts, driving the motor away from the end-stop. A similar action occurs when the h.f. limit switch SA1 is operated.

54. Microswitch contacts SA2 and SB2 are used to signal a 'servo limit' condition.

Coarse-tune discriminator (prefix code 6A)

55. The coarse-tune discriminator PS.106 (fig. 15) provides a d.c. input to the servo system during coarse-tuning. The r.f. signal from the c.v.a. is fed via terminal 6TB1-1 to pin 1 of the board, and to transformer T1. The signal is then fed to a bridge circuit consisting of R1, R2, R3 and the preset capacitor 6C1. The outputs are detected from the junction of R3 and 6C2 and the wiper of R7.

56. Capacitor 6C2 is ganged to the output of the gearbox, and its position is adjusted during 'coarse-tuning' such that its impedance gives equal-voltage amplitudes at the two detection points. R7 allows the bridge circuit to be balanced at a frequency of 1.6 MHz. The preset capacitor 6AC1 allows the

bridge, after adjustment at 1.6 MHz, to be balanced at 30 MHz. The output from pin 3 is fed to the servo pre-amplifier.

FINE TUNE DISCRIMINATOR MS.449 (prefix code 4)

57. The phase discriminator compares the phase of the input r.f. voltage and current, and provides an output which causes the 'tune' inductor IL1 to be adjusted to give the resistive condition at the MA.1004 input. The amplitude discriminator compares the amplitude of the input r.f. voltage and current, and provides an output which causes the 'load' inductor to be adjusted to give an input impedance of nominally 50 ohms. The circuit diagram is given in fig.17 and component layouts in fig.16.

Phase discriminator

58. The phase discriminator accepts an input from 4L1, a current transformer on the r.f. input line which produces two equal voltages proportional to, and in phase with, the line current. The voltages are developed across 4AR2 and 4AR5. Components 4R1, 4R2 and 4AC4 form an R-C potential divider across the input which develops a voltage across 4AC4 proportional to, and lagging by $90^\circ$, on the line voltage; this voltage across 4AC4 is vectorially added to the two equal voltages across 4AR2 and 4AR5.

59. If the phase relationship is correct, the two resultants are equal in magnitude (fig.1) and, after rectification in 4AD1, 4AD2, they cancel in 4AR4 to produce zero outputs at pins 5 and 6.

60. If the phase relationship is incorrect, the two resultants become unequal in magnitude so that, after rectification, the cancellation is not complete and a d.c. output is produced. This output is fed to the servo pre-amplifier and causes the servo system to reduce the phase error.

61. Variable resistor 4AR4 is used to compensate for any unbalance in the discriminator and 4AR16 to correct the discriminator characteristic at the low-frequency end of the range.

Amplitude discriminator

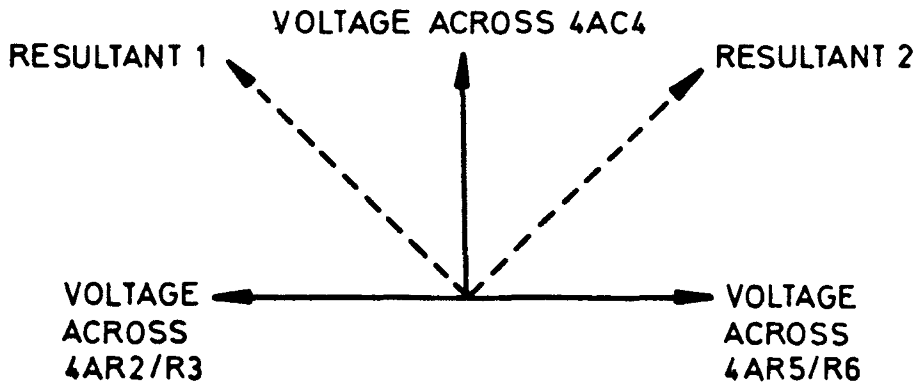
62. The amplitude discriminator is fed via 4L2, a current transformer on the input line which develops a voltage across 4AR11 proportional to line current. Components 4C1 and 4AC7 provide a capacitive potential-divider which develops a voltage across 4AC7 proportional to line voltage. These outputs are rectified in peak-to-peak detectors, and, if the impedance is correct, the outputs are equal in magnitude and cancel in 4AR10 to produce zero output at pins 2 and 3.

63. Resistor 4AR15 is included to correct the discriminator characteristic at the l.f. end of the range; resistors 4AR8 and 4AR12 reduce the effect of harmonics on the discriminator output.

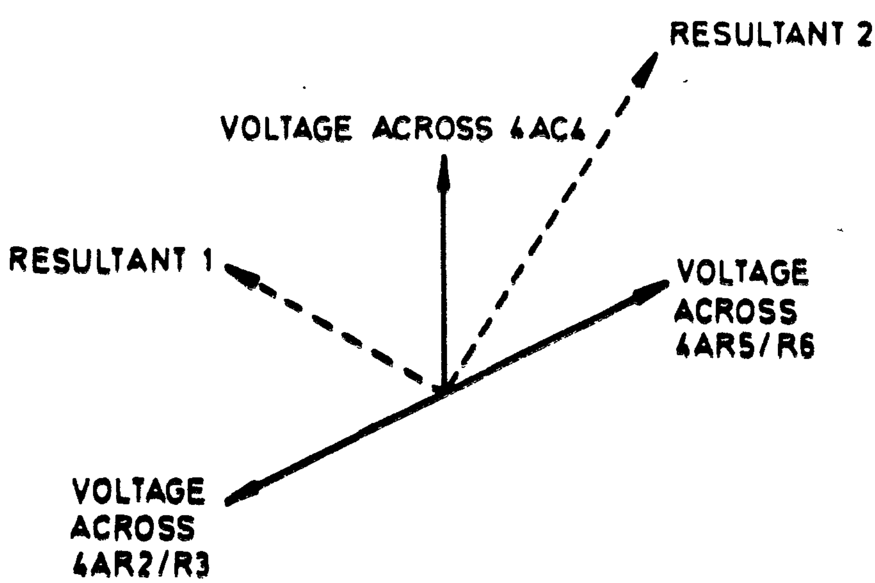
64. Meter 4M1, and its associated switch 4SA, is used to monitor the discriminator outputs, and is normally only used during manual tuning.

CONSTANT VOLTAGE AMPLIFIER MS.454 (prefix codes 5 and 5A)

65. Components on the PS.58 board of the constant voltage amplifier are prefix-coded 5A; other components are coded 5. The component layouts are given on fig.18.




(A) INPUT IMPEDANCE RESISTIVE




(B) INPUT IMPEDANCE REACTIVE

Fig.1 Phase discriminator vector diagrams : MA.1004

66. The c.v.a. contains the input and output circuits which interface the MA.1004 with the transmitter, the low-power r.f. switching relay, the r.f. detector and the constant-voltage amplifier. Apart from the high-power r.f. connections and the supply input, all external connections to the MA.1004 are made via the c.v.a. The required logic states of external control connections are +12V (nominal) or open-circuit for one state, and 0V for the second state. The connections are given in Chap. 5-1, and the circuit diagram is given in fig. 19.

Ready circuit

67. The +30V 'ready' or 0V 'not ready' signal from the tune board is applied to PL3-14, and is interfaced by TR2 to provide a 0V='ready' or +12V = 'not-ready' signal at PL2-3. An output is taken via R37 and PL3-10 to the front-panel READY indicator lamp, and, via R40 and PL2-7, to an external READY indicator lamp. Pin PL3-17 is connected to earth via the servo motor limit-switches so that the earth is removed if a 'servo limit' fault occurs (para.73). PL2-6 is the return for the external READY indicator lamp.

Coarse tune initiate circuit

▶ 68. Coarse tuning is initiated externally by a +12V or open-circuit input at PL2-8 (normal condition of the input is 0V). This signal is interfaced by TR5 to provide a 0V 'initiate' signal at PL3-8. An external signal (0V for 'initiate') may be applied to pin PL2-2 if required. TR5 can also provide a 0V 'mute' signal at PL2-14, for use whilst relay RLA/2 is energized. ◀

Servos-off circuit

69. The servos can be switched off by a 0V input at PL2-9, which is interfaced by TR9 to provide a +30V output at PL3-16. The normal input state is +12V or open-circuit.

Fault indicator circuit

70. Failure of the +30V or -30V stabilized supplies provides a fault output indication (0V = fault, +12V = normal) at PL2-1. The fault output is also provided when a servo-limit occurs (para.73). An earth input, normally derived from the transmitter cabinet contactor via PL2-4, is required before the fault circuit can operate.

71. When both the +30V and -30V supplies are available, TR14 is cut-off due to the reverse-bias on D21. In this condition, TR13 is conducting and TR12 and TR11 are cut-off, providing a +12V output at pin PL2-1, via D19 and R32. The output is limited at this voltage by the Zener diode D17.

72. If the -30V supply fails, TR14 is driven into conduction reversing the state of TR13, TR12 and TR11 and reducing the output to approximately +1.5V at PL2-1. If the +30V supply fails, there will be no voltage on D19+ and therefore on PL21, the fault output, unless this point is connected to an external source. In this event D19 is reverse-biased via R32. TR12 is therefore 'turned on' via R33 and this turns on TR11, reducing the voltage at PL2-1 to about +1.5V.

Servo limit circuit

73. A servo-limit fault (either 'tune' or 'load') applies an earth at PL3-9, which provides an external fault output (0V) at 5PL2-1 (via D16). The SERVO LIMIT indicator lamp is illuminated via R34, PL3-12 and PL3-13.

C.V.A. and relay RLA

74. When relay RLA/2 is energized by an earth at PL3-21, the low-power r.f. input at PL1 is routed directly to the output SK1. When the relay is de-energized, the input is fed to the c.v.a. via T2, and socket SK1 is earthed.

75. The r.f. signal from T2 is applied to the emitters of TR6, TR7, TR8 and TR10 via resistors R18, R19, R26 and R30. The collectors of TR7 and TR8 provide the output of the c.v.a., which is fed to the coarse-tune discriminators via T1, PL3-4 and PL3-5.

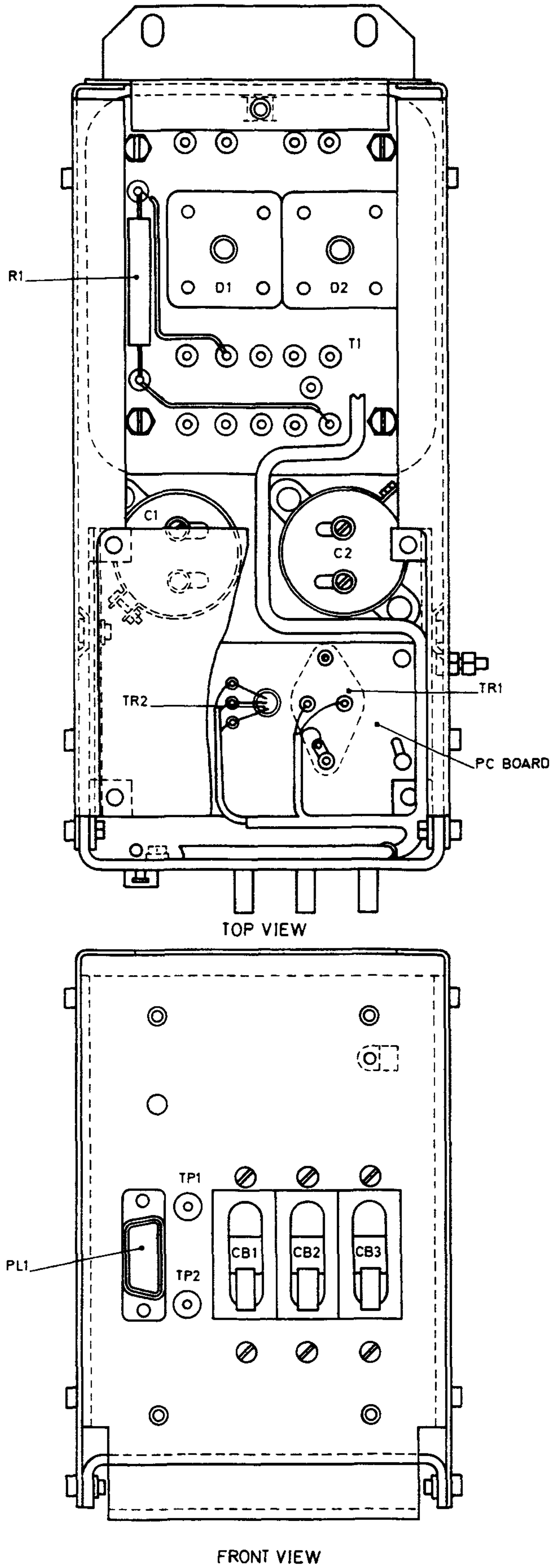
76. The output of T1 is also fed, via C4, to the detector stage D5, D6; the detected output is compared, by the long-tailed pair TR1 and TR3, with a reference level set by potentiometer R2. The output of the comparator, at TR3 collector, is amplified by TR4 and fed to TR6 and TR10, which act as variable shunts across TR7 and TR8. The output of the circuit is therefore, maintained at a constant level as pre-set by R2.

R.F. Detector

77. The r.f. input at PL1 is detected by the peak-to-peak detector D18, D20, whose output is used to drive TR15 into conduction which,in turn, drives TR16 into conduction. Transistor TR17 is then cut-off, disconnecting PL3-15 from the +30V supply and giving an open-circuit'r.f. detected' output at PL3-15. In the absence of r.f., TR17 turns on giving +30V at PL3-15.

MICROSWITCH BANK (prefix code 7)

78. The microswitch bank consists of seven microswitches which are operated by cams on a shaft driven by the 'tune' motor-and-generator unit. Switch positioning at the completion of coarse tuning is, therefore, related to input frequency. The positions of the cams are adjusted so that microswitches operate, in succession, at the frequency-range changeover points. The microswitch contacts are wired so that the highest frequency-range selected inhibits all the lower-range outputs. The output of the switchbank is fed to the range board in the control unit where it is used to select the combination of capacitors and shorted-inductor turns appropriate to the operating frequency. The circuit diagram is given in fig.21 and component layout in fig.20.




# Fig. 2 Power supply unit MS448: component layout

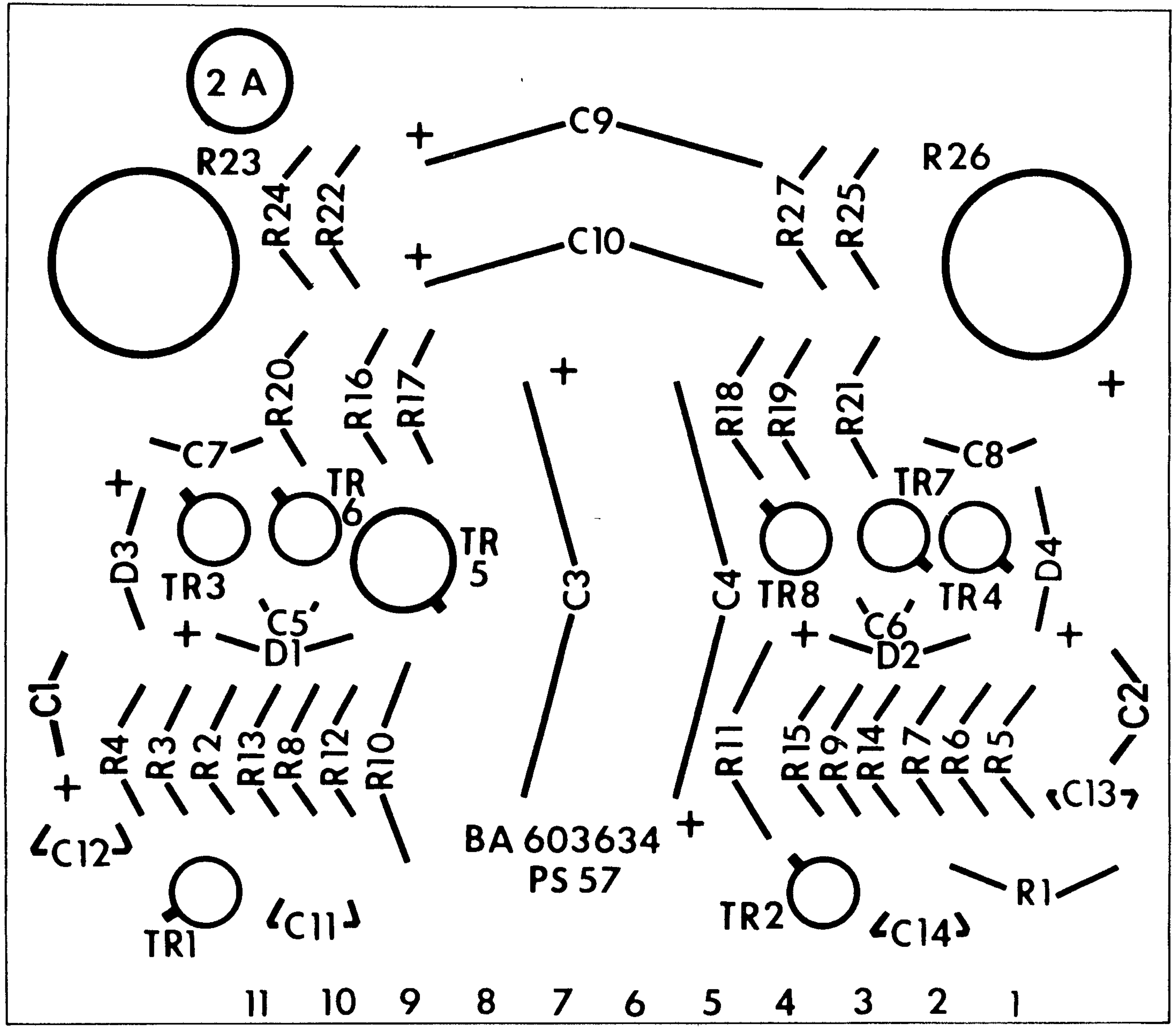
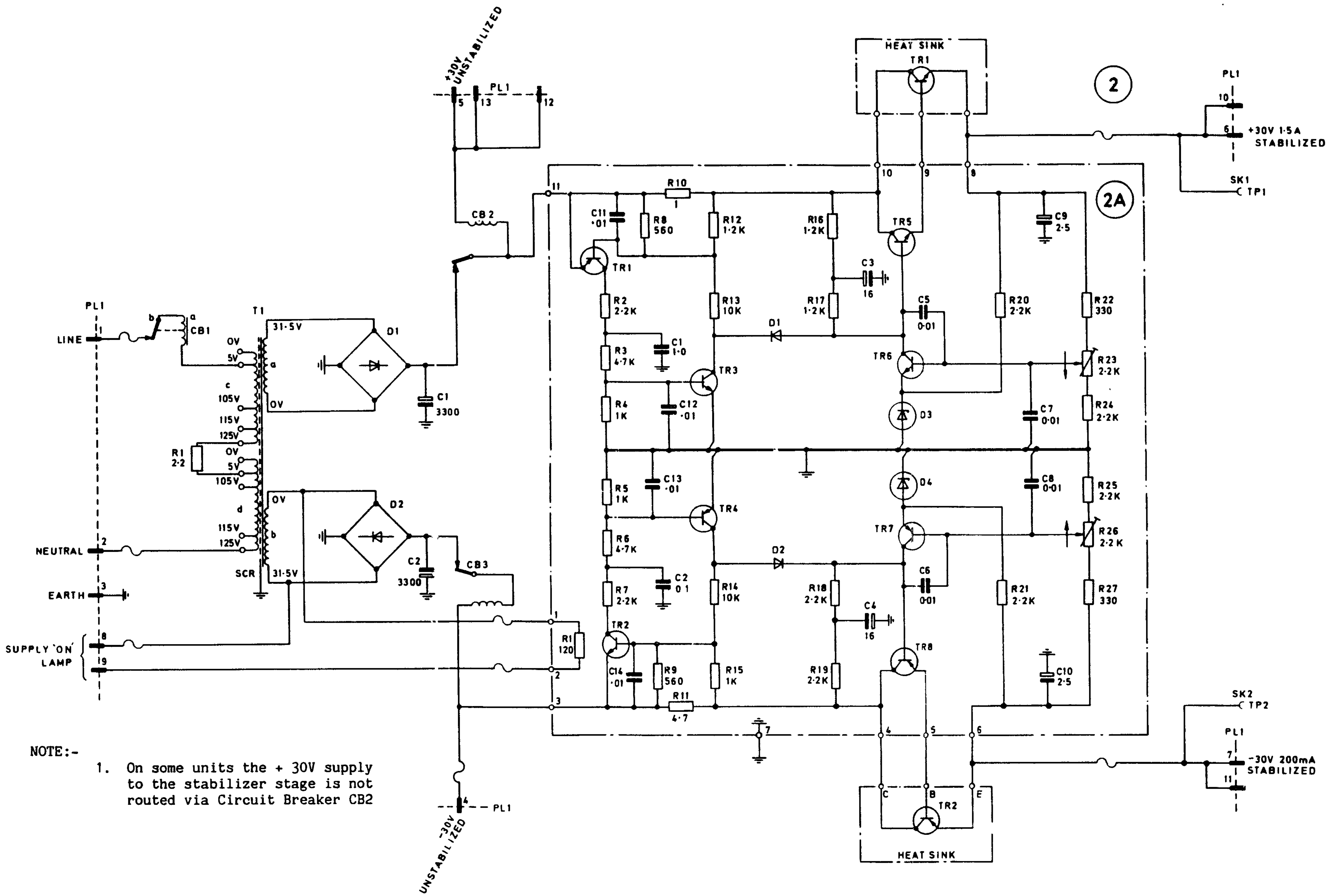


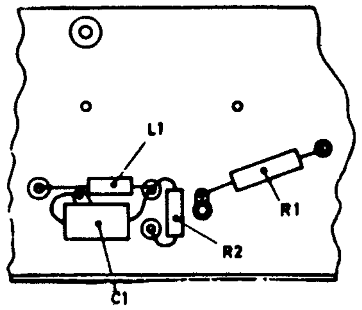

Fig. 3 Power supply board PS57: component layout



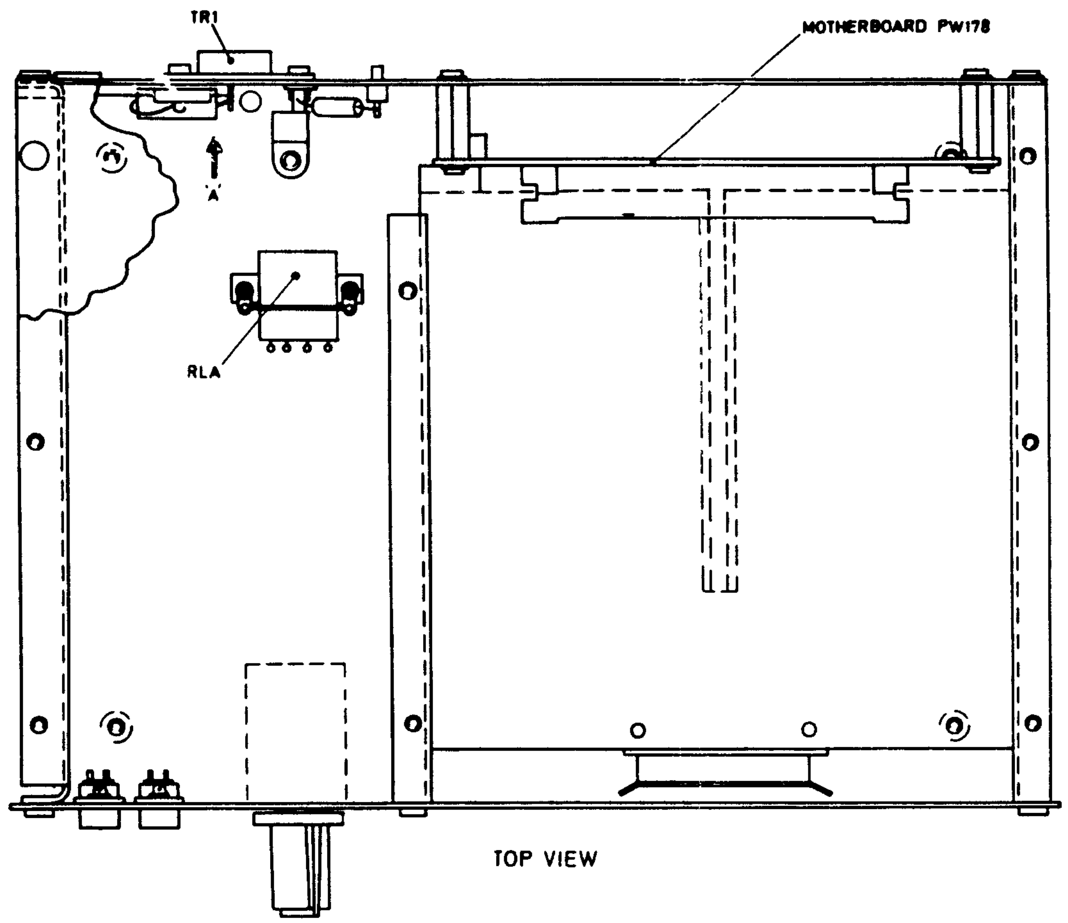

NOTE:-

1. On some units the + 30V supply to the stabilizer stage is not routed via Circuit Breaker CB2

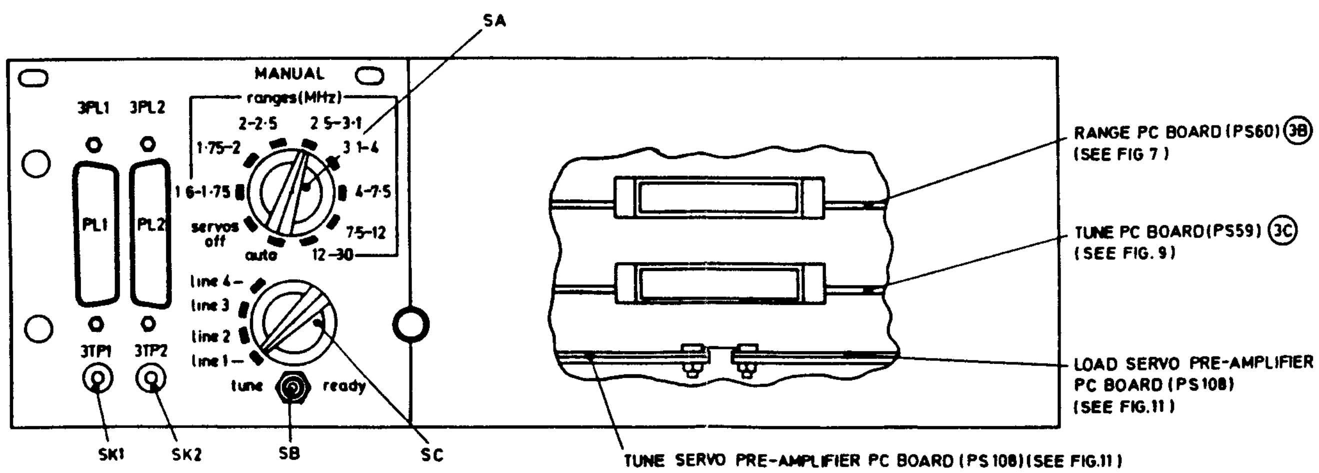
Fig. 4 **Power supply unit MS448: circuit**




SCRAP VIEW IN DIRECTION OF ARROW 'A'




TOP VIEW




FRONT VIEW

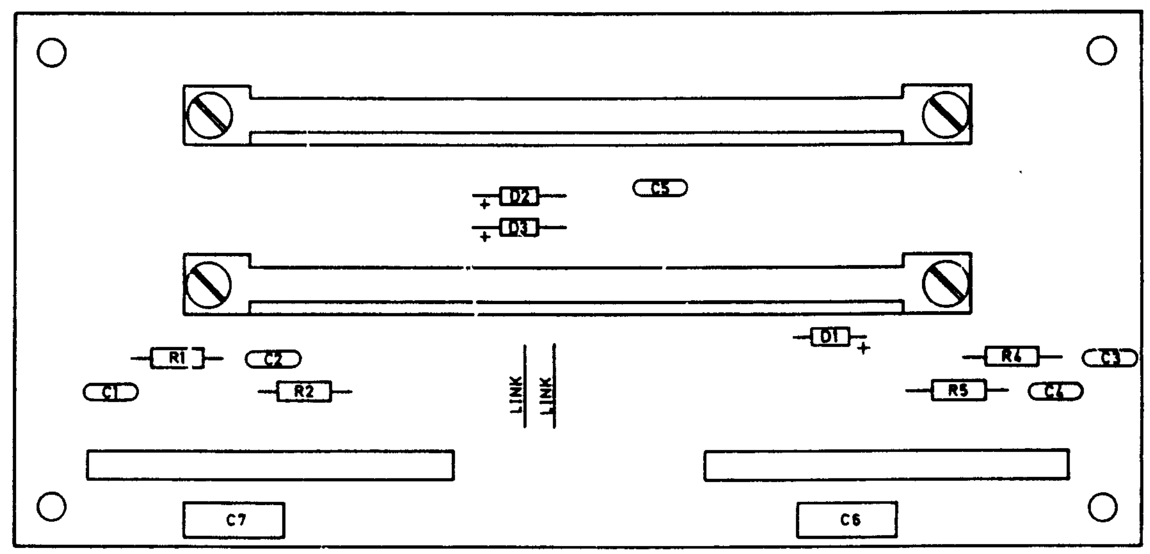



Fig. 5

# Control unit MS450 and motherboard PW178 component layout

Fig. 5

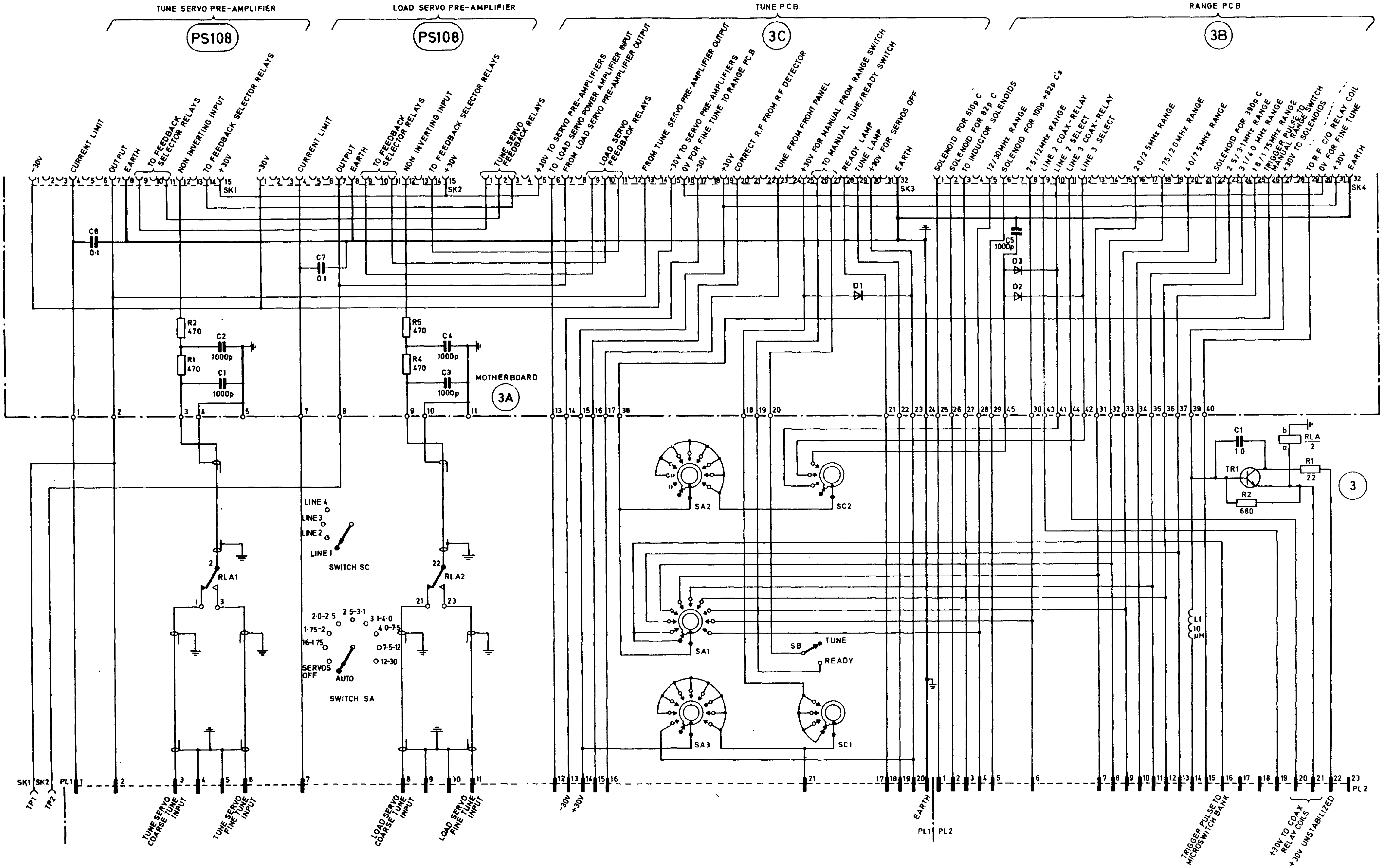



Fig. 6

## Control unit MS450: circuit



Issued Nov. 74

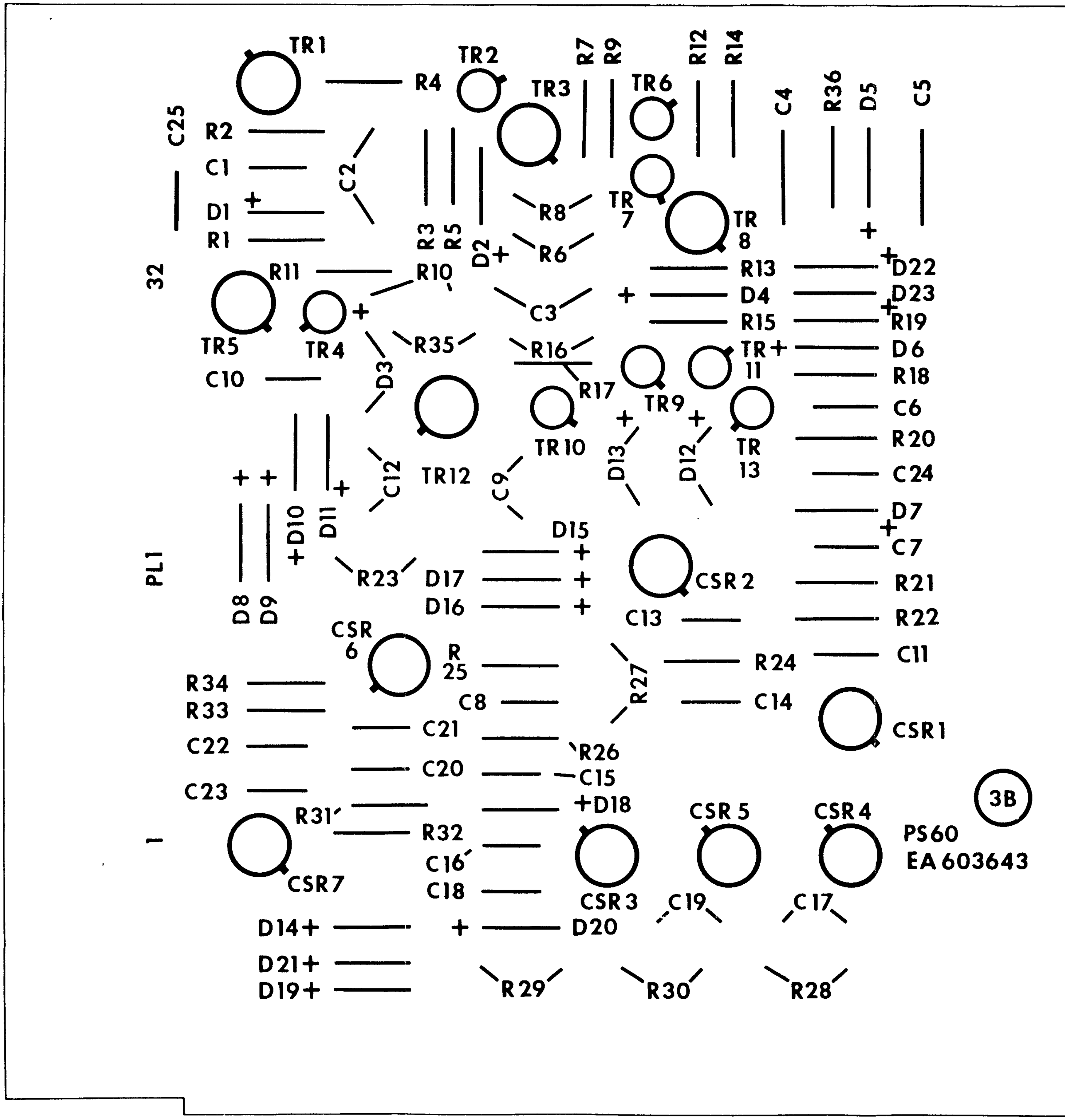
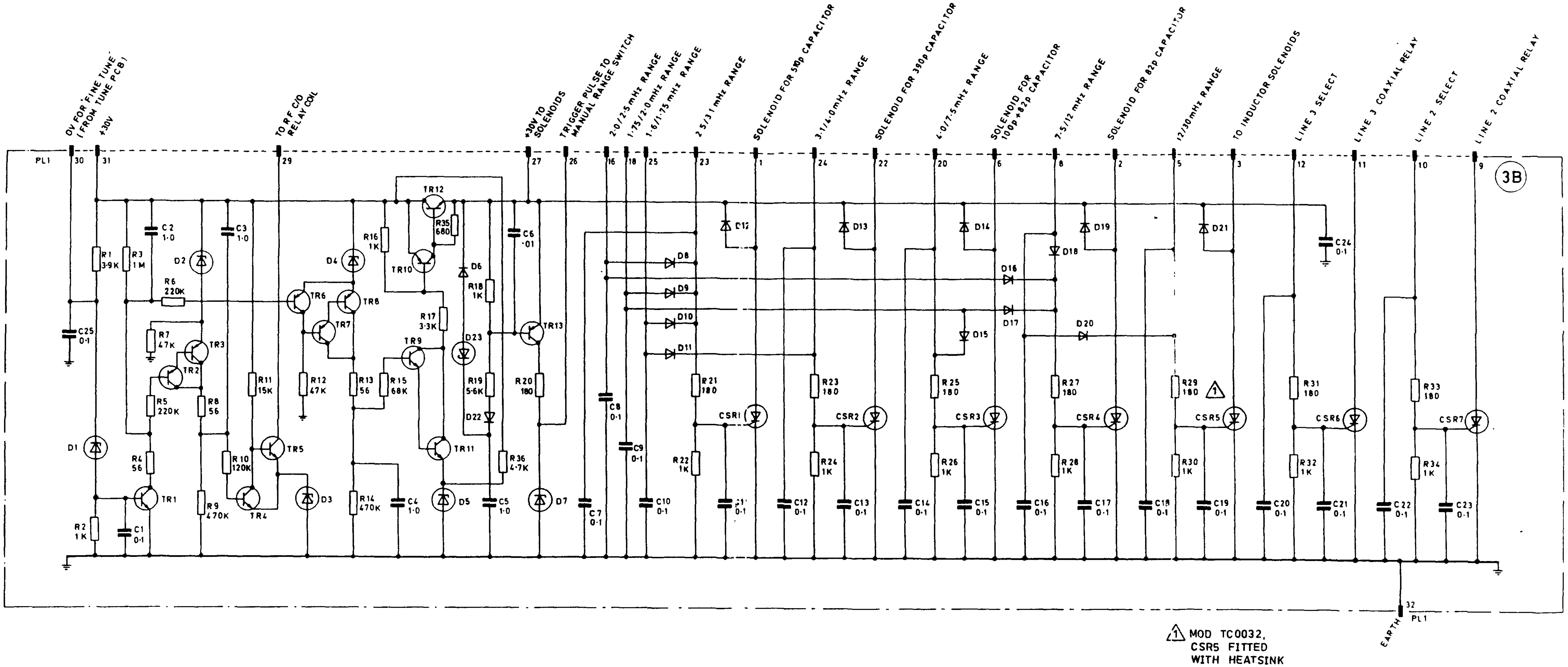


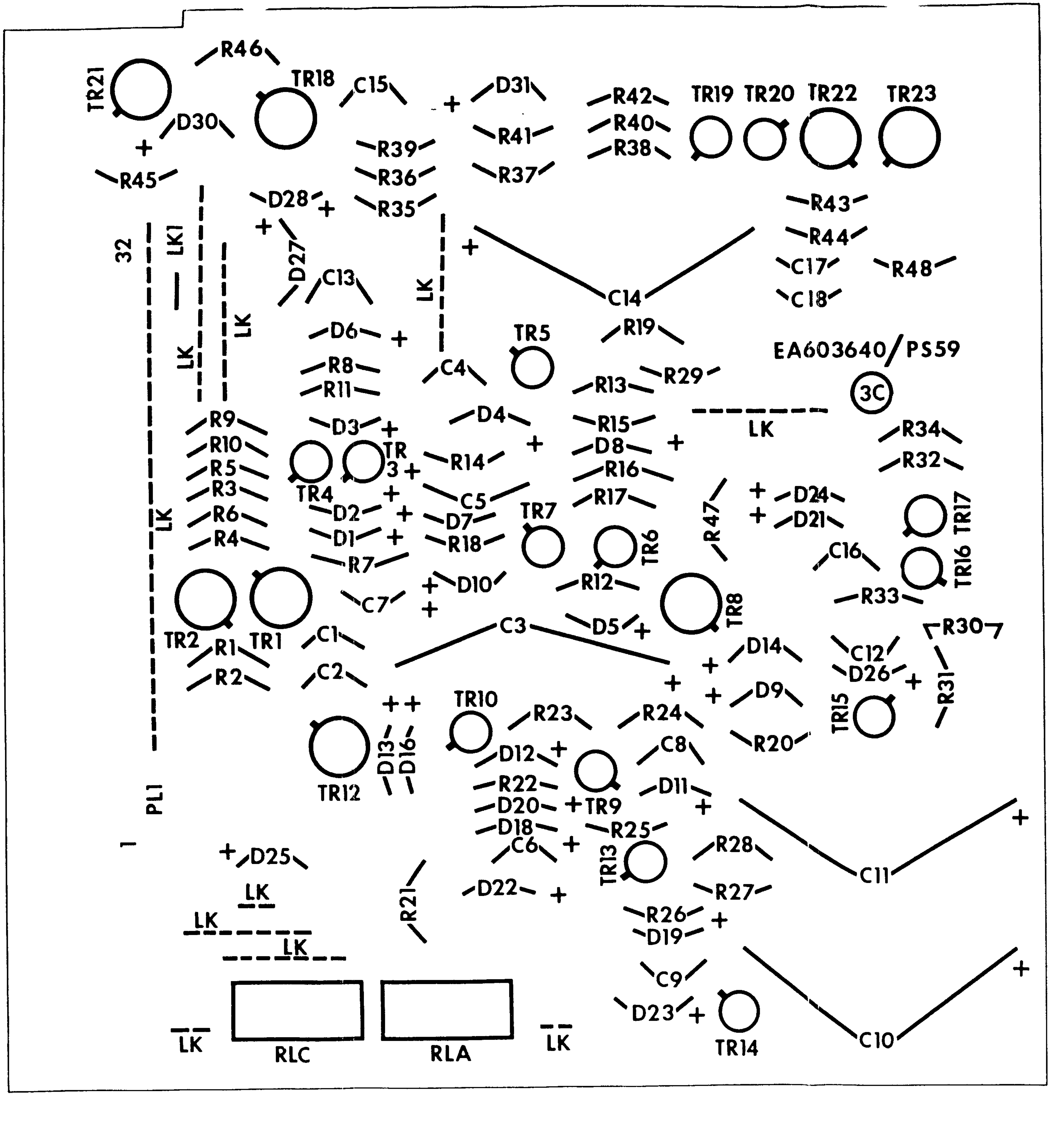

Fig. 7

Range board PS60 : component layout

Fig. 7




# Range board PS60: circuit




Tune board PS59 : component layout

Fig 9

Fig.9

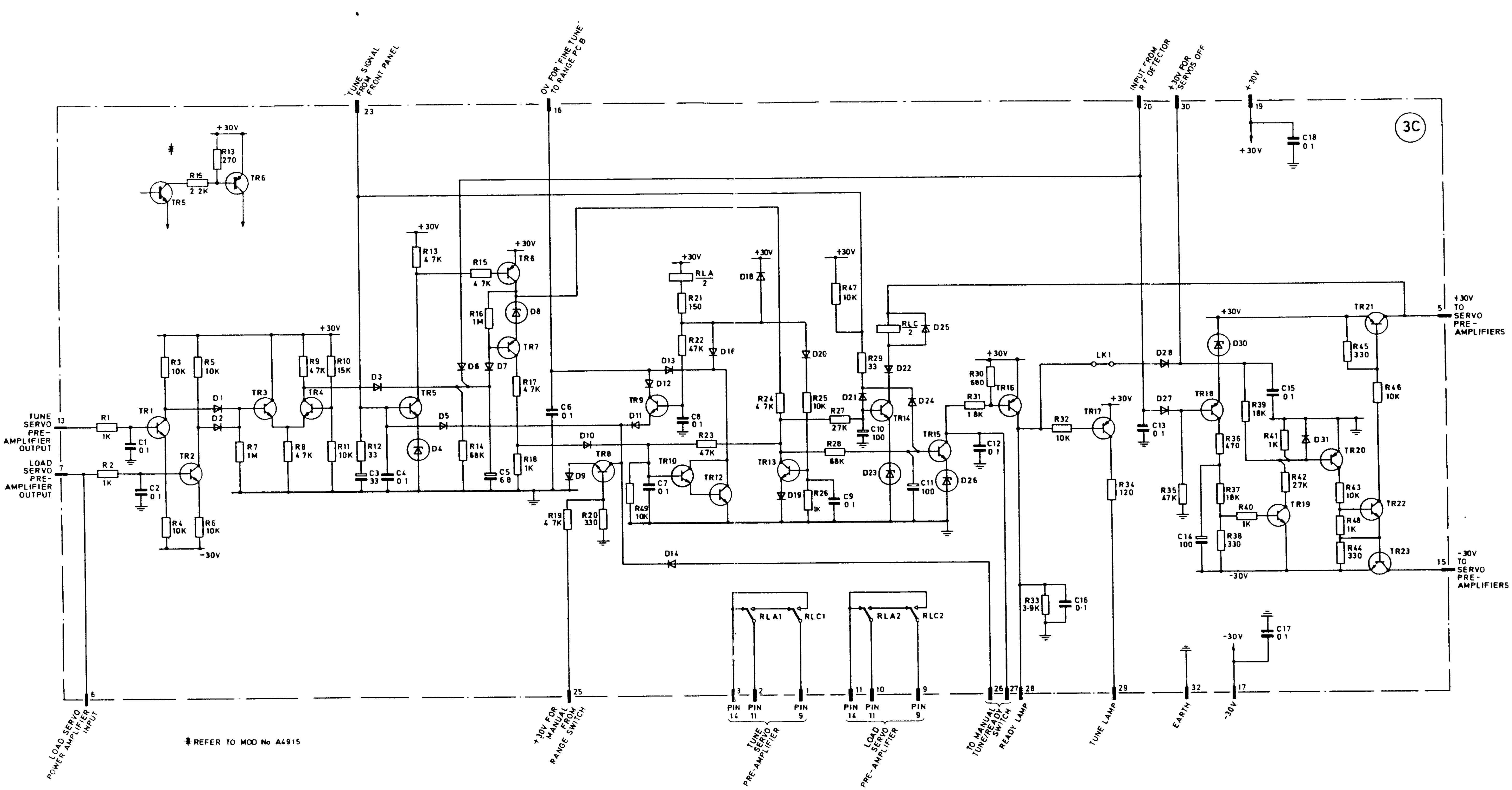



Fig 10

# Tune board PS59: circuit

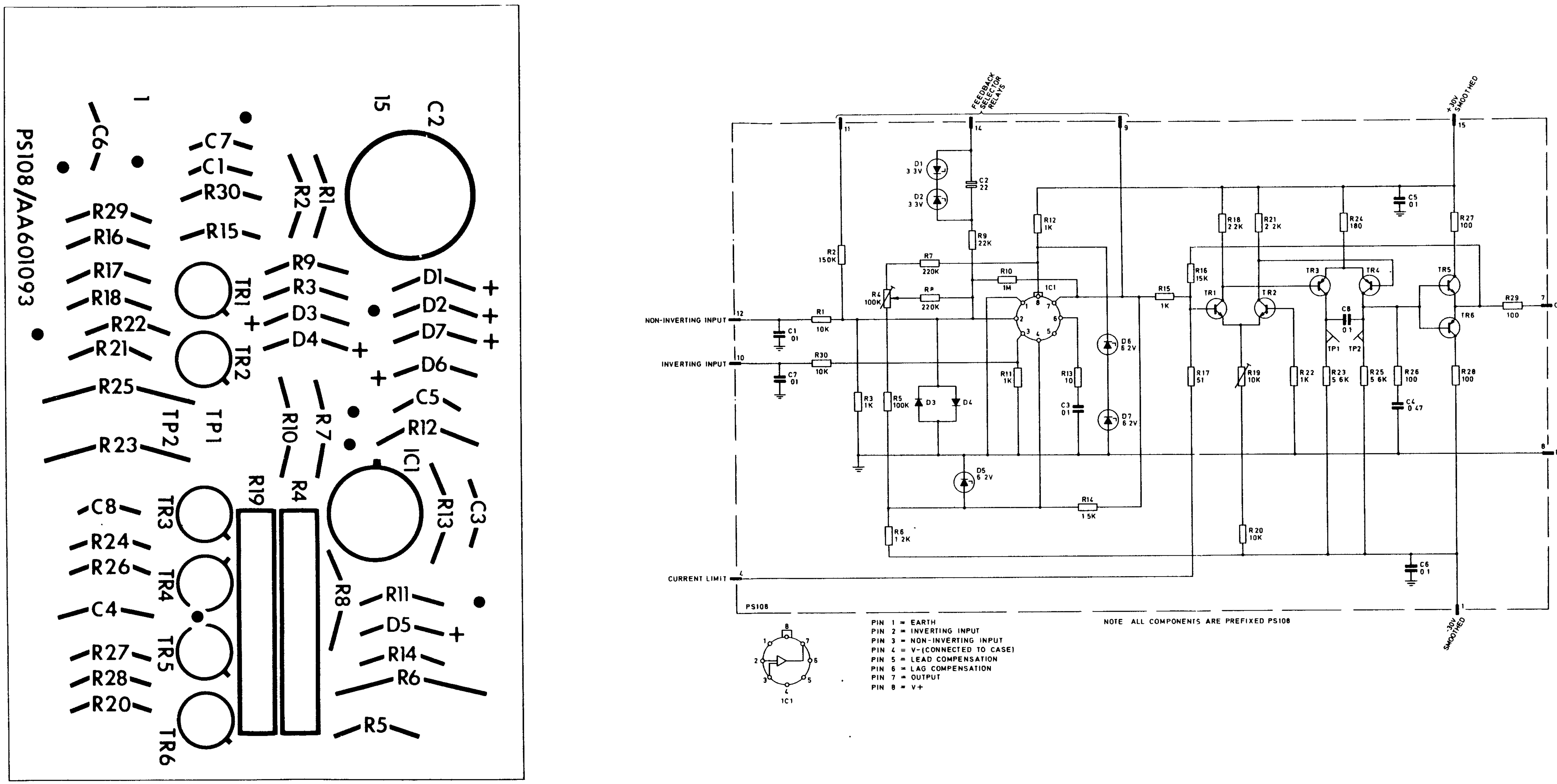
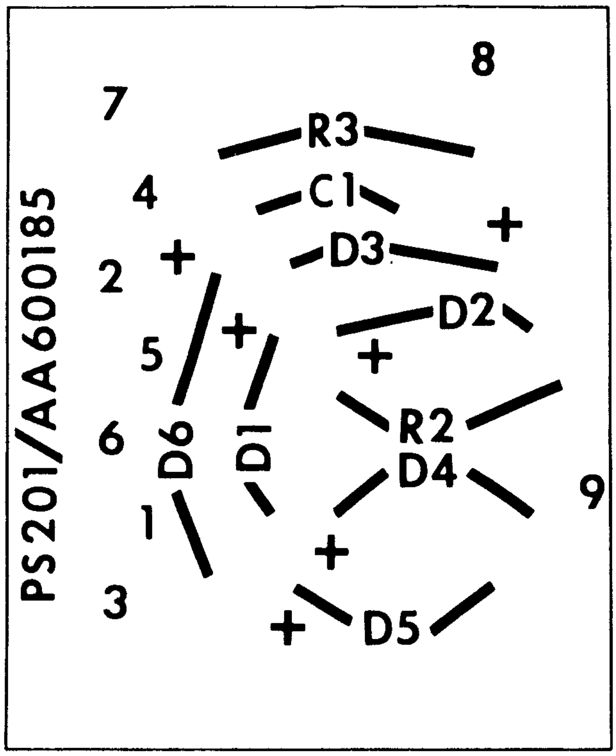



Fig 11

**Servo pre-amplifier board PS108: component layout and circuit**



Issued Nov 74



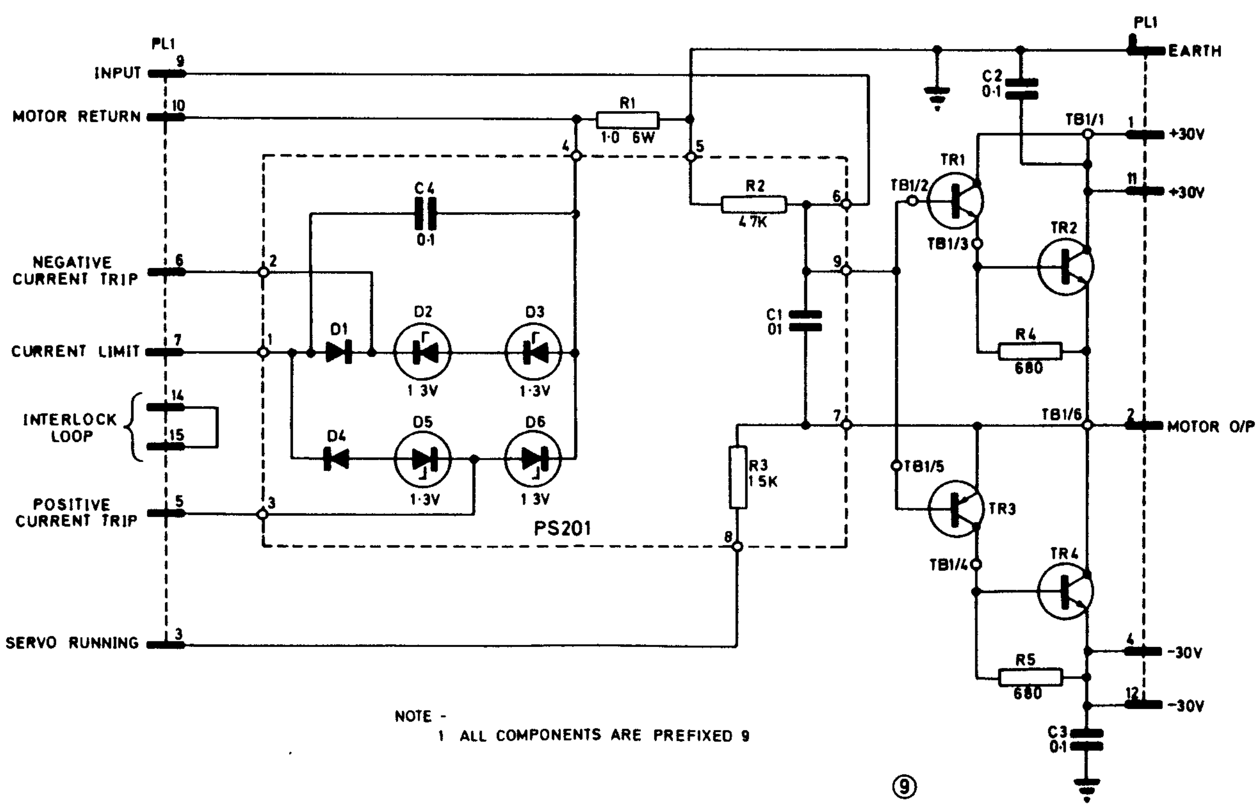
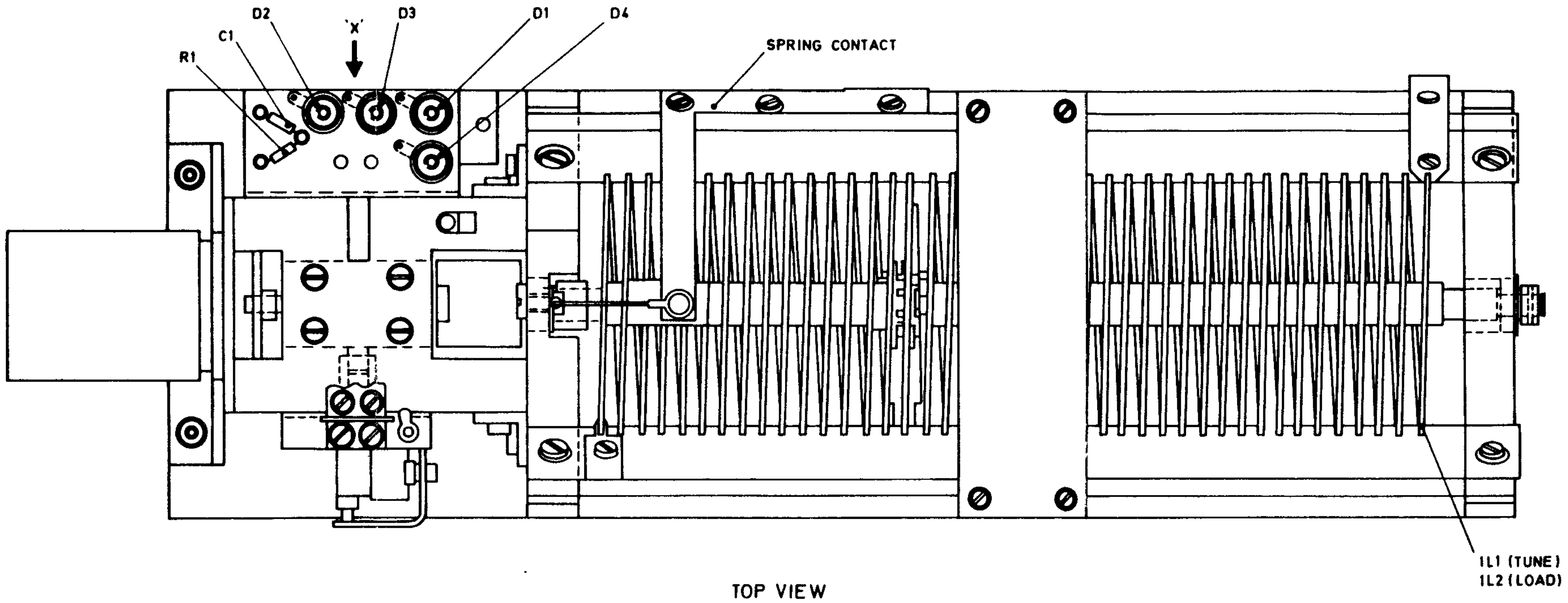
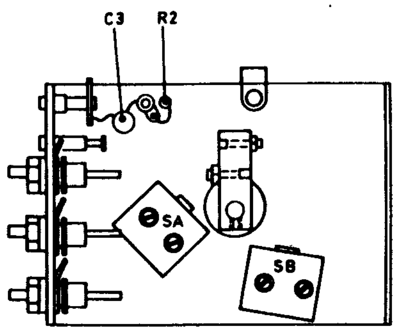




**Fig.12 Servo power amplifier unit MS265: component layout (PS201) and circuit**

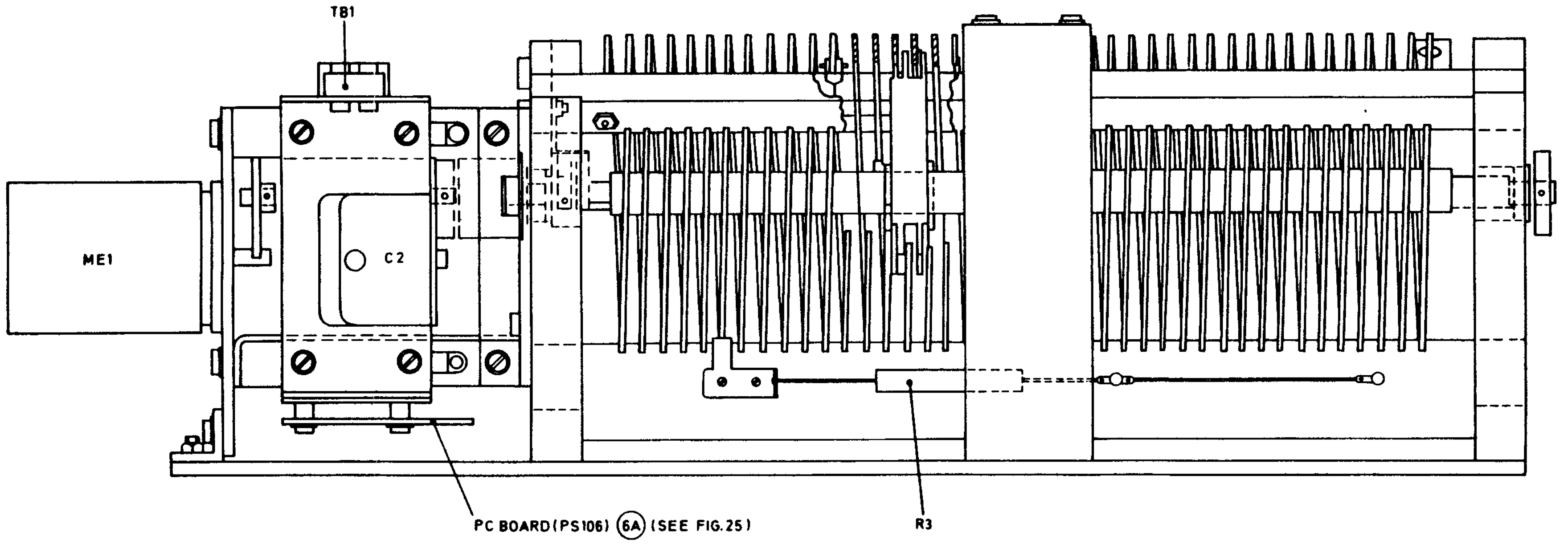



TOP VIEW




VIEW ON ARROW 'X'

EXCEPT 1L1 & 1L2 (6)

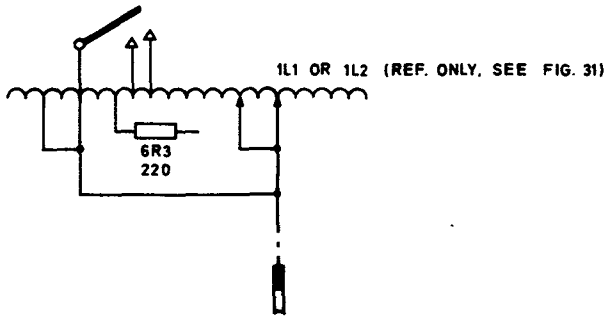


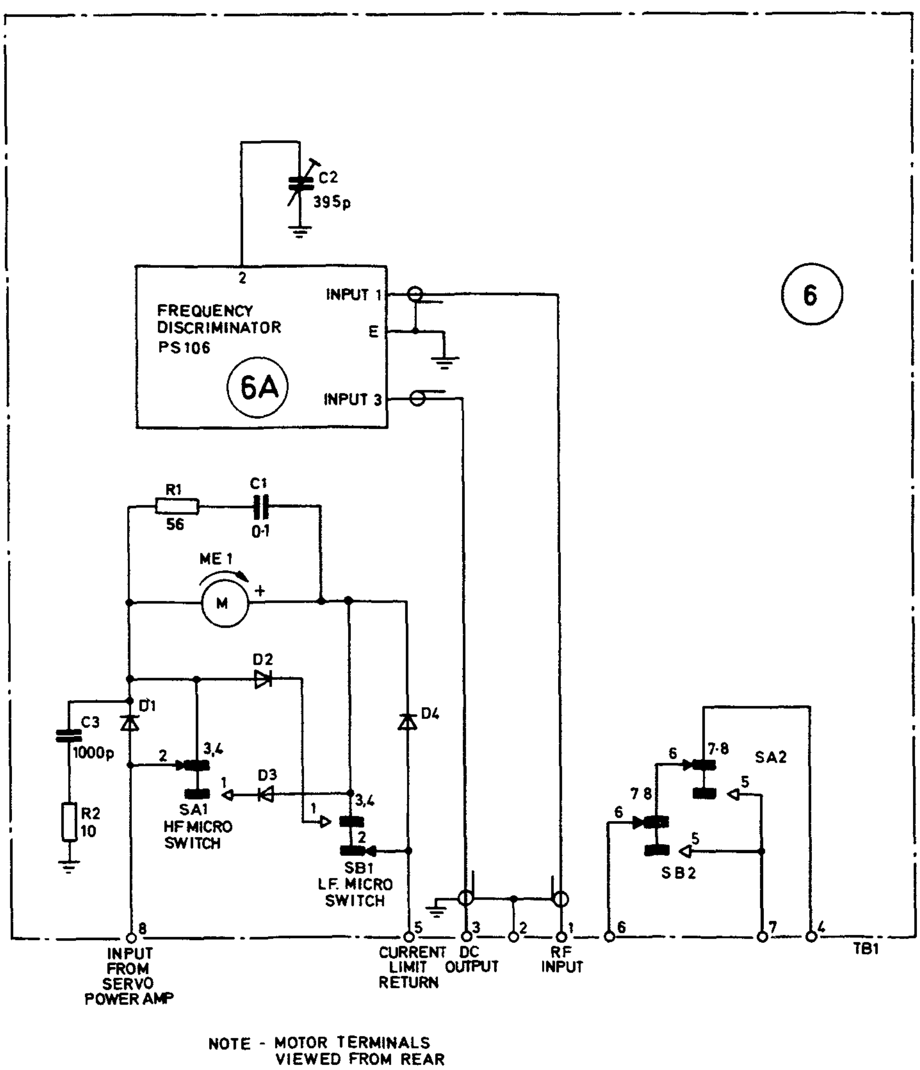

SIDE VIEW

Fig. 13

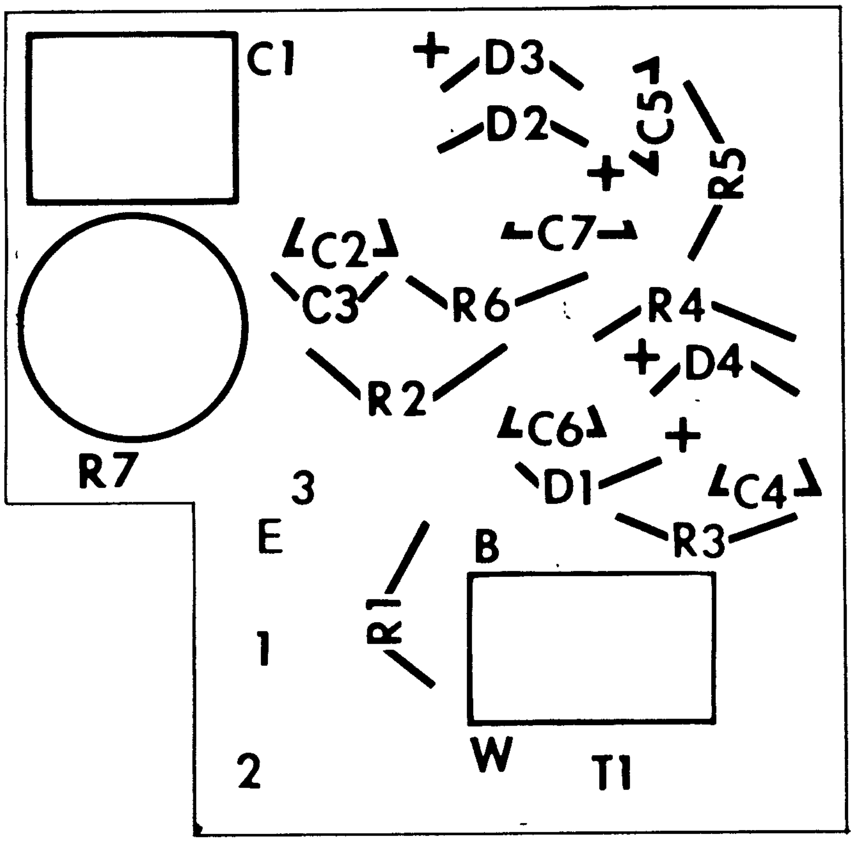
# Coil, motor and gearbox assembly MS451: component layout

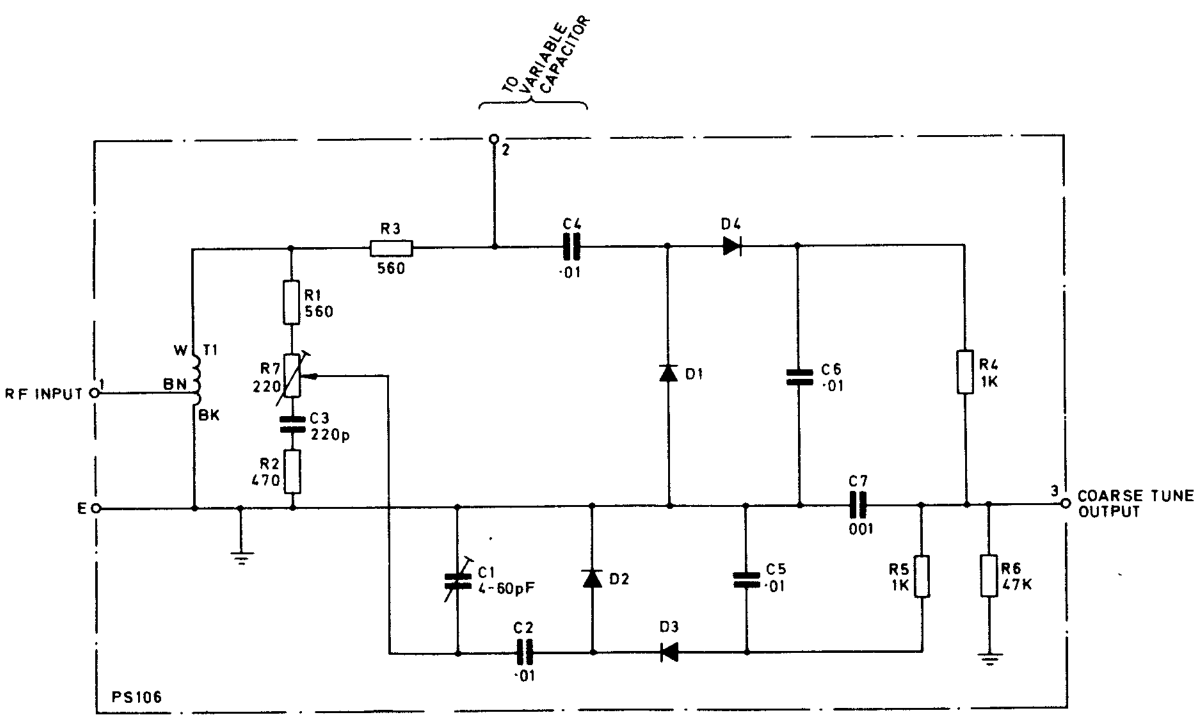
Fig. 13



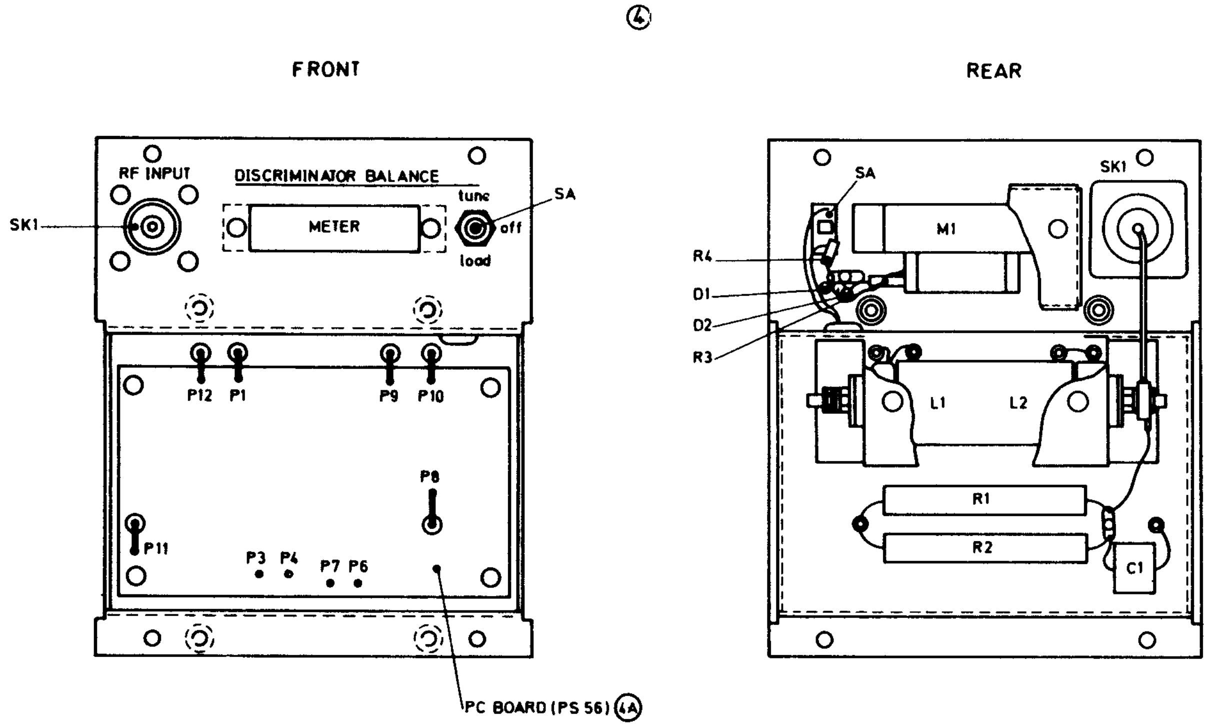

# Fig. 14 Coil, motor and gearbox assembly MS451: circuit




NOTE ALL COMPONENTS ARE PREFIXED PS106

## Fig.15 Coarse-tune discriminator board PS106: component layout and circuit



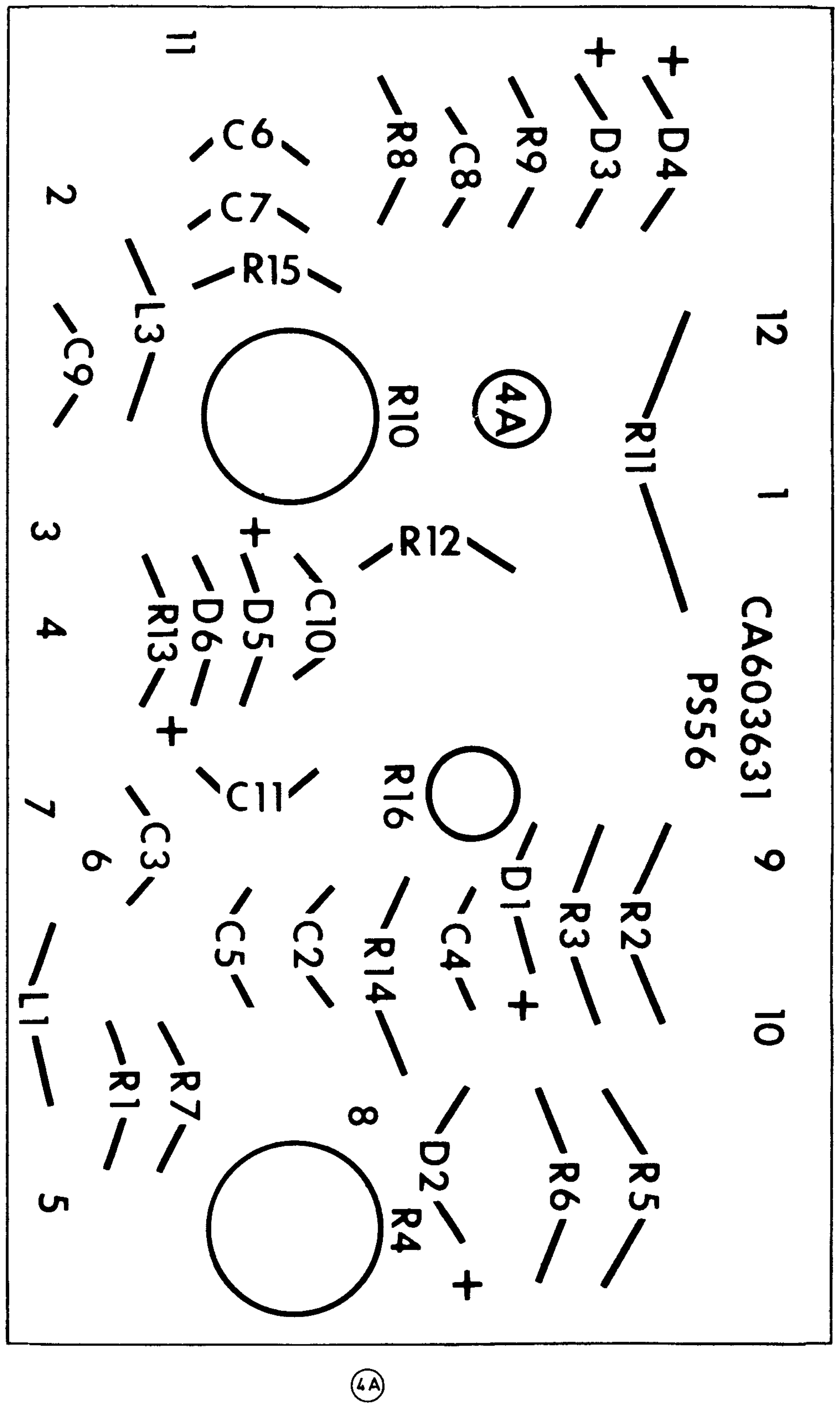
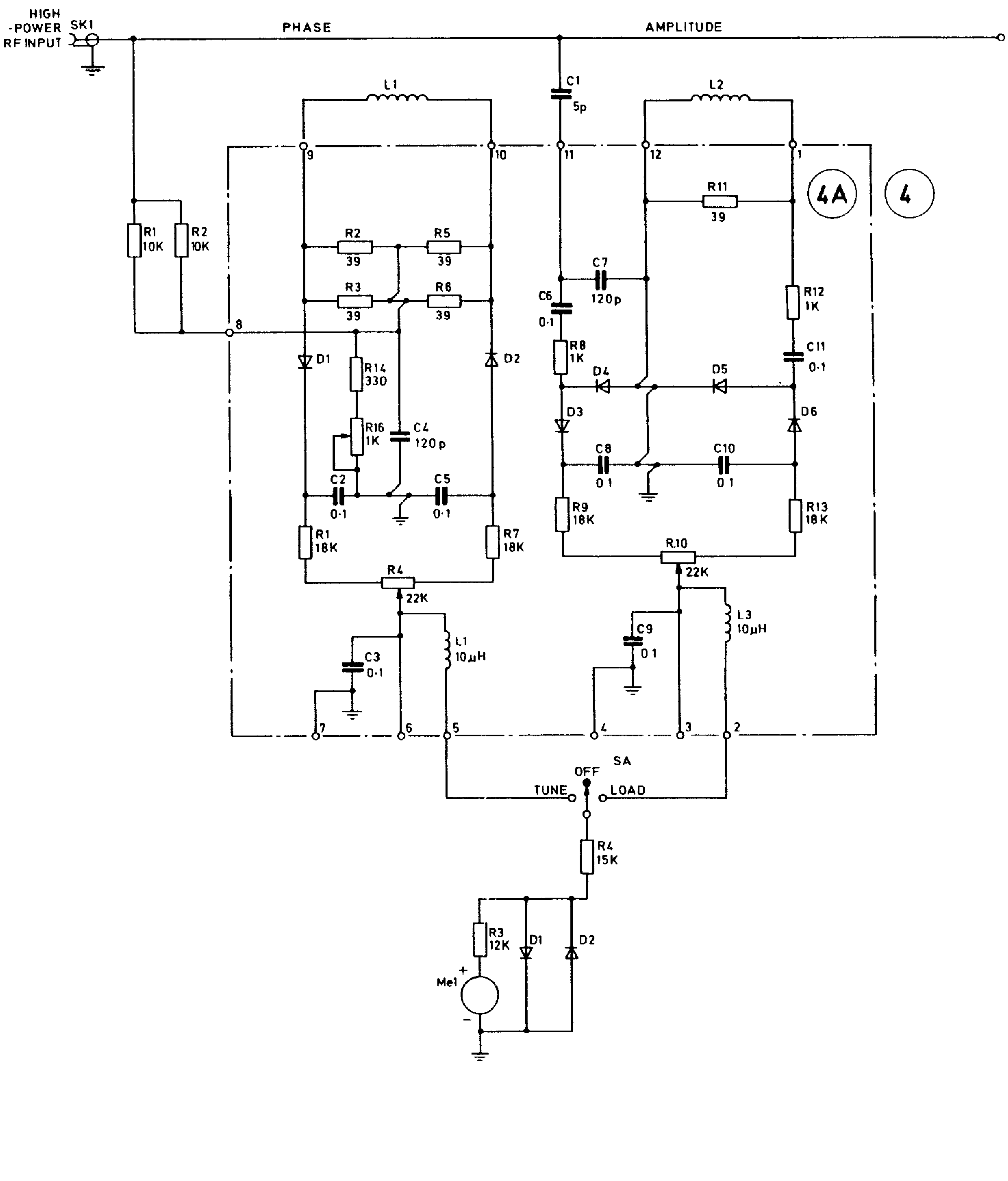
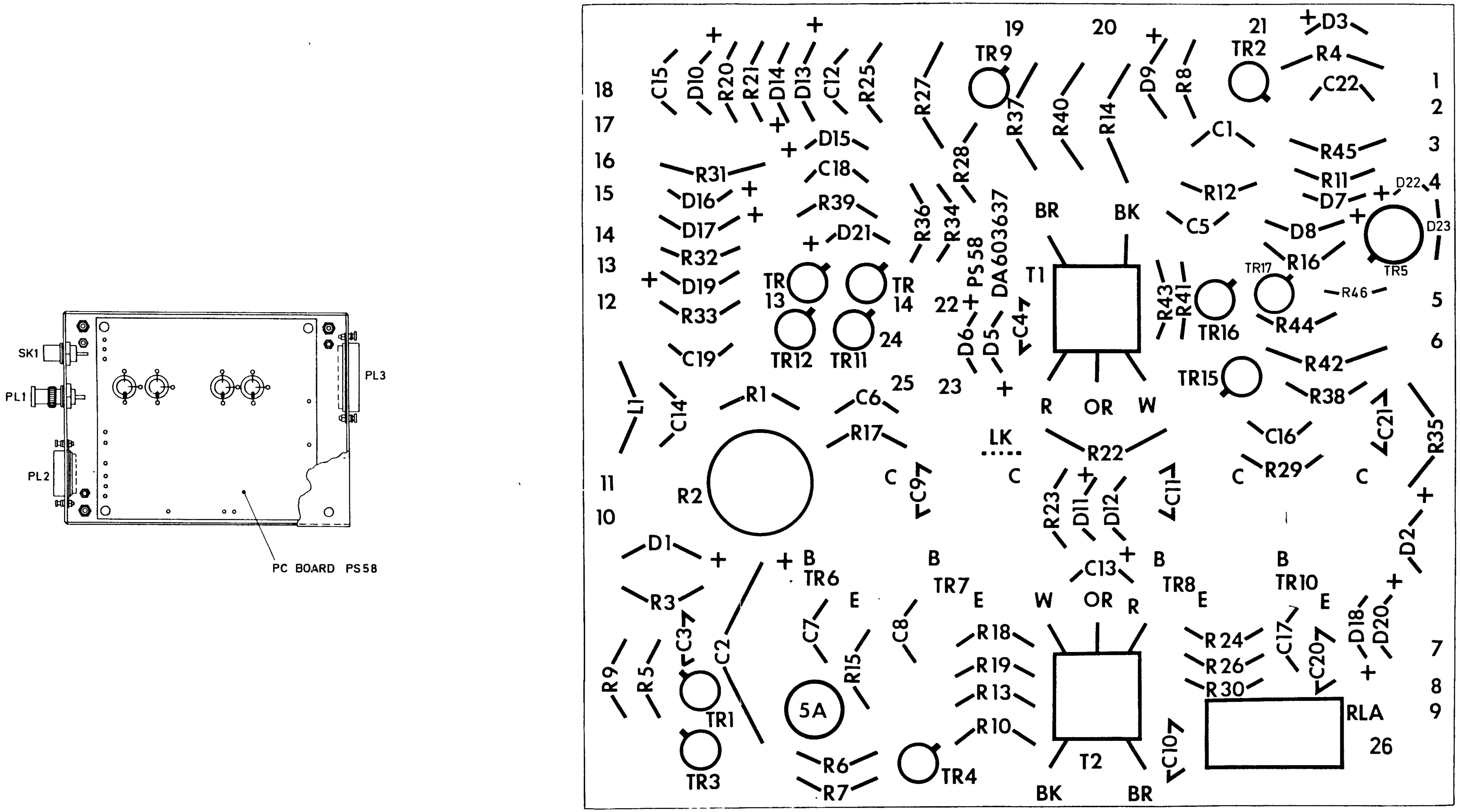




Fig.16 **Fine-tune discriminator unit MS449 and board PS56: component layout** Fig. 16




# Fig.17 Fine-tune discriminator unit MS449: circuit




Constant-voltage amplifier MS454 and board PS58: component layout

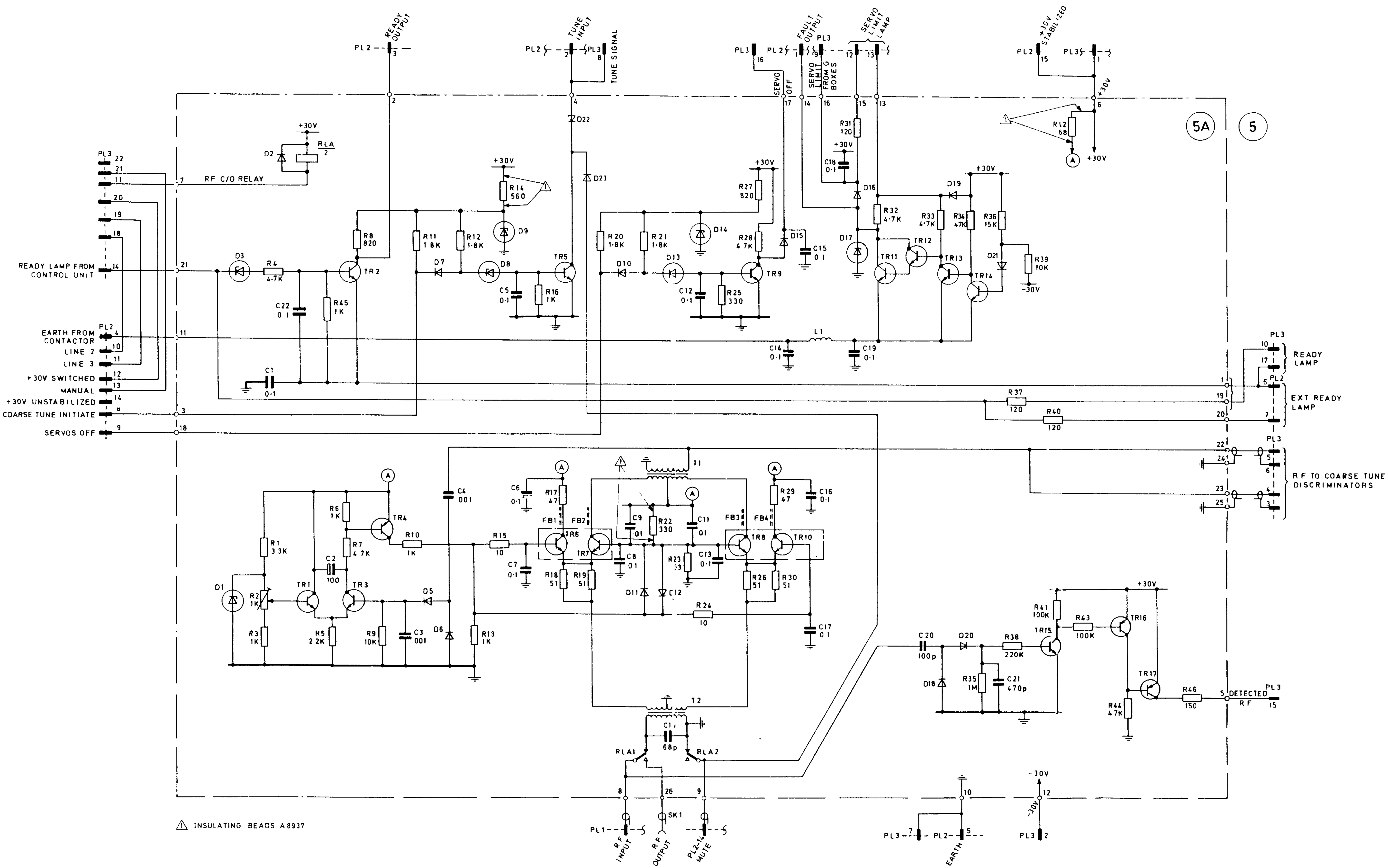
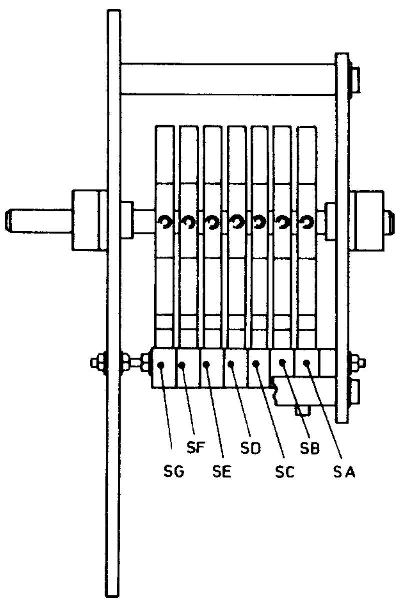


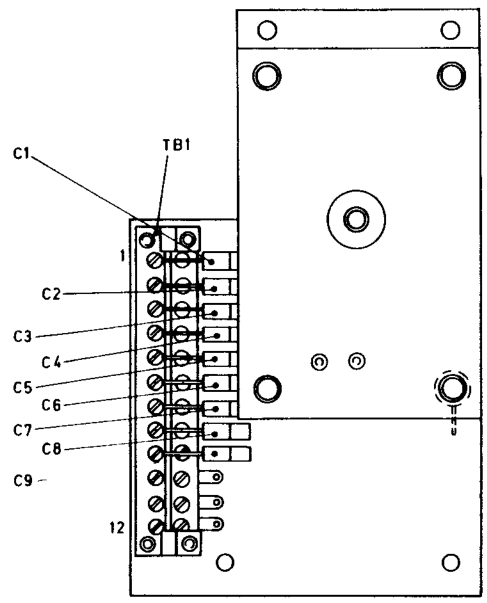
Fig 19

Constant voltage amplifier MS454: circuit

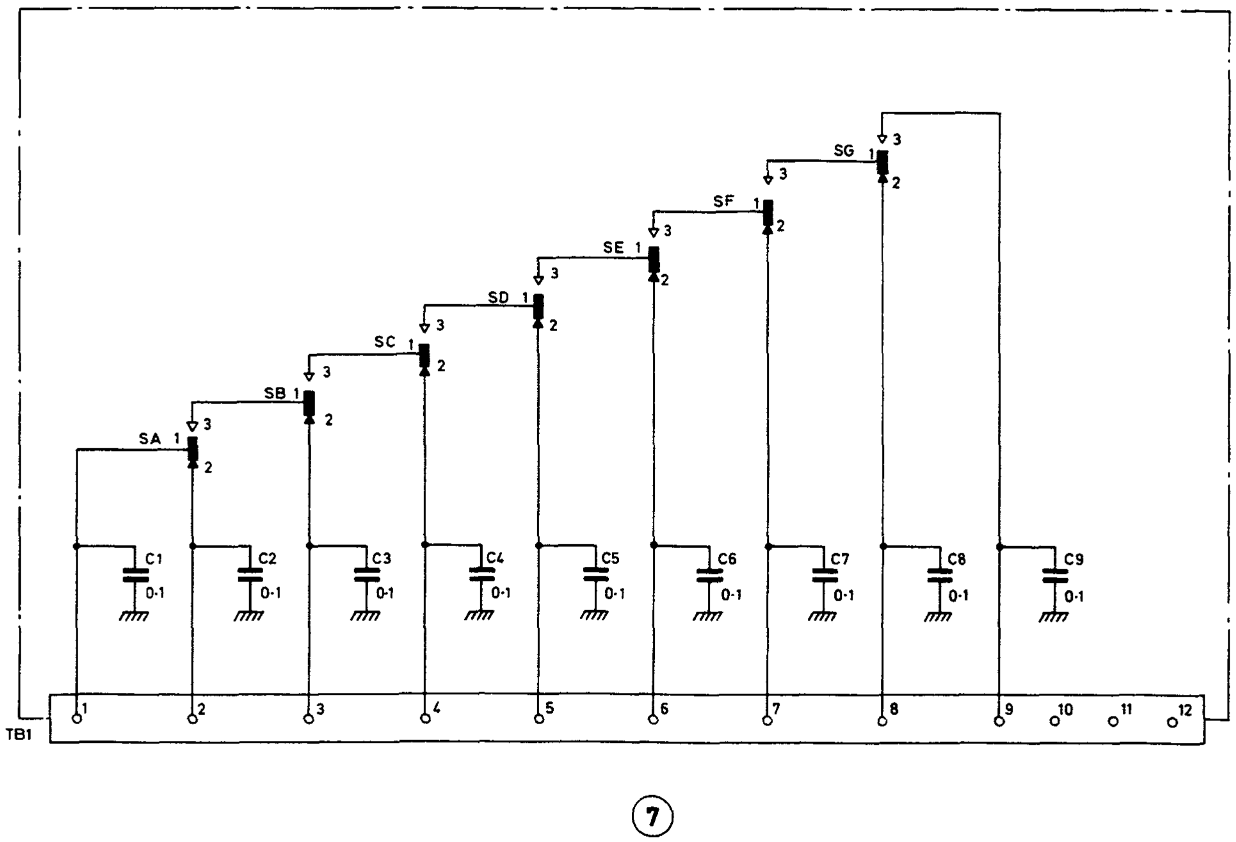
7




VIEW WITH TERMINAL BLOCK
AND CAPACITORS REMOVED




# Fig.20 Switchbank assembly:component layout




# Fig. 21 switchbank assembly: circuit

# Chapter 6-0

# FUNCTIONAL DESCRIPTION

# ASSEMBLY, LINE SWITCHING UNIT 5820-99-626-7836

# (Line switching unit MS.139)

## CONTENTS



## TABLES



## ILLUSTRATIONS



## INTRODUCTION

1. The line switching unit MS.139 is part of a line switching facility which, in terms of harmonic content, optimizes the power output performance of the transmitter at its particular operating frequency. This is achieved by varying the length of cable between the output of the linear amplifier and the input to the MA.1004 feeder matching unit.

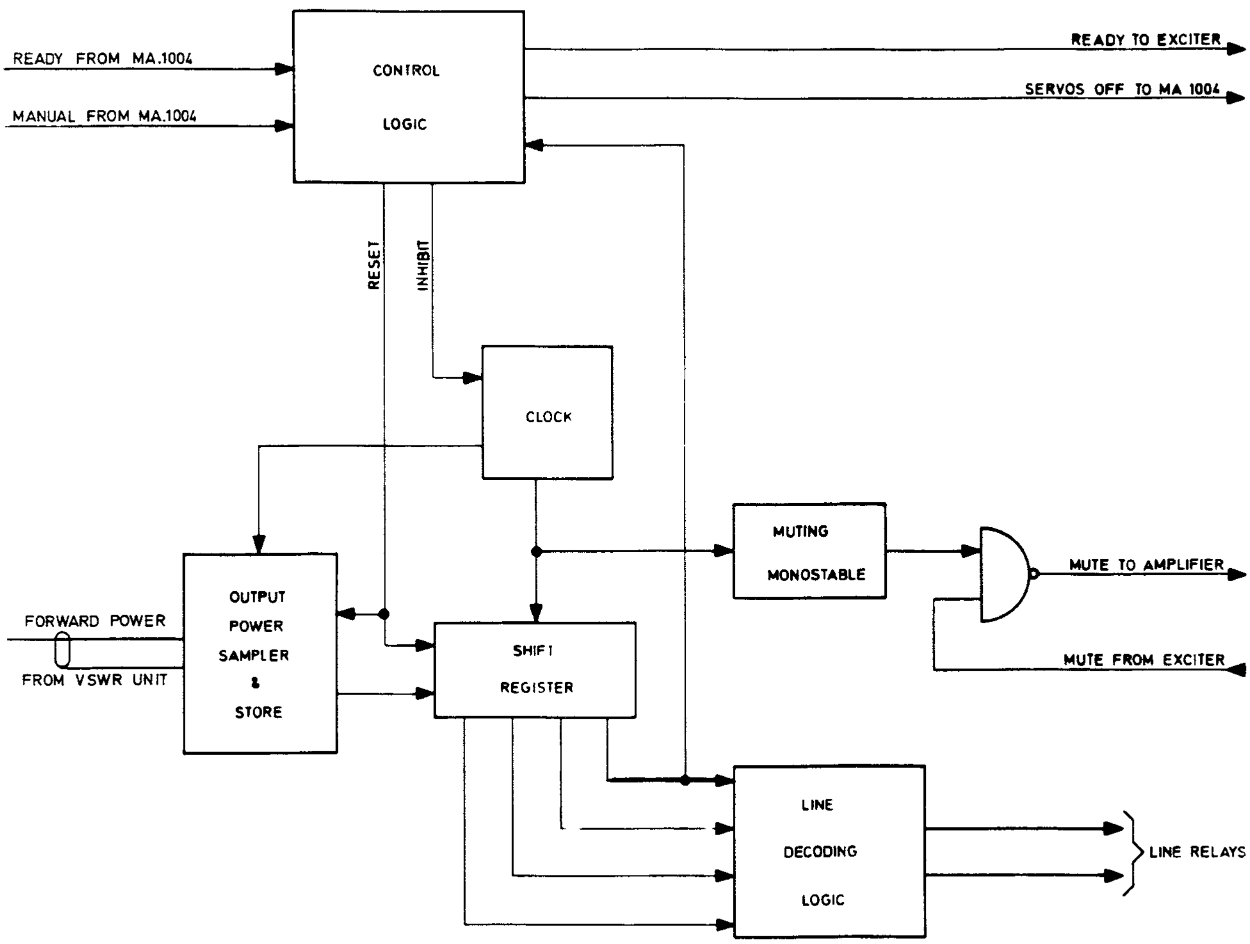



Fig. 1 Line switching unit MS.139 : block diagram

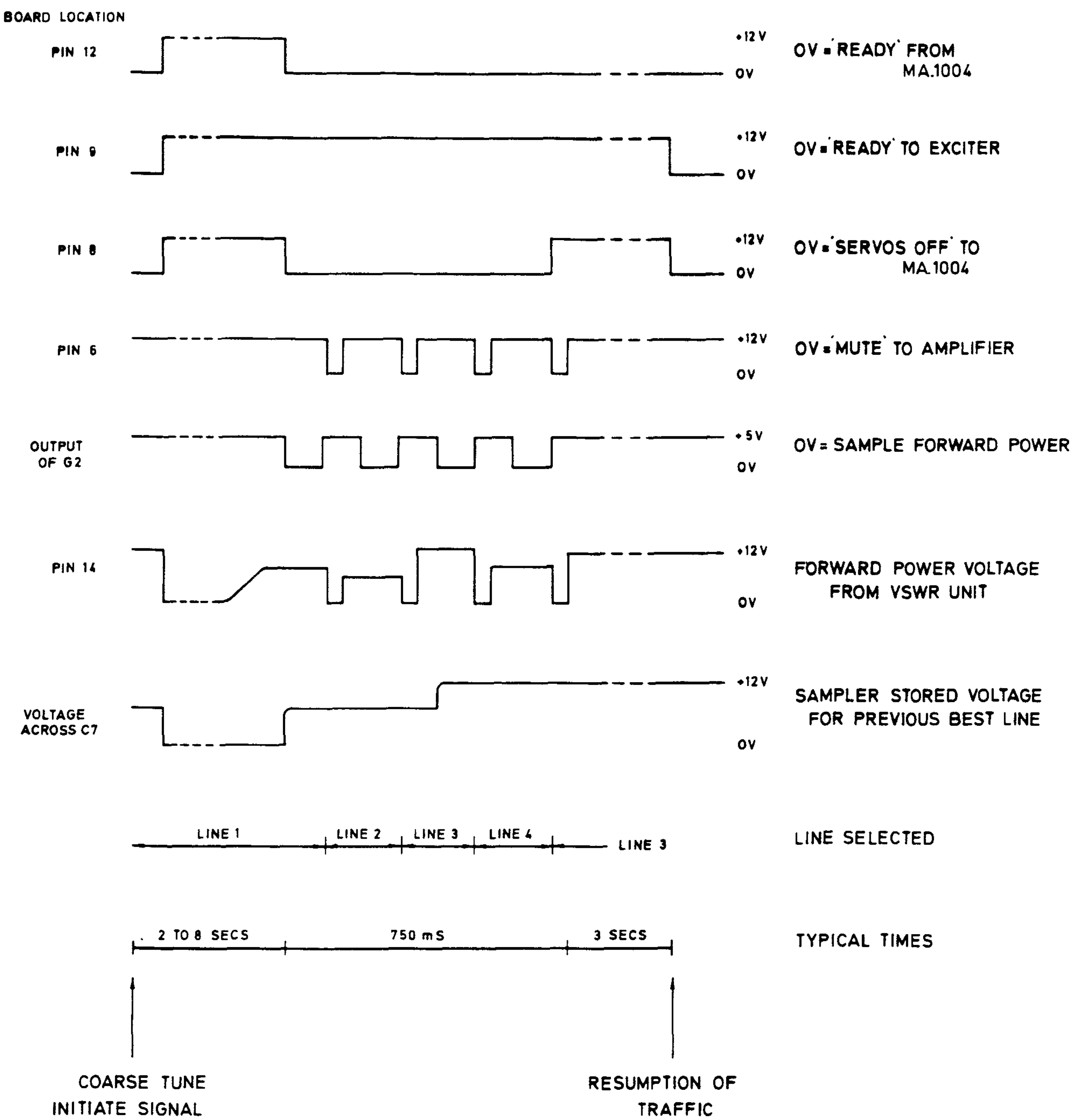



Fig.2 Automatic operation of MS.139 : waveforms

2. The MS.139 samples the forward power for each of four cable lengths and finally selects the length of cable which yields maximum forward power; the cable lengths are switched by four coaxial relays driven from the MS.139 (Chap.1-0 or 13-0).

CONSTRUCTION

3. The line switching unit is a printed circuit board housed in a metal case measuring 250 mm x 130 mm x 25 mm. A voltage regulator (X1, fig.4) is mounted on the case, and a 15-pin plug connects the unit into the transmitter system.

FUNCTIONAL DESCRIPTION

4. The line switching unit MS.139 contains the following stages (fig. 1):-

(1) Output power sampler and store

(2) Shift register

(3) Line decoding logic

(4) Muting monostable

(5) A clock

(6) Control logic

Output power sampler and store

5. The output power sampler and store samples forward power from each of the four coaxial cable lines and sets the output store to a logic '1' or logic '0' state, depending upon the forward-power voltage received from the v.s.w.r. unit MS.447 in the linear amplifier.

6. When sampling commences, the logic state of the output store is set to '0'; after first line has been sampled, it is then set to logic '1' and the second line is sampled.

7. If the forward-power voltage of the second line is less than that of the first line, the logic state of the output store will remain at '1'.

8. If the forward-power voltage of the second line is greater than that of the first line, the logic state of the output store will change to '0'.

9. Each succeeding line is compared to the previous best line, and if the forward-power voltage of the new line is greater, the output store is set to logic '0'; if it is less, the output store remains at logic '1'.

Shift register

10. The shift register stores the information from the output power sampler and store, and is initially preset to all-logic '1' state. When each sample has been taken, the register is clocked to store the logic state of the output store; after the outputs from all four lines have been sampled, the logic state of the shift register enables the line decoding logic to select the best line.

Line decoding logic

11. The line decoding logic enables each line to be selected in turn for sampling and, when all four lines have been sampled, it selects the best line using the information stored in the shift register.

## Muting monostable

12. To prevent damage to the coaxial relay contacts, the muting monostable provides a muting signal to the linear amplifier each time a new line is selected.

## Clock

13. The clock controls the sequence of sampling, line switching and muting.

## Control logic

14. The control logic provides interfacing for the external control signals and has two modes of operation, manual and automatic.

15. For manual operation, the shift register is preset to all-logic '1' condition which enables the line decoding logic to select 'line 1' which corresponds to the relay drivers in the open-circuit condition, i.e. both relays inoperative. The coaxial cable lines may now be selected manually by means of a switch.

16. For automatic operation, the control logic allows the clock to control the line switching sequence.

17. The line decoding logic applies a 'servos-off' signal to switch off the servo motors in the feeder matching unit during the line-selection sequence. When the line-selection sequence has been completed, the 'servos-off' signal is removed to enable the feeder matching unit to complete fine tuning. On completion of fine tuning,the control logic re-applies the 'servos-off' signal to the feeder matching unit and also applies a 'ready' signal to the MA.1720 drive unit.

# CIRCUIT DESCRIPTION

## Output power sampler and store

18. The output power sampler consists of transistors TR2, TR4, TR5, TR9, TR10, TR11 and TR12 and associated components; the D-type flip-flop ML2 is the output store.

19. Initially C7 is discharged by TR9, and TR2 is switched 'on'. When the first coaxial line is sampled, TR2 is switched off allowing C7 to charge up, via the emitter follower TR4, to approximately the forward-power voltage from the v.s.w.r. unit (MS.447) in the linear amplifier. The collector-current pulse in TR4, required to charge up C7, switches the collector of TR5 to +16V; this switches off TR10 and TR11 and switches on TR12. As the collector voltage of TR12 falls to 0V, the output store, a D-type flip-flop, is set to logic '0'.

20. When the first coaxial line has been sampled, transistor TR2 is switched on, reverse-biasing transistor TR4 and diode D6; capacitor C7 stores the forward-power voltage of the first line. The output store is reset to logic '1' before the second line is sampled.

21. If the forward-power voltage of the second line is less than that for the first line, C7 will not receive any extra charge, transistor TR4 will not take any collector current and the logic state of the output store will remain at '1'. If the forward-power voltage is greater, C7 will charge up to this higher voltage and the collector current taken by TR4 will switch transistors TR5 to TR12 and set the output store to logic '0'.

22. As the coaxial lines are sampled, capacitor C7 stores the forward-power voltage of the best line; thus each succeeding line is compared to the previous best line. If the forward-power voltage of the new line is greater, the output store is set to logic '0'; if it is less, the output store is left in the '1' state.

Line decoding logic

23. The line decoding logic consists of gates G7, G8, G9, G10 and G11. The four transistors TR15, TR16, TR17 and TR18 form a pair of relay-driver circuits to interface with the TTL logic levels. The line decoding logic performs two basic functions:

(1) It enables each line to be selected, in turn, for sampling.

(2) When all four lines have been sampled, it selects the best one using the information stored in the shift register.

The truth-table for this logic is shown in Table 3.

24. At the start of the sampling sequence, the shift register is preset to state No.1 (i.e. all '1's). This selectes line 1 by switching off both relay drivers. As C7 is initially discharged when line 1 is sampled, TR4 will conduct to charge this capacitor; thus the output store will be set to '0'. At the end of the sampling period, this state is clocked into the shift register.

25. The shift register is now at state No.2 and line 2 is selected for sampling as outlined in para. 25 and 26. After line 2 is sampled, the shift register will be clocked to state 3 or state 4 depending upon the forward-power voltage of line 2. Both these states select line 3 for the next stage of sampling.

26. After sampling line 3, the shift register will be clocked to one of the states 5 to 8, depending upon the forward-power voltages from the lines sampled; any of these states selects line 4 for the final stage of sampling.

27. Finally, after line 4 is sampled, the shift register is clocked to one of the remaining 8 states, numbered 8 to 15. The presence of a '0' in bit 4 of the shift register indicates that sampling is complete. The line decoding logic now selects the best line as shown in the Table 3.

28. As an example, consider state 11. The '0' in bit 4 shows that sampling is complete. The '1' in bit 3 shows that line 2 was worse than line 1. The '0' in bit 2 shows line 3 was better than line 1 and line 2. Finally, the '1' in bit 1 shows that line 4 was worse than line 3. Therefore line 3 is the best line.

Muting monostable

29. Each time a new line is selected, it is necessary to remove the r.f. signal to avoid burning the relay contacts. This is done by muting the amplifier for a short period of approximately 50 mS. This muting pulse is provided by ML8, a monostable multivibrator.

30. A transition from '1' to '0' on pin 6 of ML2 will be inverted by G5 and thus 'clock' the shift register. The negative-going transition is also sent to the 'A' inputs of the monostable to 'clock' it each time a new line is selected. TR14 and its associated components interface between the TTL

monostable output and the external muting signal levels. Diodes D12 and D13 permit the muting of the linear amplifier by the drive unit.

31. At the end of each muting pulse the positive transition on pin 1 of ML8 is used to clock the output store back to '1' state.

## Clock

32. The sequence of sampling, line switching and muting is controlled by the clock. TR1 and TR6 are used in a collector-base-coupled astable multivibrator; the timing components are C3, C5, R7, R8, R9 and R12. By adjustment of R7, the period of oscillation is set to 100 mS. The diodes D1 and D7 stop negative noise pulses on the supply line affecting the timing of the astable; D8 and R18 are included to improve the rise-time of the output.

33. The output of the astable multivibrator is used to 'clock' the D-type flip-flop ML2 which is connected to perform a divide-by-2 function. The flip-flop outputs are 1:1 mark-to-space ratio square-waves. When the Q output, pin 5, is at '0', the line is sampled and when the $\bar{Q}$ output, pin 6, undergoes a transition from '1' to '0', the next line is selected.

34. When TR3 is switched on, TR1 is held off and thus the clock is inhibited. This will occur if either the output of G2 or pin 8 of ML6 is in the '1' state.

## Control logic

35. This consists of gates G1, G2, G3, G4, G6, G12, G13 and G14 and the monostable ML9. Transistors TR7, TR8, TR19 and TR20, along with their associated components, provide interfacing for the external control signals. The control logic has two distinct modes of operation viz manual and automatic.

## Manual operation

36. The +30V manual control signal on pin 11 switches on transistor TR8 to produce a logic '0' input to gates G1 and G2. The logic '1' output of gate G1 is used to open gate G3 whilst the '1' output from gate G2 will inhibit the clock and preset all the bistables to logic '1' via the inverting gate G4.

37. Pin 8 of ML6 is preset to '0', holding the output of G12 at '1'; pin 2 of G6 is also at '0', holding the output of G6 at '1'. Thus both inputs to G13 are at '1', setting the output to '0'; this switches TR19 off, allowing the tuning unit servos to run if required.

38. As the output of G12 is at '1', G14 is held open and the 'ready' input signal from the tuning unit thus has a direct path to the 'ready' output pin 9 via TR7, G3, G14 and TR20.

39. As all the bistables are preset to the '1' state, the line decoding logic selects line 1, which corresponds to both relay drives open-circuit; the lines may now be manually selected by switches in parallel with the relay driver outputs.

## Automatic operation

40. The absence of a 'manual' signal switches TR8 off allowing its collector to rise to the '1' state. The output of G1 is therefore held at '0' closing gate G3 and holding its output at '1'.

41. When a new tuning sequence is initiated, the 'ready' input signal will not be present, thus allowing TR7 to switch on via R3 and D4. The '0' state on pin 12 of G2 sets the output of G2 to '1'. This inhibits the clock, switches on TR9 thus discharging C7 and presets all bistables to '1' via the inverting gate G4.

42. On receipt of the 0V 'ready' signal to the 'ready' input pin 12 (from the MA.1004), transistor TR7 will switch off; both inputs to gate G1 will be at logic '1' and the output of G1 will be at logic '0'. The output of G4 will go to logic '1' to remove the preset signal on the bistables. Transistors TR3 and TR9 are switched off allowing the clock to take over control of the line selection sequence.

43. During the line selection sequence, pin 9 of ML6 is at logic '1'; thus all the inputs of G6 are at '1', setting the output to '0'. This holds the output of G13 at '1' switching on TR19 to send a 'servos-off' signal to the feeder matching unit.

► 44. On completion of the line selection sequence, pin 9 of ML6 will change from '1' to '0'; this sets the output of G6 to '1'. Hence as both inputs of G13 are '1', its output is '0', switching off TR19. This allows the feeder matching unit to complete fine tuning. ◄

45. At the same time, pin 8 of ML6 changes from '0' to '1' switching on TR3 via R33 to inhibit the clock. Monostable ML9 is triggered by the positive edge of the pulse and, after a delay, its output will change from '1' to '0'. This delay is determined by C20 and R36 and is necessary to allow the feeder matching unit to complete fine tuning before signalling 'ready' back to the drive unit.

46. When the output of ML9 changes to '0', the output of G12 will remain at '1' until the monostable reverts to its original state. When this happens, the output of G12 reverts to '0' setting the outputs of G13 and G14 to '1'. Transistor TR19 and TR20 will now switch on to signal 'ready' to the exciter and switch off the servos in the feeder matching unit.

Note...

If required, the servos in the feeder matching unit may be left on after the 'ready' signal has been sent to the drive unit; this is done by removing link LK3.

47. The waveforms for automatic operation are shown on fig. 2.

48. Table 1 and Table 2 summarise the inputs to, and the outputs from, the line switching whilst Table 3 is the truth-table for the line decoding logic and the shift register.

TABLE 1

Inputs to MS.139

| PL1, pin No. | Source | Function | Signal ON condition | Signal OFF condition |
|---|---|---|---|---|
| 14 | Linear amplifier v.s.w.r. unit (MS.447) | Forward-power voltage. Typically +3V to +12V | - | - |

TABLE 1 (cont.)

| PL1, pin No. | Source | Function | Signal ON condition | Signal OFF condition |
|---|---|---|---|---|
| 12 | MA.1004 | 'Ready' input | 0V | +12V |
| 7 | | Exciter mute | 0V | +12V |
| 11 | Manual/auto switch (MA.1004) | Manual | +28V | Open-circuit |

TABLE 2

Outputs from MS.139

| PL1, pin No. | Function | Sent to | Signal ON condition | Signal OFF condition |
|---|---|---|---|---|
| 4 | Select line 3 relay | Line switching relay | 0V | Open-circuit |
| 5 | Select line 2 relay | Line switching relay | 0V | Open-circuit |
| 6 | Amplifier mute | Linear amplifier | 0V | +12V |
| 8 | Servos off | Feeder matching unit | 0V | +12V |
| 9 | 'Ready' output | Exciter | 0V | +12V |

TABLE 3

Truth-table: line decoding logic and shift register

| State No. | Shift register states | | | | Line selected | Line 2 relays | Line 3 relays |
|---|---|---|---|---|---|---|---|
| | Bit 1 | Bit 2 | Bit 3 | Bit 4 | | | |
| 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| 2 | 0 | 1 | 1 | 1 | 2 | 1 | 0 |
| 3 | 1 | 0 | 1 | 1 | 3 | 0 | 1 |
| 4 | 0 | 0 | 1 | 1 | 3 | 0 | 1 |
| 5 | 1 | 1 | 0 | 1 | 4 | 1 | 1 |
| 6 | 0 | 1 | 0 | 1 | 4 | 1 | 1 |
| 7 | 1 | 0 | 0 | 1 | 4 | 1 | 1 |
| 8 | 0 | 0 | 0 | 1 | 4 | 1 | 1 |
| 9 | 1 | 1 | 1 | 0 | 1 | 0 | 0 |
| 10 | 0 | 1 | 1 | 0 | 4 | 1 | 1 |
| 11 | 1 | 0 | 1 | 0 | 3 | 0 | 1 |
| 12 | 0 | 0 | 1 | 0 | 4 | 1 | 1 |

TABLE 3 (cont.)

| State No. | Shift register states | | | | Line selected | Line 2 relays | Line 3 relays |
|---|---|---|---|---|---|---|---|
| | Bit 1 | Bit 2 | Bit 3 | Bit 4 | | | |
| 13 | 1 | 1 | 0 | 0 | 2 | 1 | 0 |
| 14 | 0 | 1 | 0 | 0 | 4 | 1 | 1 |
| 15 | 1 | 0 | 0 | 0 | 3 | 0 | 1 |
| 16 | 0 | 0 | 0 | 0 | 4 | 1 | 1 |

Power supply

49. Power for the MS.139 is provided by the stabilized power supplies of the associated feeder matching unit. The nominal input voltage is between +27V and +30V; current consumption is typically 200 mA.

50. Transistor TR13 and associated components stabilize the supply voltages from the feeder matching unit and provide +12V and +16V outputs.

51. The +16V is used to power the output power sampler and store whilst the +12V is used for the noise-immunity circuits of the control logic.

52. The regulator X1, which is mounted on the case of the MS.139, provides +5V for the TTL logic stages.

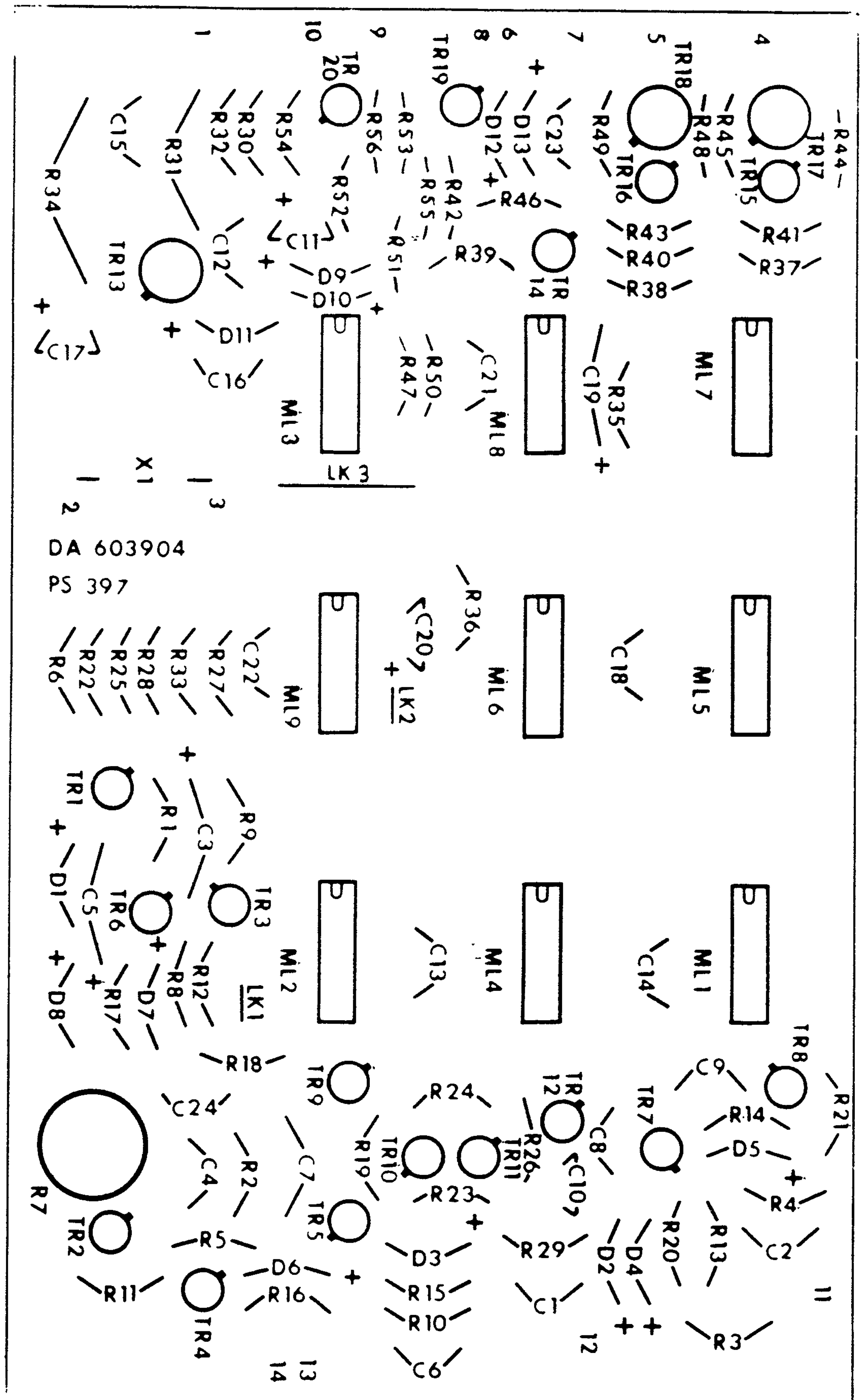
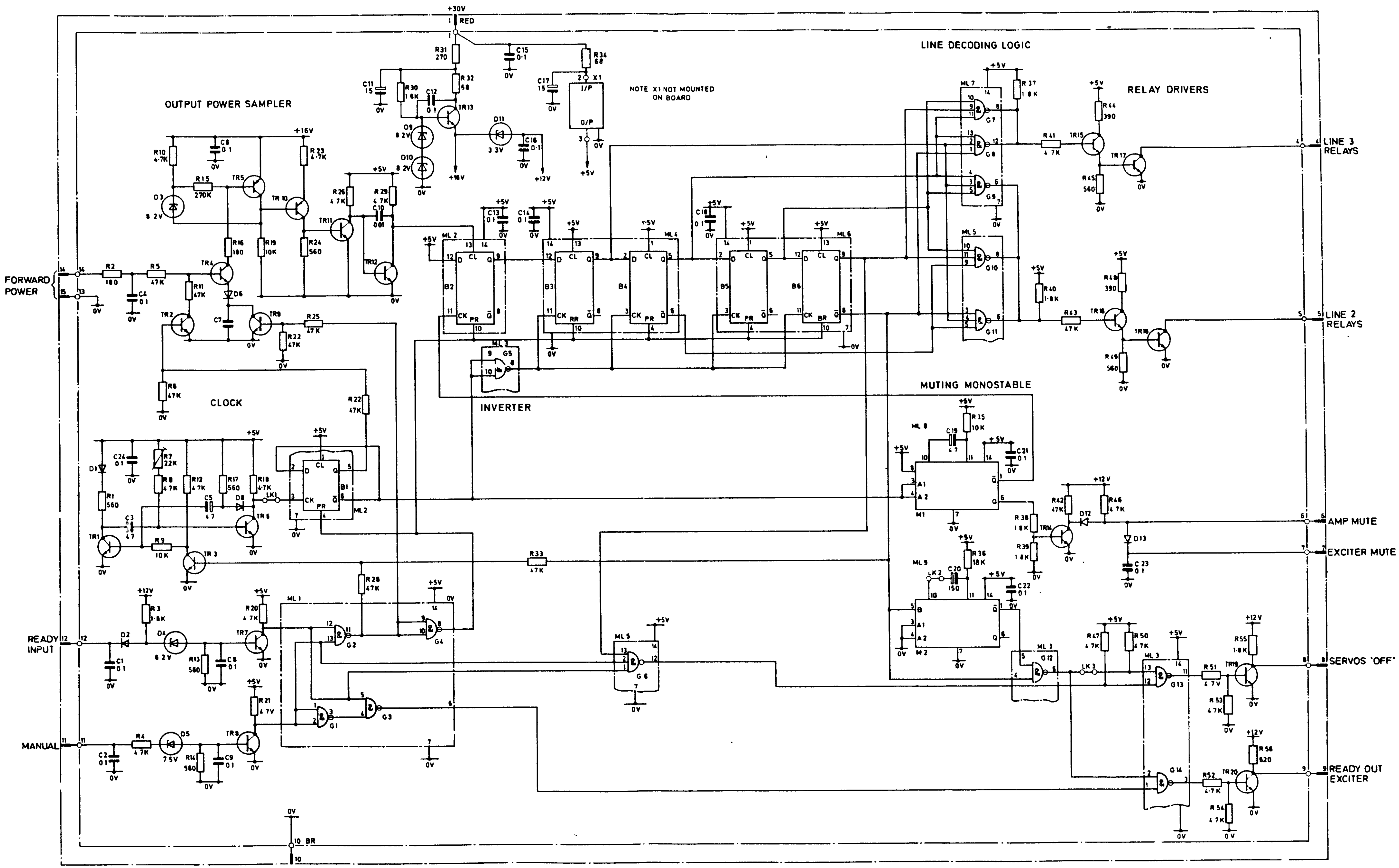



Fig.3 Line switching unit MS.139: component layout




Line switching unit MS139: circuit

Chapter 6-1

# SERVICING AND PERFORMANCE CHECKS

# ASSEMBLY, LINE SWITCHING UNIT 5820-99-626-7836

(Line switching unit MS.139)

CONTENTS



ILLUSTRATIONS



## INTRODUCTION

1. This chapter gives the fault-location procedures followed by the post-repair performance checks.

## SERVICING

### Test equipment

2. The following items are required for bench-testing the unit:-

(1) Multimeter set CT.498A.

(2) Oscilloscope set CT.588.

(3) Power supply +30V, rating 250mA.

(4) Power supply, adjustable +5V to +10V, rating 10mA.

(5) Resistor 3.3 kΩ, 1W (2 off required).

(6) Resistor 4.7 kΩ, 1/4W.

(7) Resistor 33 kΩ, 1/4W.

(8) Mating connector, 15-way.

(9) Pushbutton switch or equivalent: single-pole make.

### Fault location

3. Fault-finding in the line switching unit is carried out with the aid of the technical description. A thorough understanding of Chap.6-0 is an essential aid to fault-location and reference should be made to the relevant paragraphs. Operating voltages will in general be self-evident from the circuit diagram.

4. Under normal conditions, a sequence of four d.c. levels is applied to TR4 base; these 'forward power' signals are switched at 100 ms intervals. In order to examine the logic states pertaining to each level, the clock output (TR6) is disconnected and 'manual' clock pulses are applied to ML2.

5. (1) Place the unit on the bench and remove the top cover.

(2) Connect a 3.3 kΩ test resistor between pins 4 and 1 of the mating connector. Connect a 3.3 kΩ resistor between pins 5 and 1.

(3) Connect the +30V supply to pins 1 (positive) and 10. Switch the supply ON.

(4) Check that the following supply rails are present:-

(a) +5V at pin 3 of module X1.

(b) +12V at D11 anode.

(c) +16V at D11 cathode.

(5) Check that the following voltages are present:-

(a) +30V at pin 4 of the board.

(b) +30V at pin 5.

(c) +12V at pin 6.

(d) +12V at pin 7.

(e) 0V (nominal) at pin 8.

(f) +12V at pin 9.

(g) +12V at pin 12.

(6) Apply a +30V 'manual' input to pin 11 and check that pin 8 rises to +12V.

(7) Apply a 0V 'ready' input to pin 12 and check that pin 9 goes to 0V.

(8) Remove the inputs from pins 11 and 12. Check that pins 8 and 9 revert to their previous levels.

(9) Repeat operations (6) to (8) and check that the levels at pins 4 to 7 are unaffected.

6. (1) Switch OFF. Carefully unsolder link LK1. Make the connections shown in fig.1 and then switch ON again.

(2) Check whether the shift register is at state No.1 (Table 3 of Chap. 6-0); if not, manually 'clock' ML2 to obtain this condition.

Note...

One clock input to ML2 is provided by an instantaneous transition to +5V followed by a 0V input.

(3) Check that pin 13 of ML2 is at +5V; if not, a fault exists in the output power sampler circuits.

(4) Connect the variable-voltage d.c. supply to pin 14 (positive). Set the input level to about +6V initially.

(5) Clock this input into the shift register and check that the relevant outputs are obtained at pins 4 and 5 of the board.

(6) Continue clocking the register through the remaining states, varying the input levels in 0.5V steps as required.

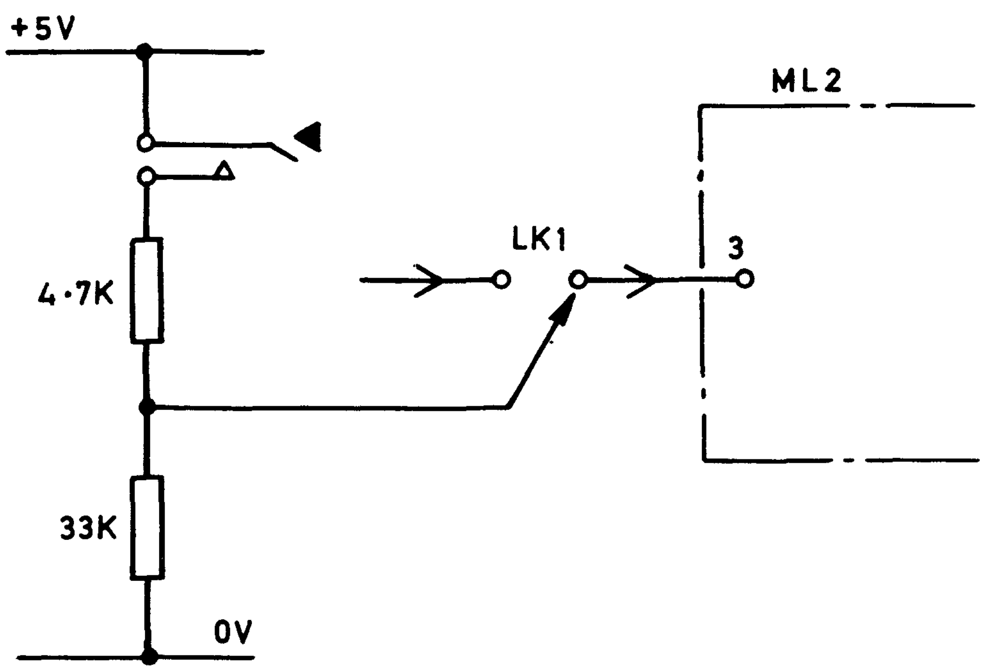



Fig.1 Manual clock-pulse

(7) At each state, check with the oscilloscope that the 50 ms 'mute' signals are developed at pin 6 of the board.

(8) Check for a 5V p-p square-wave signal at TR6 collector. The period of oscillation should be 100 ms; if not, adjust preset control R7 to give this value.

(9) At the final transition of ML6 outputs, check that pin 8 of PL1 goes to 0V and, after a time-delay of about 3s, reverts to +12V.

Dismantling and reassembly

7. The manner of dismantling is self-evident after the removal of the top cover; reassembly is effected in the reverse order. Prior to re-fitting to the transmitter cabinet check that link LK1 has been re-made; check all other connections disturbed during the tests.

PERFORMANCE CHECKS

8. The following operations constitute the post-repair checks. No post-repair adjustments are required.

9. (1) Withdraw the mating connector (1SK36) to the extent of its cableform and connect the MS.139 to the transmitter.

(2) Switch the transmitter ON.

(3) Using a frequency of 5 MHz, carry out the manual tuning procedures (Chap.1-2 and 13-2).

(4) Note the level of the r.f. power output.

(5) Measure the levels at pins 4 and 5 on the MS.139 board and hence determine which relays are energized; 0V for 'on', +30V for released.

(6) Set the transmitter to a frequency of 18 MHz and repeat operations (3) to (5).

(7) Re-set to a frequency of 5 MHz and carry out the automatic tuning sequence.

(8) Check that:-

(a) The r.f. power output is the same as that obtained at operation (4).

(b) The line selection is as for operation (5).

(9) Repeat operations (7) and (8) using a frequency of 18 MHz.

(10) Switch the transmitter OFF.

(11) Re-fit the cover to the MS.139 and re-install the unit.

# Chapter 11

## GENERAL DESCRIPTION

## TRANSMITTING SET, RADIO UK/FRT-618 (TTA.1860S)

CONTENTS



ILLUSTRATIONS



### INTRODUCTION

1. It is desirable to treat all system aspects of the transmitting set, radio UK/FRT-618 (TTA.1860S), when operating singly or in conjunction with the drive unit assembly 5820-99-631-8614 (MA.1721S), in one chapter (Chap. 13-0 to 13-4); hence, only general information on the TTA.1860S is given in the following paragraphs.

### WARNING

A. RACAL MA1720 DRIVE UNITS ARE NOT TO BE LIFTED OUT OF THEIR EQUIPMENT RUNNERS UNLESS THE UNIT IS BEING REMOVED FROM THE CABINET AND THEN ONLY BY TWO TRADESMEN.
AFTER EMBODIMENT OF MODIFICATION TC 0088 IT WILL BE NECESSARY TO REMOVE TWO BLANKING PLATES FROM THE RUNNERS TO FACILITATE REMOVAL OF DRIVE UNITS. (RAF LOCKING ONLY).

B. AT NO TIME ARE PERSONNEL TO BE PERMITTED TO WORK BELOW A UK/FRT 618 TRANSMITTER SUB-ASSEMBLY WHICH HAS BEEN WITHDRAWN OUT OF THE CABINET ON ITS EQUIPMENT-RUNNERS, EG. RACAL MA1720 DRIVE UNIT. THIS IS TO MINIMISE THE POSSIBILITY OF THE EXTENDED SUB-ASSEMBLY SLIPPING, FALLING AND INJURING PERSONNEL WORKING BELOW.

C. TRADESMEN ARE TO SATISFY THEMSELVES, BY PHYSICAL EXAMINATION, THAT WHEN A SUB-ASSEMBLY, EG. RACAL MA1720 DRIVE UNIT IS FULLY WITHDRAWN OUT OF ITS UK/FRT 618 TRANSMITTER CABINET, ALL LOCATING-LUGS AT THE SIDE OF THE SUB-ASSEMBLY ARE SECURELY LOCATED IN THE EQUIPMENT RUNNERS.

GENERAL DESCRIPTION

2. The TTA.1860S (fig.1) is a locally-controlled h.f. transmitter assembly providing voice and telegraph communication in the frequency range 1.6 MHz to 30 MHz.

3. The operating channels are selected at 100 Hz spacing. The carrier frequencies are generated by frequency synthesis and are referenced to an internal standard frequency source.

4. The following operation modes are provided:-

(1) Upper - sideband telephony (A3A, A3J)

(2) Lower - sideband telephony (A3A, A3J)

(3) Independent sideband telephony (A3B)

(4) Compatible a.m. telephony (A3H)

(5) C.W. telegraphy (A1)

(6) M.C.W. telegraphy (A2H, A2J)

5. When used singly (the single-drive configuration), a 1 kW (nominal) r.f. output is provided by the combined outputs from eight r.f. power modules, each delivering 125W. When used in conjunction with the MA.1721S (dual-drive conditions), two separate 500W outputs are provided. Wide-band techniques are used throughout the power amplifying stages; no 'transmitter tuning' is required.

6. A feeder matching network provides optimum coupling between the transmitter output and a 50Ω (nominal) antenna load. The network is adjusted automatically whenever the operating frequency is changed.

7. The primary power source for the transmitting set is a 210V to 250V single-phase a.c. supply.

8. It may be noted that the drive unit MA.1720S, the feeder matching unit MA.1004 and the line switching assembly within the TTA.1860S are identical items to those fitted to the MA.1721S.

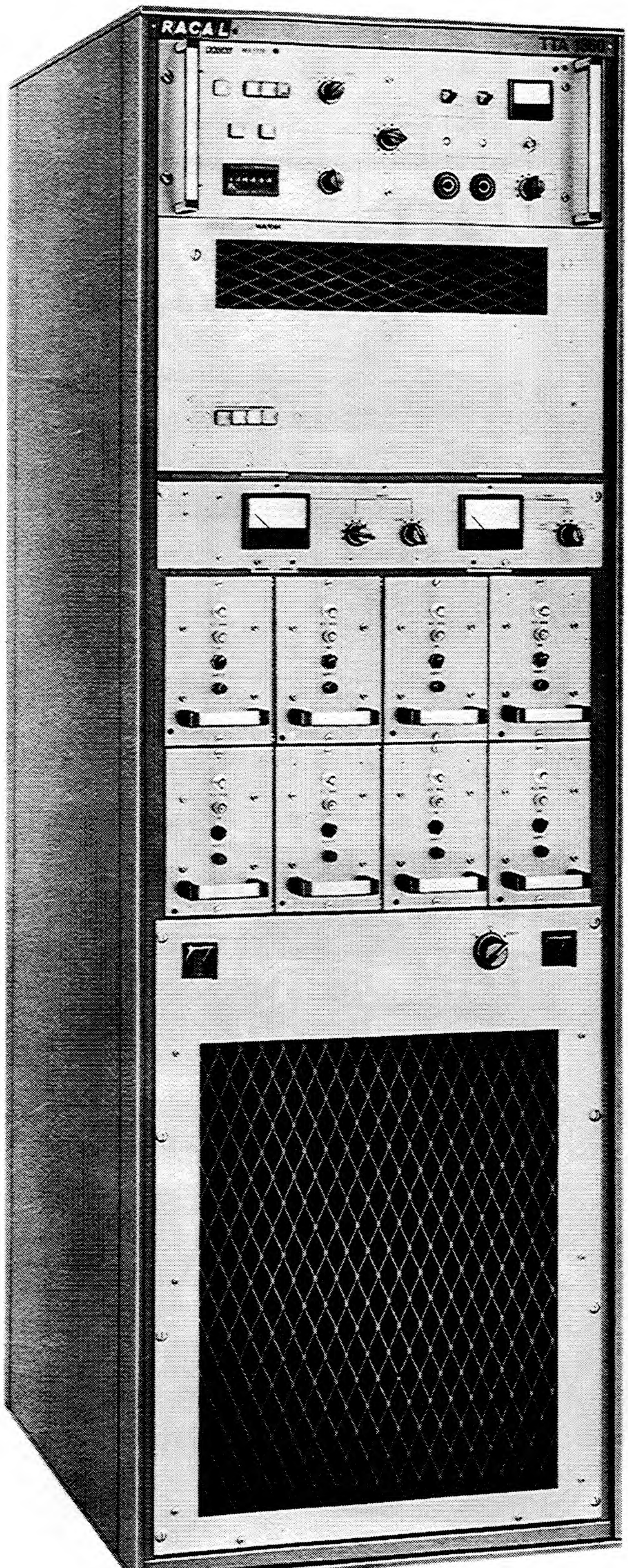



Fig.1 Transmitting set, radio UK/FRT-618: general view

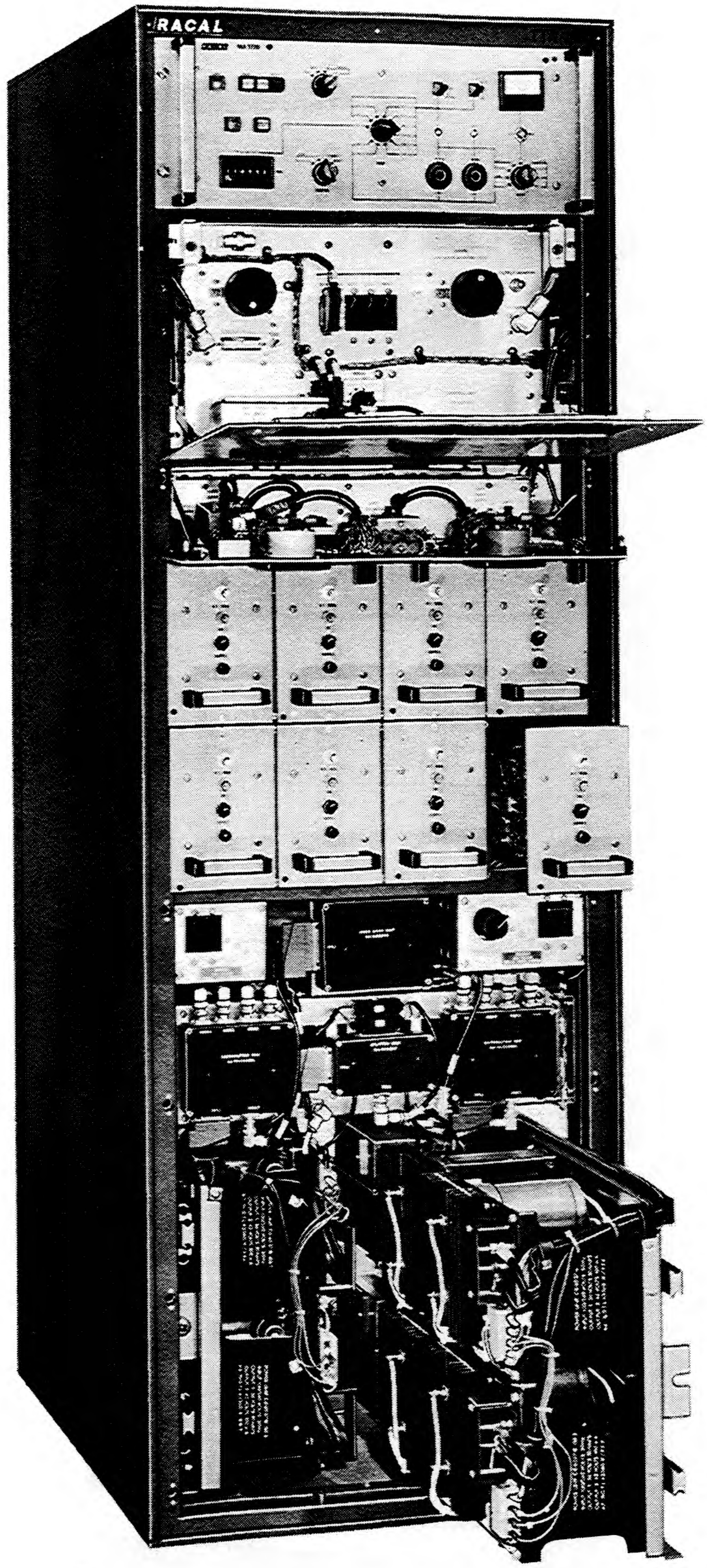



Fig.2    Transmitting set, radio UK/FRT-618: front panel removed

Chapter 12-0

GENERAL DESCRIPTION

DRIVE UNIT ASSEMBLY 5820-99-631-8614 (MA.1721S)

CONTENTS



ILLUSTRATIONS



INTRODUCTION

1. It is necessary to treat all system aspects of the drive unit assembly 5820-99-631-8614 (MA.1721S) in conjunction with the transmitting set, radio UK/FRT-618 (TTA.1860S). This information is given in Chap.13-0 to 13-4 and hence only general information on the MA.1721S is given in the following paragraphs.

WARNING

A. RACAL MA1720 DRIVE UNITS ARE NOT TO BE LIFTED OUT OF THEIR EQUIPMENT RUNNERS UNLESS THE UNIT IS BEING REMOVED FROM THE CABINET AND THEN ONLY BY TWO TRADESMEN.
AFTER EMBODIMENT OF MODIFICATION TC 0088 IT WILL BE NECESSARY TO REMOVE TWO BLANKING PLATES FROM THE RUNNERS TO FACILITATE REMOVAL OF DRIVE UNITS. (RAF LOCKING ONLY).

B. AT NO TIME ARE PERSONNEL TO BE PERMITTED TO WORK BELOW A UK/FRT 618 TRANSMITTER SUB-ASSEMBLY WHICH HAS BEEN WITHDRAWN OUT OF THE CABINET ON ITS EQUIPMENT-RUNNERS, EG. RACAL MA1720 DRIVE UNIT. THIS IS TO MINIMISE THE POSSIBILITY OF THE EXTENDED SUB-ASSEMBLY SLIPPING, FALLING AND INJURING PERSONNEL WORKING BELOW.

C. TRADESMEN ARE TO SATISFY THEMSELVES, BY PHYSICAL EXAMINATION, THAT WHEN A SUB-ASSEMBLY, EG. RACAL MA1720 DRIVE UNIT IS FULLY WITHDRAWN OUT OF ITS UK/FRT 618 TRANSMITTER CABINET, ALL LOCATING-LUGS AT THE SIDE OF THE SUB-ASSEMBLY ARE SECURELY LOCATED IN THE EQUIPMENT RUNNERS.

GENERAL DESCRIPTION

2. The MA.1721S (fig.1) provides the additional r.f. drive source and feeder matching facilities required when the TTA.1860S is used in the dual-drive configuration. The drive unit MA.1720S, the feeder matching unit MA.1004 and the line switching assembly, which are identical items to those fitted in the TTA.1860S, are fully described in Chap.2, 5 and 6 respectively.

3. The physical construction of the bench-mounted cabinet is similar to that of the 1 kW cabinet assemblies (Chap. 3-0).

4. The assembly also contains the output combining unit MS.560 and two r.f. dummy loads which together provide the 'dual-drive to single antenna' facility. Detailed descriptions of these items are given in Chap. 12-1.

5. The primary power source for the MA.1721S is a 210V to 250V single-phase a.c. supply.

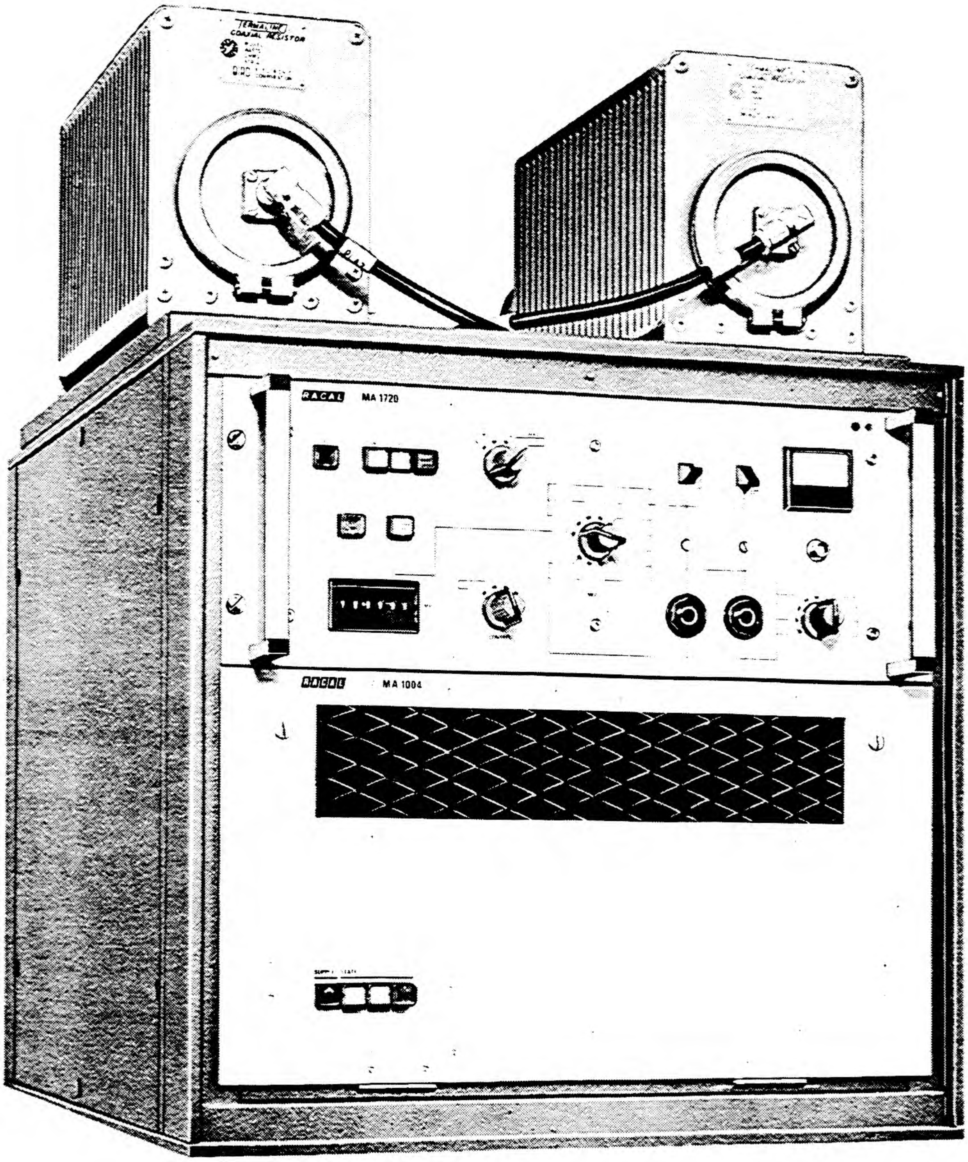



Fig.1 Drive unit assembly 5820-99-631-8614 : general view

Chapter 12-1

# DESCRIPTION, SERVICING AND REPAIR: COMBINER UNIT 10D/5895-99-633-5683 (MS.560) AND DUMMY LOADS

CONTENTS



ILLUSTRATIONS



## INTRODUCTION

1. The combiner unit MS.560 (fig.1) is a wideband hybrid network. It accepts the separate outputs from r.f. paths 1 and 2 and provides a combined - signal output to the wideband antenna. Any losses incurred in the combining process are dissipated in two dummy loads.

## DESCRIPTION OF COMBINER UNIT

2. The elements of the hybrid network are encapsulated in a rectangular metal case. The complete unit is fitted to the top plate of the MA.1721S cabinet.

3. All external connections viz. two inputs, one output and two loads are made via coaxial connectors on the front and side faces of the unit.

4. The nominal impedance at each of the five ports of the network is 50 ohms, unbalanced.

5. Under normal conditions, a 3dB loss is incurred in each path; a 2 x 250W output is produced from two 500W inputs. The losses are dissipated in the dummy loads.

6. When terminated into a 50-ohm antenna, the hybrid network provides at least 20dB isolation between input ports throughout the frequency range. The r.f. paths from MA.1004 No.1 and No.2 remain separate and hence adjustments carried out on one transmitter have no effect upon the operation of the other.

## DESCRIPTION OF DUMMY LOADS

7. The r.f. dummy loads (fig.1 of Chap.12-0) provide two low-reflection, non-radiating terminations for the 'ballast' ports of the MS.560.

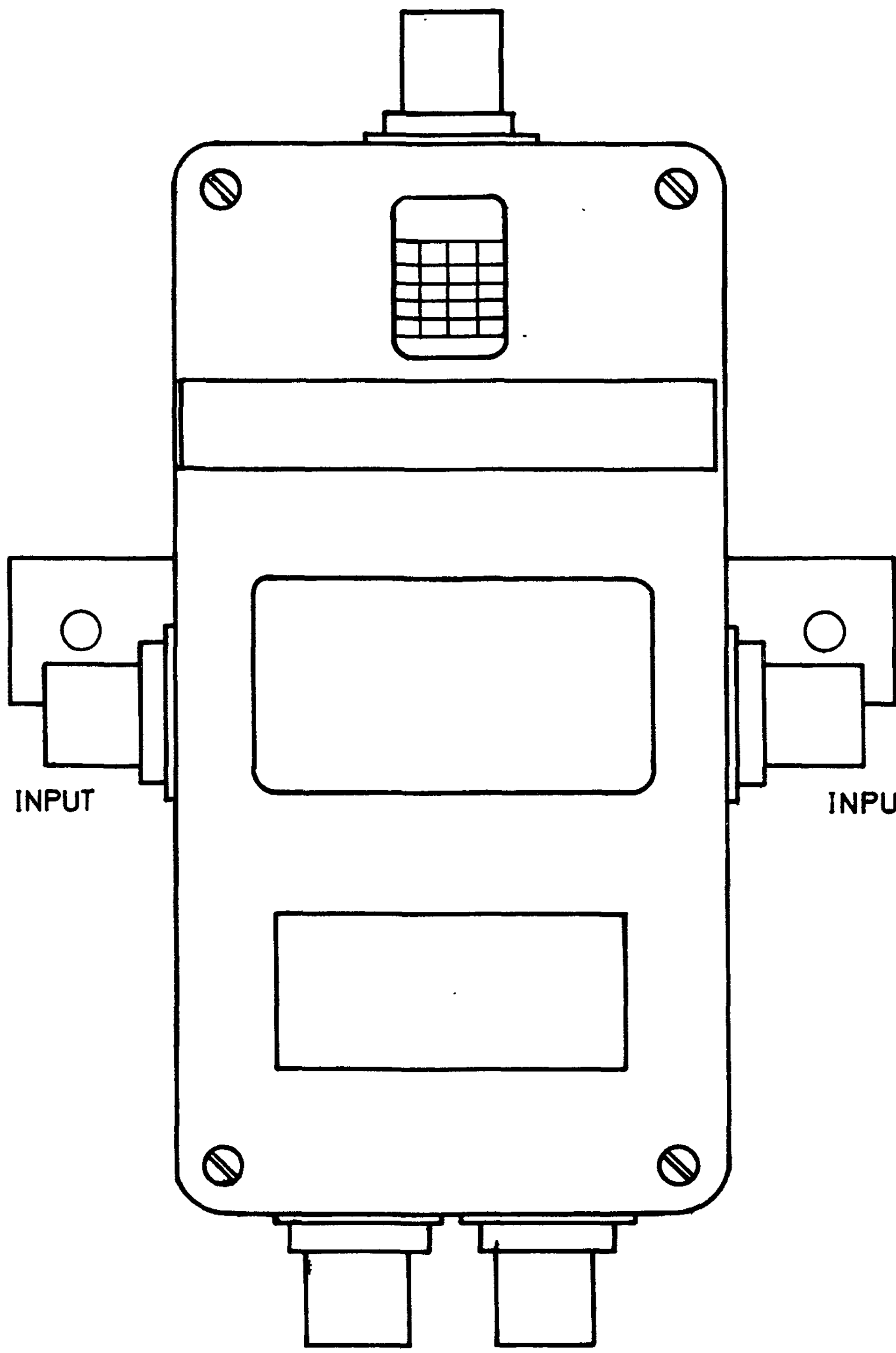



Fig.1 Combiner unit MS.560: top view

8. Each unit is housed in a rectangular metal case with transverse cooling fins spaced evenly along its entire length. Reinforced fins at front and rear are angled outward to form mounting flanges. The unit is filled with a specially selected dielectric coolant. The r.f. input connector is situated on the front face of the unit.

9. The dissipative element consists of a high accuracy carbon film resistor immersed in a dielectric coolant. The resistor is enclosed in an exponentally tapered housing to produce a linear reduction in surge impedance which is directly proportional to the distance along the resistor. When surrounded by the coolant, the characteristic impedance at the front end of the resistor is 50 ohms. Half way along the resistor the characteristic impedance is 25 ohms, compensating for resistance already passed over, whilst at the rear end of the resistor the characteristic impedance is zero ohms. This produces a practically reflectionless line termination over the entire frequency range up to about 1 GHz. The power rating of the load is 500W (continuous).

10. The r.f. power applied to the resistor generates heat in the resistor which in turn heats the dielectric coolant. By convection the heated oil flows through slotted openings in the coaxial shell to the walls of the metal tank. The series of radiating fins fitted to the tank transmit the heat of the coolant into the surrounding air. When the coolant is heated, thermal expansion causes the oil to flow into an expansion tank mounted at the rear of the radiator.

Note...

> The dummy load is designed to be used in the horizontal plane only i.e. with mounting brackets facing down. The unit is mounted by means of the four mounting brackets. When mounting or deploying for use, allow at least six inches at the sides and the top of the unit for air circulation.

## SERVICING AND REPAIR OF COMBINER UNIT

11. The encapsulation of the hybrid network precludes its repair. In the event of failure, replace the entire unit.

## SERVICING AND REPAIR OF DUMMY LOADS

### Load resistance

12. Accurate d.c. measurement of the load resistor, between the inner and outer conductors, will provide a good check on the condition of the resistor. A resistance bridge with an accuracy of better than one percent at 50 ohms should be used for this measurement. The resistance, measured at room temperature, should be within $\pm$ 1 ohm of the value stamped on the label; if not, replace the entire unit.

### Coolant

13. Check that the clamping band (front of unit) is secure and that no significant loss of coolant has occured. If in doubt, replace the entire unit.

Chapter 13-0

# FUNCTIONAL DESCRIPTION

# SINGLE- AND DUAL-DRIVE SYSTEMS

CONTENTS



TABLES



ILLUSTRATIONS

## INTRODUCTION

WARNING

A. RACAL MA1720 DRIVE UNITS ARE NOT TO BE LIFTED OUT OF THEIR EQUIPMENT RUNNERS UNLESS THE UNIT IS BEING REMOVED FROM THE CABINET AND THEN ONLY BY TWO TRADESMEN.
AFTER EMBODIMENT OF MODIFICATION TC 0088 IT WILL BE NECESSARY TO REMOVE TWO BLANKING PLATES FROM THE RUNNERS TO FACILITATE REMOVAL OF DRIVE UNITS. (RAF LOCKING ONLY).

B. AT NO TIME ARE PERSONNEL TO BE PERMITTED TO WORK BELOW A UK/FRT 618 TRANSMITTER SUB-ASSEMBLY WHICH HAS BEEN WITHDRAWN OUT OF THE CABINET ON ITS EQUIPMENT-RUNNERS, EG. RACAL MA1720 DRIVE UNIT. THIS IS TO MINIMISE THE POSSIBILITY OF THE EXTENDED SUB-ASSEMBLY SLIPPING, FALLING AND INJURING PERSONNEL WORKING BELOW.

C. TRADESMEN ARE TO SATISFY THEMSELVES, BY PHYSICAL EXAMINATION, THAT WHEN A SUB-ASSEMBLY, EG. RACAL MA1720 DRIVE UNIT IS FULLY WITHDRAWN OUT OF ITS UK/FRT 618 TRANSMITTER CABINET, ALL LOCATING-LUGS AT THE SIDE OF THE SUB-ASSEMBLY ARE SECURELY LOCATED IN THE EQUIPMENT RUNNERS.

1. An introduction to the transmitting set, radio UK/FRT-618 (Racal TTA.1860S) and the separate drive unit assembly 5820-99-631-8614 (Racal MA.1721S) is given in Chap.11 and 12. This chapter gives the physical and functional descriptions for all configurations of the system viz. single-drive and dual-drive.

## CONSTRUCTION

2. The TTA.1860S is housed in a single floor-standing cabinet. It consists of the main units listed in Table 1. The location of these items is given in fig. 1.

TABLE 1

List of main units - TTA.1860S

| Assembly | Nato No. | Manufacturer's ref. |
|---|---|---|
| Transmitter sub-assembly | 5820-99-631-8612 | 1 kW Cabinet assembly) )TA.1810S |
| Amplifier-stabilizer | 5820-99-626-4730 | MM.420 (8 off) ) |
| Transmitter drive unit | 5820-99-631-8611 | MA.1720S |
| Adaptor, antenna to transmitter | 5820-99-624-5394 | MA.1004 |
| Line switching unit | 5820-99-626-7836 | MS.139 |

3. With reference to Table 1, the 1 kW cabinet assembly (when supplied as such) does not include the MM.420 amplifier-stabilizers. The transmitter sub-assembly is not a functional entity until the eight amplifier-stabilizers have been fitted; it then becomes a linear amplifier assembly (TA.1810S), which is not a replaceable stores item as a whole. The TTA.1860S is formed when the remaining main units have been fitted.

4. The MA.1721S is housed in a bench-mounting cabinet and is installed in close proximity to the TTA.1860S; if necessary, the MA.1721S may be mounted on top of the TTA.1860S. The two cabinets are interconnected via r.f. cables, the length of which is critical.

5. The MA.1721S consists of the main units listed in Table 2.

TABLE 2

List of main units - MA.1721S

| Assembly | Nato No. | Manufacturer's ref. |
|---|---|---|
| Transmitter drive unit | 5820-99-631-8611 | MA.1720S |
| Adaptor, antenna to transmitter | 5820-99-624-5394 | MA.1004 |
| Line switching unit | 5820-99-626-7836 | MS.139 |
| Combiner unit | 5895-99-633-5683 | MS.560 |
| Dummy load | | |

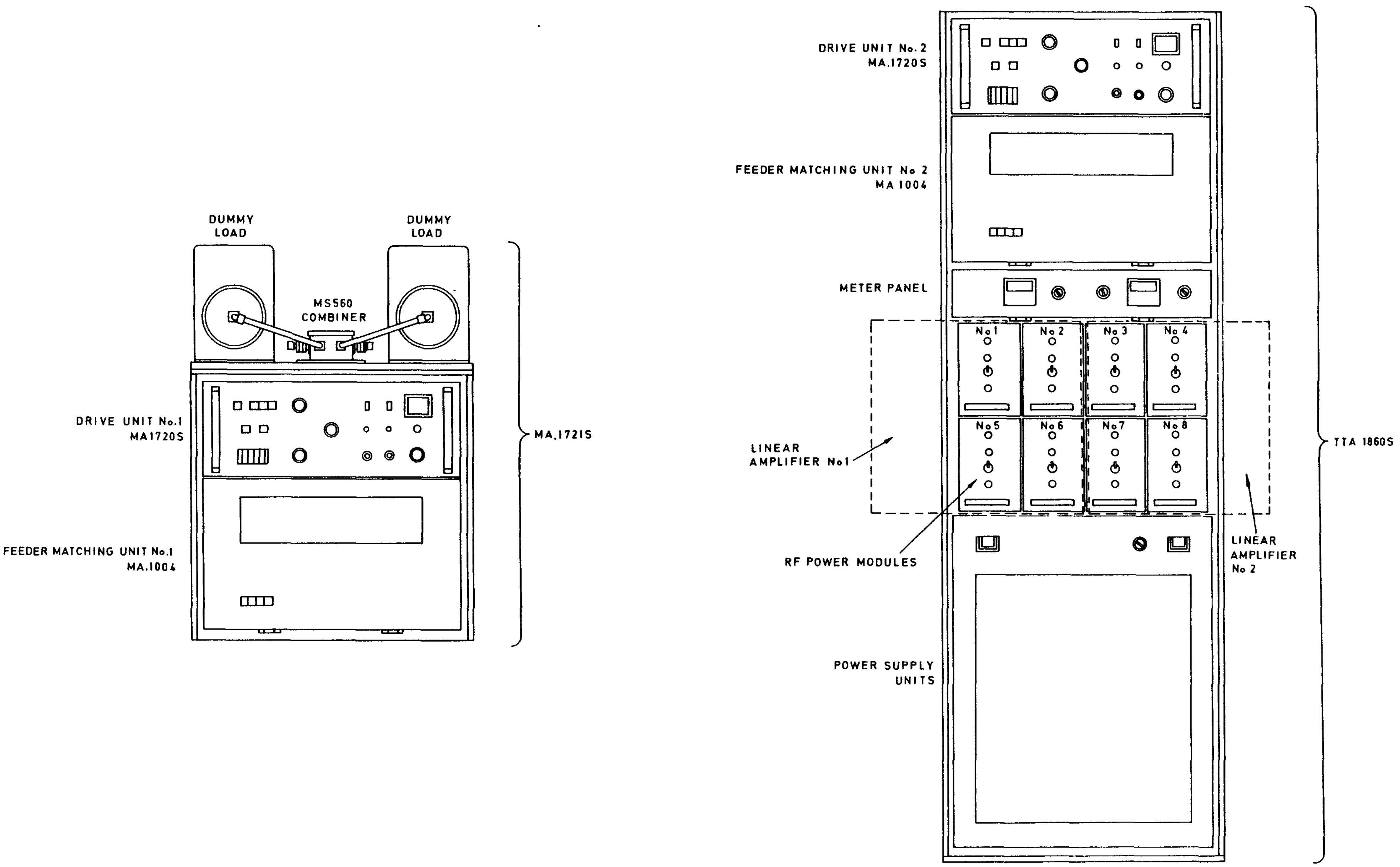



Fig.1

# Dual-drive transmitting system: location of main units

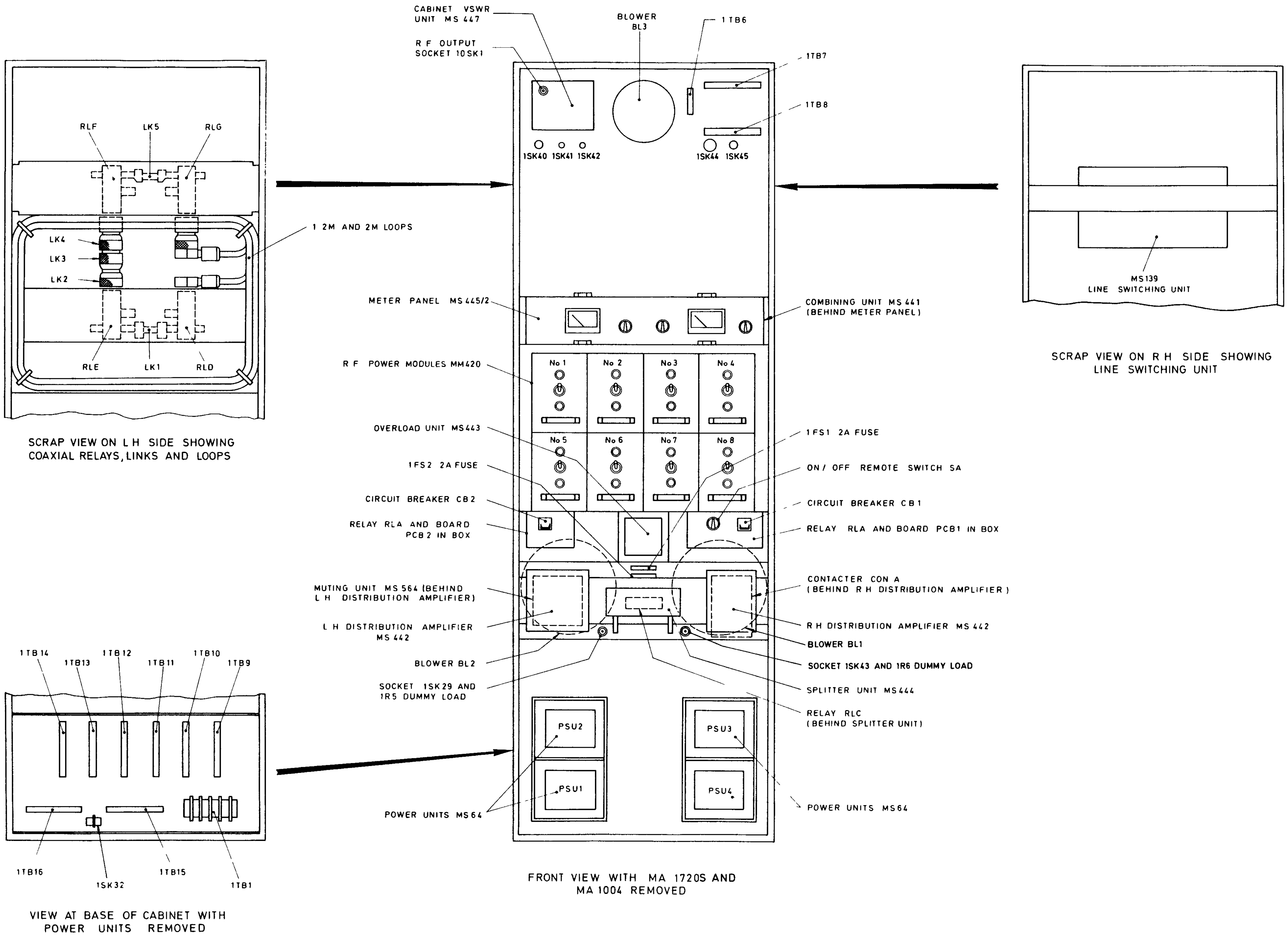



Fig. 2

# Transmitter sub-assembly: location of sub-assemblies

Fig. 2

6. The sub-assemblies contained in all the main units are listed in Tables 3 to 6. The layouts of the transmitter sub-assembly and the drive unit assembly are given in fig.2 and 3 respectively.

TABLE 3

List of sub-assemblies - transmitter sub-assembly

| Sub-assembly | Nato No. | Manufacturer's ref. |
|---|---|---|
| Power supply | 5820-99-626-4731 | MS.64/1 (4 off) |
| OR | | |
| Power supply | 5820-99-643-6159 | MS.64/2 (4 off) |
| Combining unit | 5820-99-626-3417 | MS.441 |
| Distribution amplifier | 5820-99-630-7603 | MS.442 (2 off) |
| Overload unit | 5820-99-630-7604 | MS.543 |
| Splitter unit | 5820-99-630-7605 | MS.444 |
| Meter panel assembly | | MS.445/2 |
| Voltage standing wave ratio (v.s.w.r.) assembly | 5820-99-630-7337 | MS.447 |
| Muting unit | 5820-99-633-2059 | MS.564 |

TABLE 4

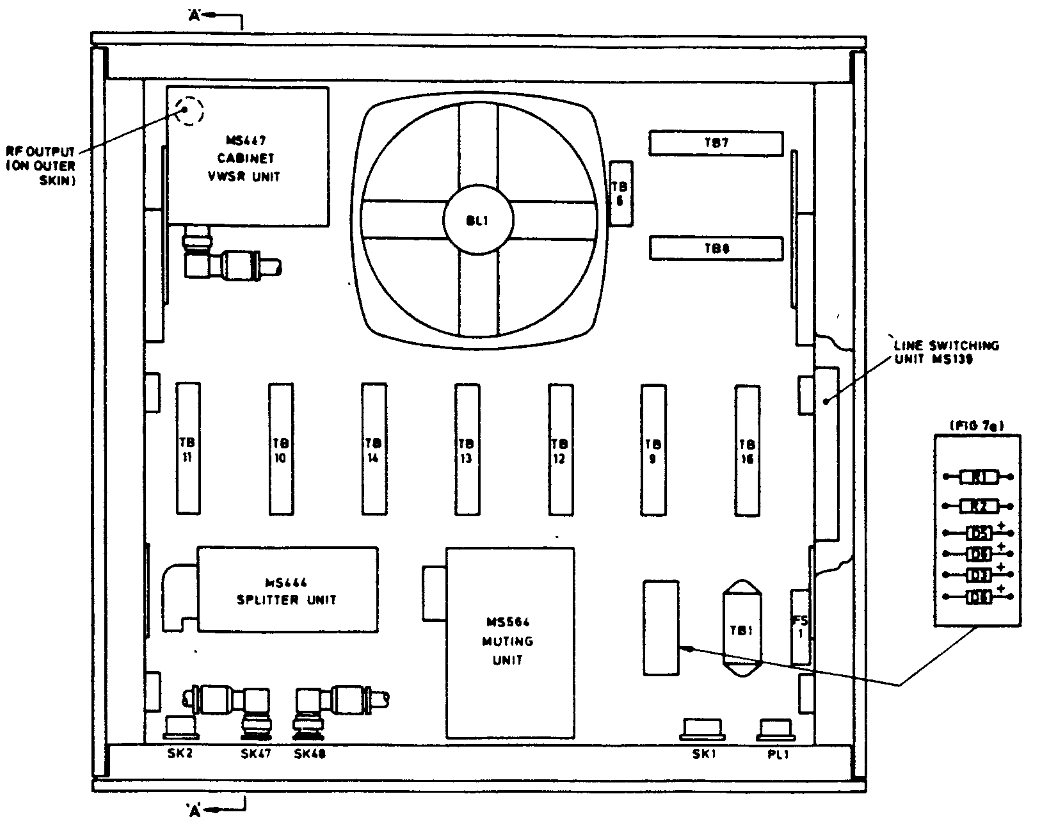
List of sub-assemblies - amplifier-stabilizer MM.420

| Sub-assembly | Nato. No. | Manufacturer's ref. |
|---|---|---|
| Radio frequency amplifier | 5820-99-626-4732 | MM.320 |
| Voltage stabilizer | 5820-99-626-3419 | MS.440 |

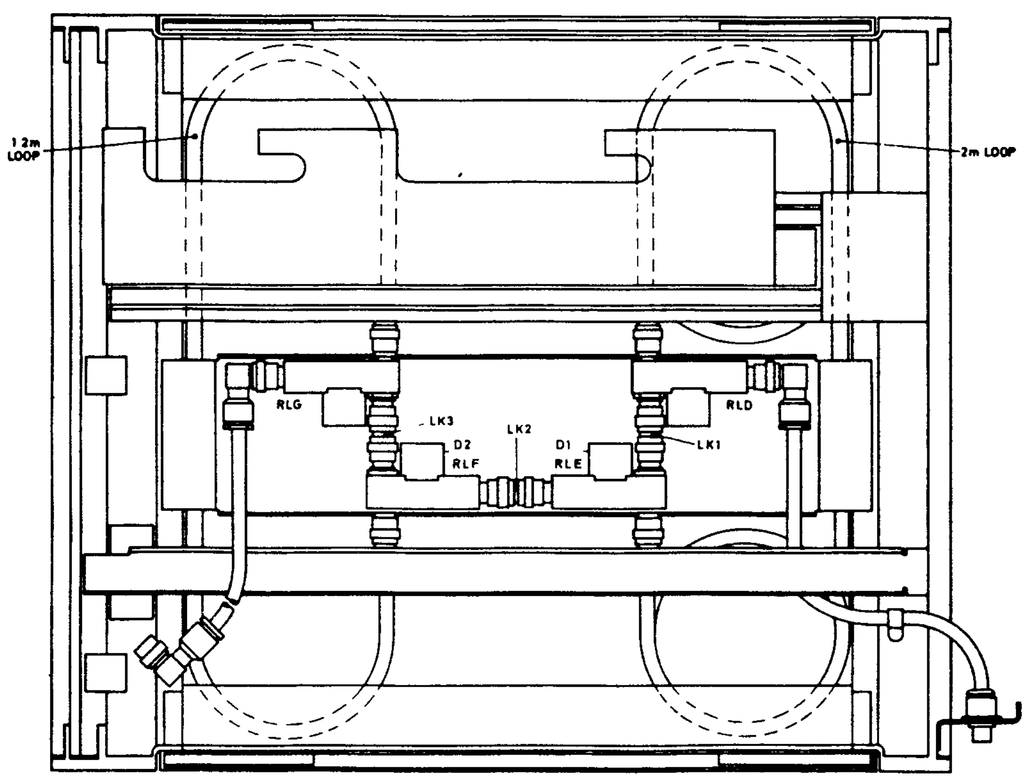
TABLE 5

List of sub-assemblies - transmitter drive unit MA.1720S

| Sub-assembly | Nato. No. | Manufacturer's ref. |
|---|---|---|
| Standard frequency source | | 9400 |
| 34MHz generator board | | PM.344 |
| L.F. loop board | | PM.349 |
| Transfer loop board | | PS.338 |
| H.F. loop and oscillator board | | PS.337 |
| Low level board | | PM.341 |
| Mixer and output board | | PM.342 |
| Noise immunity board | | PM.346 |
| Control board | | PM.345 |
| Power supply board | | PM.343 |




FRONT VIEW WITH MA1720S AND MA1004 REMOVED




VIEW IN DIRECTION OF ARROW 'A'

Fig.3 Drive unit assembly : location of sub-assemblies



17554 419642 167 8.77 LT LTD RC1526

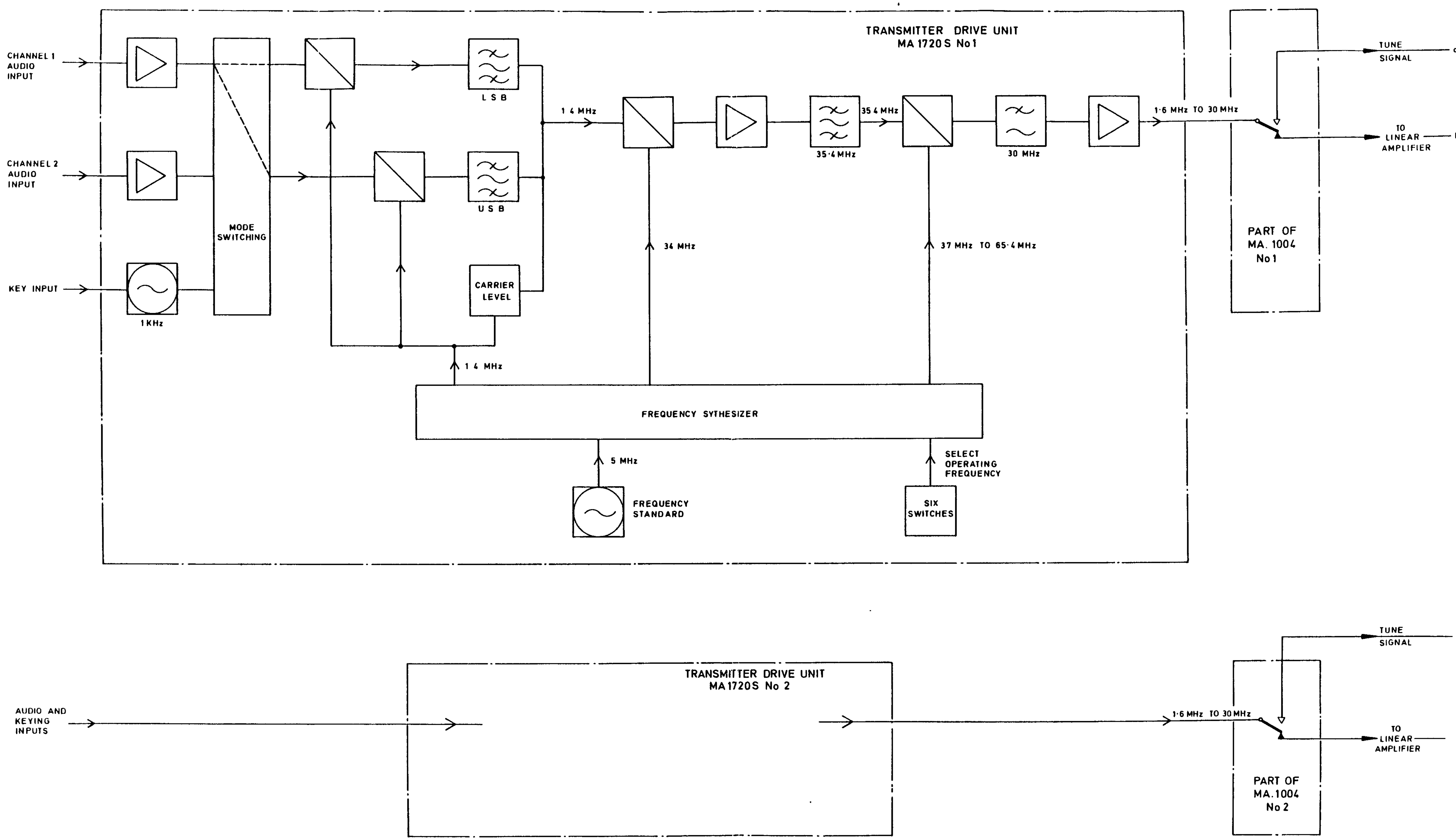



Fig. 4a

Transmitting system, single-or dual-drive: simplified block diagram (Sheet 1 of 3)

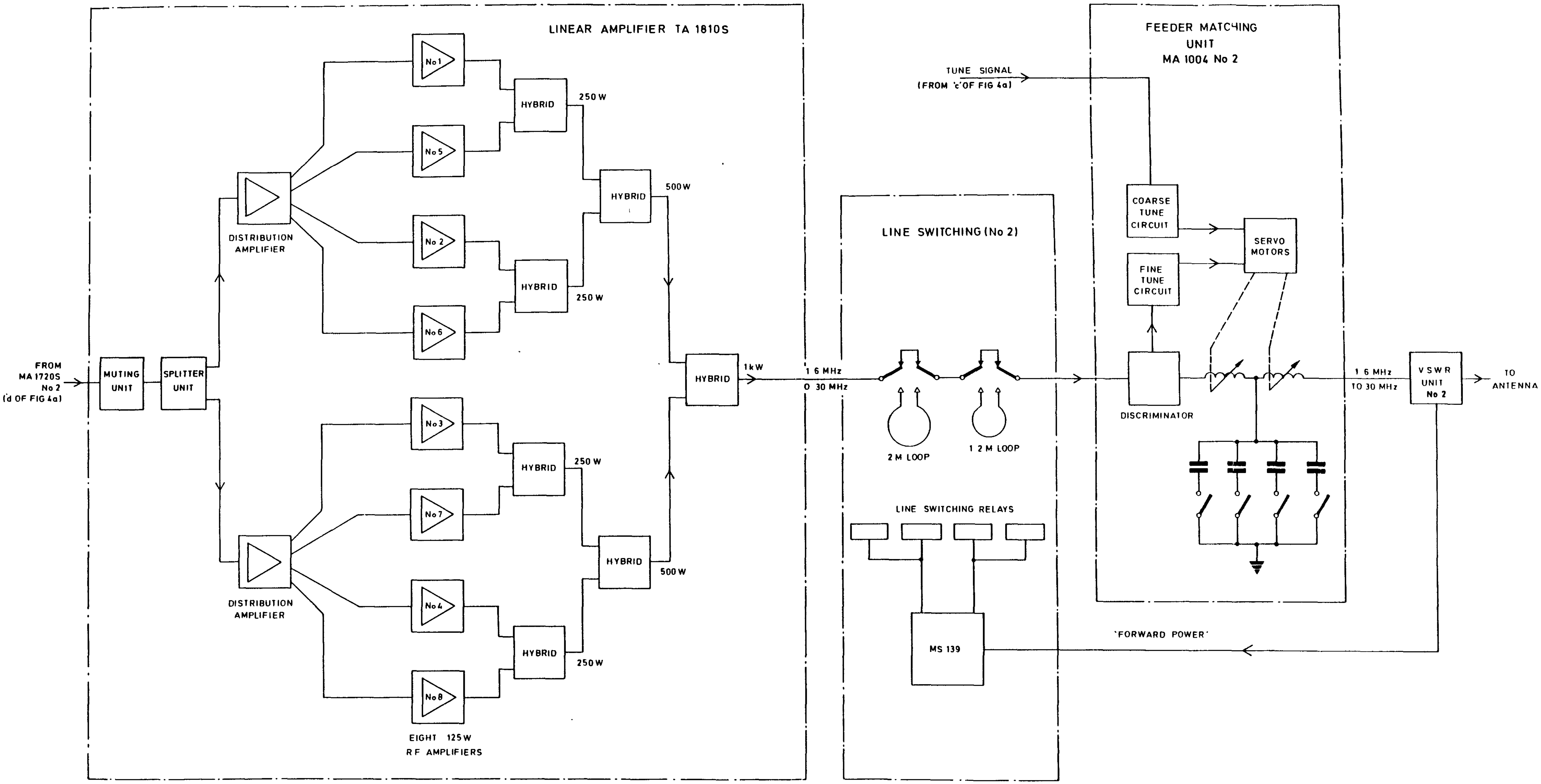



Fig. 4b

**Transmitting system, single-drive: simplified block diagram (Sheet 2 of 3)**

Fig 4b

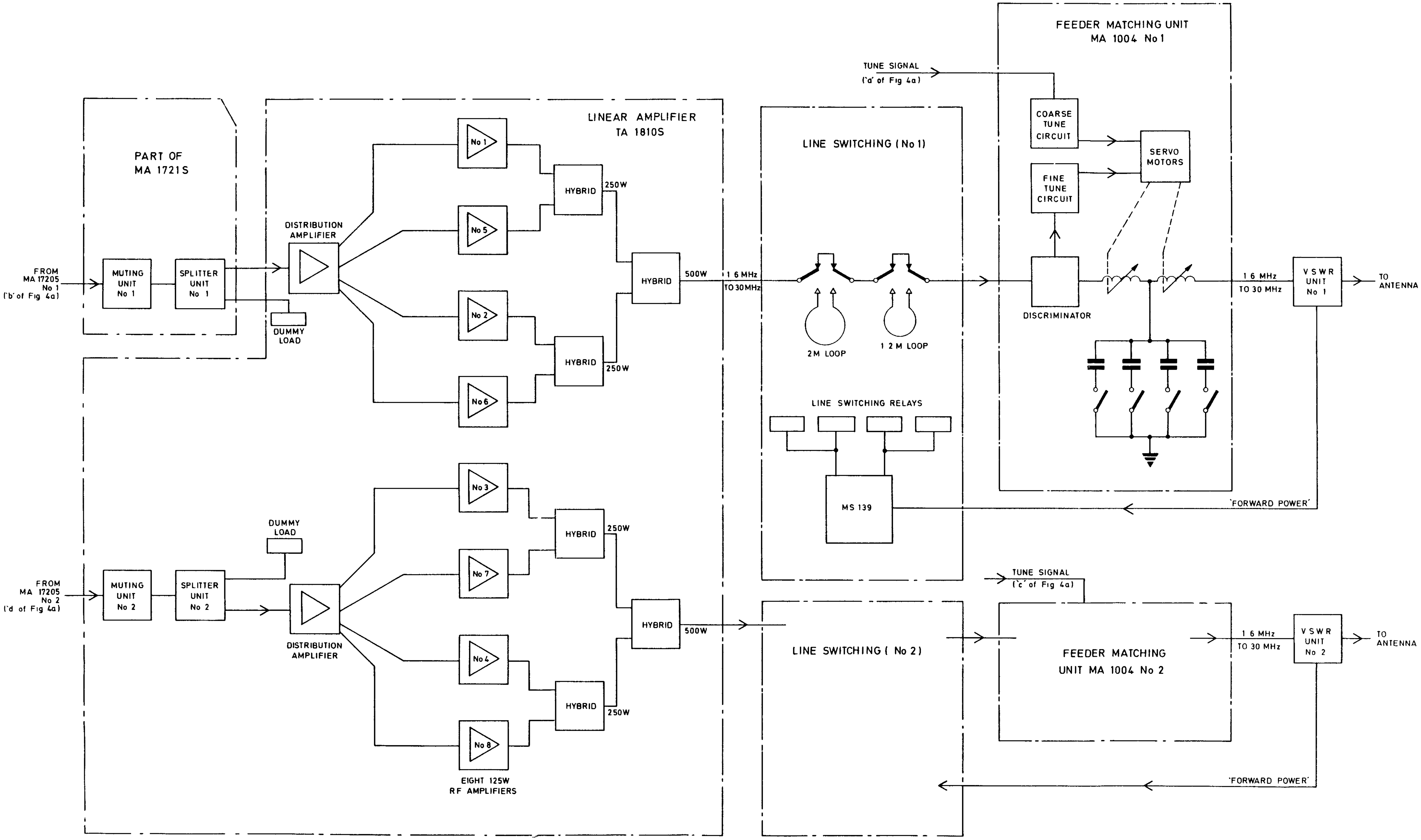



Fig 4c

**Transmitting system, dual-drive: simplified block diagram (Sheet 3 of 3)**

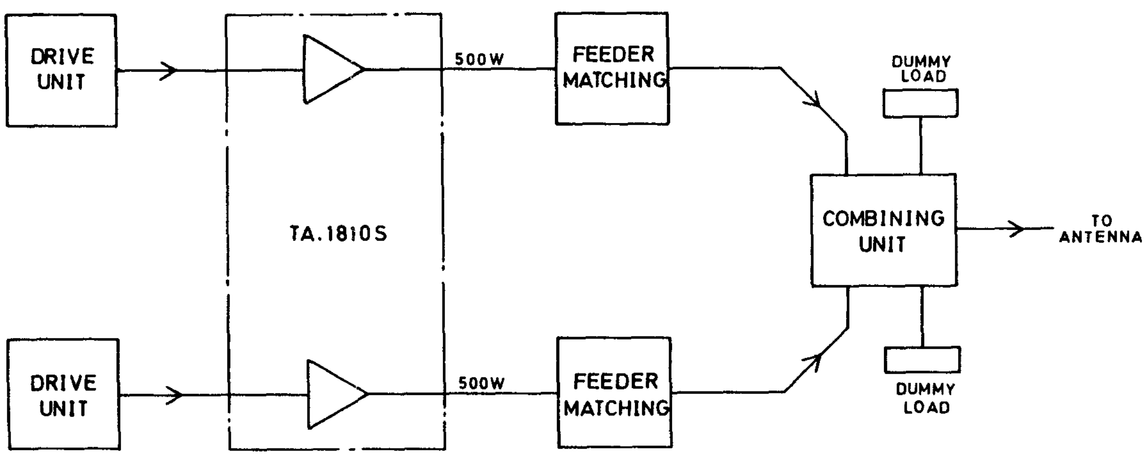



**Fig.5 Common antenna working: simplified block diagram**

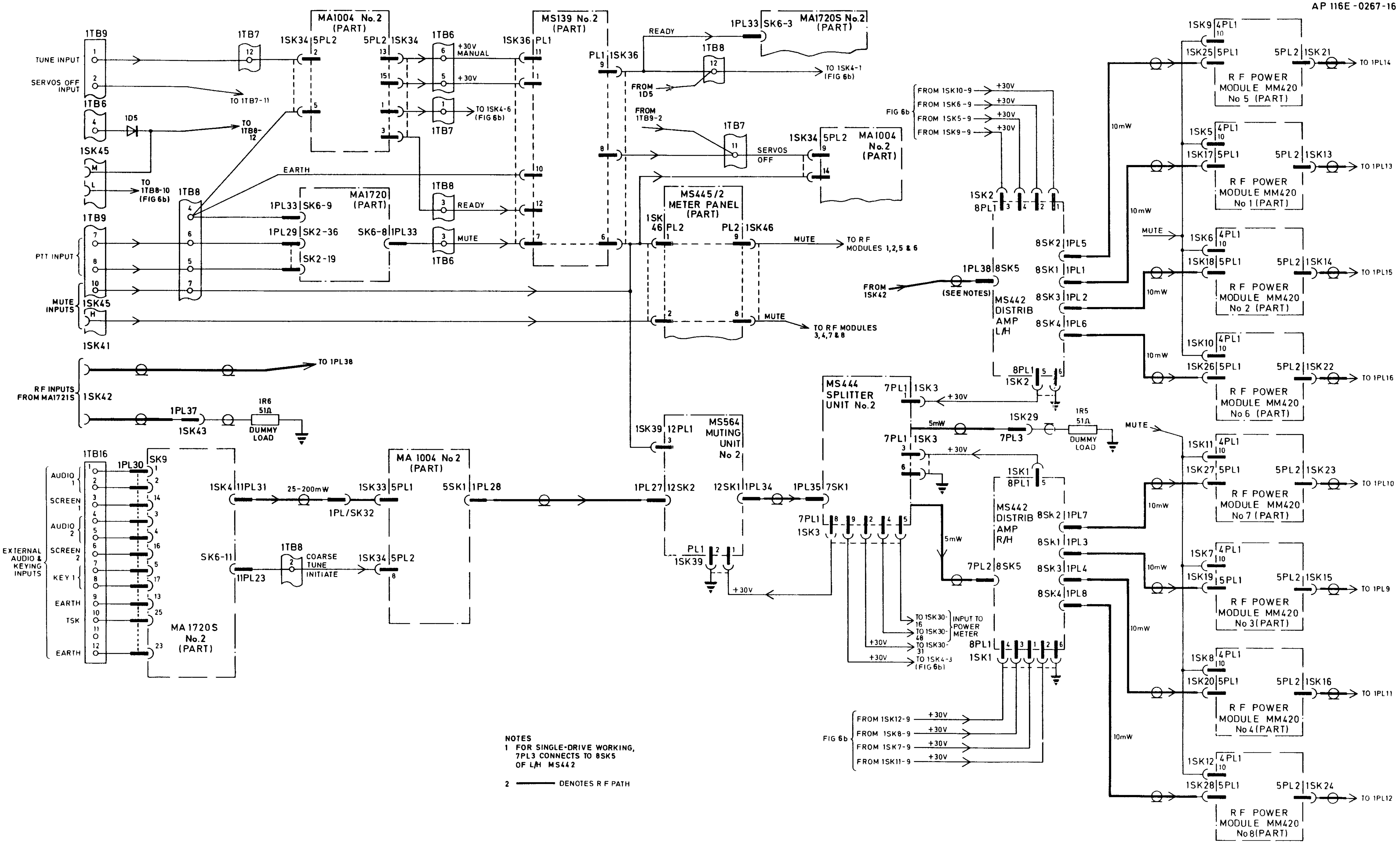



Fig 6a

**Transmitting set, radio: interconnecting (functional) diagram (Sheet 1 of 3)**

Fig 6a

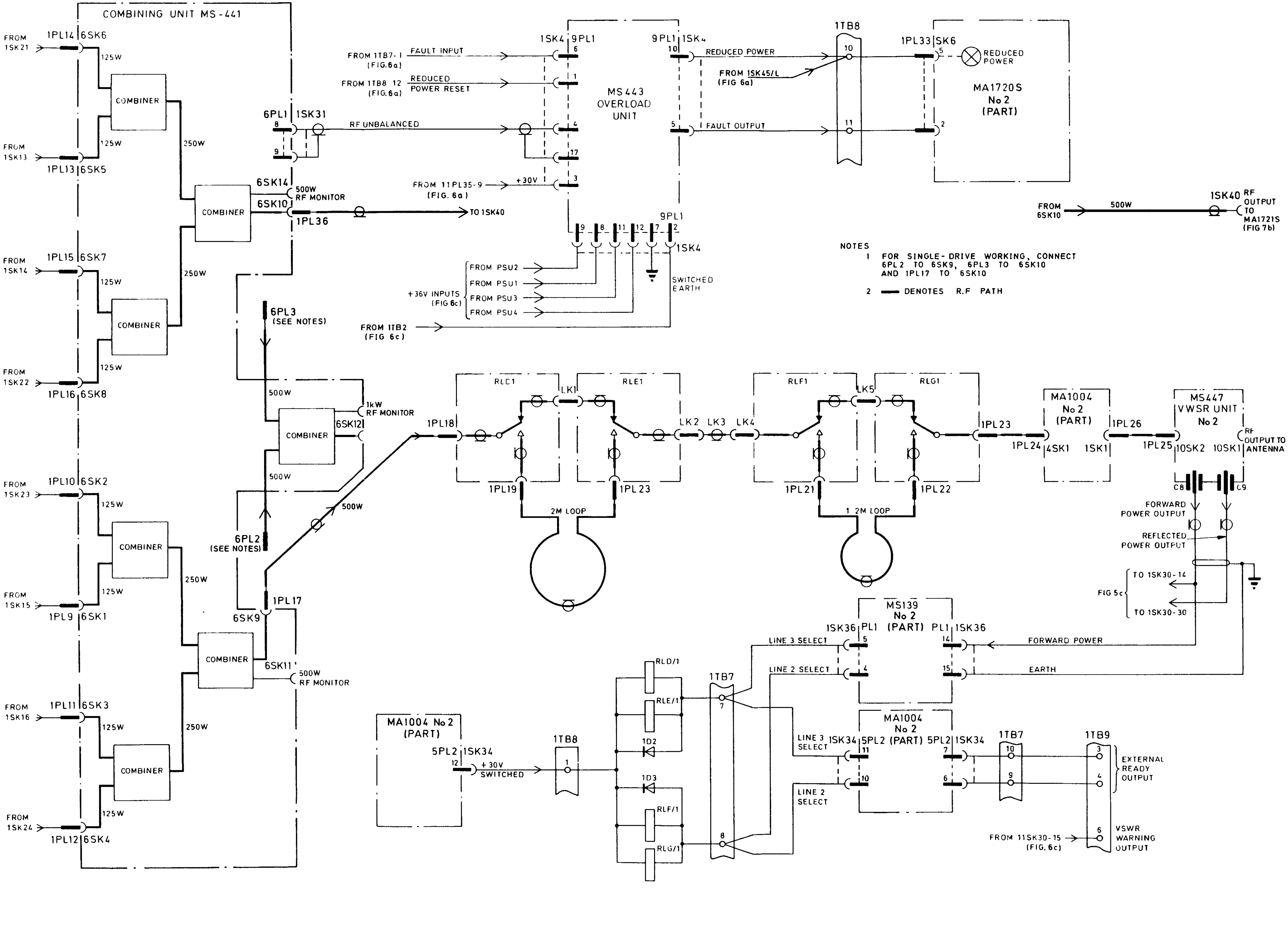



Fig.6b **Transmitting set, radio: interconnecting (functional) diagram (Sheet 2 of 3)** Fig.6b

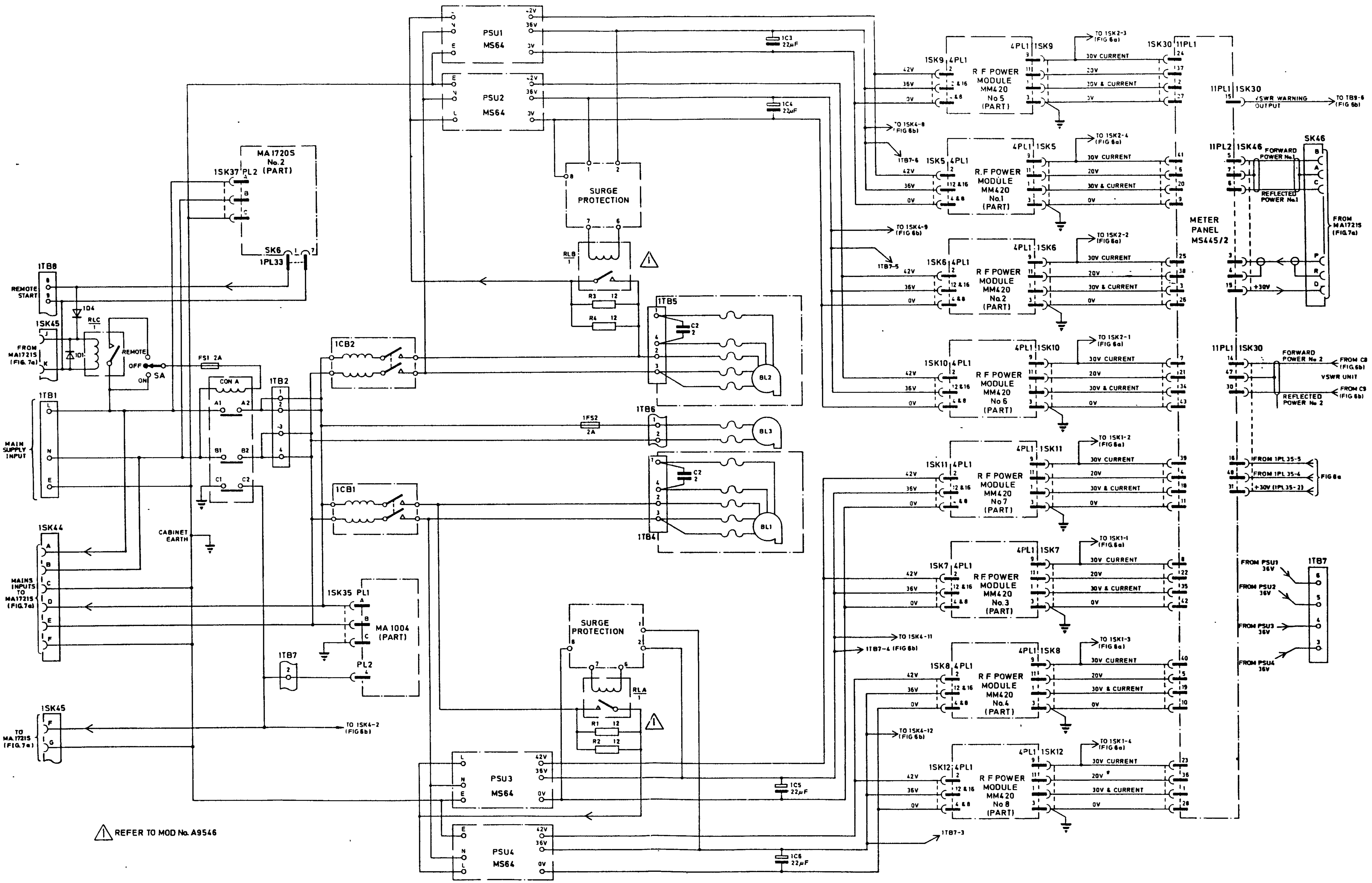



Fig.6c

Transmitting set, radio: interconnecting (functional) diagram (Sheet 3 of 3)

Fig.6c

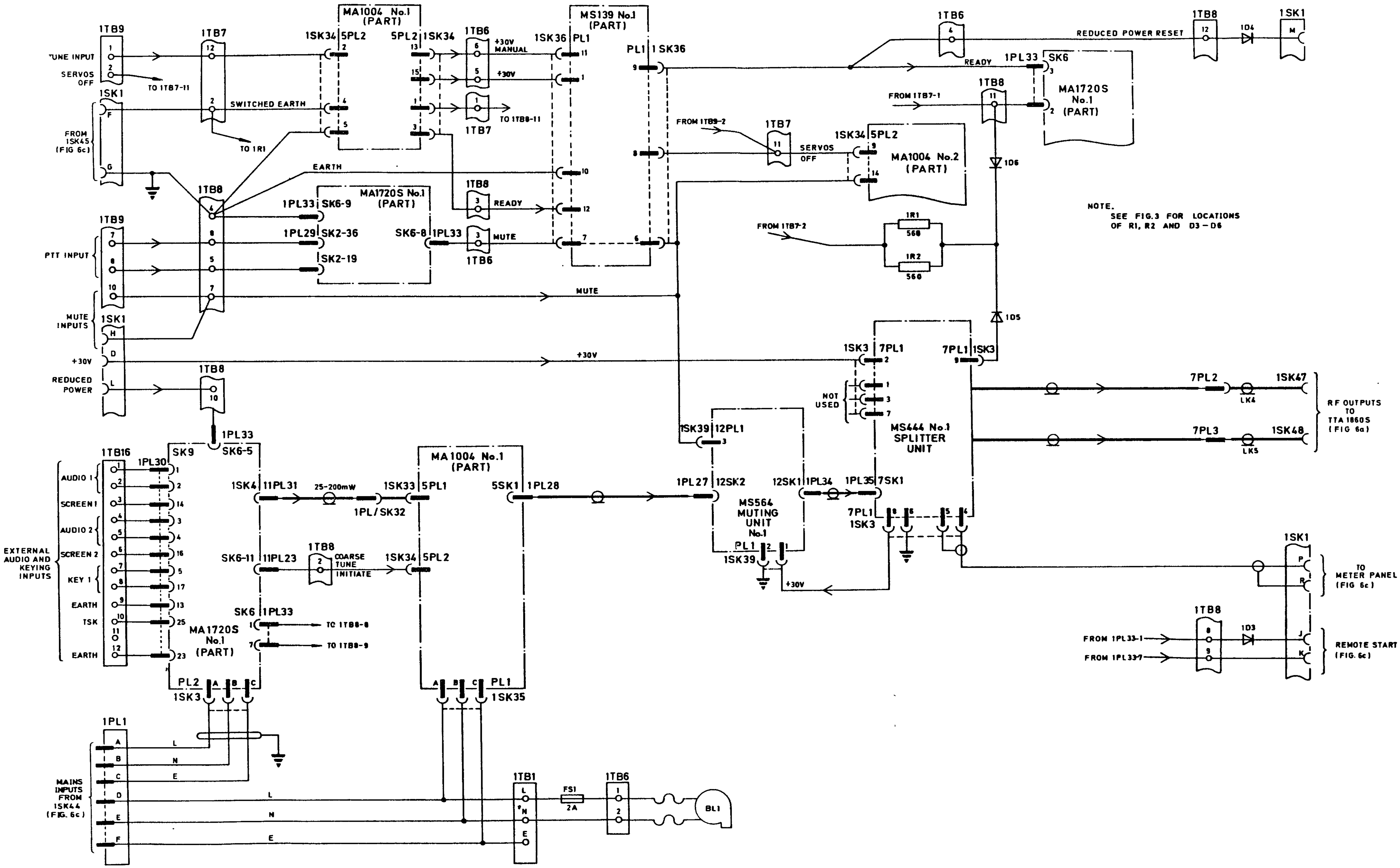
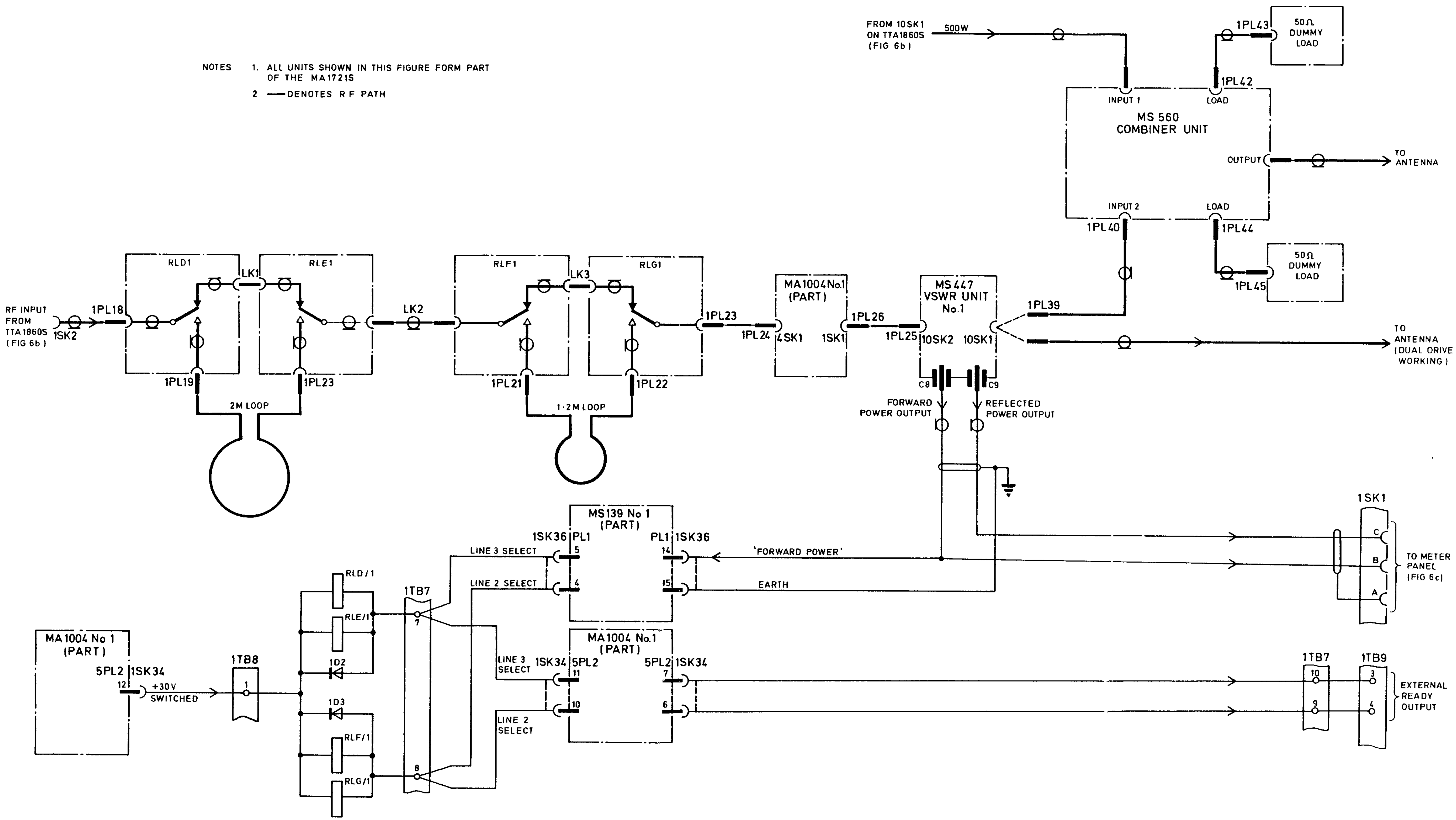



Fig.7a Drive unit assembly: interconnection (functional) diagram (Sheet 1 of 2) Fig.7a

NOTES 1. ALL UNITS SHOWN IN THIS FIGURE FORM PART OF THE MA1721S
2 —— DENOTES R F PATH




Drive unit assembly : interconnection ( functional ) diagram (Sheet 1 of 2)

Fig 7b

TABLE 6

List of sub-assemblies - feeder matching unit MA.1004

| Sub-assembly | Nato No. | Manufacturer's ref. |
|---|---|---|
| Power supply | | MS.448 |
| Control unit | | MS.450 |
| Fine-tune discriminator | | MS.449 |
| Constant voltage amplifier | | MS.454 |
| Servo power amplifier | | MS.265 (2 off) |
| Coil, motor and gearbox assembly (L/H and R/H) | | MS.451 (2 off) |

BRIEF FUNCTIONAL DESCRIPTION

7. These paragraphs describe, with the aid of block diagrams, the basic functions of the main units of the transmitting system. Where two main signal paths are identical, only one will be described; the units are referenced in accordance with fig.1. Fig.4a (disregarding MA.1720S No.1) and 4b show the single-drive system, i.e. the TTA.1860S used singly. The dual-drive configurations are shown in fig. 4a, 4c and 5.

Transmitter drive units

8. The MA.1720S (fig.4a) provides, by frequency synthesis, radio frequencies of high stability and of standard accuracy for driving the linear amplifier.

9. Frequency synthesis is a method of generating a range of output signals, each of which bears a precise relationship to a harmonic or sub-harmonic of a standard frequency. In the MA.1720S, the phase-lock loop technique is employed and the output frequencies are presented in a decade scale. A full description of the synthesis process is given in Chap. 2-5-1.

10. The drive unit covers the range 1.6 MHz to 30 MHz; in this range discrete operating frequencies at 100 Hz spacing are selected by six manual switches. Each output has the same stability and accuracy as the in-built 5 MHz standard frequency source.

11. A 1.4 MHz carrier is amplitude-modulated by the audio frequency inputs (channel 1 for s.s.b. and c.w. modes, channels 1 and 2 for i.s.b.). The carrier and sideband components of the modulated signal are then selected, as required by the operating mode, and converted to r.f. signals at the radiated frequency. These signals, at power levels up to 200 mW, are then passed to the linear amplifier assembly. A full description of the modulation process and of the subsequent frequency conversions is given in Chap. 2-5-2.

## Linear amplifiers

12. As stated in para. 3, the linear amplifier assembly TA.1810S becomes an operational entity when the amplifier-stabilizers MM.420 are fitted into the transmitter sub-assembly.

13. In the single-drive configuration (fig. 4b), the modulated r.f. output from the drive unit (No.2) is fed via the muting unit to a splitter network and thence to two distribution amplifiers. Each distribution amplifier provides four identical outputs to drive the power amplifier stages.

14. Each MM.420 delivers 125W (nominal) into 50Ω and, since they are driven in phase, all the MM.420 outputs are in phase. The outputs are combined in 'pairs' (250W level) and then in 'fours' by means of hybrid networks. The resultant 500W outputs are finally combined to provide the 1 kW output.

15. In the dual-drive configurations (fig. 4c), each distribution amplifier is fed from its associated drive unit MA.1720S. Two separate 500W outputs are developed. The signal output frequency from linear amplifier 1 (r.f. power modules 1, 2, 5 and 6) is determined by the settings of drive unit No.1 and that from linear amplifier 2 by drive unit No.2.

16. The TA.1810S will continue to function, at reduced power, if one or more amplifier-stabilizers is switched off or removed. Failure of an MM.420 does not disable the transmitting system. The hybrid combining networks provide isolation between individual outputs and the matching to the remaining units is unaffected by the presence - or otherwise - of an unserviceable MM.420.

## Amplifier power supplies

17. Two separate power supply systems are incorporated, each system feeding a bank of four amplifier-stabilizers. The distribution amplifiers, splitter unit and other 'common' stages are fed jointly from the two systems. The interconnections between the d.c. supply rails are such that transmission can continue without interruption if one system is disabled.

## Feeder matching

18. For optimum performance, the linear amplifier requires a 50Ω non-reactive load. The MA.1004 (fig. 4b) provides matching between the antenna load impedance, which can have a voltage standing wave ratio (v.s.w.r.) of up to 3:1 relative to the 50Ω nominal value, and the TA.1810S output. The MA.1004 contains a 'T' network which is aligned automatically by means of a servo system.

19. The feeder matching sequence (para. 35) is initiated each time the operating frequency is changed. A low-level signal from the MA.1720S, fed via the MA.1004 coarse-tune circuits, causes the network elements to be set close to their final values. When the full power output of the TA.1810S is subsequently fed via the MA.1004, its fine-tune circuits operate to optimize the settings.

20. The output matching is further improved by means of the line switching unit. The MS139 connects the optimum length of coaxial cable between the TA.1810S and the MA.1004. The cable length - one of four - is chosen on a maximum power output basis (para. 43).

21. Two identical feeder matching systems are provided by the TTA.1860S/MA.1721S in combination. For 'dual-drive to separate antennas' working (fig. 4C), the 500W output from linear amplifier 1 is fed via line switching unit

No.1 and MA.1004 No.1 and that from linear amplifier 2 via the second path. Feeder matching is effected separately for each output path, the sequence being initiated by the relevant MA.1720S. The transmitting system thus functions as two independent transmitters, each delivering 500W output to its antenna.

Antenna combiner

22. In the 'dual-drive to single antenna' configuration (fig. 5) the 500W outputs from linear amplifiers 1 and 2 are matched individually to the input ports of the MS.560 combiner unit. The MS.560 (Chap. 12-1) is a hybrid network, two ports of which are terminated with 50Ω dummy loads. The resultant output from the MS.560 (two separate 250W signals) is fed to a wideband antenna.

DETAILED DESCRIPTION

23. These paragraphs describe, with the aid of interconnecting diagrams, the events occurring between the instant of switch-on and the realization of r.f. power output to the antenna.

Power supply switching

24. The single phase supply to the TTA.1860S (fig. 6c) is normally controlled via the MA.1720S; its SUPPLY pushbutton (not shown) becomes the master control. With the supply present at 1TB1, PL2 on the MA.1720S is permanently 'live'.

25. Assuming the drive unit (No.2) to be switched on, operation of the STANDBY pushbutton on the MA.1720S applies 12V via switch SA (set to REMOTE) to energize relay RLC/1 and in turn operate contactor CON A.

26. A similar action takes place when the STANDBY pushbutton on MA.1720S NO.1 is depressed. Either pushbutton may be used; alternatively, SA may be set to ON, by-passing the action of the relay.

27. When contactor CON A operates, airblower BL3 starts and power is applied to the MA.1004. The resultant +30V and -30V supplies feed the servo system and the MS.139.

28. With contact breaker 1CB2 closed (manually) prior to switch-on, air-blower BL2 starts and power is applied via surge - limiting resistors R3 and R4 to power supply units 1 and 2. When their +42V and +36V outputs become available, the surge protection circuit energizes relay RLB/1; R3 and R4 are short-circuited and the full supply voltage is applied to PSU1 and PSU2.

29. The power supplies PSU3 and PSU4 and air-blower BL1 are controlled in a similar manner via 1CB1. The distribution of the +42V and +36V supplies is self-evident in fig. 6c.

30. Voltage stabilizers in each MM.420 convert the +42V and +36V inputs to +30V and +20V supply rails for the power amplifier stages. The +30V outputs are also fed to the distribution amplifiers and thence to the MS.443, the MS.444 and the MS.564.

Supply monitoring

31. The SUPPLY indicator-lamps on each main unit are self-explanatory.

32. The +30V and +20V supply rails and the power amplifier load currents are measured individually at the MS.445/2 meter panel (fig. 6c).

33. The +36V outputs from all four power units (PSU1-4) are monitored by the MS.443 overload unit (fig. 6b). The absence of any one supply causes pin 10 of 9PL1 to go to +12V and hence light the REDUCED POWER lamp on the MA.1720S.

34. Absence of either supply (+30V or -30V) in the MA.1004 results in a 0V level at pin 1 of 5PL2. This fault signal is fed via the MS.443 (9PL1, pins 6 and 5) to the MA.1720S.

Feeder matching sequence

35. The following events occur during a change of operating frequency and it is assumed that the MA.1004 and MS.139 are both set for automatic operation.

36. When one or more of the frequency-setting switches (thumbwheels) on the MA.1720S is re-set, the synthesizer goes momentarily out-of-lock. This condition causes the MA.1720S control board to effect the following:-

(1) Mute the MA.1720S r.f. output.

(2) Apply the 'mute' command to the TA.1810S. This 0V signal is fed via the MA.139 (PL1 pins 7 and 6, fig. 6a).

(3) Select the 'tune' signal conditions (c.w. mode).

(4) The RESET lamp glows.

37. The IN-LOCK lamp is also extinguished and, when the synthesizer has locked to the new operating frequency, the lamp is re-lit. Since the locking action is virtually instantaneous, the lamp may just flicker.

Note...

Should the IN-LOCK lamp remain extinguished, a fault condition exists.

38. When the RESET pushbutton on the MA.1720S is pressed:-

(1) The 'coarse-tune initiate' command (+12V at pin 11 of SK6) is applied to the MA.1004 (fig. 6a).

(2) After a two-second delay, the MA.1720S is de-muted.

(3) The RESET lamp is extinguished.

The low-level 'tune' signal is now available.

39. In the MA.1004, a relay (5RLA) breaks the path between 5PL1 and 5SK1 and connects the 'tune' signal input to the coarse-tune circuits. The presence of the signal activates the servo system and coarse-tuning commences; this sequence is fully described in Chap. 5-0.

40. Selection of the coarse-tune condition lights the TUNE lamp on the MA.1004 and provides a 'not ready' signal (+12V) via the MS.139 (PL1 pins 12 and 9) to the MA.1720S; this causes the READY lamp, on the MA.1720S to be extinguished.

41. On completion of the coarse-tuning sequence, the servo motors being at rest:-

(1) Relay 5RLA releases and the MA.1720S output is re-connected to the TA.1810S.

(2) The MA.1004 switches to the fine-tune mode; this condition is maintained until a subsequent change in operating frequency.

(3) A 'ready' signal is applied to activate the MS.139.

(4) The MS139 applies an inhibit to the MA.1004 servo system; this prevents simultaneous operation of the fine-tune circuits whilst the MS.139 is active.

42. The high-power 'tune' signal from the TA.1810S (fig. 6b) is now fed via the line switching relays (RLD to RLG) to the MA.1004 and thence via the v.s.w.r. unit to the antenna. The presence of the r.f. signal lights the r.f. monitor lamps on the r.f. power modules.

Note...

For 1 kW output, all eight lamps should glow; for dual-drive conditions, the appropriate four lamps.

43. Line selection now takes place; the control signals for the MS.139 are provided by the 'forward power' detector of the v.s.w.r. unit. Each of four line lengths - 2m, 3.2m, a direct connection or 1.2m of coaxial cable - is connected in turn and the line length giving maximum power output is selected (fig. 6b). To prevent damage to the relay contacts, the TA.1810S is muted momentarily each time a relay is operated; the r.f. monitor lamps flicker in sympathy.

44. When the optimum line length has been determined:-

(1) The MS.139 'rests'.

(2) The servo inhibit is removed.

(3) The MA.1004 'fine-tunes', setting the 'T' network to its final values.

45. On completion of fine-tuning:-

(1) A 'ready' signal is applied to the MA.1720S.

(2) The MS.139 re-applies the servo inhibit to the MA.1004.

46. At the MA.1720S the 'ready' signal effects the following:-

(1) The 'tune' signal is removed.

(2) The drive unit reverts to the selected operational mode.

(3) The READY lamp is lit.

47. When feeder matching is performed manually, e.g. during maintenance, the sequence of events is similar to that described above. These procedures are fully described in Chap. 13-2.

RF monitoring

48. The r.f. output from each MA.1720S is indicated on its front panel meter.

49. The input level to the MS.564, the power output to the antenna and the reflected power are measured at the meter panel MM.445/2 (both paths of the dual-drive system).

50. Should the reflected power exceed a predetermined level (v.s.w.r. greater than 3:1), a warning signal is generated in the MS.445; this signal appears at pin 6 of 1TB9 (fig. 6b).

51. RF monitor sockets are provided on each MM.420 and on the hybrid combining networks; these connections provide for r.f. measurements at the 125W, 500W and 1 kW levels.

52. Each MM.420 carries a r.f. monitor lamp. Under normal conditions, all eight lamps (in dual-drive, two groups of four) glow with equal brilliance and hence a low-power output from one unit is self-evident.

53. If one or more amplifier-stabilizers is giving zero or reduced power output, a 'r.f. unbalanced' signal is generated in the hybrid combining unit MS.441 (fig. 6b). This signal is fed via the MS.443 to give the 'reduced-power' indication at the MA.1720S.

# Chapter 13-1

## SETTING-UP INSTRUCTIONS

## SINGLE AND DUAL-DRIVE SYSTEM (TTA.1860S AND MA.1721S)

CONTENTS



ILLUSTRATIONS

## INTRODUCTION

### WARNING

A. RACAL MA1720 DRIVE UNITS ARE NOT TO BE LIFTED OUT OF THEIR EQUIPMENT RUNNERS UNLESS THE UNIT IS BEING REMOVED FROM THE CABINET AND THEN ONLY BY TWO TRADESMEN.
AFTER EMBODIMENT OF MODIFICATION TC 0088 IT WILL BE NECESSARY TO REMOVE TWO BLANKING PLATES FROM THE RUNNERS TO FACILITATE REMOVAL OF DRIVE UNITS. (RAF LOCKING ONLY).

B. AT NO TIME ARE PERSONNEL TO BE PERMITTED TO WORK BELOW A UK/FRT 618 TRANSMITTER SUB-ASSEMBLY WHICH HAS BEEN WITHDRAWN OUT OF THE CABINET ON ITS EQUIPMENT-RUNNERS, EG. RACAL MA1720 DRIVE UNIT. THIS IS TO MINIMISE THE POSSIBILITY OF THE EXTENDED SUB-ASSEMBLY SLIPPING, FALLING AND INJURING PERSONNEL WORKING BELOW.

C. TRADESMEN ARE TO SATISFY THEMSELVES, BY PHYSICAL EXAMINATION, THAT WHEN A SUB-ASSEMBLY, EG. RACAL MA1720 DRIVE UNIT IS FULLY WITHDRAWN OUT OF ITS UK/FRT 618 TRANSMITTER CABINET, ALL LOCATING-LUGS AT THE SIDE OF THE SUB-ASSEMBLY ARE SECURELY LOCATED IN THE EQUIPMENT RUNNERS.

1. There are three main requirements for setting-up either the single or the dual-drive system viz. the preliminary adjustments, the patching of r.f. cables and the switch-on sequence. The procedures, which are given separately for each system, must be carried out in the order given, at initial switch-on or after a repair.

2. Certain checks involve the removal of units; the removal instructions are given in Chap. 13-3. When re-fitting the units to the cabinet, ensure that all cables are dressed to their correct positions. Where cable connections are disturbed, the re-connections must be made following each particular check or adjustment.

## SINGLE-DRIVE SYSTEM

### PRELIMINARY ADJUSTMENTS - TRANSMITTING SET TTA.1860S

3. The location of all operational controls is given in Chap. 13-2.

(1) Ensure that the main a.c. supply to the transmitting set is switched OFF.

(2) Set the SUPPLY pushbutton on the MA.1720S (No.2) to OFF (released).

(3) Set the ON/OFF/REMOTE switch on the power supply front panel to OFF.

(4) Set both main circuit breakers CB1 and CB2 to OFF.

### Power supplies

4. (1) Remove the power supply front panel.

(2) Withdraw the left-hand pair of MS.64 power supply units. Check that both mains voltage selectors are set for the local supply voltage. Re-set as necessary and then re-fit the units.

(3) Repeat step (2) for the right-hand pair of units.

Attenuator settings

5. (1) Remove the cover from the muting unit MS.564 (No.2). Check that the links are set for 6 dB attenuation, i.e. from pin 8 to pin 9 and from pin 12 to pin 13. Re-fit the cover to the unit.

(2) Remove the cover from the splitter unit MS.444 (No.2). Check that the links are set for 0 dB attenuation, i.e. from pin 9 to pin 10 and from pin 13 to SK1. Re-fit the cover to the unit.

(3) Re-fit the power supply front panel.

Amplifier-stabilizers

6. Set the SUPPLY switches on each MM.420 to ON (total eight switches).

Feeder matching and line switching units

7. (1) Remove the MA.1004 (No.2) from the cabinet.

(2) Remove the top cover from the MA.1004. Check that the primary connections to the mains transformer are appropriate to the supply voltage; adjust as necessary (soldered connections). Replace the cover.

(3) Remove the cover plate from the MA.1004 control unit. Check that link LK1 ('servos-off') on the tune board is not connected. Re-fit the board and the cover plate.

(4) Remove the cover from the MS.139 line switching unit. Check that link LK3 is connected. Re-fit the cover.

(5) Re-fit the MA.1004 to the cabinet and secure. Lower the front panel.

(6) On the MA.1004 front sub-panel set the following controls:-

(a) MANUAL switches to AUTO and LINE 1.

(b) DISCRIMINATOR BALANCE switch to OFF.

(c) TUNE/READY switch to READY.

(d) Contact breakers CB1, CB2 and CB3 to ON (up).

(7) Close the front panel and then set the front panel controls as follows:-

(a) SUPPLY pushbutton to OFF.

(b) TUNE pushbutton to OFF.

Drive Unit

8. (1) Remove the MA.1720S (No.2) from the cabinet.

(2) Check that the mains voltage selector is set for the local supply voltage; re-set as necessary.

(3) Set the FREQ. STD. switch to INT.

(4) Check that fuse-link FS1 is serviceable and of correct rating (500 mA).

(5) Re-fit the MA.1720S to the cabinet and secure.

(6) Set the front panel controls as follows:-

(a) SUPPLY pushbutton to OFF.

(b) STANDBY pushbutton to OFF.

(c) EHT pushbutton to OFF.

(d) CONTROL switch to LOCAL SYNTH.

(e) MODE switch to SSB SUPP.

(f) Sideband switch to UPPER.

(g) VOX/PTT/TX switch to TX.

(h) TUNE/MUTE/OPERATE switch to OPERATE HIGH.

(j) Frequency selection switches to 03.0000 MHz or as required.

Note...

The most significant digit cannot be set to '3' i.e. the maximum frequency setting is 29.9999 MHz.

## RF CABLE PATCHING

### Connection for 1 kW output (fig. 1)

9. (1) Ensure that the dummy load is connected to 10SK1 (ANTENNA).

(2) Lower the meter panel to its fullest extent, i.e. remove the retaining arm and allow the meter panel to rest gently on its hinges.

(3) Set both 'mute' selector switches to the TTA.1860S position.

(4) Check that the following r.f. connections have been made.

Adjust as necessary:-

(a) 6PL2 to 6SK9.

(b) 6PL3 to 6SK10.

(c) 1PL17 to 6SK12.

(5) Check that the unused cables are stowed correctly.

(6) Close the meter panel.

(7) Remove the power supply front panel.

(8) Check that the following r.f. connections have been made. Adjust as necessary:-

(a) 7PL2 to 8SK5 on the right-hand distribution amplifier MS.442.

(b) 7PL3 to 8SK5 on the left-hand MS.442.

(c) 1PL37 to 1SK43.

(d) 1PL38 to 1SK29.

(9) Re-fit the power supply front panel.

### Connection for 500W output

10. This configuration (fig.2) is used in the event of partial failure of the TA.1810S and is included for completeness. The 500W connection allows transmission to continue, at reduced power output, whilst maintenance is in progress. The procedures assume that the left-hand band of amplifier-stabilizers feeds the antenna and the right-hand bank is terminated with the dummy load; the alternate connections will be self-evident from fig.6a, Chap. 13-0.

11. (1) Set the ON/OFF/REMOTE switch to OFF.

(2) Lower the meter panel to its fullest extent, i.e. remove the retaining arm and allow the meter panel to rest gently on its hinges.

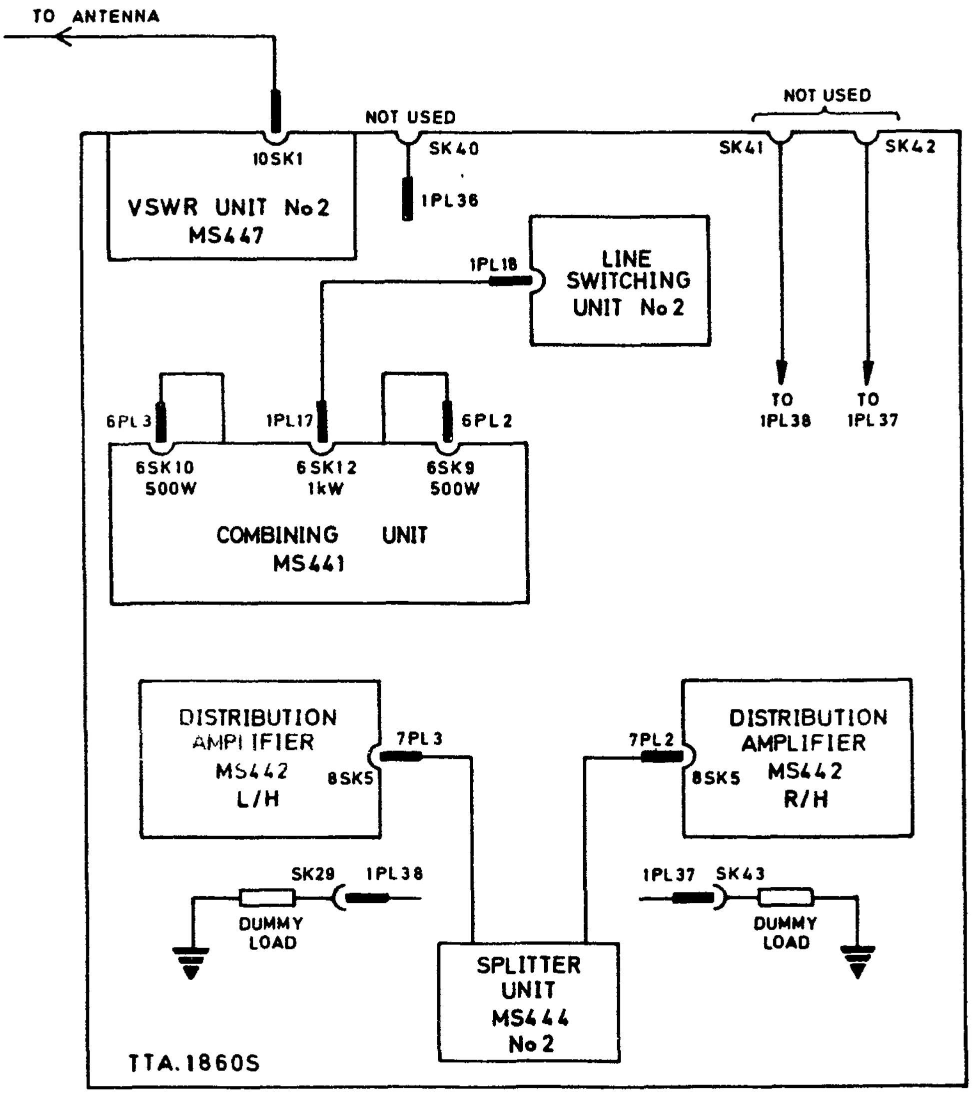
(3) Disconnect the r.f. cable (6PL3) from 6SK10.

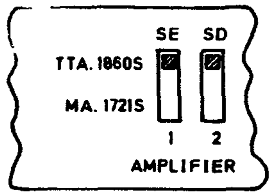
(4) Disconnect the r.f. cable (1PL17) from 6SK12 (1 kW output) on the combining unit. Connect 1PL17 to 6SK10.

(5) Disconnect the r.f. cable (6PL2) from 6SK9.

(6) Connect 6SK9 to the dummy load (rating 500W, 50-ohm nominal). Note that an external power indicator is also required.

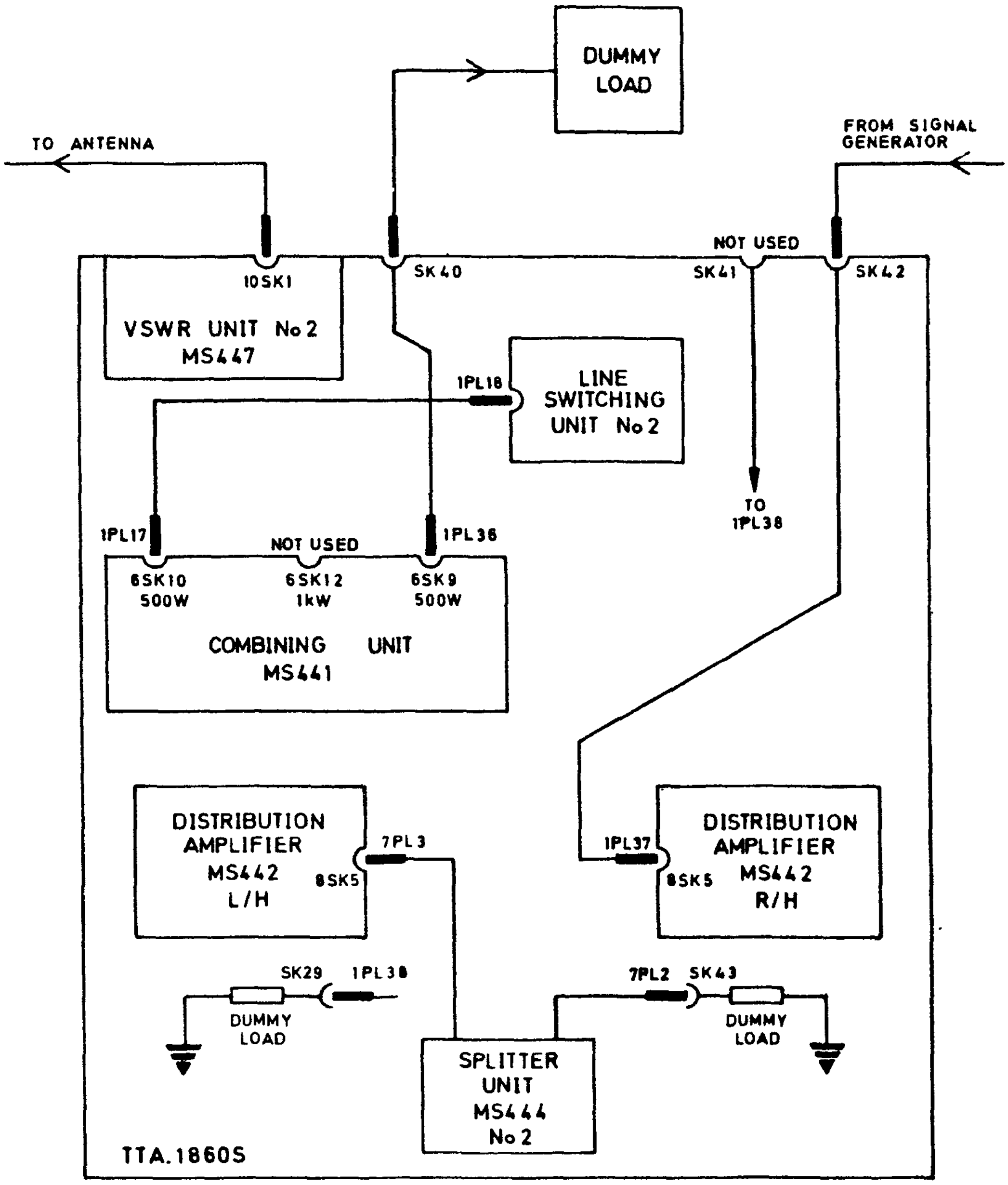
(7) Check that both 'mute' switches are set to the TTA.1860S position.

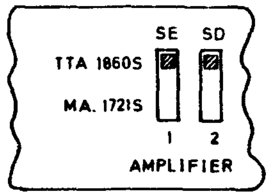


REAR VIEW OF METER PANEL

Fig.1 Single-drive, 1 kW output : r.f. cable patching




REAR VIEW OF METER PANEL

Fig.2 Single-drive, 500W output : r.f. cable patching

(8) Check that the unused cables are stowed correctly.

(9) Making due allowance for the r.f. cable connected at step (6), close the meter panel.

(10) Remove the power supply front panel.

(11) Disconnect the r.f. cable (7PL2) from 8SK5 on the right-hand distribution amplifier MS.442.

(12) Connect 7PL2 to 1SK29, i.e. to dummy load 1R5.

(13) Connect 1PL37 to 8SK5 on the right-hand MS.442.

(14) Check that the following r.f. connections have been made:-

(a) 7PL3 to 8SK5 on the left-hand MS.442.

(b) 1PL38 to 1SK43.

(15) Re-fit the power supply front panel.

(16) Connect 1SK42 to the output of an external signal source (e.g. signal generator).

SWITCH-ON SEQUENCE

12. (1) Set the main a.c. supply to ON.

(2) Depress the SUPPLY pushbutton on the MA.1720S (No.2) and check that the SUPPLY and IN-LOCK lamps glow.

(3) Set the ON/OFF/REMOTE switch to REMOTE.

(4) Depress the STANDBY pushbutton on the MA.1720S. Check that the STANDBY lamp glows, main contactor CON A closes and air blower BL3 operates (audible checks).

(5) Check that the RESET lamp on the MA.1720S is extinguished; if not, depress the RESET pushbutton.

(6) Depress the SUPPLY pushbutton on the MA.1004 (No.2) and check that the SUPPLY lamp glows.

(7) Set contact breaker CB2 to ON.

(8) Check that airblower BL2 operates and that the SUPPLY lamps on the left-hand bank of amplifier-stabilizers glow (total four lamps).

(9) Set CB2 to OFF. Airblower BL2 will stop and the lamps will be extinguished.

(10) Set contact breaker CB1 to ON.

(11) Check that airblower BL1 now operates and that the SUPPLY lamps on the right-hand bank of four units glow.

(12) Re-set CB2 to ON. All three blowers should now run and all eight lamps should be glowing.

SUPPLY VOLTAGES

13. (1) At the meter panel, measure the supply voltages generated within MM.420 No.1, i.e. set the MODULE switches to 1 and 20V and then to 1 and 30V.

(2) Repeat step (1) using appropriate switch settings for each remaining MM.420.

Note...

The presence of +20V and +30V outputs from each MM.420 indicates that all four MS.64 power supply units are functioning correctly.

(3) Set the METER switch on the MA.1720S to the -7, +5, +12 and +20 VOLTS positions in turn. A meter-reading within the green band should be obtained in each case.

(4) Set contact breakers CB1 and CB2 to OFF.

LINE LEVELS

14. It is assumed for setting-up purposes that test tones of the required line input level, e.g. 0 dBm, are being applied to the AUDIO 1 and AUDIO 2 inputs.

15. (1) Set the METER switch on the MA.1720S to LINE 1 and check that the meter indicates the AUDIO 1 input level e.g. 0 dBm.

(2) Set the METER switch to SET 1.

(3) Adjust the SET LINE 1 preset control until a 0 dBm level is obtained.

(4) Set the METER switch to LINE 2 and check the AUDIO 2 level.

(5) Set the METER switch to SET 2.

(6) Adjust the SET LINE 2 control until a 0 dBm level is obtained.

SSB modes

16. (1) Set the METER switch to RF.

(2) Check that the meter indicates -3 dB: (100 mW r.f. output) approximately.

(3) Set the 'sideband' selector switch to LOWER and repeat step (2).

ISB mode

17. (1) Re-set the sideband switch to UPPER.

(2) Disable the AUDIO 2 input.

(3) Set the MODE switch to ISB -26.

(4) Check that 25mW r.f. output (-9 dB on the meter) is obtained.

(5) Disable the AUDIO 1 input.

(6) Re-connect the AUDIO 2 input.

(7) Check that 25 mW output is again obtained.

Note...

If the AUDIO 1 input is now re-connected, a 100 mW p.e.p. output is developed from the dual-tone input. Under these conditions, the meter indicates -6 dB approximately.

SWITCH-OFF SEQUENCE

18. (1) Set the STANDBY pushbutton on the MA.1720S to OFF (released).

(2) Set the TUNE/MUTE/OPERATE switch to MUTE.

(3) Set the ON/OFF/REMOTE switch to OFF.

Notes...

1. Step (1) is sufficient to switch-off the transmitting set. Steps (2) and (3) are safety measures; should the STANDBY pushbutton be depressed inadvertently, the TA.1810S will not be activated and hence undesired transmissions cannot take place.

2. The SUPPLY pushbutton on the MA.1720S should be left ON.

## DUAL-DRIVE SYSTEM

PRELIMINARY ADJUSTMENTS - TRANSMITTING SET TTA.1860S

19. The preliminary adjustments required for the dual-drive system are as given in para. 3 to 8 (single-drive).

PRELIMINARY ADJUSTMENTS - DRIVE UNIT ASSEMBLY MA.1721S

20. Except for the sequence of operations, the procedures for the MA.1721S are as given for the TTA.1860S; the minor differences are due to the physical locations of sub-assemblies.

Drive unit

21. Carry out the procedures given in para. 8 for MA.1720S No.1.

Attenuator settings

22. (1) Remove the MA.1004 (No.1) from the cabinet.

(2) Carry out the procedures given in para. 5(1) and 5(2) for MS.564 No.1 and MS.444 No.1.

Feeder matching and line switching units

23. Carry out the procedures given in para. 7(2) to 7(7) for MA.1004 No.1 and MS.139 No.1.

R.F. CABLE PATCHING

24. The procedures are given for the 'dual-500W to separate antennas' configuration (fig. 3); the r.f. patching requirements for the other configurations will be evident from fig.4 to 6.

The configurations are:-

(1) Dual-drive to separate antennas.

(2) Dual-drive to common antenna.

(3) 1 kW output using drive unit No.1.

(4) 1 kW output using drive unit No.2.

It may be noted that para. 9 provides complete details for the 1 kW single-drive conditions.

Connection for 500W outputs to separate antennas

25. (1) Connect 10SK1 (ANTENNA 1) on the MA.1721S to a suitable dummy load (rating 500W, 50-ohm nominal).

(2) Connect 10SK1 on the TTA.1860S to a suitable dummy load.

(3) Lower the meter panel to its fullest extent, i.e. remove the retaining arm and allow the meter panel to rest gently on its hinges.

(4) Set the 'mute' selector switches as follows:-

(a) AMPLIFIER 1 to MA.1721S.

(b) AMPLIFIER 2 to TTA.1860S.

(5) Check that the following r.f. connections have been made. Adjust as necessary:-

(a) 1PL36 to 6SK10.

(b) 1PL17 to 6SK9.

(c) 1PL18 to line switching unit No.2.

(6) Check that the unused cables are stowed correctly. Close the meter panel.

(7) Remove the power supply front panel.

(8) Check that the following r.f. connections have been made:-

(a) 1PL37 to 1SK43.

(b) 1PL38 to 8SK5 on the left-hand MS.442.

(c) 7PL3 to 1SK29.

(d) 7PL2 to 8SK5 on the right-hand MS.442.

(9) Re-fit the power supply front panel.

(10) Check that the inter-cabinet wiring is in accordance with fig. 3.

SWITCH-ON SEQUENCE

26. (1) Carry out the procedures given in para. 12.

(2) Set the STANDBY pushbutton on MA.1720S No.2 to OFF (released).

(3) The air-blowers will stop and the eight lamps will be extinguished.

(4) Repeat steps 12(2) and 12(4) to 12(6) for MA.1720 No.1 and MA.1004 No.1. Check that the conditions of para. 12 (12) are again satisfied.

(5) Reset the STANDBY pushbutton on MA.1720S No.2 to ON.

SUPPLY VOLTAGES

27. (1) Carry out the procedures given in para. 13(1) to 13(3).

(2) Repeat step 13(3) for MA.1720S No.1.

(3) Set contact breakers CB1 and CB2 to OFF.

## LINE LEVELS

28. It is assumed for setting-up purposes that test tones of the required line input level, e.g. 0 dBm, are being applied to the AUDIO 1 and AUDIO 2 inputs of the TTA.1860S.

29. (1) Carry out the procedures given in para. 15 to 17 for MA.1720S No.2.

(2) Transfer the test tone inputs to the MA.1721S.

(3) Repeat step (1) for MA.1720S No.1.

## SWITCH-OFF SEQUENCE

30. (1) Set the STANDBY pushbutton on MA.1720S No.1 to OFF.

(2) Set the TUNE/MUTE/OPERATE switch to MUTE.

(3) Repeat steps (1) and (2) for MA.1720S No.2.

(4) Set the ON/OFF/REMOTE switch to OFF.

Notes...

1. Steps (1) and (3) are sufficient to switch-off the transmitting set. Step (4) is a safety measure; should either STANDBY pushbutton be depressed inadvertently, the TA.1810S will not be activated and hence undesired transmission cannot take place.
2. The SUPPLY pushbuttons on both drive units should be left ON.

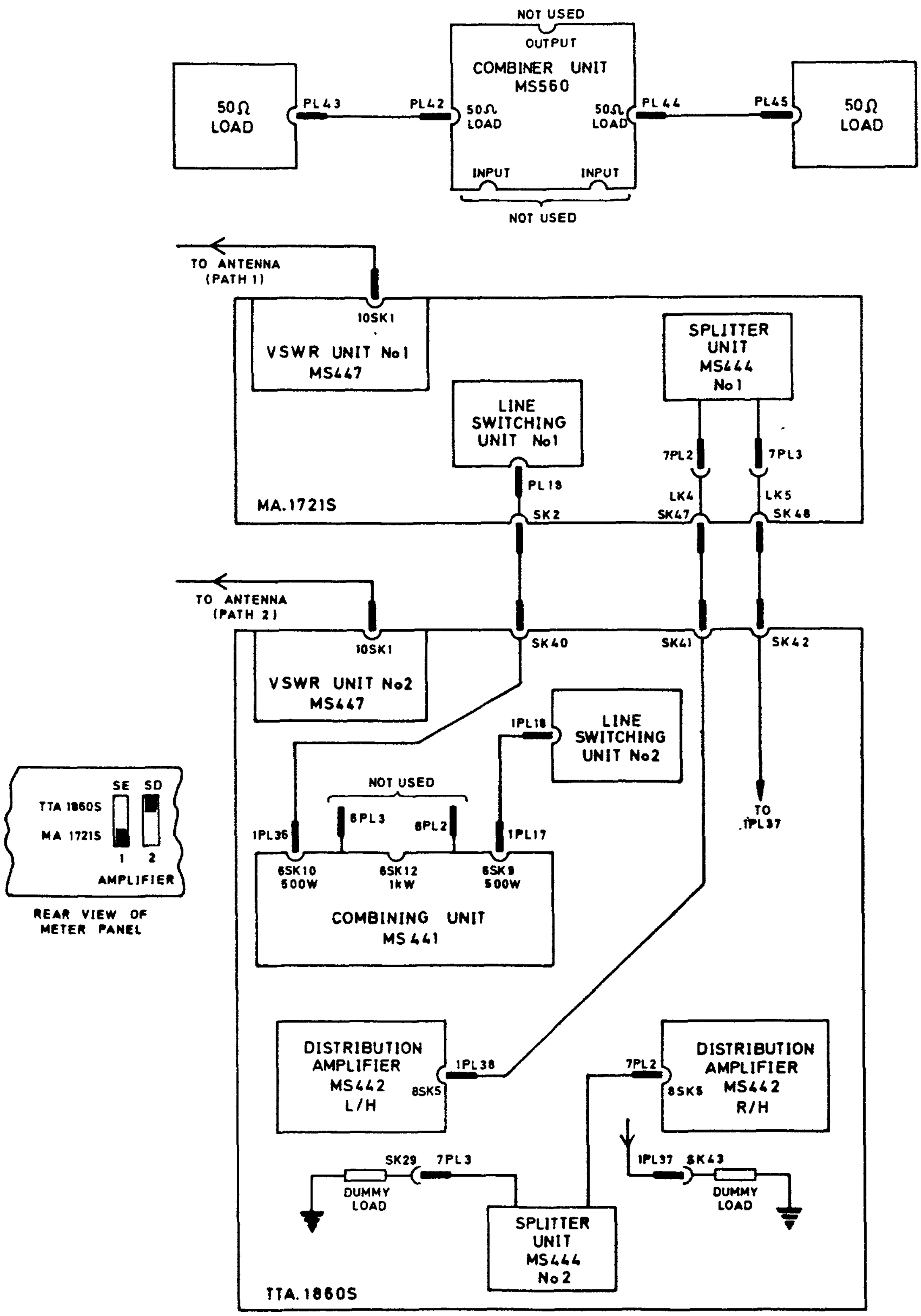



Fig.3 Dual-drive to separate antennas : r.f. cable patching

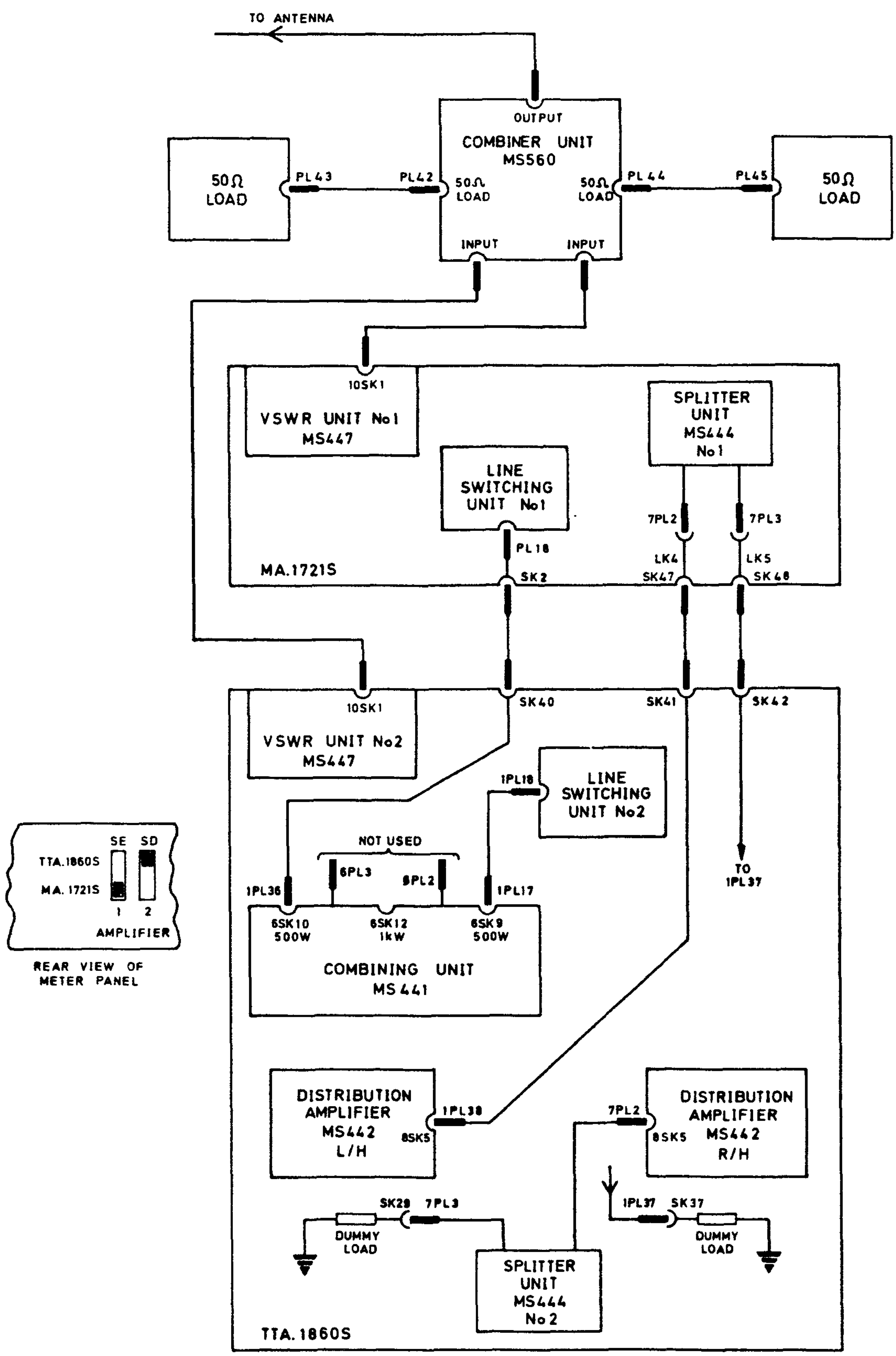



Fig.4 Dual-drive to common antenna : r.f. cable patching

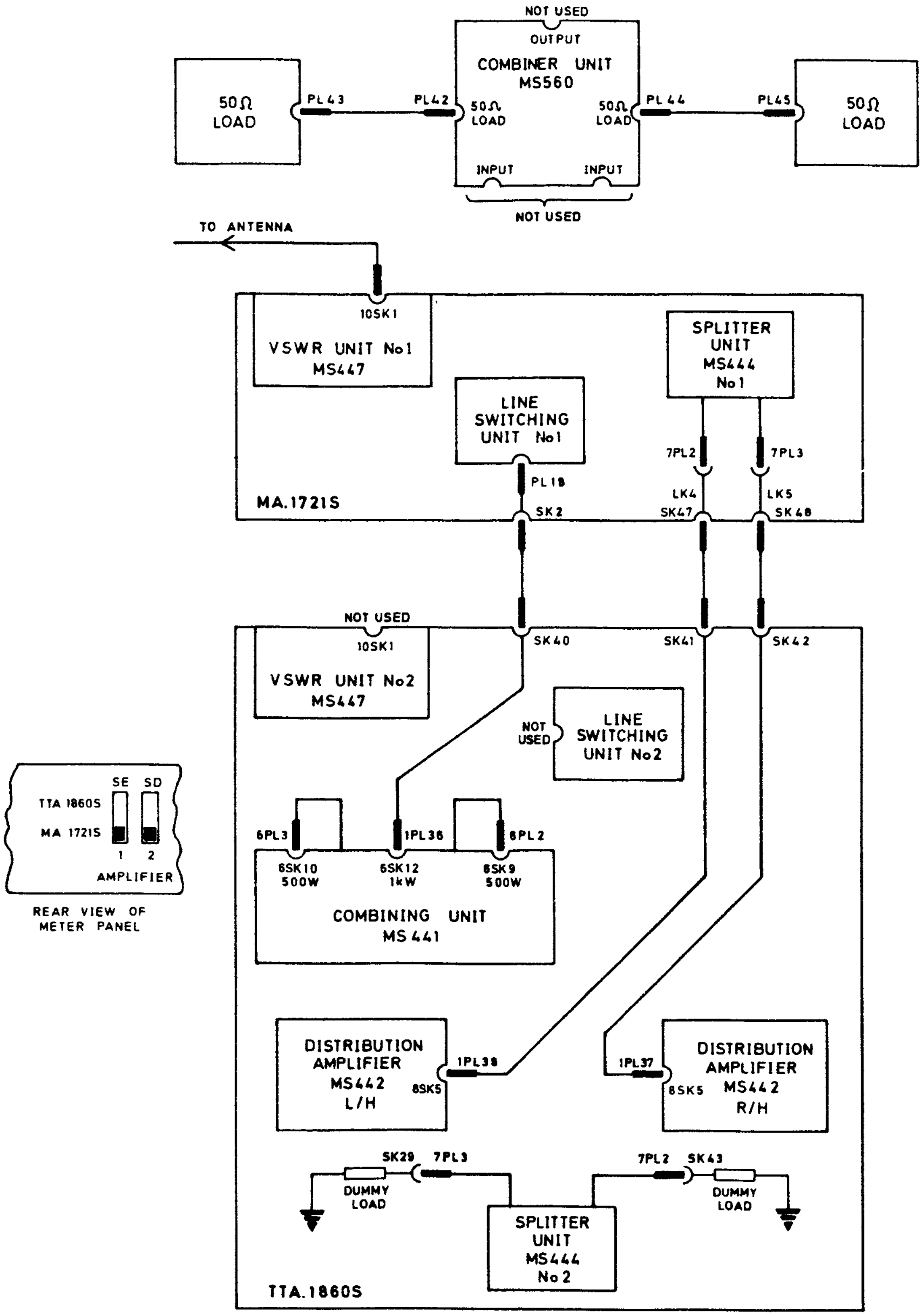



Fig.5 1 kW output using drive unit No.1 : r.f. cable patching

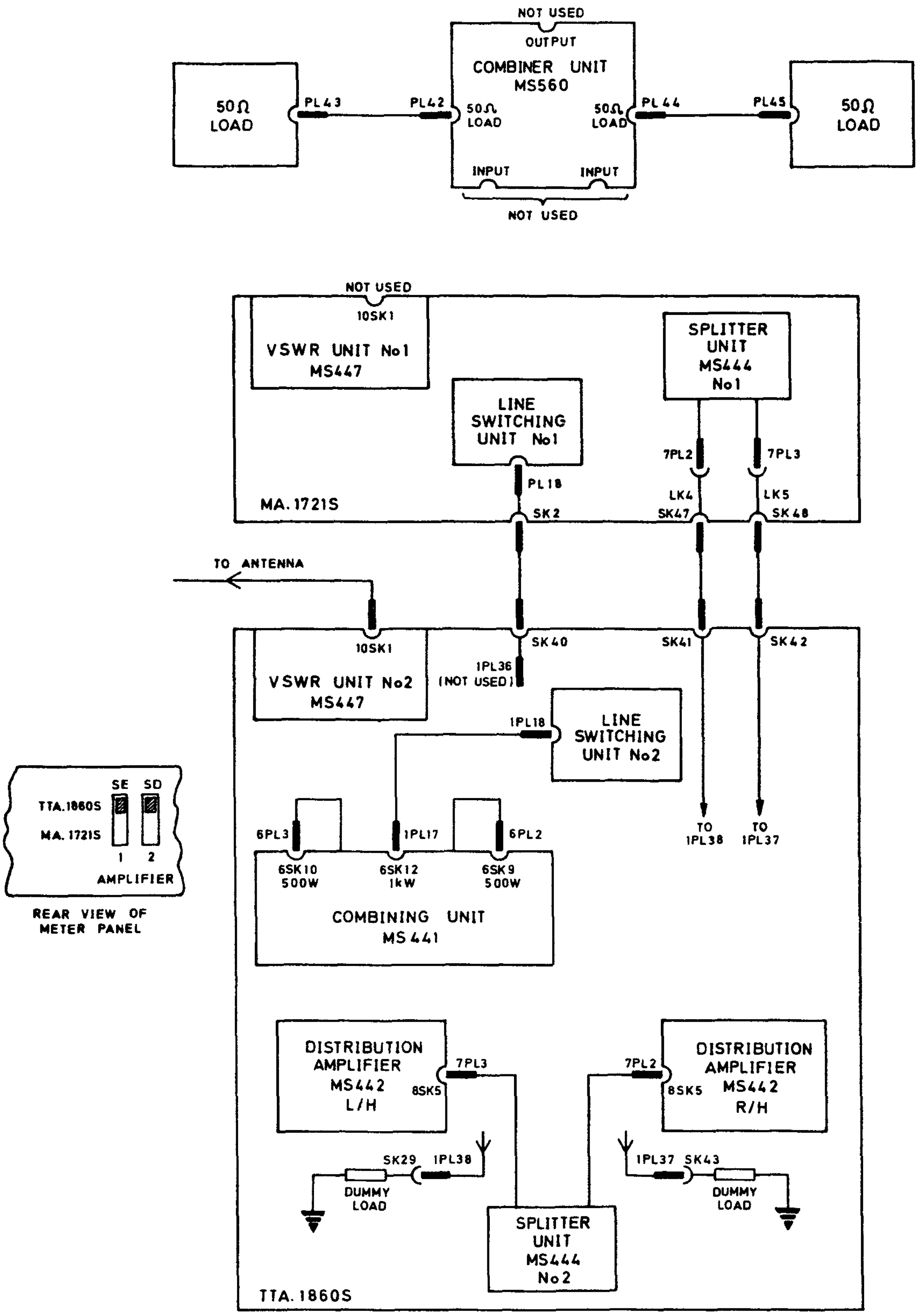



Fig.6 1 kW output using drive unit No.2 : r.f. cable patching

# Chapter 13-2

## OPERATING INSTRUCTIONS

## SINGLE AND DUAL-DRIVE SYSTEM (TTA.1860S and MA.1721S)

### CONTENTS



### TABLES



### ILLUSTRATIONS

INTRODUCTION

1. This chapter describes the functions of the controls and indicators followed by the operating procedures. The procedures, which are given separately for each system, must be carried out in the order given. The transmitting systems are normally operated using the 'automatic' tuning procedures. The manual tuning procedures are used for maintenance purposes or in the event of failure of the automatic system; instructions are also given for by-passing the feeder matching equipment.

FUNCTIONS OF CONTROLS AND INDICATORS

2. The following paragraphs describe the functions of all front panel controls and indicators (TTA.1860S and MA.1721S).

Drive unit (fig. 2)

3. (1) SUPPLY pushbutton (with locking action): controls the a.c. supply to the MA.1720S. This switch also acts as the master power control for the TTA.1860S. The a.c. supply is normally kept ON to maintain the best stability and ageing characteristics of the frequency standard.

(2) SUPPLY lamp: glows when power is switched on.

(3) STANDBY pushbutton (with locking action): controls the operation of the main supply contactor. This is the normal supply control for the TTA.1860S.

(4) STANDBY lamp: glows when power is applied to the TA.1810S and the MA.1004.

(5) READY pushbutton (not used in the TTA.1860S).

(6) READY lamp: glows when the transmitter is ready to accept traffic, i.e. when the feeder matching sequence is completed. (The 'EHT' engraving should be disregarded).

(7) RESET pushbutton (non-locking): initiates the feeder matching sequence. This pushbutton is depressed by the operator whenever the MA.1720S is set to a new operating frequency or the MA.1004 is retuned to an existing one.

(8) RESET lamp: glows when either:-

(a) The MA.1720S is muted owing to the re-setting of the frequency selector switches.

(b) A fault occurs in the MA.1004.

(c) A complete failure of the TA.1810S power supplies occurs.

(9) IN-LOCK lamp: glows when the synthesizer is locked to the selected frequency.

(10) REDUCED POWER lamp: glows when either:-

(a) One or more r.f. modules are switched off or fail.

(b) A partial failure of the TA.1810S power supplies occurs.

(11) TUNE/MUTE/OPERATE switch (four position):-

(a) TUNE: selects the low-level 'tune' signal for the MA.1004.

(b) MUTE: mutes the drive to the TA.1810S.

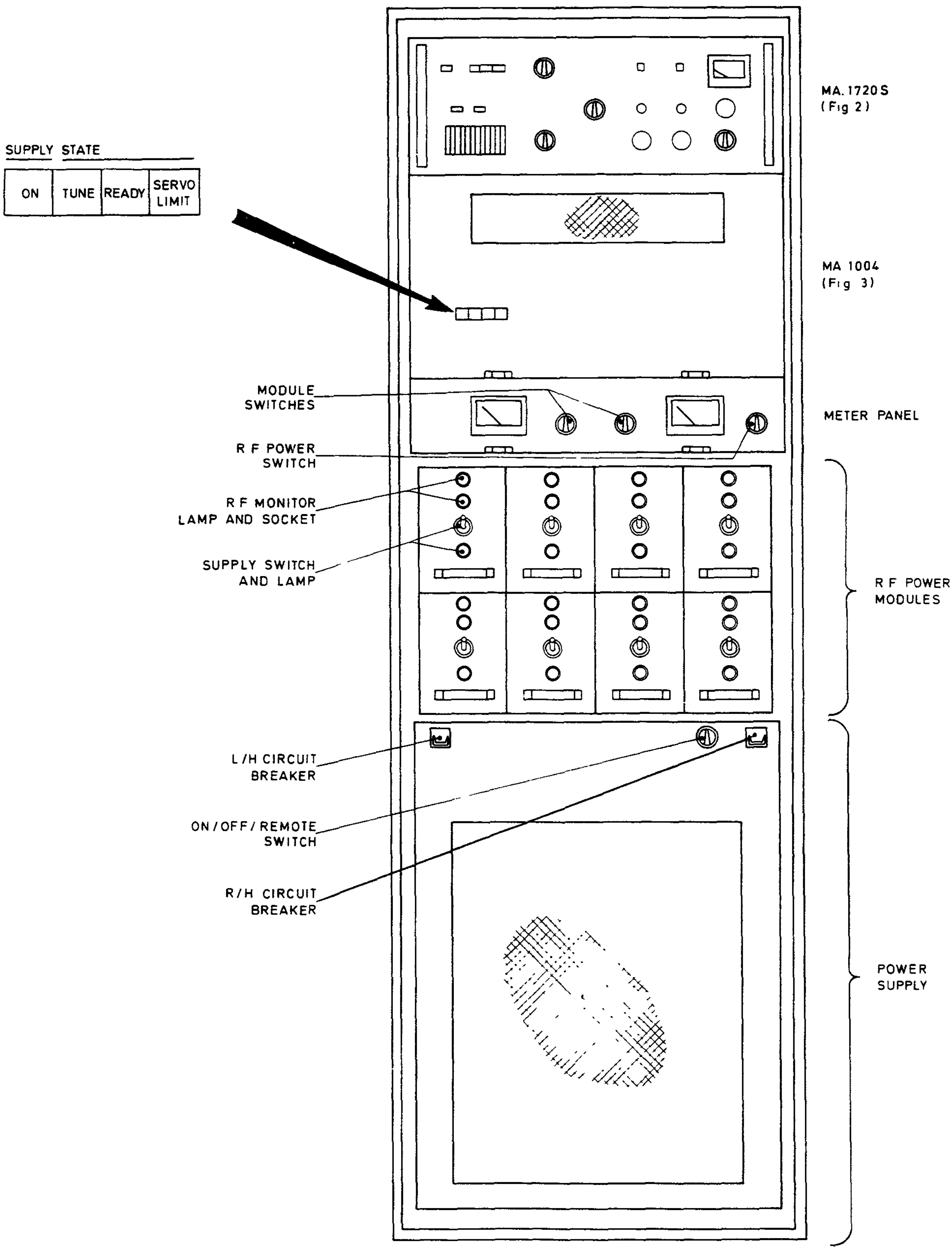



Fig.1 Transmitter sub-assembly : location of controls

(c) OPERATE LOW: selects reduced r.f. output levels (-6 dB approx.) from the MA.1720S.

(d) OPERATE HIGH: selects normal r.f. output levels from the MA.1720S. This switch position is the one normally used.

(12) VOX/PTT/TX switch (three position):-

(a) VOX: voice-operated transmit/receive switching.

(b) PTT: manual 'press-to-talk' transmit/receive switching.

(c) TX: continuous transmission.

(13) Frequency selector switches (six thumbwheels): the function is self-evident. The operating frequency is displayed in decade form.

(14) CONTROL selector switch (four position):-

(a) LOCAL PROG: this position is selected if the operating frequency is set by means of an external pre-programmer unit.

(b) LOCAL SYNTH: the operating frequency is set by the thumbwheel switches.

(c) EXTENDED: control effected via an external control panel.

(d) REMOTE: control effected via a remote control system.

The CONTROL switch is normally kept in the LOCAL SYNTH position.

(15) MODE selector switch (eleven position): selection of the following operational modes:-

(a) CW: continuous wave (keyed carrier) mode. Note that in this mode the frequency selector switches are set to 1 kHz above the required operating frequency.

(b) KEY SUPP: keyed tone in sideband, carrier suppressed.

(c) KEY -6; keyed tone in sideband with -6 dB carrier.

(d) RTTY TEST )
(e) RTTY ) The RTTY generator board is not fitted to MA.1720S.

(f) AM-6: compatible a.m. with -6 dB carrier.

(g) SSB-16: single sideband with -16 dB carrier.

(h) SSB-26: single sideband with -26 dB carrier.

(j) SSB SUPP: single sideband, carrier suppressed.

(k) ISB-26: independent sidebands with -26 dB carrier.

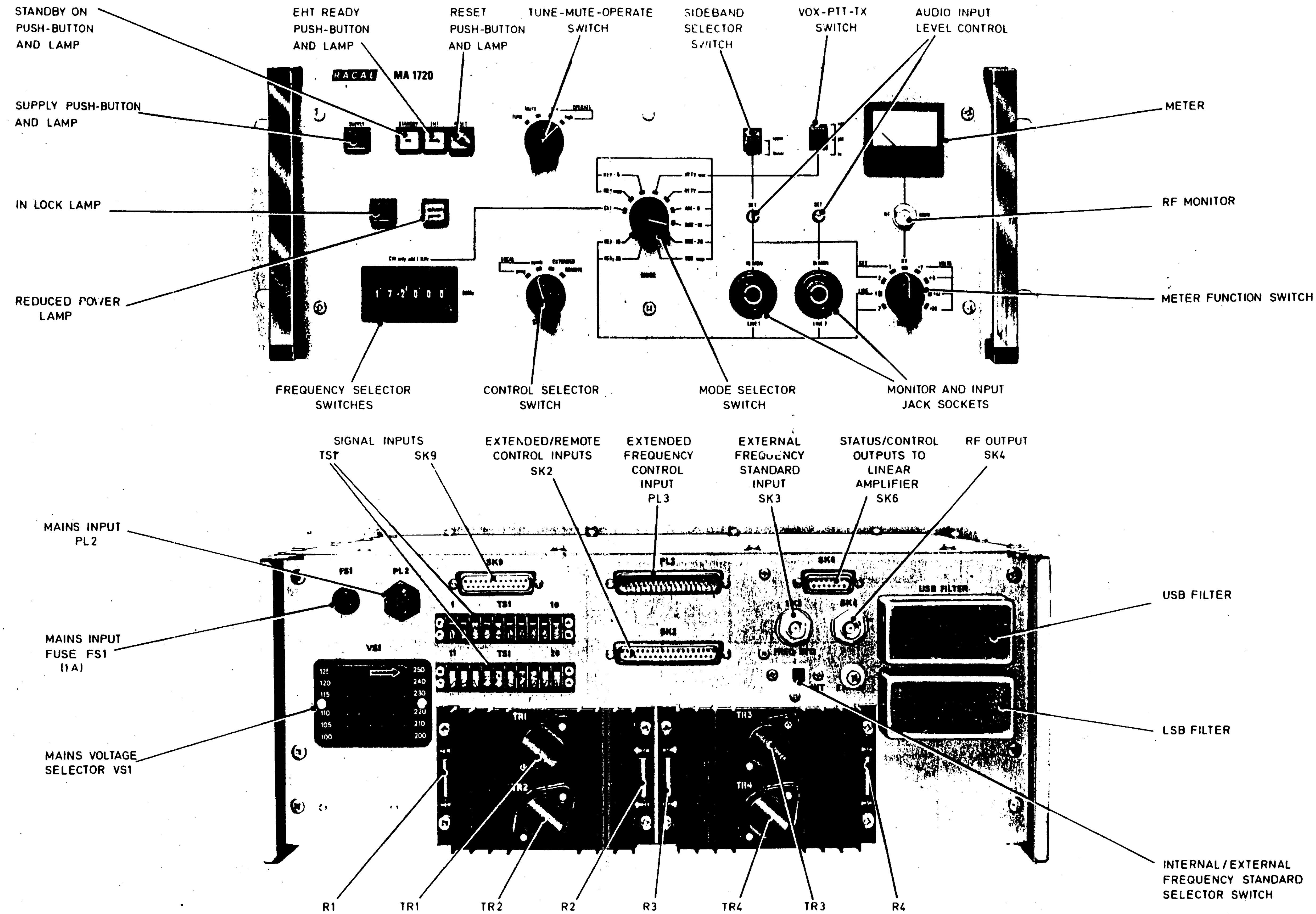
(l) ISB-16: independent sidebands with -16 dB carrier.

(16) Sideband switch (two position): used in conjunction with the MODE switch. Selects UPPER or LOWER sideband operation when item (15) is set to positions (g), (h) or (j).

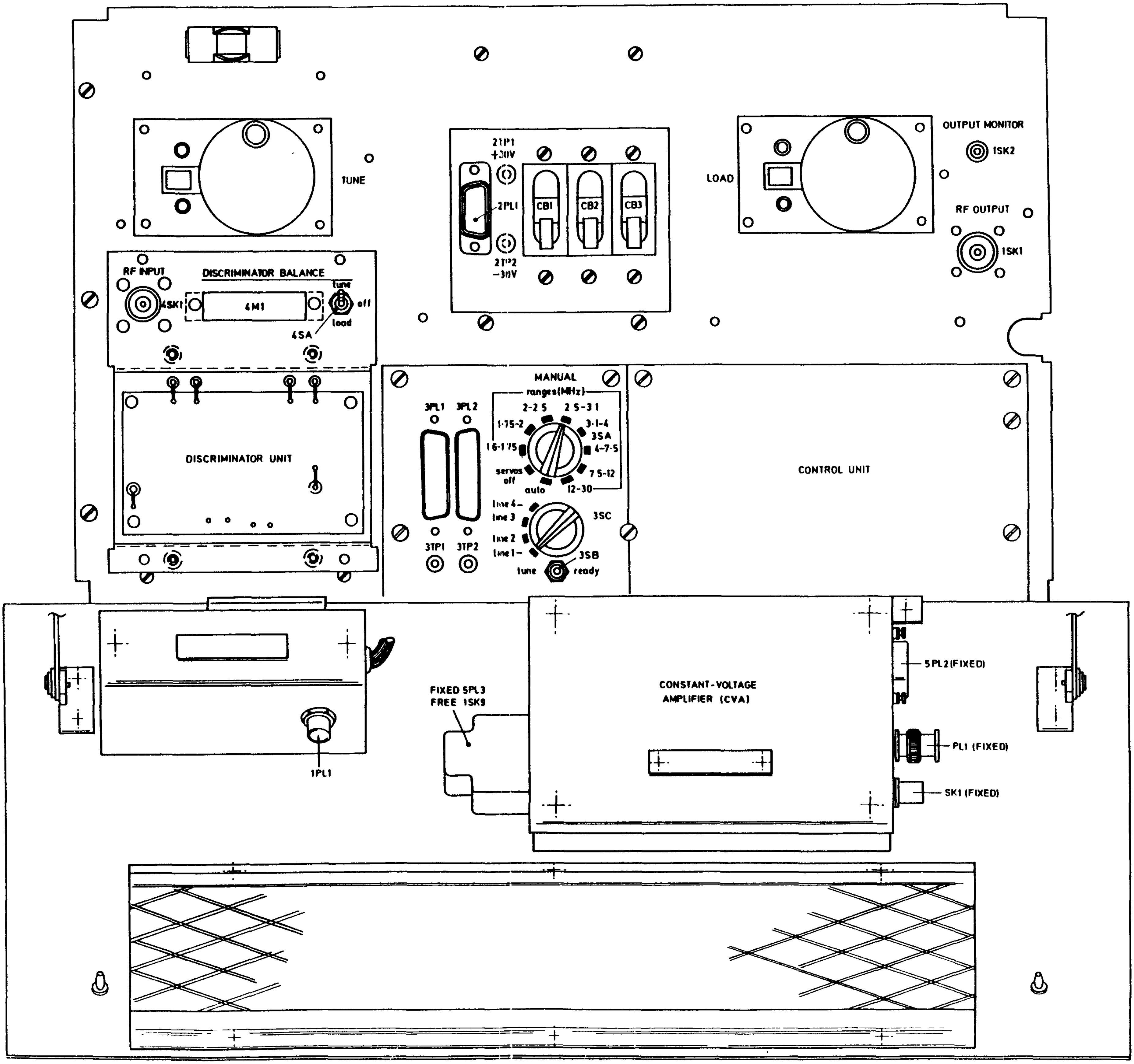
(17) METER switch (nine position): for measuring the following parameters (operating conditions are given in Table 1):-

(a) LINE 2: line 2 audio input level.

(b) LINE 1: line 1 audio input level.




Drive unit : Location of controls




VIEW WITH FRONT PANEL LOWERED

Fig. 3 **Feeder matching unit: location of controls** Fig. 3

(c) SET 2: audio input level to line 2 amplifier.

(d) SET 1: audio input level to line 1 amplifier.

(e) RF: r.f. output level to the TA.1810S.

(f) -7 VOLTS )
(g) +5 VOLTS )
(h) +12 VOLTS ) supply rails.
(j) +20 VOLTS )

(18) SET LINE 1 (preset): adjusts audio level to line 1 amplifier.

(19) SET LINE 2 (preset): adjusts audio level to line 2 amplifier.

(20) Meter: used in conjunction with METER switch.

4. The following front panel monitoring points are also provided:-

(1) RF MON (coaxial connector): provides a sample of the r.f. output for use with external test equipment e.g. a frequency counter.

(2) IN/MON LINE 1 jack (multiway connector): provides monitoring and signal access to this audio path.

(3) IN/MON LINE 2 jack: as for item (2).

Feeder matching unit (fig. 3)

5. (1) SUPPLY ON pushbutton (including indicator lamp): controls the a.c. supply input to the MA.1004.

(2) SUPPLY ON lamp: glows when power is switched on.

(3) TUNE pushbutton (including indicator lamp): this control, which manually initiates a tuning sequence, is not normally used.

(4) TUNE STATE lamp: glows during the tuning sequence.

(5) READY STATE lamp: glows when the tuning sequence is completed.

(6) SERVO LIMIT STATE lamp: glows when a servo system is driven to an extreme of travel.

6. The following items are located on the sub-front panel:-

(1) Circuit breaker CB1: power supply protection, a.c. supply input. Normally ON (toggle up).

(2) Circuit breaker CB2: +30V supply protection. Normally ON.

(3) Circuit breaker CB3: -30V supply protection. Normally ON.

(4) TUNE control and turns counter: manual adjustment of 'tune' inductor.

(5) LOAD control and turns counter: manual adjustment of 'load' inductor.

(6) DISCRIMINATOR BALANCE switch (three position): measurement of the following:-

(a) TUNE: 'tune' discriminator output.

(b) OFF: self-evident. Normal position of switch.

(c) LOAD: 'load' discriminator output.

(7) Meter, centre zero: used in conjunction with item (6).

(8) MANUAL RANGES switch (ten position):-

(a) AUTO: normal position of switch.

(b) SERVOS OFF: inhibits operation of servo motors.

(c) 1.6 - 1.75 MHz :
(d) 1.75 - 2 MHz :
(e) 2 - 2.5 MHz :
(f) 2.5 - 3.1 MHz :
(g) 3.1 - 4 MHz :
(h) 4 - 7.5 MHz :
(j) 7.5 - 12 MHz :
(k) 12 - 30 MHz :

} manual selection of switched capacitors appropriate to each of eight frequency bands.

(9) LINE switch (four position): manual selection of line length (coaxial cables between the TA.1810S and the MA.1004).

(10) TUNE/READY switch (two position):-

(a) TUNE: used during the manual tuning sequence.

(b) READY: provides 'ready' signal to the MA.1720S on completion of the manual tuning sequence.

Meter panel (fig. 1)

7. (1) MODULE selector switch (eight position) and 'meter range' switch (three position): measurement of the following parameters on each amplifier-stabilizer:-

(a) CURRENT: load current drawn from the +30V supply.

(b) 20V: supply rail.

(c) 30V: supply rail.

(2) RF POWER switch (six position): measurement of the following:-

(a) INPUT1,250 mW: drive level from MA.1720S No.1 to the TA.1810S.

(b) INPUT2,250 mW: drive level from MA.1720S No.2 to the TA.1810S.

(c) FORWARD 1,1250W: power output to antenna 1.

(d) FORWARD 2,1250W: power output to antenna 2.

(e) REFLECTED 1,250W: power reflected from antenna 1.

(f) REFLECTED 2,250W: power reflected from antenna 2.

Note...

The ratio of the forward and reflected powers is a measurement of the voltage standing wave ratio.

(3) meter (left-hand): used in conjunction with MODULE selector switches.

(4) Meter (right-hand): used in conjunction with the RF POWER switch.

8. The following items are located at the rear of the meter panel:-

(1) Muting selector switch SD (two position): selection of muting signal input to the TA.1810S.

(2) Muting selector switch SE: as item (1).

(3) Two VSWR WARNING switches: both switches are left in the NORMAL position.

Amplifier-stabilizers (fig. 1)

9. Each MM.420 carries the following:-

(1) SUPPLY switch: controls +30V and +20V supplies to the amplifier stages.

(2) SUPPLY lamp: glows when power is switched on.

(3) ON lamp: glows when unit is providing r.f. output. Under normal conditions, all eight ON lamps (two groups of four in dual-drive) should glow with equal brilliance. The degree of brilliance is somewhat dependent upon the operating frequency.

(4) RF MON (coaxial connector): provides a sample of the r.f. output for use with external test equipment.

Power supply panel (fig. 1)

10. (1) Circuit breaker CB2 (left-hand): controls the a.c. supply to power supply units PSU 1 and PSU 2.

(2) Circuit breaker CB1 (right-hand): controls the a.c. supply to PSU 3 and PSU 4.

(3) ON/OFF/REMOTE switch (three position):-

(a) ON: operates main contactor, over-riding the action of relay PLC/1.

(b) OFF; self-evident.

(c) REMOTE: control of main contactor via the MA.1720S. Normal position of switch.

## SINGLE-DRIVE

### OPERATING PROCEDURES

11. It is assumed that the setting-up procedures of Chap. 13-1, para. 3 to 18 have been completed and that the required audio line inputs are present.

Automatic tuning

12. (1) Check that an antenna of the correct impedance (50-ohm nominal) has been connected to 10SK1 (ANTENNA).

(2) Check that the front panel controls are set as follows:-

(a) SUPPLY pushbutton on the MA.1720S to ON i.e. with lamp glowing.

(b) STANDBY pushbutton to OFF.

(c) TUNE/MUTE/OPERATE switch to OPERATE HIGH.

(d) CONTROL switch to LOCAL SYNTH.

(e) SUPPLY pushbutton on the MA.1004 to ON.

(f) SUPPLY switch on each MM.420 to ON (eight switches).

(g) Both circuit breakers on the power supply panel to ON.

(h) ON/OFF/REMOTE switch to REMOTE.

(3) On the MA.1720S set the following controls:-

(a) Frequency selector switches (thumbwheels) to desired operating frequency.

(b) MODE and 'sideband' switches as required.

(c) VOX/PTT/TX switch as required.

(4) Depress the STANDBY pushbutton on the MA.1720S and check that:-

(a) The STANDBY, RESET and IN LOCK lamps glow.

(b) Main contactor CON A closes and all three airblowers operate (audible checks).

(c) The SUPPLY lamp on the MA.1004 glows.

(d) The SUPPLY lamp on each MM.420 glows.

(5) Depress the RESET pushbutton on the MA.1720S and check that the following sequence occurs:-

(a) The RESET lamp is extinguished.

(b) The MA.1004 carries out the feeder matching sequence (audible check and TUNE lamp glows).

(c) The TUNE lamp on the MA.1004 is extinguished and then the READY lamp glows.

(d) The line-selection procedure takes place. At this stage the ON lamp on each MM.420 should glow and a flicker may be observed coincident with the operation of the line selection relays.

(e) The READY lamp on the MA.1720S glows: the TTA.1860S is now tuned and ready to accept traffic.

(6) To measure the transmitter output power, set the RF POWER switch on the meter panel to FORWARD2,1250W (para. 23).

Change of operating mode or frequency

13. Changes to the operating mode or sideband may be made during normal transmission by re-setting the MODE and 'sideband' switches on the MA.1720S as required.

14. Changes to the operating frequency are made as follows:-

(1) Reset the thumbwheel switches on the MA.1720S to the new frequency.

(2) Depress the RESET pushbutton.

(3) Check that step 12(5) is repeated.

MANUAL TUNING

15. The following procedures are used for maintenance purposes or in the event of a failure of the MA.1004 servo system.

16. (1) Carry out the procedures given in para. 12(1) to 12(4).

(2) Lower the hinged front panel of the MA.1004 and set the sub-front panel controls as follows:-

(a) TUNE/READY switch to TUNE.

(b) MANUAL LINE switch to LINE 1.

(c) MANUAL RANGES switch to suit the operating frequency.

Note...

If the frequency is at end-of-band e.g. 2.5 MHz, either range may be used (2 - 2.5 MHz or 2.5 - 3.1 MHz).

(3) Referring to the tuning graph (fig. 4), adjust the TUNE control to give the counter reading appropriate to the operating frequency.

(4) Repeat step (3) using the LOAD control.

(5) Depress the RESET switch on the MA.1720S.

(6) Set the DISCRIMINATOR BALANCE switch to TUNE and adjust the TUNE control to give a centre-zero meter reading.

(7) Set the DISCRIMINATOR BALANCE switch to LOAD and adjust the LOAD control for a centre-zero meter reading.

(8) Repeat steps (6) and (7) alternately for best balance.

CAUTION...

Do not set either the TUNE or the LOAD control below 100 or above 208 counter reading.

(9) Set the RF POWER switch on the meter panel to FORWARD2,1250W and note the forward power output (right-hand meter).

(10) Set the MANUAL LINE switch on the MA.1004 to LINE 2, 3 and 4 in turn and note the forward power output in each case.

(11) Select the LINE position giving the greatest power output.

(12) Repeat steps (6) to (8).

(13) Set the TUNE/READY switch to READY and the DISCRIMINATOR BALANCE switch to OFF.

(14) Close the MA.1004 front panel.

(15) Check that the READY lamps on the MA.1004 and the MA.1720S are both glowing: the TTA.1860S is now tuned and ready to accept traffic.

(16) To change the operating frequency:-

(a) Set the thumbwheels on the MA.1720S to the frequency.

(b) Repeat steps (2) to (15) above.

BY-PASSING THE FEEDER MATCHING UNIT

17. The following procedures allow transmission to continue in the event of a failure of the MA.1004. Under these conditions, the harmonic performance will be degraded, and if there is other than unity v.s.w.r. on the antenna feeder, the power output will be reduced.

18. (1) Set the STANDBY switch on the MA.1720S to OFF.

(2) Check that the a.c. supplies are removed from the TA.1810S.

(3) Lower the hinged front panel of the MA.1004.

(4) Disconnect the high-power r.f. cables from the RF INPUT and RF OUTPUT sockets.

(5) Disconnect the low-power r.f. cables from 5PL1 and 5SK1 (rear of front panel).

(6) Remove the MA.1004 from the cabinet; the removal instructions are given in Chap. 13-3.

◄ (7) Disengage the multiway connector (1SK36) from the MS.139.

(8) Connect the MS.139 dummy plug (part of accessory kit CA.608) to 1SK36.

(9) Interconnect the high-power r.f. cables using the adaptor provided (located above the TUNE control on the MA.1004).

(10) Interconnect the low-power r.f. cables disconnected at operation (5).

(11) Check that all unused cables are stowed correctly.

(12) Set the STANDBY switch on the MA.1720S to ON. ►

19. Transmission may now be resumed. The operating procedures are similar to those given in para. 12: the differences will be self-evident.

OPERATION AT 500W POWER LEVEL

20. The following paragraphs describe the operation of the TA.1810S as a 500W linear amplifier. This configuration is used in the event of a partial failure of the TA.1810S: it allows transmission to continue, at reduced power output, whilst maintenance is in progress. The procedures assume that the left-hand bank of amplifier-stabilizers feeds the antenna. The right-hand bank is terminated with the dummy load and is driven from an external signal source.

21. (1) Carry out the r.f. patching procedures given in Chap. 13-1, para. 11.

(2) Set the controls on the power supply front panel as follows:-

(a) Left-hand circuit breaker to ON.

(b) Right-hand circuit breaker to OFF.

(c) ON/OFF/REMOTE switch to REMOTE.

(3) Set the STANDBY switch on the MA.1720S to ON.

(4) To set up for transmission at a 500W power level, carry out the procedures given in para. 12 but with CB1 switched OFF.

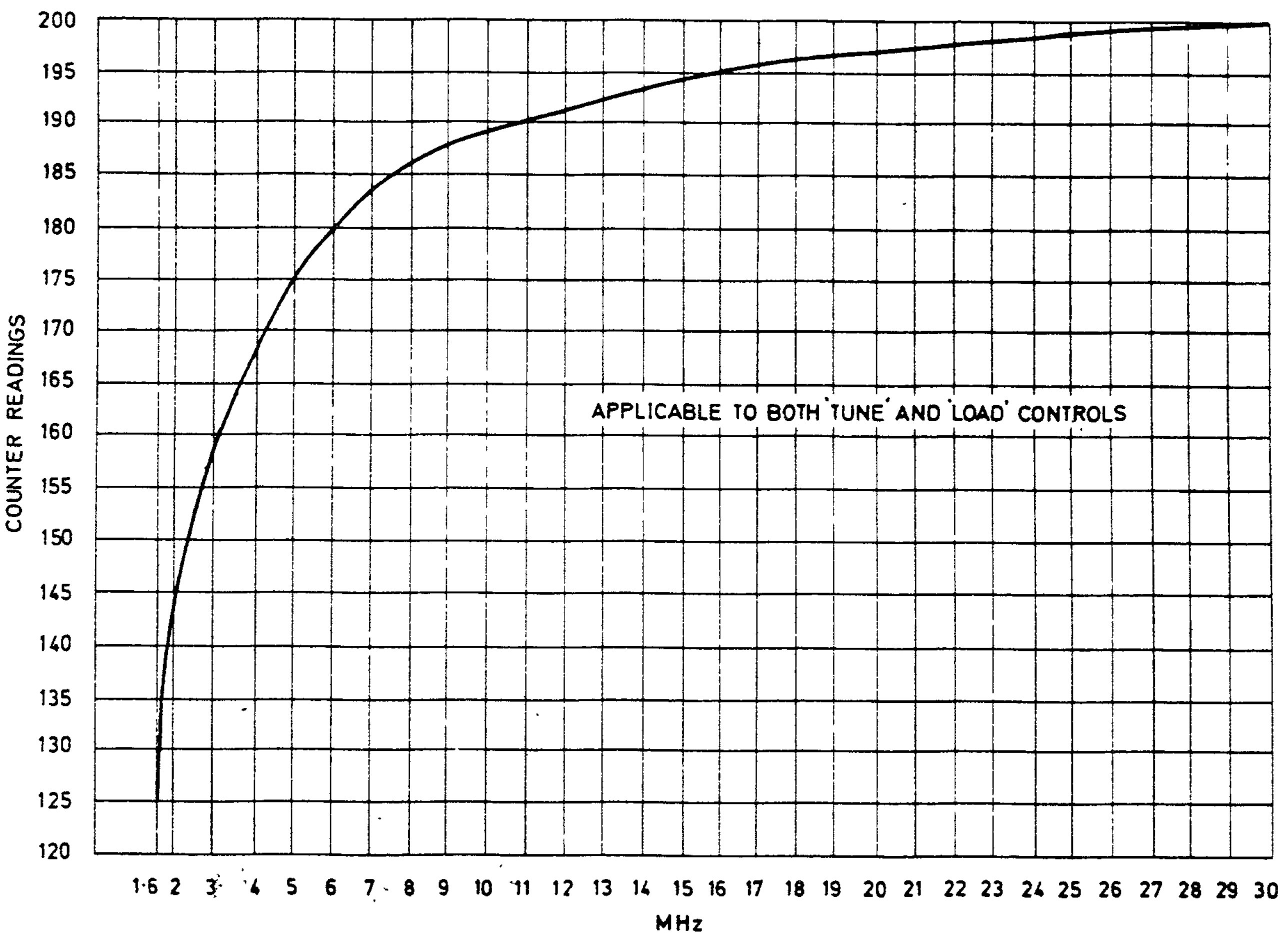



Fig. 4 Feeder matching unit : manual tuning graph

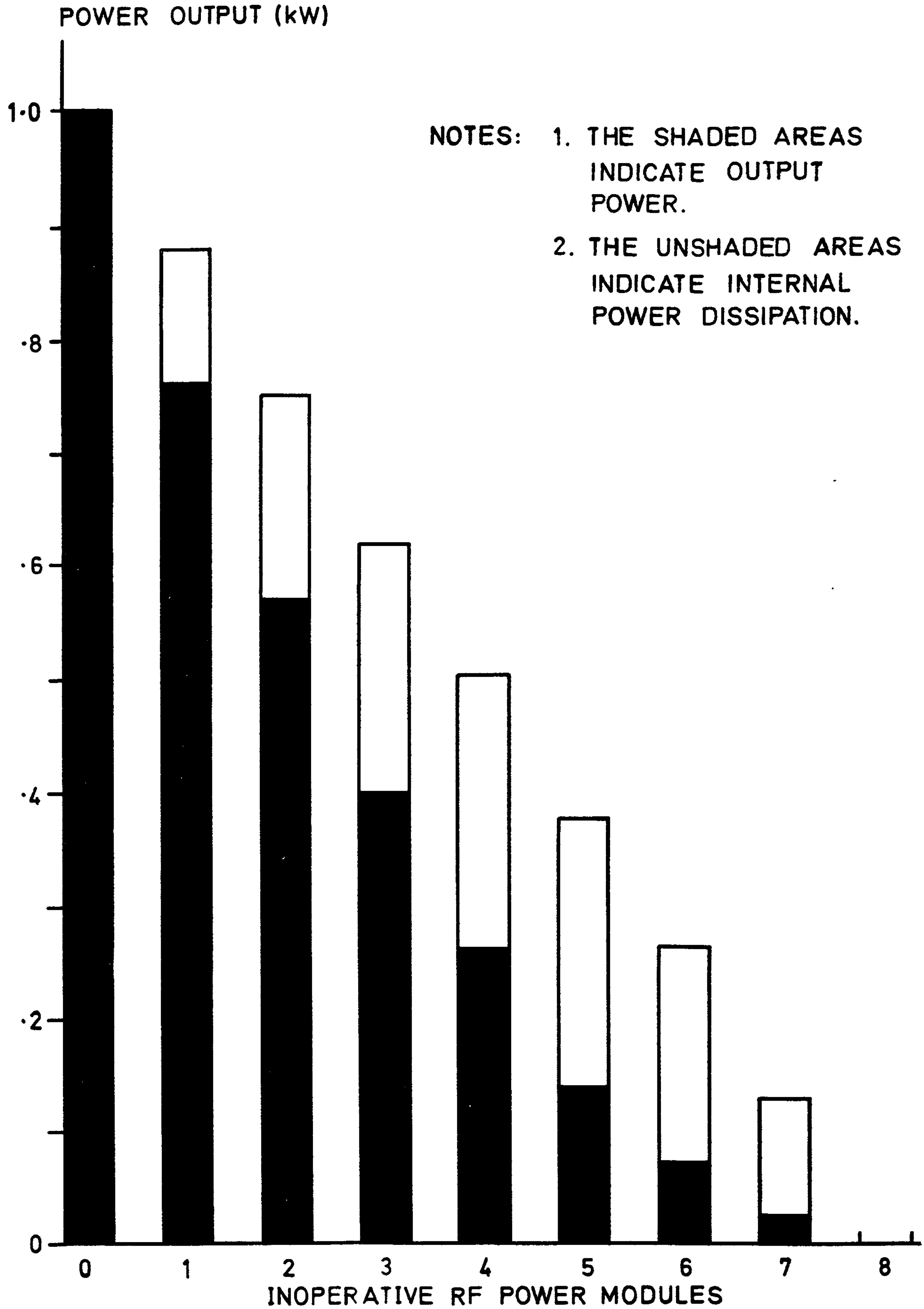



Fig.5 Available-power chart

(5) To activate the right-hand bank of amplifier-stabilizers:-

(a) Check that the test signal input level is not greater than 100 mV e.m.f.

(b) Set the right-hand circuit breaker to ON.

(c) Switch each MM.420 ON in turn and check its supply rails.

(d) Increase the signal input level until the desired power output level is obtained, as indicated on the external test equipment.

Note...

The muting facility is common to both banks of amplifier-stabilizers and hence r.f. output to the dummy load is obtained only whilst the left-hand bank is 'active'.

22. It may be noted that when one of the amplifier-stabilizers e.g. No.3 is switched off, the power output falls by more than 1/8 of the total. Part of the output from the companion unit (No. 7) is dissipated in the combining network. If a second MM.420 e.g. No.6 is now switched off, part of No.2 output is also lost. Figure 5 shows how the effect is cumulative down to the last MM.420. Should faults develop in more than two amplifier-stabilizers, and assuming spares are not available, it is advantageous to transfer four serviceable units into one bank and operate the TA.1810S in the 500W configuration.

Note...

Record the original position of each MM.420 affected e.g. 'No.8 temporarily moved to No.5 position'.

MONITORING

23. Monitoring is carried out by means of the front panel meters and indicator lamps (para.2) and by connection of external test equipment to the MONITOR sockets. Typical signal levels are listed in Tables 1 and 2; since the r.f. levels vary according to the frequency and mode of operation, the actual values should be logged at initial installation of the equipment.

TABLE 1

Signal levels - front panel meters

| Sub-assembly | Switch position | Normal indication |
|---|---|---|
| Drive unit. | LINE 2 | Dependent upon line input level |
| | LINE 1 | Dependent upon line input level |
| | SET 2 | 0 dBm (nominal) : adjusted by the appropriate SET control. |
| | SET 1 | 0 dBm (nominal) : adjusted by the appropriate SET control. |
| | RF | As logged for each mode. |
| | -7 VOLTS | Within green band. |
| | +5 VOLTS | Within green band. |

TABLE 1 (cont.)

| Sub-assembly | Switch position | Normal indication |
|---|---|---|
| Drive unit - cont. | +12 VOLTS | Within green band. |
| | +20 VOLTS | Within green band. |
| Meter panel. (See Notes) | CURRENT | Up to 13A (as logged). |
| | 20V | 20V |
| | 30V | 30.5V |
| | INPUT 1,250 mW | Up to 100 mW (as logged). |
| | INPUT 2,250 mW | Up to 100 mW (as logged). |
| | FORWARD 1,1250W | Up to 1250W (as logged). |
| | FORWARD 2,1250W | Up to 1250W (as logged). |
| | REFLECTED 1 250W | Up to 250W (as logged). |
| | REFLECTED 2 250W | Up to 250W (as logged). |

Notes...

1. The CURRENT, 20V and 30V measurements apply to each amplifier-stabilizer, as selected by the MODULE switch.
2. For single-drive operation, the 'path 2' switch positions are to be used.

TABLE 2

Signal levels - monitor sockets

| Sub-assembly and test-point | Instrument | Normal indication |
|---|---|---|
| Drive unit. | | |
| (a) RF MON socket | Oscilloscope | Up to 0.3V p-p (as logged) when terminated in 50Ω. |
| | Electronic voltmeter | Up to 0.1V r.m.s. (as logged) when terminated in 50Ω. |
| (b) IN/MON LINE 1 jack<br>(c) IN/MON LINE 2 jack | AF signal source or headphones | See Note 1. |
| Feeder matching unit. | | |
| OUTPUT MONITOR | Oscilloscope | Up to 2V p-p (as logged) when terminated in 50Ω. |
| | Electronic voltmeter | Up to 0.7V r.m.s. (as logged) when terminated in 50Ω. |

TABLE 2 (cont.)

| Sub-assembly and test-point | Instrument | Normal indication |
|---|---|---|
| Combining unit | | |
| (a) RF MON 1 kW socket | Oscilloscope | Up to 3V p-p (as logged) when terminated in 50Ω. |
| | Electronic voltmeter | Up to 1V r.m.s. (as logged) when terminated in 50Ω. |
| (b) RF MON 500W sockets | Oscilloscope | Up to 2V p-p (as logged) when terminated in 50Ω. |
| | Electronic voltmeter | Up to 0.7V r.m.s. (as logged) when terminated in 50Ω. |
| Amplifier stabilizers | | |
| RF MON sockets (See Note 2) | Oscilloscope | Up to 10V peak-to-peak when terminated in 50Ω. |
| | Electronic voltmeter | Up to 3V r.m.s. when terminated in 50Ω. |

Notes...

1. The jacks provide for the injection of audio test signals to the drive unit or for headphone monitoring of the normal line inputs.
2. The levels quoted should be obtained at each of the eight sub-assemblies.

## DUAL DRIVE

### OPERATING PROCEDURES

24. The operating procedures are given for each of the following configurations:-

(1) Dual-drive to separate antennas.

(2) Dual-drive to common antenna.

(3) 1 kW output using drive unit No.1.

(4) 1 kW output using drive unit No.2.

Where the procedures are similar, cross-reference is made to the single-drive system.

25. It is assumed that the setting-up procedures Chap.13-1, para. 19 to 30 have been completed and that the required audio line inputs are present.

### Dual-drive to separate antennas

26. (1) Check that an antenna of the correct impedance (50Ω nominal) has been connected to 10SK1 (ANTENNA) on the TTA.1860S.

(2) Repeat step (1) for the MA.1721S.

(3) Check that the front panel controls on the TTA.1860S are set as follows:-

(a) SUPPLY pushbutton on the MA.1720S (No.2) to ON i.e. with lamp glowing.

(b) STANDBY pushbutton to OFF.

(c) TUNE/MUTE/OPERATE switch to OPERATE HIGH.

(d) CONTROL switch to LOCAL SYNTH.

(e) SUPPLY pushbutton on the MA.1004 (No.2) to ON.

(f) SUPPLY switch on each MM.420 to ON.

(g) Both circuit breakers on the power supply panel to ON.

(h) ON/OFF/REMOTE switch to REMOTE.

(4) On MA.1720S No.2 set the following controls:-

(a) Frequency selector switches (thumbwheels) to desired operating frequency.

(b) MODE and 'sideband' switches as required.

(c) VOX/PTT/TX switch as required.

(5) Repeat steps (3)(a) to (3)(e) and (4) for the MA.1721S.

(6) Depress the STANDBY pushbutton on MA.1720S No.2 and check that:-

(a) The STANDBY, RESET and IN LOCK lamps glow.

(b) Main contactor CON A closes and all three airblowers operate (audible checks).

(c) The SUPPLY lamp on MA.1004 No.2 glows.

(d) The SUPPLY lamp on each MM.420 glows.

(e) The SUPPLY lamp on MA.1004 No.2 glows.

(7) Depress the STANDBY pushbutton on MA.1720S No.1 and check that the relevant STANDBY, RESET and IN LOCK lamps glow.

Automatic tuning

27. (1) Depress the RESET pushbutton on MA.1720S (No.1) and check that the following sequence occurs:-

(a) The RESET lamp on this drive unit is extinguished.

(b) The MA.1004 No.1 carries out the feeder matching sequence (audible check and TUNE lamp glows).

(c) The TUNE lamp on the MA.1004 is extinguished and then the READY lamp glows.

(d) The line-selection procedure takes place. At this stage the ON lamps on the left-hand bank of four r.f. modules should glow and a flicker may be observed coincident with the operation of the line selection relays.

(e) The READY lamp on MA.1720S No. 1 glows.

Path 1 of the TTA.1860S/MA.1721S combination is now tuned and ready for traffic.

(2) To measure the power output from path 1 (500W nominal), set the RF POWER switch on the meter panel to the FORWARD 1,1250W position.

(3) Repeat steps (1) and (2) for path 2.

Note...

The above sequence is not mandatory. Path 1 and path 2 may be 'tuned' simultaneously or as required.

Dual-drive to common antenna

28. (1) Carry out the r.f. patching procedures (Chap. 13-1, para. 24) appropriate to this configuration.

(2) Check that the output from the MS.560 output combining unit is connected to a wide-band antenna.

(3) Operate the transmitting set as described in para. 26 and 27 (1).

(4) Repeat step 27 (1) for path 2.

Note...

The impedances presented by the antenna at the two operating frequencies may be such that the isolation between input ports of the MS.560 is degraded. Under these conditions, feeder matching for path 2 cannot be accomplished whilst transmitter No. 1 is radiating - or vice-versa. Feeder matching is carried out for one path and then that transmitter is muted whilst the second path is aligned.

(5) The READY lamp on MA.1720S No. 2 should glow within 10 seconds of depressing the RESET pushbutton. If not:-

(a) Set the TUNE/MUTE/OPERATE switch on MA.1720S No. 1 to MUTE.

(b) Repeat step 27 (1) for path 2.

(c) When path 2 has tuned (appropriate READY lamps glowing), re-set the TUNE/MUTE/OPERATE switch on MA.1720S No. 1 to OPERATE HIGH.

1 kW output using drive unit No. 1 (MA.1721S)

29. (1) Carry out the r.f. patching procedures (Chap. 13-1, para. 24), appropriate to this configuration.

(2) Set the STANDBY pushbutton on MA.1720S No.2 to OFF.

(3) Set the SUPPLY pushbutton on MA.1004 No.2 to OFF.

(4) Operate the transmitting set as described in para. 26 and 27 noting that:-

(a) The r.f. output is via path 1 only.

(b) The MA.1720S No. 2, the MA.1004 No. 2 and path 2 line switching are inoperative.

1 kW output using drive unit No. 2 (TTA.1860S)

30. As for para. 29; the differences will be self-evident. It may be noted that the operating conditions are as for single-drive.

Change of operating mode or frequency

31. Changes to the operating mode or sideband may be made during normal transmission by resetting the MODE and 'sideband' switches on the relevant MA.1720S as required.

32. Changes to the operating frequency are made as follows:-

(1) Reset the thumbwheel switches on the relevant MA.1720S to the new frequency.

(2) Depress the RESET pushbutton.

(3) Check that step 27 (1) is repeated.

(4) For common antenna working, refer to the note in para. 28 and , as necessary, perform step 28 (5).

MANUAL TUNING

33. The following procedures are used for maintenance purposes or in the event of a failure of the MA.1004 servo system.

34. (1) Carry out the procedures given in para. 26.

(2) Carry out the procedures given in para. 16. At step 16(9), set the RF POWER switch as required.

BY-PASSING THE FEEDER MATCHING UNIT

35. Carry out the procedures given in para. 17 and 18.

36. Transmission may now be resumed. The operating procedures are similar to those given in para. 26 and 27; the differences will be self-evident.

MONITORING

37. Monitoring is carried out as described in para. 23. The signal levels quoted apply to each drive unit and feeder matching unit.

# Chapter 13-3

## SINGLE AND DUAL-DRIVE SYSTEM (TTA.1860S AND MA.1721S)

## SERVICING

CONTENTS

CONTENTS (cont.)



TABLES



INTRODUCTION

WARNING

A. RACAL MA1720 DRIVE UNITS ARE NOT TO BE LIFTED OUT OF THEIR EQUIPMENT RUNNERS UNLESS THE UNIT IS BEING REMOVED FROM THE CABINET AND THEN ONLY BY TWO TRADESMEN.
AFTER EMBODIMENT OF MODIFICATION TC 0088 IT WILL BE NECESSARY TO REMOVE TWO BLANKING PLATES FROM THE RUNNERS TO FACILITATE REMOVAL OF DRIVE UNITS. (RAF LOCKING ONLY).

B. AT NO TIME ARE PERSONNEL TO BE PERMITTED TO WORK BELOW A UK/FRT 618 TRANSMITTER SUB-ASSEMBLY WHICH HAS BEEN WITHDRAWN OUT OF THE CABINET ON ITS EQUIPMENT-RUNNERS, EG. RACAL MA1720 DRIVE UNIT. THIS IS TO MINIMISE THE POSSIBILITY OF THE EXTENDED SUB-ASSEMBLY SLIPPING, FALLING AND INJURING PERSONNEL WORKING BELOW.

C. TRADESMEN ARE TO SATISFY THEMSELVES, BY PHYSICAL EXAMINATION, THAT WHEN A SUB-ASSEMBLY, EG. RACAL MA1720 DRIVE UNIT IS FULLY WITHDRAWN OUT OF ITS UK/FRT 618 TRANSMITTER CABINET, ALL LOCATING-LUGS AT THE SIDE OF THE SUB-ASSEMBLY ARE SECURELY LOCATED IN THE EQUIPMENT RUNNERS.

1. This chapter gives a guide to the location of a fault to user-replaceable unit level. Information is also given on routine servicing procedures and for the removal and re-fitting of units.

## TEST EQUIPMENT

2. The common test equipment and tools necessary for the maintenance and servicing of the TTA.1860S and the MA.1721S are listed in Table 1. Authorised equivalent items of test equipment may be used instead of those listed in Table 1, provided that their parameters are at least as good as the equipment they replace.

TABLE 1

List of test equipment

| ALTE Item No. | Reference No. | Nomenclature | Remarks |
|---|---|---|---|
| Section 'A' - general purpose electrical engineering test equipment | | | |
| A1 | 5QP/6625-99-105-7049 | Multimeter set CT.498A | |
| A2 | 10S/6625-99-193-4355 | Electronic voltmeter | Marconi 2603 |
| A3 | 10S/6625-99-952-0447 | Signal generator | Marconi TF2005 |

TABLE 1 (cont.)

| ALTE Item No. | Reference No. | Nomenclature | Remarks |
|---|---|---|---|
| A4a | 10S/6625-99-527-1079 | Spectrum analyser main-frame 141T | |
| A4b | 10S/6625-99-621-8509 | Spectrum analyser r.f. section HP8553B | |
| A4c | 10S/6625-99-621-8508 | Spectrum analyser i.f. section HP8552B | |
| A5 | 110S/6625-00-649-5070 | Wattmeter, directional | Bird 43 |
| A6 | 110B/9542785 | Detecting element 1000W, 2-30 MHz | For use with item A5 |
| A7 | 10S/6625-99-628-5323 | Frequency counter | Racal 9059 |
| A8 | 10K/6150-99-628-5325 | Mains power unit, option 08 | For use with item A7 |
| A9 | 10ZZ/205705 | Oscilloscope set CT.588 | Tektronix 475 |
| A10 | 10S/17198 | Dummy load 1 kW, 50 ohms | Bird 8890 |
| | Section 'D' GSE and special tools | | |
| D1 | 10H/1142429 | 'T' connector, coaxial, TM7948 | For use with item A2 |
| D2 | 10H/6625-99-631-9452 | Accessory kit CA.607 comprising:-<br>(a) Amplifier module extension lead assembly.<br>(b) Combiner patch lead assembly.<br>(c) Amplifier module blanking panel assembly.<br>(d) Amplifier module mating connectors. | Racal BA604043 For use with MM.420 |
| D3 | 10H/6625-99-631-9453 | Accessory kit CA.608 comprising:-<br>(a) Servo pre-amp extension board.<br>(b) Tune and range extension board.<br>(c) Mating connectors.<br>◀ (d) Dummy plug. ▶ | Racal BA604044 For use with MA.1004 |
| D4 | 10A/12783 | Brinkley earthing stick | |
| D5 | 10W/5905-99-633-3089 | Rheostat 5.8 ohms, 20A | Berco SE |

## ROUTINE SERVICING

3. Routine servicing is carried out at the intervals specified in Topic 45 of this publication. The following procedures should be carried out for the relevant units in both cabinets.

### Air blowers

4. The air blowers BL1 and BL2, which are fitted above the power supply units, employ sealed bearings which require no lubrication.

### Extractor fan

5. The extractor fan BL3 (BL1 in the MA.1721S) is fitted to the top of the cabinet. After a considerable period of use, or after some 12 months storage under tropical conditions without use, it will be found that the oil has migrated from the grease in the bearings of the rotor. As a result the fan will tend to overheat and will ultimately seize up. To obviate this failure, the fan should be periodically examined and if necessary overhauled and the bearings replaced.

### Removal and re-fitting of rotor bearings

6. (1) Remove the extractor fan from the cabinet (para. 98).

(2) Slacken off the hexagon-headed screw retaining the impeller. Remove the impeller and clean off any dust.

(3) Remove any dust from the fan housing.

(4) Remove the two 6 BA nuts securing the two through-bolts. Withdraw the through-bolts.

(5) Remove the rear bearing housing.

(6) Remove the rotor with its two bearings.

(7) Examine the rotor and bearings for signs of over-heating. If severely discoloured, (e.g. due to a stalled fan having been left on for a considerable period), the rotor assembly should be replaced. A small amount of discolouration is acceptable.

(8) Remove the bearings using a bearing puller, taking care to avoid damage to the shaft. Discard the bearings.

(9) If the shaft is scored or damaged, restore polish with very fine emery cloth.

(10) Fit the replacement bearings, non-shielded faces outwards. Avoid pressure on the outer race. The new bearings should be a neat fit, not requiring excess force to fit them but the shaft must not slip in the inner race.

(11) A small quantity of XG 274 grease should be added to the two-bearing housing after cleaning; this will increase the life of the fan by acting as a reservoir. Excess grease will cause pressure in the bearings and result in over-heating and failure.

(12) Check the field windings for overheating, continuity and insulation to frame. Remove any dust.

(13) Re-fit the rotor with bearings and bearing housings. Secure with the two through-bolts.

(14) Re-fit the impeller, ensuring that the screw seats in the dimple in the shaft.

(15) Connect the fan to a suitable a.c. supply and check for correct operation.

(16) Re-fit the fan assembly to the cabinet.

Main contactor

7. Examine the contacts of the main contactor for burning or pitting; replace as necessary. The contactor is located at the rear of the hinged panel. Access will be self-evident after removal of the contactor cover plates.

Air filters

8. The air filters, one in the power supply front panel and one in the hinged front panel of the MA.1004, should be removed and cleaned using warm soapy water. Ensure that the filters are dry before re-fitting to the unit.

Coil and gearbox sub-assemblies

9. (1) Remove the MA.1004 from the cabinet (para. 78).

(2) Remove the top cover from the MA.1004 (fourteen screws).

(3) Examine the spur gears of the gearboxes and re-lubricate as required using XG 287 grease.

(4) Examine the small insulating wear-strips located at two corners of the rotor (either side of the coil helix) and replace as required. The new items are attached with Evostik 528 adhesive.

(5) Check the backlash between the rotor assembly and shaft of the 'tune' inductor.

(a) Rotate the manual tuning control to bring one corner of the rotor assembly to the top and then hold the handle firmly in this position.

(b) With a suitable tool e.g. a small screwdriver, try to push the corner of the rotor around the helix in either direction. Note the two limits of free movement.

(c) The distance between these positions should not exceed one-eighth inch at the circumference of the coil. If this figure exceeds one-eighth inch, the backlash adjustments should be performed.

(d) Rotate the manual tuning control so that the rotor contacts point to the bottom of the unit. Using a small screwdriver inserted between the coil turns, tighten both of the screws visible in the body of the rotor by one-eighth turn only.

(e) Recheck the backlash and continue adjustment as necessary ensuring that both screws are turned through the same angle each time. Do not overtighten the adjustment screws.

(6) Repeat operation (5) for the 'load' inductor.

(7) Re-fit the top cover and re-install the unit.

CRYSTAL OSCILLATOR ADJUSTMENT

10. The output frequency of the standard frequency source within the MA.1720S should be adjusted to compensate for crystal ageing.

11. (1) Connect the RF MON socket on the front panel of the MA.1720S to the 'test' input of the frequency counter.

(2) Set the frequency selector switches on the MA.1720S to 29.0000 MHz.

(3) Using a 10s count-time, check that the counter indicates 29.0000 MHz ± 1 Hz.

(4) If the reading is incorrect, withdraw the MA.1720S and remove the top cover. Remove the rubber bung from the hole in the frequency standard module.

(5) Make appropriate adjustments to give the desired counter reading.

(6) Replace the rubber bung and the top cover.

12. If a counter having a range of up to 29.000 MHz is not available, the check can be carried out at a lower frequency; the use of the higher frequency gives greater accuracy of adjustment.

## FAULT LOCATION, SINGLE-DRIVE SYSTEM

13. These paragraphs give, with the aid of the interconnecting (functional) diagrams (Chap.13-0), a guide to the location of a fault to user - replaceable unit level. A thorough understanding of Chap. 13-0 is an essential aid to fault-finding and reference should be made to the relevant paragraphs for details of the 'command' and supervisory signals.

14. The faults are grouped under the following main headings:-

(1) Failure of the drive unit.

(2) Loss of drive to the linear amplifiers.

(3) Zero or reduced output from the linear amplifiers.

(4) Failure of the feeder matching equipment.

(5) Power supply failure.

15. Where a complete set of serviceable spares is available, the substitution method must be used. The tests, which assume an initial 'no-output' condition, must be carried out in the order given.

DRIVE UNIT

16. (1) Set the ON/OFF/REMOTE switch to OFF.

(2) Lower the meter panel and connect the dummy load the directional wattmeter (items A5, A6 and A10 of Table 1) to 6SK12 on the combining unit MS.441. Set the power indicator for 1 kW forward power.

(3) Check that all three circuit breakers on the MA.1004 are set to ON. Set the SUPPLY pushbutton on the MA.1004 to ON.

(4) Set the SUPPLY switch on each MM.420 to ON.

(5) Set both circuit breakers on the power supply panel to ON.

(6) Set the ON/OFF/REMOTE switch to REMOTE.

(7) Set the controls on the MA.1720S as follows:-

(a) SUPPLY pushbutton to ON.

(b) STANDBY pushbutton to ON.

(c) TUNE/MUTE/OPERATE switch to OPERATE HIGH.

(d) Control switch to LOCAL SYNTH.

(e) Frequency selector switches (thumbwheels) to the desired test frequency.

(f) MODE switch to AM-6.

(g) VOX/PTT/TX switch to TX.

(8) Check that the SUPPLY, STANDBY, RESET and IN LOCK lamps on the MA.1720S glow.

(9) Check that:-

(a) Main contactor CON A closes and all three airblowers operate (audible checks).

(b) The SUPPLY lamp on each MM.420 glows; if not, refer to para. 23.

(c) The SUPPLY lamp on the MA.1004 glows.

(d) The SERVO LIMIT lamp on the MA.1004 is extinguished; if this lamp glows, refer to para. 33.

(10) Set the METER switch on the MA.1720S to the -7, +5, +12 and +20 VOLTS positions in turn. A meter-reading within the green band should be obtained in each case; if not, carry out the adjustments given in para. 22.

(11) Depress the RESET pushbutton on the MA.1720S and check that the RESET lamp is extinguished.

(12) Set the METER switch to RF and check that the meter indicates the r.f. output level (-6 dB approximately).

(13) Set the MODE switch to each remaining position in turn and check that appropriate c.w. output levels are obtained.

17. (1) Carry out the line level checks given in Chap.13-1, para. 14 to 17.

(2) Disable the test tone inputs.

(3) Re-set the TUNE/MUTE/OPERATE switch to TUNE.

<u>Remedial action</u>

18. (1) If the synthesizer failed to 'lock' at operation 16(8), try several changes in test frequency. If the 'in-lock' condition cannot be obtained, replace the frequency standard in the MA.1720S (para. 77).

Note...

The frequency standard is the only user-replaceable sub-assembly in the drive unit.

(2) If the synthesizer still fails to 'lock', re-fit the original frequency standard and then replace the entire MA.1720S. Having installed the new unit, repeat operations 16(7) to (13). After the installation of a new frequency standard, the adjustments of para. 10 must be carried out before resuming transmission.

19. If no r.f. output is indicated on the meter and the RESET lamp continues to glow, depress the RESET pushbutton for five seconds. If the r.f. output appears for about two seconds and then falls again, a fault condition external to the drive unit may be inhibiting the output. Withdraw the MA.1720S, disengage the multiway connector from socket SK6 and repeat operation 16(10). If the 'no-output' condition persists, replace the MA.1720S.

20. If operation 19 resulted in the desired r.f. output, re-connect SK6. Lower the hinged front panel of the MA.1004 and disengage the multiway connector from 5PL2 (rear of hinged panel). If the fault symptom re-appears, change the overload unit MS.443; if not, the fault lies in the MA.1004 (para. 34).

21. If the desired output levels are not obtained for either operation 16(12), 16(13) or 19(1), replace the entire MA.1720S.

22. If the desired meter readings are not obtained at operation 16(10):-

(1) Withdraw the MA.1720S.

(2) Remove the bottom cover plate from the power supply board PM.343 (located centre left of chassis, four screws).

(3) Measure the supply rails at tags 1 to 4 of the adjacent terminal strip TB2.

(4) Make appropriate adjustments to the preset controls on the PM.343 to give the following voltages:-

(a) -7V at tag 1: adjust R12.

(b) +5V at tag 2: adjust R9.

(c) +12V at tag 3: adjust R33.

(d) +20V at tag 4: adjust R22.

Note...

If no output is obtained at tag 2, check fuselink FS2.

(5) Remove the multimeter connections and re-fit the bottom cover.

(6) Re-fit the MA.1720S.

If the supply voltages are still incorrect, replace the entire MA.1720S.

23. If the SUPPLY lamp on one particular MM.420 failed to glow at operation 16(9):-

(1) Re-set its SUPPLY switch to OFF and then remove the suspect r.f. module.

(2) Check that +42V is present at pin 2 of the MM.420 supply socket.

(3) Check that +36V is present at pins 12 and 16.

(4) If the supply inputs are correct, fit the replacement r.f. module.

CAUTION...

The conditions of para. 23 indicate an overload of the MS.440 stabilizer. Do not attempt to re-fit the suspect module to the TTA.1860S until the cause of the overload has been eliminated. The actions of withdrawal and re-fitting of the MM.420 reset the overload-trip circuits and the resultant current surges will cause further damage to the faulty unit.

TRANSMITTER POWER SUPPLIES

24. (1) At the meter panel, measure the supply voltages generated within MM.420 No.1, i.e. set the MODULE switches to 1 and 20V and then to 1 and 30V.

(2) Repeat operation (1) using appropriate switch settings for each remaining MM.420.

Notes...

1. The presence of +20V and +30V outputs from each MM.420 is a good indication that all four MS.64 power supply units are functioning correctly.
2. The failure of any one of the +36V supply rails will result in a REDUCED POWER indication at the MA.1720S.

(3) If the correct meter readings are not obtained for one particular MM.420, transfer the suspect module to a known 'good' position. If the fault symptom now appears at this position, replace the MM.420.

(4) If a pair of modules, e.g. No.1 and No.5 exhibit identical symptoms, the associated MS.64 power supply may be faulty. Check the modules as in operation (1) and, if serviceable, re-fit them to their correct positions. Referring to Chap.13-0, fig. 6c measure the outputs from the suspect MS.64 and replace as necessary.

(5) Re-fit any modules removed during tests.

25. Measure the +30V supplies to the MS.444 splitter unit and the MS.564 muting unit:-

(1) Remove the power supply front panel.

(2) Remove the two screws securing the hinged panel to the cabinet.

(3) Ease the panel outwards about 2 inches and then disconnect the r.f. cables from the left-hand MS.442 distribution unit. The panel can now swing clear.

(4) Disengage the multiway connector from the MS.444.

(5) Check that +30V is present at both pin 1 and pin 3 of 1SK3.

(6) Re-fit the connector to the MS.444.

(7) Disengage the multiway connector from the MS.564.

(8) Check that +30V is present at pin 1 of 1SK39.

(9) Check that a 0V 'mute' signal is not present at pin 3 of 1SK39.

(10) Re-fit the connector to the MS.564.

(11) Re-connect the r.f. cables and close the hinged panel.

Note...

The +30V outputs from four MM.420 modules are combined in each MS.442. Provided at least one MM.420 is active, the MS.444 and hence the MS.564 receives the required +30V supply input.

TRANSMITTER DRIVE

26. Set the RF POWER switch on the meter panel to INPUT 2, 250 mW. A signal level of about 100 mW should be indicated. If zero or reduced signal level is obtained, a fault exists in either the MA.1004, the MS.564 or the MS.444.

(1) Lower the hinged front panel of the MA.1004. Disconnect the low-power r.f. cables from 5PL1 and 5SK1 and connect them together. If the correct signal level is now obtained, switch OFF and replace the constant voltage amplifier MS.452 (para. 81); if not, re-connect the r.f. cables to 5PL1 and 5SK1. Close the front panel of the MA.1004.

(2) Open the hinged panel (para. 88). Disconnect the r.f. cables from the MS.564 and interconnect them via a BNC adaptor. If the r.f. input signal is now present, the MS.564 is faulty; if not, the fault lies in the MS.444. Replace as necessary.

LINEAR AMPLIFIER OUTPUTS

27. The linear amplifier should now be delivering about 1 kW to the dummy load; measure the actual value. Check that the r.f. monitor lamp on each MM.420 is glowing and that they all glow with approximately equal brilliance.

28. (1) Set the MODULE switches on the meter panel to measure the CURRENT drawn by each MM.420. The actual values should be as logged for the TUNE condition.

(2) If the current drawn by one particular MM.420 e.g. No.1 is less than the expected value, transfer the suspect module to a know 'good' position. If the fault symptom now appears at this position, replace the MM.420.

(3) If operation (2) has no effect upon the current reading, re-fit MM.420 No.1 to its correct position. Release the hinged panel and temporarily transpose the r.f. cables to 8SK1 and 8SK2 on the left hand distribution amplifier. If the fault symptom now appears at MM.420 No.2, one of the MM.442 outputs is faulty; replace the MM.442. Re-fit the r.f. cables to their correct positions.

Combining unit

29. If all the current readings are correct but zero or reduced output is obtained, the fault is probably in the combining unit MS.441, and may be located as follows:-

(1) Set the SUPPLY switches on all eight MM.420 modules to OFF.

(2) Transfer the wattmeter connections from 6SK12 to 6SK10.

(3) Switch ON modules No.1 and No.5 only and measure the resultant r.f. power output.

(4) Repeat operation (3) using modules No.2 and No.6 only.

(5) Measure the output from modules No.1, No.2, No.5 and No.6 together.

(6) Repeat operation (1) and then transfer the wattmeter connections to 6SK9.

(7) Repeat operations (3) and (4) using module pairs No.3, No.7 and No.4, No.8.

(8) Repeat operation (5) for the right-hand bank of modules.

(9) The power level at operations (3), (4) and (7) should be 125W approx. in each case. If not, the combiner circuit associated with the reduced power reading is faulty.

(10) The power levels at operations (5) and (8) should each be 500W approx. If not, the combiner circuit feeding the relevant output (6SK9 or 6SK10) is faulty.

(11) If the outputs via 6SK9 and 6SK10 are of correct level but that via 6SK12 is not, the final combiner stage is faulty.

If the specified power levels are not obtained, replace the combining unit (para. 94).

OUTPUT TO ANTENNA

30. At this stage the correct r.f. output is available from the linear amplifier. The fault must therefore lie between 6SK12 and the antenna connection.

(1) Set the STANDBY pushbutton on the MA.1720S to OFF.

(2) Connect the wattmeter and dummy load to 10SK1 (ANTENNA).

(3) Check that the following r.f. connections have been made. Adjust as necessary:-

(a) 6PL2 to 6SK9.

(b) 6PL3 to 6SK10.

(c) 1PL17 to 6SK12.

(d) 1PL18 to the line switching unit.

(4) Check that all eight r.f. power modules and the MA.1004 are switched ON.

(5) Re-set the STANDBY pushbutton to ON.

(6) Depress the RESET pushbutton to initiate the automatic tuning sequence. On completion, the power output to the dummy load should be 1 kW approximately.

(7) At the meter panel, measure the actual FORWARD 2 and REFLECTED 2 power levels.

31. If no r.f. output is obtained, a fault exists in either the MA.1004 or the line-switching circuits. By-pass the MA.1004 (Chap.13-2, para. 17). If the r.f. output to the dummy load is now satisfactory, the fault is in the MA.1004 (para. 33); if not, a discontinuity exists either between 1PL17 and 1PL24 (line-switching relays) or between 1PL26 and 10SK1.

32. Having established a continuous signal path to the dummy load, measure the FORWARD power level at the meter panel. If the indicated power is not in agreement with the r.f. wattmeter reading, the v.s.w.r. unit MS.447 may be faulty. Lower the meter panel and check that about 2V is present at pin 1 of the v.s.w.r. warning board PS.446. If it is, re-calibration is required as given in Chap.13-4; if zero or reduced voltage is obtained at pin 1, replace the MS.447 (para. 95).

Note...

A failure of the 'forward power' signal to the MS.139 will inhibit the automatic line-selection sequence.

FEEDER MATCHING UNIT

33. At various stages in the previous tests, a fault-symptom within the MA.1004 was apparent. The following tests localize the fault to one of the direct-exchange sub-assemblies.

Fault signal

34. (1) Re-fit the MA.1004 to the cabinet.

(2) Depress the SUPPLY pushbutton and check that the SUPPLY lamp glows.

(3) Check that the SERVO LIMIT lamp is extinguished.

(4) Lower the hinged front panel and check that:-

(a) All three circuit breakers are ON.

(b) A +30V supply is present at 2TP1.

(c) A -30V supply is present at 2TP2.

(d) The TUNE and LOAD turns counters are not at the limits of their working range.

(5) Set the TUNE/READY switch to TUNE.

35. If the desired results are obtained at operation 34(4), repeat the procedures given in para. 19 and 20. If the 'fault' signal is generated, replace the MS.454 constant voltage amplifier. If the fault condition persists, re-fit the original MS.454 and then replace the entire MA.1004.

CAUTION...

Considerable torque is generated by the servo motors and hence the TUNE and LOAD controls must not be touched during an 'automatic' tuning sequence. Under certain fault conditions, one or both motors may become active during 'manual' tuning; if this condition is suspected, release the control immediately.

Servo limit

36. If the SERVO LIMIT lamp is glowing, set the TUNE/READY switch on the MA.1004 to TUNE. Ascertain whether manual adjustment of the LOAD and LOAD controls is possible; if it is, set each inductor to give a turns-counter reading between 120 and 180. If the SERVO LIMIT lamp remains ON, replace the MS.454.

37. If on attempting to adjust either inductor it self-runs back to the end stop, the associated servo power amplifier is probably faulty; replace the MS.265. If the fault condition persists, re-fit the original MS.265 and then replace the entire MA.1004.

Note...

The supply for the 'tune' MS.265 is obtained via the 'load' MS.265 and hence removal of the 'load' amplifier will inhibit the operation of the 'tune' servo system.

## Manual tuning

38. Carry out the manual tuning procedures given in Chap.13-2, para. 15.

39. If the desired power output is not obtained, first replace the PS.60 range board (para. 84); if still incorrect, replace the PS.59 tune board also. If the results are now satisfactory, re-fit the original PS.60 and hence localize the fault to either the PS.59 or the PS.60. If replacement of both boards does not rectify the fault, refit the original boards and replace the entire MA.1004.

## Automatic tuning

40. On satisfactory completion of the manual tuning procedure, automatic tuning may be attempted. Select a different test frequency from that used in para. 38, e.g. change the drive unit settings from 8 MHz to 20 MHz.

41. Carry out the automatic tuning procedures given in Chap. 13-2, para. 12, checking that the following sequence takes place:-

(1) Coarse-tune.

(2) First fine-tune.

(3) Line selection.

(4) Second fine-tune.

42. At operation 41(1), check that the TUNE and LOAD inductors are driven to approximately the settings given in Chap.13-2, fig.4. If not, depress the RESET pushbutton the MA.1720S for about five seconds; check that the TUNE lamp on the MA.1004 glows. If still incorrect, depress the TUNE pushbutton on the MA.1004; if coarse-tuning now takes place, a fault exists in the 'coarse-tune-initiate' signal from the drive unit.

43. If neither inductor 'coarse-tunes', first replace the MS.454 constant voltage amplifier; if still incorrect, replace the PS.59 tune board also. If results are now satisfactory, re-fit the original MS.454 and hence localize the fault to either the MS.454 or the PS.59. If replacement of both items does not rectify the fault, re-fit the original items and then replace the entire MA.1004.

44. If one inductor fails to coarse-tune, the fault lies in the relevant servo amplifier stages. A faulty MS.265 could have damaged the associated PS.108 servo pre-amplifier board; it is therefore necessary to replace the MS.265 first. If the inductor still fails to coarse-tune, replace the PS.108 also. If replacement of both items does not rectify the fault, re-fit the original items and replace the entire MA.1004.

45. The MA.1004 should now carry out the coarse-tune and then the fine-tune actions.

46. If the fine-tune action does not take place, remove the cover from the MS.454 and check that the 'coarse-tune-initiate' signal (+12V) is not present at pin 3 of the printed-wiring board. If +12V is present at pin 3, the fault is probably external to the MA.1004; check the signal level from pin 11 of SK6 on the MA.1720S.

47. If operation 46 is correct but fine-tune action is not obtained, the servo systems may require mechanical re-alignment. Replace the entire MA.1004.

## FAULT LOCATION, DUAL-DRIVE SYSTEM

48. These paragraphs give, with the aid of the interconnecting (functional) diagrams (Chap.13-0), a guide to the location of a fault to user - replaceable unit level. A thorough understanding of Chap.13-0 is an essential aid to fault-finding and reference should be made to the relevant paragraphs for details of the 'command' and supervisory signals.

49. Where the fault location procedures for the dual-drive system are similar to those given for single-drive, cross-reference is made within this chapter.

50. The faults are grouped under the following main headings:-

(1) Failure of the drive unit.

(2) Loss of drive to the linear amplifiers.

(3) Zero or reduced output from the linear amplifiers.

(4) Failure of the feeder matching equipment.

(5) Power supply failure.

51. Where a complete set of serviceable spares is available, the substitution method must be used.

52. Unless stated otherwise, the TTA.1860S and the MA.1721S are connected in the 'dual-drive to separate antennas' configuration.

53. The procedures, which assume an initial 'no-output' condition, are given for path 2 only; the differences for path 1 will be mainly self-evident. Where the connections are changed for path 1, the relevant plug or socket reference is given in brackets.

### DRIVE UNIT NO.2

54. (1) Set the ON/OFF/REMOTE switch to OFF. Check that the STANDBY push-buttons on MA.1720S No.1 and No.2 are both set to OFF (released).

(2) Lower the meter panel and connect the dummy load and directional wattmeter (tems A5, A6 and A10 of Table 1) to 6SK9 (6SK10 for path 1) on the combining unit MS.441. Set the power indicator for 1 kW forward power.

(3) Check that all three circuit breakers on MA.1004 No.2 are set to ON. Set the SUPPLY pushbutton on the MA.1004 to ON.

(4) Set the SUPPLY switch on each MM.420 to ON.

(5) Set both circuit breakers on the power supply panel to ON.

(6) Set the ON/OFF/REMOTE switch to REMOTE.

(7) Set the controls on MA.1720S No.2 as follows:-

(a) SUPPLY pushbutton to ON.

(b) STANDBY pushbutton to ON.

(c) TUNE/MUTE/OPERATE switch to OPERATE HIGH.

(d) Control switch to LOCAL SYNTH.

(e) Frequency selector switches (thumbwheels) to the desired test frequency.

(f) MODE switch to AM-6.

(g) VOX/PTT/TX switch to TX.

(8) Check that the SUPPLY, STANDBY, RESET and IN LOCK lamps on the MA.1720S glow.

(9) Check that:-

(a) Main contactor CON A closes and all three airblowers operate (audible checks).

(b) The SUPPLY lamp on each MM.420 glows; if not, refer to para.23.

(c) The SUPPLY lamp on MA.1004 No.2 glows.

(d) The SERVO LIMIT lamp on the MA.1004 is extinguished; if this lamp glows, refer to para.33.

(10) Set the METER switch on the MA.1720S to the -7, +5, +12 and +20 VOLTS positions in turn. A meter-reading within the green band should be obtained in each case; if not, carry out the adjustments given in para. 22.

(11) Depress the RESET pushbutton on the MA.1720S and check that the RESET lamp is extinguished.

(12) Set the METER switch to RF and check that the meter indicates the r.f. output level (-6 dB approximately).

(13) Set the MODE switch to each remaining position in turn and check that appropriate c.w. output levels are obtained.

55. (1) Carry out the line level checks given in Chap. 13-1, para. 14 to 17.

(2) Disable the test tone inputs.

(3) Re-set the TUNE/MUTE/OPERATE switch to TUNE.

Remedial action

56. (1) If the synthesizer failed to 'lock' at operation 54(8), try several changes in test frequency. If the 'in-lock' condition cannot be obtained, replace the frequency standard in the MA.1720S (para. 77).

Note...

The frequency standard is the only user-replaceable sub-assembly in the drive unit.

(2) If the synthesizer still fails to 'lock', re-fit the original frequency standard and then replace the entire MA.1720S. Having installed the new unit, repeat operations 54 (7) to (13). After the installation of a new frequency standard, the adjustments of para. 10 must be carried out before resuming transmission.

57. If no r.f. output is indicated on the meter and the RESET lamp continues to glow, depress the RESET pushbutton for five seconds. If the r.f. output appears for about two seconds and then falls again, a fault condition external to the drive unit may be inhibiting the output. Withdraw the MA.1720S, disengage the multiway connector from socket SK6 and repeat operation 54 (10). If the 'no-output' condition persists, replace the entire MA.1720S.

58. If operation 57 resulted in the desired r.f. output, re-connect SK6. Lower the hinged front panel of MA.1004 No.2 and disengage the multiway connector from 5PL2 (rear of hinged panel). If the fault symptoms reappears, change the overload unit MS.443; if not, the fault lies in the MA.1004 (para. 33).

59. If the desired output levels are not obtained for either operations 54(12), 54(13) or 55, replace the entire MA.1720S.

TRANSMITTER POWER SUPPLIES

60. Carry out the procedures given in para. 24 and 25.

TRANSMITTER DRIVE

61. Set the RF POWER switch on the meter panel to INPUT 2, 250 mW (INPUT 1 for path 1). A signal level of about 100 mW should be indicated. If zero or reduced signal level is obtained, a fault exists in either the MA.1004, the MS.564 or the MS.444; refer to para. 26.

Note...

The signals for path 1 are fed via inter-cabinet r.f. cables.

LINEAR AMPLIFIER OUTPUTS

62. The linear amplifier should now be delivering about 500W to the dummy load; measure the actual value. Check that the r.f. monitor lamps on the right-hand bank of r.f. modules are glowing and that they all glow with approximately equal brilliance.

63. (1) Set the MODULE switches on the meter panel to measure the CURRENT drawn by each of the four modules. The actual values should be as logged for the TUNE condition.

(2) If the current drawn by one particular MM.420, e.g. No.3 (No.1, path 1) is less than the expected value, transfer the suspect module to a known 'good' position. If the fault symptom now appears at this position, replace the MM.420.

(3) If operation (2) has no effect upon the current reading, re-fit MM.420 No.3 to its correct position. Release the hinged panel and temporarily transpose the r.f. cables to 8SK1 and 8SK2 on the right-hand distribution amplifier. If the fault symptom now appears at MM.420 No.7 (No.2), one of the MM.442 outputs is faulty; replace the MM.442. Refit the r.f. cables to their correct positions.

Combining unit

64. If all the current readings are correct but zero or reduced r.f. output is obtained, the fault is probably in the combining unit MS.441, and may be located as follows:-

(1) Set the SUPPLY switches on all eight MM.420 modules to OFF.

(2) Switch ON modules No.3 and No.7 only and measure the resultant r.f. power output.

(3) Repeat operation (2) using modules No.4 and No.8 only.

(4) Measure the output from modules No.3, No.4, No.7 and No.8 together.

Note...

For path 1 use module pairs No.1, No.5 and No.2, No.6 of the left-hand bank of modules.

(5) The power levels at operations (2) and (3) should be 125W approx. in each case. If not, the combiner circuit associated with the reduced power reading is faulty.

(6) The power level at operation (4) should be 500W approx. If not, the combiner circuit feeding the relevant output (6SK9 or 6SK10) is faulty.

If the specified power levels are not obtained, replace the combining unit (para. 94).

OUTPUT TO ANTENNA, PATH 2

65. At this stage the correct r.f. output is available from the linear amplifier. The fault must therefore lie between 6SK9 and the ANTENNA connection on the TTA.1860S.

(1) Set the STANDBY pushbuttons on both MA.1720S No.1 and No.2 to OFF.

(2) Connect the wattmeter and dummy load to 10SK1 (ANTENNA).

(3) Connect 1PL17 to 6SK9 and 1PL18 to the line switching unit (No.2).

(4) Check that all eight r.f. power modules and MA.1004 No.2 are switched ON.

(5) Re-set the STANDBY pushbutton on MA.1720S No.2 to ON.

(6) Depress the RESET pushbutton to initiate the automatic tuning sequence. On completion, the power output to the dummy load should be 500W approximately.

(7) At the meter panel, measure the actual FORWARD 2 and REFLECTED 2 power levels.

66. If no r.f. output is obtained, a fault exists in either the MA.1004 or the line-switching circuits. By-pass the MA.1004 (Chap.13-2, para. 17). If the r.f. output to the dummy load is now satisfactory, the fault is in the MA.1004; refer to para. 33.

67. If the r.f. output is not obtained with the MA.1004 by-passed, a discontinuity exists either between 1PL17 and 1PL24 (line-switching relays) or between 1PL26 and 10SK1.

68. Having established a continuous signal path to the dummy load, measure the FORWARD 2 power level at the meter panel. If the indicated power is not in agreement with the r.f. wattmeter reading, v.s.w.r. unit MS.447 No.2 may be faulty. Lower the meter panel and check that about 2V is present at pin 1 of the right-hand v.s.w.r. warning board PS.446. If it is, re-calibration is required as given in Chap.13-4; if zero or reduced voltage is obtained at pin 1, replace the MS.447 (para. 95).

Note...

A failure of the 'forward power' signal to the MS.139 will inhibit the automatic line-selection sequence.

OUTPUT TO ANTENNA, PATH 1

69. With the correct r.f. output available from the linear amplifier, the fault must lie between 6SK10 on the combining unit and the ANTENNA connection on the MA.1721S.

(1) Set the STANDBY pushbuttons on both MA.1720S No.1 and No.2 to OFF.

(2) Connect the wattmeter and dummy load to 10SK1 (ANTENNA) on the MA.1721S.

(3) Check that the following r.f. connections have been made. Adjust as necessary:-

(a) 1PL36 to 6SK10.

(b) 1SK40 to SK2 on the MA.1721S.

(c) 1PL18 to line switching unit MS.139 No.1.

(4) Check that all eight r.f. power modules and MA.1004 No.1 are switched ON.

(5) Re-set the STANDBY pushbutton on MA.1720S No.1 to ON.

(6) Depress the RESET pushbutton to initiate the automatic tuning sequence. On completion, the power output to the dummy load should be 500W approximately.

(7) At the meter panel, measure the actual FORWARD 1 and REFLECTED 1 power levels.

70. If the required r.f. output is not obtained, by-pass MA.1004 No.1 (Chap.13-2, para. 17). If the r.f. output is now satisfactory, the fault is in the MA.1004; refer to para. 33.

71. If the r.f. output is not obtained with the MA.1004 by-passed, check for a discontinuity in the high-level signal path between 1PL36 on the TTA.1860S and 1PL18 on the MA.1721S and thence to the ANTENNA connection; the section between 1SK40 and SK2 is an inter-cabinet r.f. cable.

72. Having established a continuous signal path to the dummy load, measure the FORWARD 1 power level at the meter panel. If the indicated power is not in agreement with the r.f. wattmeter reading, v.s.w.r. unit MS.447 No.1 may be faulty. Lower the meter panel and check that about 2V is present at pin 1 of the left-hand v.s.w.r. warning board PS.446; if it is, re-calibration is required as given in Chap. 13-4. If zero or reduced voltage is obtained at

pin 1, check for continuity between MS.447 No.1 and the meter panel (this path includes inter-cabinet wiring); if correct, replace the MS.447 (para. 107).

## REMOVAL AND RE-FITTING OF UNITS

73. The following conditions are assumed:-

(1) The main a.c. supply to the TTA.1860S has been disconnected.

(2) The main a.c. supply to the MA.1721S has been disconnected.

(3) The ON/OFF/REMOTE switch is set to OFF.

(4) All high-voltage points have been made safe, e.g. capacitors discharged.

74. The re-fitting procedures are in general the reverse of those given for removal; minor differences will be self-evident.

### AMPLIFIER/STABILIZERS MM.420

75. (1) Set the SUPPLY switch on the relevant MM.420 to OFF.

(2) Release the dzus fasteners and withdraw the unit.

(3) When re-fitting the unit, ensure that it is correctly located in the guide rails, and then ease into place.

Note...

It is permissible to remove or re-fit the MM.420 whilst the transmitter is 'live'.

### DRIVE UNIT MA.1720S No.2

76. (1) Remove the four screws securing the MA.1720S to the cabinet.

(2) Partially withdraw the unit to gain access to the connectors at the rear of the unit.

(3) Release the slidelocks and disengage the multiway connectors.

(4) Disconnect the r.f. cables.

(5) Lift the MA.1720S clear.

### Frequency standard

77. (1) Remove the top cover from the MA.1720S (sixteen screws).

(2) Remove the four screws securing the frequency standard mounting plate.

(3) Withdraw the frequency standard sub-assembly from its socket.

(4) Noting its orientation, detach the mounting plate. Re-fit to the new unit.

### FEEDER MATCHING UNIT MA.1004 No.2

78. (1) Release the dzus fasteners and lower the hinged meter panel.

(2) Lower the hinged front panel of the MA.1004.

(3) Disconnect the high-power r.f. cables from the RF INPUT and RF OUTPUT sockets.

(4) Disconnect the low-power r.f. cables from 5PL1 and 5SK1 (rear of front panel).

(5) Release the slidelocks and disengage the multiway connectors.

(6) Dress the cables to the sides of the cabinet.

(7) Release the side arms and lower the front panel to its fullest extent. Remove the four screws securing the MA.1004 to the cabinet.

(8) Close the front panel and lift the MA.1004 clear (two persons are required).

(9) When re-fitting the unit, check that the cables do not obstruct the movement of the hinged panel or of the manual tuning controls when the panel is raised.

Servo power amplifiers MS.265

79. (1) Remove the MA.1004 from the cabinet (para. 78).

(2) Remove the bottom cover from the MA.1004 (eleven screws).

(3) Disengage the relevant multiway connector.

(4) Release the four green-painted captive screws.

(5) Lift the unit clear.

Power supply MS.448

80. (1) Remove the MA.1004 from the cabinet (para. 78).

(2) Remove the top cover from the MA.1004 (fourteen screws).

(3) Lower the hinged front panel.

(4) Disengage the multiway connector.

(5) Remove the four screws securing the MS.448 to the sub-front panel.

(6) Remove the two screws securing the rear of the unit.

(7) Disconnect the r.f. cable braid at the side of the MS.448.

(8) Slide the power supply rear-wards and then lift upwards, front first.

Constant voltage amplifier MS.452

81. (1) Lower the hinged front panel of the MA.1004.

(2) Disconnect the cables from 5PL1 and 5SK1.

(3) Release the slidelocks and disengage the multiway connectors.

(4) Remove the cover from the amplifier unit (four screws).

(5) Remove the four hexagon pillars.

(6) Lift the unit clear.

Servo pre-amplifier board PS.108

82. (1) Lower the hinged front panel of the MA.1004.

(2) Remove the five screws securing the right-hand front panel of the control unit.

(3) Gently withdraw the printed-wiring board from its socket.

Tune board PS.59

83. As for para. 82.

Range board PS.60

84. As for para. 82.

## 1 kW CABINET ASSEMBLY

Power supply units MS.64

85. Power supply units PSU1 to 4 are mounted in two banks of two; the instructions are given for the left-hand bank.

86. (1) Remove the power supply front panel (eight dzus fasteners).

(2) Remove the large Posidriv screw securing the left-hand angle bracket to the front edge of the cabinet.

(3) Withdraw the left-hand bank of power supplies to the full extent of the runners.

(4) Remove the mains shroud.

(5) Using a multimeter, check that a.c. supplies are not present at the transformers.

(6) Disconnect the mains supply cable.

(7) Separate the mains wiring to the two power supplies.

(8) Support the relevant power supply and then remove the three screws securing the bottom of the power supply to the mounting panel.

(9) Loosen but do not remove the three screws securing the top of the power supply.

(10) Lift the power supply from the mounting panel.

Note...

Two or more persons are required when removing a bank of two units from the cabinet.

87. In an emergency, it is permissible to remove a power supply MS.64 whilst transmission is in progress. Set the appropriate circuit breaker (CB1 or CB2) to OFF and then proceed with caution.

Distribution amplifiers MS.442

88. To remove the left-hand MS.442:-

(1) Remove the power supply front panel.

(2) Remove the two screws securing the hinged panel to the cabinet.

(3) Ease the panel outwards about 2 inches and then disconnect the r.f. cables from the left-hand MS.442. The panel can now swing clear.

(4) Disengage the multiway connector from the left-hand MS.442.

(5) Remove the four screws securing the mounting strips to the hinged panel.

(6) As required, detach the mounting strips from the unit (four screws) and re-fit to the new unit.

89. To remove the right-hand MS.442:-

(1) Carry out operations 88(1) to (3).

(2) Disconnect the r.f. cables from the right-hand unit.

(3) Carry out operations 88 (4) to (6) for the right-hand unit.

Muting unit MS.564 No.2

90. (1) Remove the left-hand distribution amplifier (para. 88).

(2) Disconnect the r.f. cables and disengage the multiway connector from the MS.564.

(3) Remove the four screws (front of hinged panel) securing the MS.564 and lift clear.

Splitter unit MS.444 No.2

91. (1) Carry out operations 88 (1) to (3).

(2) Disconnect the r.f. cables from the MS.444.

(3) Carry out operations 88 (4) to (6) for the MS.444.

Overload unit MS.443

92. (1) Carry out operations 88 (1) to (3).

(2) Disengage the multiway connector on the MS.443.

(3) Remove the cover from the MS.443 (four screws).

(4) Remove the four nuts and bolts securing the MS.443 to the hinged panel and lift clear.

Meter panel assembly

93. (1) Release the dzus fasteners and lower the meter panel.

(2) Release the slidelock and disengage the multiway connector.

(3) Release the left-hand stay from the slotted member.

(4) Supporting the meter panel assembly, remove the four hinge-retaining screws (a short screwdriver is required) and lift clear.

Combining unit MS.441

94. (1) Remove the MA.1004 (para. 78).

(2) Lower the meter panel.

(3) Disconnect the r.f. connections at the front of the MS.441.

(4) Release the four green-painted captive screws (two either side) securing the MS.441 to the mounting plate.

(5) Remove the two screws securing the rear of the MS.441 to the bearer bar.

(6) Disconnect the four r.f. cables at the left-hand side of the MS.441, noting their positions. Disengage the multiway connector.

(7) Disconnect the four r.f. cables at the right-hand side of the MS.441.

(8) Lift the unit upwards and then forwards until clear of the cabinet.

VSWR unit MS.447 No.2

95. (1) Remove the MA.1720S from the cabinet (para. 76).

(2) Disconnect the r.f. cable from the MS.447.

(3) Unsolder the twin screened cable and the single screened cable.

(4) Remove the cover from the MS.447 (four screws).

(5) Remove the four nuts securing the unit and lift clear.

Blower units BL1 and BL2

96. The instructions are given for the left-hand blower unit.

97. (1) Remove all eight amplifier stabilizers (para. 75).

(2) Remove the top left-hand power supply unit MS.64 (para. 86).

(3) Release the hinged panel bearing the distribution amplifiers etc. and swing the panel clear (para. 88).

(4) Remove the mains shroud and disconnect the main supply leads for both blowers.

(5) Remove the mains connector block for the left-hand blower unit.

(6) Provide a suitable support for the blower assembly.

(7) Remove the screws securing the assembly to the mounting frame (access is provided via apertures at the left-hand edge of the unit).

(8) Lower the assembly clear of the duct and then lift clear.

(9) Disconnect the capacitor and then release from its mounting.

(10) Remove the blower from its mounting frame (seven screws).

Extractor fan BL3

98. (1) Remove the MA.1720S from the cabinet (para. 76).

(2) Disconnect the mains supply leads to the fan.

(3) Remove the four Posidriv screws securing the fan assembly and lift clear.

LINE SWITCHING UNIT MS.139 No.2

99. (1) Remove the MA.1004 from the cabinet (para. 78).

(2) Disengage the multiway connector from the MS.139.

(3) Remove the cover from the unit (four screws).

(4) Remove the four unit-retaining screws and lift clear.

DRIVE UNIT ASSEMBLY MA.1721S

100. The unit-removal instructions for the MA.1721S are as given for the TTA.1860S; the minor differences are due to the physical locations of the sub-assemblies.

Drive unit MA.1720S No.1

101. Carry out the procedures given in para. 73 for MA.1720S No.1.

102. Refer to para. 74 for the removal of the frequency standard.

Feeder matching unit MA.1004 No.1

103. Carry out the procedures given in para. 78 for MA.1004 No.1.

104. Refer to para. 79 to 84 for the removal of sub-assemblies.

Line switching unit MS.139 No.1

105. (1) Remove the MA.1004 from the cabinet (para. 78).

(2) Disengage the multiway connector from the MS.139.

(3) Remove the cover from the unit (four screws).

(4) Remove the four unit-retaining screws and lift clear.

Extractor fan BL1

106. (1) Remove the MA.1720S from the cabinet (para. 76).

(2) Disconnect the mains supply leads to the fan.

(3) Remove the four Posidriv screws securing the fan assembly and lift clear.

VSWR unit MS.447 No.1

107. (1) Remove the MA.1720S from the cabinet (para. 76).

(2) Disconnect the r.f. cable from the MS.447.

(3) Unsolder the twin screened cable and the single screened cable.

(4) Remove the cover from the MS.447 (four screws).

(5) Remove the four nuts securing the unit and lift clear.

Muting unit MS.564 No.1

108. (1) Remove the MA.1004 from the cabinet (para. 78).

(2) Disconnect the r.f. cables and disengage the multiway connector from the MS.564.

(3) Remove the four screws securing the MS.564 and lift clear.

Splitter unit MS.444 No.1

109. (1) Remove the MA.1004 from the cabinet (para. 78).

(2) Disconnect the r.f. cables and disengage the multiway connector from the MS.444.

(3) Remove the four screws securing the mounting strips of the MS.444 and lift clear.

(4) As required, detach the mounting strips from the unit (four screws) and re-fit to the new unit.

Combiner unit MS.560

110. (1) Disconnect the high-power r.f. cables from the MS.560, noting their positions.

(2) Remove the two screws securing the unit and lift clear.

Dummy load

111. (1) Disconnect the r.f. cable from the relevant dummy load.

(2) Remove the four screws securing the dummy load and lift clear.

# Chapter 13-4

## SINGLE AND DUAL-DRIVE SYSTEM (TTA.1860S AND MA.1721S)

## OVERALL PERFORMANCE CHECKS AND ADJUSTMENTS

CONTENTS



ILLUSTRATIONS



### INTRODUCTION

1. The performance checks, which are given separately for each system, are carried out in the order given to prove the serviceability of the TTA.1860S and the MA.1721S.

2. Instructions are also given for the electrical adjustments required following an unsatisfactory performance check.

3. The procedures assume that the setting-up instructions (Chap. 13-1) have been carried out and that the required audio line inputs are present.

## FUNCTIONAL CHECKS, SINGLE-DRIVE SYSTEM

### FEEDER MATCHING SEQUENCE

4. (1) Connect the dummy load to 10SK1 (ANTENNA) on the TTA.1860S.

(2) Disable the AUDIO 1 and AUDIO 2 inputs.

(3) Check that the front panel controls on the TTA.1860S are set as follows:-

(a) SUPPLY pushbutton on the MA.1720S (No.2) to ON, i.e. with lamp glowing.

(b) STANDBY pushbutton to OFF.

(c) TUNE/MUTE/OPERATE switch to OPERATE HIGH.

(d) CONTROL switch to LOCAL SYNTH.

(e) SUPPLY pushbutton on the MA.1004 (No.2) to ON.

(f) SUPPLY switch on each MM.420 to ON.

(g) Both circuit breakers on the power supply panel to ON.

(h) ON/OFF/REMOTE switch to REMOTE.

(4) Depress the STANDBY pushbutton on the MA.1720S and check that:-

(a) The STANDBY, RESET and IN LOCK lamps glow.

(b) Main contactor CON A closes and all three airblowers operate (audible checks).

(c) The SUPPLY lamp on the MA.1004 (No.2) glows.

(d) The SUPPLY lamp on each MM.420 glows.

(5) On the MA.1720S, set the following controls:-

(a) MODE switch to CW.

(b) VOX/PTT/TX switch to TX.

(c) METER switch to RF.

(6) Set the frequency selector switches (thumbwheels) to 2.000 MHz.

(7) Depress the RESET pushbutton on the MA.1720S and check that the following sequence occurs:-

(a) The RESET lamp is extinguished and the 'tune' r.f. output is obtained from the drive unit.

(b) The MA.1004 carries out the feeder matching sequence (audible check and TUNE lamp glows).

(c) The TUNE lamp on the MA.1004 is extinguished and then the line-selection procedure takes place. The ON lamp on each MM.420 should glow and a flicker may be observed coincident with the operation of the line selection relays.

(d) The READY lamp on the MA.1720S glows and the 'tune' signal is removed.

Note...

At this stage, the r.f. power output falls to zero.

(8) Repeat operations (6) and (7) for each of the following test frequencies in turn:-

4 MHz, 6 MHz, 8 MHz, 10 MHz, 12 MHz, 14 MHz, 18 MHz, 20 MHz, 24 MHz, 26 MHz, 28 MHz and 29.9 MHz.

SERVO LIMIT

5. Simulate a 'servo limit' fault condition as follows:-

(1) Set the thumbwheel switches on the MA.1720S to 1.000 MHz, i.e. to a frequency which is not within the working range of the MA.1004.

(2) Depress the RESET pushbutton to initiate the feeder matching sequence.

(3) Check that after a short delay:-

(a) The SERVO LIMIT lamp on the MA.1004 glows.

(b) The RESET lamp on the MA.1720S glows.

(4) Reset the thumbwheel switches to 2.000 MHz.

(5) Depress the RESET pushbutton and check that operation 4(7) is now repeated.

POWER OUTPUT

6. (1) Set the MA.1720S to the 'c.w. key-down' condition. Link contacts 11 and 13 of the plug provided and insert it into jack JK1 on the MA.1720S; alternatively, interconnect terminals 7 and 8 of 1TB16.

(2) Set the RF POWER switch on the meter panel to FORWARD 2, 1250W. Measure the c.w. power output to the dummy load; at least 800W should be obtained.

(3) Reset the MA.1720S to 'key-up' conditions.

Note...

If the required output is not obtained and it appears that all the r.f. modules are functioning correctly, refer to para. 11.

(4) Set the MA.1720S to 4.000 MHz and depress the RESET pushbutton. When the feeder matching sequence is completed, repeat operations (1) to (3).

(5) Repeat operation (4) for each of the remaining test frequencies listed in para. 4 (8).

REDUCED-POWER INDICATOR

7. (1) Set the SUPPLY switch on MM.420 No.1 to OFF.

(2) Check that the REDUCED POWER lamp on the MA.1720S glows.

(3) Switch the r.f. module ON again.

(4) Depress the RESET pushbutton on the MA.1720S and check that the REDUCED POWER lamp is extinguished.

(5) Repeat operations (1) to (4) for each remaining r.f. module in turn.

## PERFORMANCE CHECKS AND ADJUSTMENTS

8. The following tests can only be carried out by maintenance units having the appropriate test equipment. A list of approved test equipment is given in Table 1 of Chap. 13-3.

### CALIBRATION OF R.F. POWER METER

9. (1) Set the STANDBY pushbutton on the MA.1720S to OFF (released).

(2) Disconnect the r.f. cable from the dummy load and insert the directional wattmeter (items A5 and A6 of Table 1) at this point.

(3) Set the power indicator on the wattmeter for 1 kW forward power.

(4) Depress the STANDBY pushbutton on the MA.1720S.

(5) Set the MODE switch to CW.

(6) Set the MA.1720S to 10.000 MHz and depress the RESET pushbutton.

(7) When the feeder matching sequence is completed, select the c.w. key-down condition (para. 6).

(8) Measure the forward power output using the wattmeter. Note the actual level as a reference value.

(9) Check that the FORWARD 2 power reading on the meter panel is in agreement with that of the wattmeter. If not, lower the meter panel and make the required slight adjustment to preset control 11AR1 on the right-hand board PS.446 (rear of panel). Close the meter panel.

10. (1) Switch OFF r.f. modules No.1, No.2, No.3 ...... in turn until the r.f. power output falls below 250W. Note the actual value.

(2) Lower the meter panel.

(3) Set the NORMAL/CALIBRATE switch to CALIBRATE.

(4) Set the RF POWER switch to REFLECTED 2, 250W.

(5) Adjust preset control 11AR2 (right-hand board) until the value noted at step (1) is indicated on the lower (250W) scale of meter ME2.

(6) Reset the NORMAL/CALIBRATE switch to NORMAL and close the meter panel.

(7) Switch all the r.f. modules ON again.

(8) Depress the RESET pushbutton on the MA.1720S and check that the REDUCED POWER lamp is extinguished.

### DISCRIMINATOR ALIGNMENT

11. Re-alignment of the discriminator circuits within the MA.1004 may be required following an unsatisfactory performance check at para. 6.

CAUTION...

These procedures require the use of both 'automatic' and manual adjustment of the MA.1004. Considerable torque is developed by the servo motors. No attempt must be made to manually adjust either the TUNE or the LOAD control whilst 'automatic' conditions prevail.

12. (1) Set the STANDBY pushbutton on the MA.1720S to OFF.

(2) Disconnect the directional wattmeter from the dummy load. Reconnect the dummy load 'direct'.

(3) Lower the hinged front panel of the MA.1004.

(4) Disconnect the high-power r.f. cable from the RF INPUT socket (4SK1) and insert the wattmeter at this point using the minimum length of r.f. cable.

(5) Set the power indicator on the wattmeter for 1 kW forward power.

(6) Depress the STANDBY pushbutton.

(7) Set the MODE switch to CW.

(8) Set the MA.1720S to 10.000 MHz and depress the RESET pushbutton.

(9) When the 'automatic' feeder matching sequence is completed, select the 'c.w. key-down' condition (para. 6).

(10) Check that at least 800W forward power is indicated on the wattmeter.

(11) Set the MA.1720S to the 'key-up' condition. Set the power indicator for reflected power. Re-apply the 'c.w. key-down' condition.

(12) Check that less than 50W reflected power is indicated on the wattmeter.

13. If the above conditions are not obtained:-

(1) Set the TUNE/READY switch on the MA.1004 to TUNE.

(2) Remove the front cover from the discriminator unit (four screws).

(3) Set preset control 4AR16 fully counter-clockwise.

(4) Make small manual adjustments to the TUNE and LOAD controls to give a minimum indication on the wattmeter.

(5) Set the DISCRIMINATOR BALANCE switch to TUNE and check that a centre-zero meter reading is obtained; if not, make a slight adjustment to preset control 4AR4.

(6) Set the DISCRIMINATOR BALANCE switch to LOAD and check that a centre-zero meter reading is obtained; if not, make a slight adjustment to preset control 4AR10.

(7) Set the STANDBY pushbutton to OFF.

(8) Disconnect the wattmeter from 4SK1. Reconnect the high-power r.f. cable 'direct'.

(9) Depress the STANDBY pushbutton and, after five seconds, the RESET pushbutton.

(10) Check that at least 800W forward power output is obtained; if not, make a slight adjustment to the TUNE control to maximize the power output.

(11) Check that a centre-zero meter reading is obtained; if not, adjust preset control 4AR16 for a centre-zero reading.

(12) Reset the TUNE/READY switch to READY.

(13) Re-fit the front cover to the discriminator unit.

INTERMODULATION PRODUCTS

14. (1) Set the TUNE/MUTE/OPERATE switch to MUTE.

(2) Lower the hinged front panel of the MA.1004.

(3) Connect the 'test' input of the spectrum analyser (item A4 of Table 1) to the OUTPUT MONITOR socket 1SK2 on the MA.1004.

(4) Connect the balanced 600 ohm output of the audio signal generator (item A3) to the AUDIO 1 input of the TTA.1860S.

(5) Set the audio generator for two-tone operation at frequencies of 1100 Hz and 1775 Hz. Set the level of each tone to 0 dBm.

(6) On the MA.1720S set the controls as follows:-

(a) TUNE/MUTE/OPERATE switch to OPERATE HIGH.

(b) MODE switch to SSB SUPP.

(c) 'Sideband' switch to UPPER.

(d) VOX/PTT/TX switch to TX.

(7) Set the MA.1720S to 10.000 MHz.

(8) Depress the RESET pushbutton to initiate the feeder matching sequence.

(9) Set the spectrum analyser for operation at the test frequency and adjust to display the wanted tone outputs at the 0 dB reference level.

Note...

The TTA.1860S will now provide about 1 kW p.e.p. output but the r.f. wattmeter will indicate 500W only.

(10) Measure the level of any intermodulation products. These signals, which appear equally-spaced from the wanted tones, should be not less negative than -35 dB relative to the 0 dB reference level.

(11) Set the 'sideband' switch to LOWER and repeat operation (10).

(12) Re-set the 'sideband' switch to UPPER.

(13) Repeat operations (7) to (12) for the following test frequencies:- 4 MHz, 6 MHz and 8 MHz. In each case, check that the intermodulation products are within the limits stated at operation (10).

(14) Repeat operations (7) to (12) for the following test frequencies, noting that a limit of -25 dB applies at operation (10):-

12 MHz, 14 MHz, 16 MHz, 18 MHz, 20 MHz, 24 MHz, 26 MHz, 28 MHz and 29.9 MHz.

CARRIER LEVELS

15. (1) Set the MA.1720S to 29.999 MHz.

(2) Set the MODE switch to CW and set for the 'c.w. key-down' condition (para. 6).

(3) Set the METER switch to RF.

(4) Set the TUNE/MUTE/OPERATE switch to OPERATE HIGH and check that an r.f. output level of 0 dB ± 2 dB is obtained. Note the actual value as a reference level.

(5) Set the TUNE/MUTE/OPERATE switch to TUNE. Check that the r.f. level is now within ± 0.5 dB of that noted at operation (5).

16. If the required levels are not obtained:-

(1) Withdraw the MA.1720S and remove the top cover.

(2) Adjust preset control R204 on the low-level board PM.341 until the meter reading reaches a maximum value.

(3) Re-set the TUNE/MUTE/OPERATE switch to OPERATE HIGH.

(4) Adjust preset control R70 on the mixer output board PM.342 to give a 0 dB reading on the MA.1720S meter.

17. (1) Set the MA.1720S to 10.000 MHz.

(2) Set the a.f. generator for single-tone operation at a frequency of 1000 Hz. Set the signal input level to 0 dBm.

(3) Set the MODE switch on the MA.1720S to SSB SUPP.

(4) Set the 'sideband' switch to UPPER.

(5) Adjust the spectrum analyser to display the single-tone output at the 0 dB reference level; this is the reference level for the following tests.

(6) Locate the suppressed carrier signal (if any) spaced 1 kHz from the 'wanted' tone. Check that the level of any signal found is not less negative than -40 dB relative to the 0 dB level.

(7) Set the 'sideband' switch to LOWER and check that the conditions of operation (6) are again satisfied.

(8) Set the MODE switch to SSB-26.

(9) Set the 'sideband' switch to UPPER and LOWER in turn and check that the carrier level is -26 dB ± 1 dB in each case.

(10) Set the MODE switch to SSB-16.

(11) Set the 'sideband' switch to UPPER and LOWER in turn and check that the carrier level is -16 dB ± 1 dB in each case.

(12) Set the MODE switch to AM-6.

(13) Check that the carrier level is -6 dB ± 1 dB and that the 'wanted' tone is also displayed at this level.

(14) Set the MODE switch to CW and check that a single output is present at the 0 dB level.

(15) Set the a.f. signal input to -60 dBm and check that the output noted at operation (14) is removed.

CLOSEDOWN PROCEDURE

18. On completion of testing:-

(1) Release the STANDBY pushbutton on the MA.1720S.

(2) Set the ON/OFF/REMOTE switch to OFF.

(3) Disconnect the test equipment as appropriate.

## FUNCTIONAL CHECKS, DUAL-DRIVE SYSTEM

19. Where the functional checks for the dual-drive system are similar to those given for single-drive, cross-reference is made to the relevant paragraphs.

20. Unless stated otherwise, the checks are carried out in the order given, with the TTA.1860S and the MA.1721S connected in the 'dual-drive to separate antennas' configuration (Chap. 13-1, para. 24).

PATH 2

Feeder matching sequence

21. (1) Check that the STANDBY pushbuttons on both MA.1720S No.1 and No.2 are OFF (released).

(2) Carry out the procedures given in para. 4 using MA.1720S No.2 and MA.1004 No.2. The ON lamps on r.f. modules No.3, No.4, No.7 and No.8 only should glow at operation 4(7).

Servo limit

22. Simulate a 'servo limit' fault condition as follows:-

(1) Set the thumbwheel switches on MA.1720S No.2 to 1.000 MHz, i.e. to a frequency which is not within the working range of MA.1004 No.2.

(2) Depress the RESET pushbutton to initiate the feeder matching sequence.

(3) Check that after a short delay:-

(a) The SERVO LIMIT lamp on MA.1004 No.2 glows.

(b) The RESET lamp on the MA.1720S glows.

(4) Reset the thumbwheel switches to 2.000 MHz.

(5) Depress the RESET pushbutton and check that a correct feeder matching sequence now takes place.

Power output

23. (1) Set the MA.1720S to the 'c.w. key-down' condition. Link contacts 11 and 13 of the plug provided and insert it into jack JK1 on the MA.1720S; alternatively, interconnect terminals 7 and 8 of 1TB16.

(2) Set the RF POWER switch on the meter panel to FORWARD 2, 1250W. Measure the c.w. power output to the dummy load; at least 400W should be obtained.

(3) Set the RF POWER switch to REFLECTED 2, 250W. The reflected power level should not exceed 50W.

(4) Reset the MA.1720S to 'key-up' conditions.

Note...

If the required output is not obtained or the reflected power level is excessive, refer to para. 32.

(5) Set the MA.1720S to 4.000 MHz and depress the RESET pushbutton. When the feeder matching sequence is completed, repeat operations (1) to (4).

(6) Carry out the power output measurements for each of the following test frequencies in turn:-

6 MHz, 8 MHz, 10 MHz, 12 MHz, 14 MHz, 18 MHz, 20 MHz, 24 MHz, 26 MHz, 28 MHz and 29.9 MHz.

Reduced-power indicator

24. (1) Set the SUPPLY switch on MM.420 No.3 to OFF.

(2) Check that the REDUCED POWER lamp on MA.1720S No.2 glows.

(3) Switch the r.f. module ON again.

(4) Depress the RESET pushbutton on MA.1720S No.2 and check that the REDUCED POWER lamp is extinguished.

(5) Repeat operations (1) to (4) for r.f. modules No.4, No.7 and No.8 in turn.

PATH 1

25. (1) Set the STANDBY pushbutton on MA.1720S No.2 to OFF.

(2) Transfer the dummy load connections from the TTA.1860S to 10SK1 (ANTENNA) on the MA.1721S.

(3) Carry out the procedures given in para. 4 using MA.1720S No.1 and MA.1004 No.1.

(4) Carry out the servo limit check (para. 22) using MA.1720S No.1 and MA.1004 No.1.

(5) Set the RF POWER switch on the meter panel to FORWARD 1, 1250W.

(6) Carry out the power output checks given in para. 23 for path 1.

(7) Carry out the procedures given in para. 24 using r.f. modules No.1, No.2, No.5 and No.6.

(8) Set the STANDBY pushbutton on MA.1720S No.1 to OFF.

## PERFORMANCE CHECKS AND ADJUSTMENTS, DUAL-DRIVE SYSTEM

26. The following tests can only be carried out by maintenance units having the appropriate test equipment; a list of approved test equipment is given in Table 1 of Chap. 13-3.

27. Except for the actual power levels, the procedures for the dual-drive system are similar to those given for single-drive.

## CALIBRATION OF R.F. POWER METER

28. The calibration of the FORWARD 1, 1250W and FORWARD 2, 1250W meter ranges requires about 1 kW output power levels.

29. (1) Set the ON/OFF/REMOTE switch to OFF.

(2) Connect the TTA.1860S in the '1 kW output using drive unit No.2' configuration (fig.6 of Chap.13-1).

(3) Connect the dummy load to 10SK1 (ANTENNA) on the TTA.1860S. Insert the directional wattmeter (items A5 and A6 of Table 1) at the input connector to the dummy load.

(4) Re-set the ON/OFF/REMOTE switch to REMOTE.

(5) Set the RF POWER switch on the meter panel to FORWARD 2, 1250W.

(6) Carry out the procedures given in para. 9(3) to (9) using MA.1720S No.2.

Note...

The preset controls for path 2 metering are carried on the right-hand board PS.446.

(7) Set the RF POWER switch to REFLECTED 2, 250W and carry out the procedures given in para. 10.

30. (1) Set the STANDBY switch on MA.1720S No.2 to OFF.

(2) Set the ON/OFF/REMOTE switch to OFF.

(3) Connect the TTA.1860S and the MA.1721S in the '1 kW output using drive unit No.1' configuration (fig.5 of Chap.13-1).

(4) Transfer the wattmeter and dummy load connections to 10SK1 (ANTENNA) on the MA.1721S.

(5) Re-set the ON/OFF/REMOTE switch to REMOTE.

(6) Set the RF POWER switch to FORWARD 1, 1250W.

(7) Repeat the procedures given in para.9(3) to (9) and para. 10 using MA.1720S No.1 and make appropriate adjustments for the path 1 r.f. metering circuits.

(8) Re-set the STANDBY pushbuttons on both MA.1720S No.1 and No.2 to OFF.

(9) Set the ON/OFF/REMOTE switch to OFF.

## COMBINED OUTPUT

31. (1) Connect the TTA.1860S and the MA.1721S in the 'dual-drive to common antenna' configuration (fig.4 of Chap.13-1).

(2) Transfer the wattmeter and dummy load connections to the OUTPUT socket on the MS.560 combiner unit.

(3) Set the power indicator on the wattmeter for 1 kW forward power.

(4) Set the STANDBY pushbutton on MA.1720S No.2 to OFF.

(5) Re-set the ON/OFF/REMOTE switch to REMOTE.

(6) Using the procedures of para. 21 and 23, set path 1 (MA.1720S No.1) to give a 500W (nominal) c.w. output at a frequency of 10 MHz.

(7) Set the RF POWER meter to FORWARD 1, 1250W and note the actual power output (at least 400W).

(8) Check that about 250W is indicated on the r.f. wattmeter. Note the actual value.

(9) Check that the reflected power in path 1 is less than 50W.

(10) Set the STANDBY pushbutton on MA.1720S No.2 to OFF.

(11) Repeat operations (6) to (9), setting path 2 (MA.1720S No.2) for 500W output.

(12) Re-set both STANDBY pushbuttons to OFF.

(13) Re-connect the TTA.1860S and the MA.1721S in the 'dual-drive to separate antennas' configuration.

DISCRIMINATOR ALIGNMENT

32. Re-alignment of the discriminator circuits within the relevant MA.1004 may be required following an unsatisfactory performance check (para. 23 and 25). The re-alignment is carried out at the 1 kW power level.

CAUTION...

These procedures require the use of both 'automatic' and manual adjustment of the MA.1004. Considerable torque is developed by the servo motors. No attempt must be made to manually adjust either the TUNE or the LOAD control whilst 'automatic' conditions prevail.

33. The procedure is given for MA.1004 No.1; the differences for MA.1004 No.2 will be self-evident:-

(1) Set the ON/OFF/REMOTE switch to OFF.

(2) Set the STANDBY pushbuttons on both MA.1720S No.1 and No.2 to OFF.

(3) Connect the TTA.1860S and the MA.1721S in the '1 kW output using drive unit No.1' configuration (Chap.13-1, para. 24).

(4) Carry out the procedures given in para. 12 and 13.

INTERMODULATION PRODUCTS

34. (1) Check that both STANDBY pushbuttons are OFF.

(2) Check that the dummy load is connected to 10SK1 (ANTENNA) on the TTA.1860S.

(3) Depress the STANDBY pushbutton on MA.1720S No.2.

(4) Carry out the procedures given in para. 14 using MA.1720S No.2 and MA.1004 No.2. A p.e.p. output of about 500W should be obtained at step 14(9).

(5) Disable path 2, by setting the STANDBY pushbutton on MA.1720S No.2 to OFF.

(6) Transfer the dummy load connections to 10SK1 on the MA.1721S.

(7) Transfer the spectrum analyser connections to MA.1004 No.1.

(8) Transfer the audio inputs to the MA.1721S cabinet.

(9) Repeat operations (3) to (5) using MA.1720S No.1 and MA.1004 No.1.

CARRIER LEVELS

35. (1) Carry out the procedures given in para. 15 for MA.1720S No.1.

(2) Transfer the audio input to the TTA.1860S cabinet.

(3) Repeat operation (1) for MA.1720S No.2.

CLOSEDOWN PROCEDURE

36. On completion of testing:-

(1) Release the STANDBY pushbuttons on both the drive units.

(2) Set the ON/OFF/REMOTE switch to OFF.

(3) Disconnect the test equipment as appropriate.

(4) Re-fit any cables disturbed during testing.

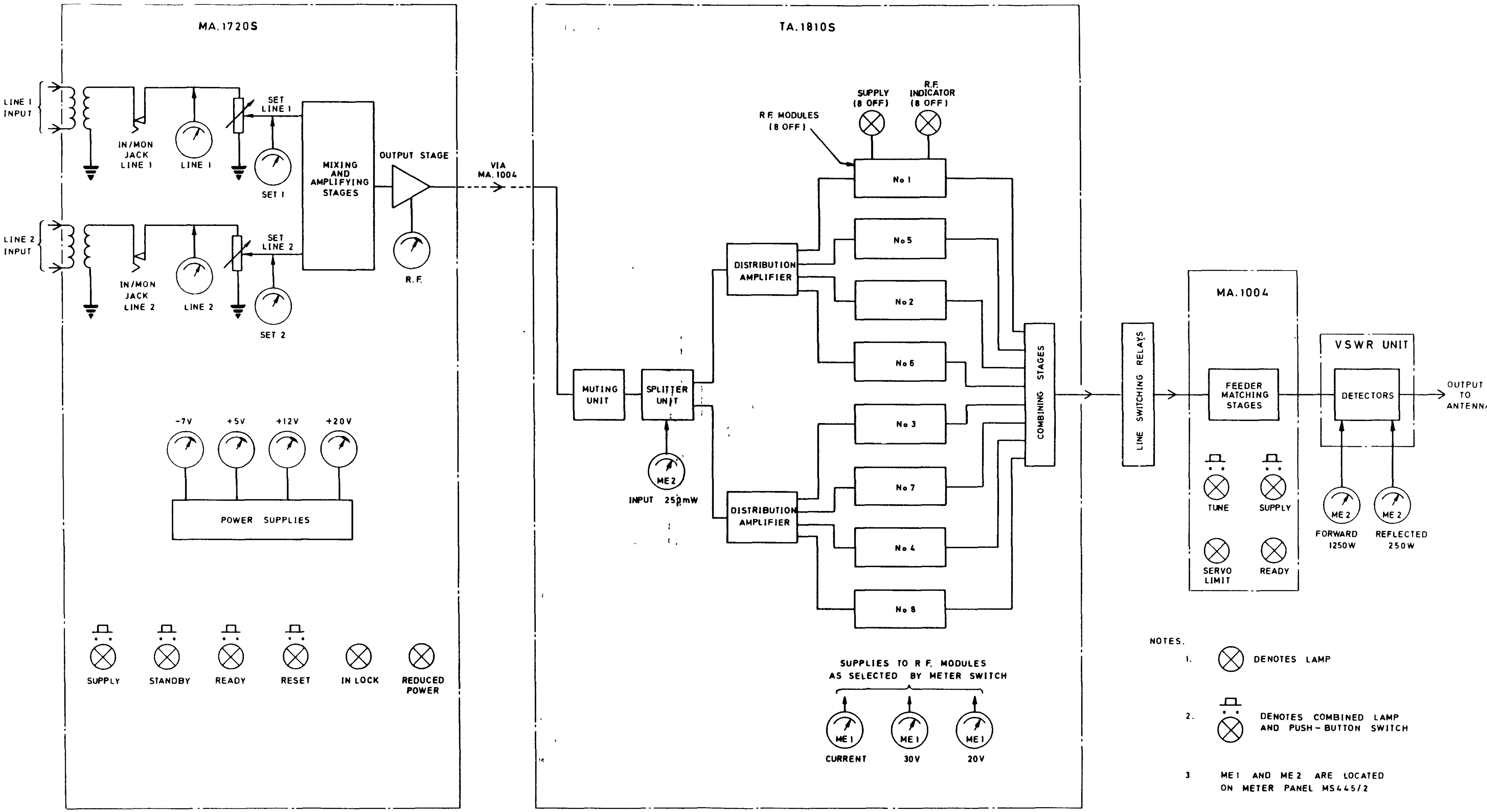



Fig.1 Metering points diagram: single drive Fig 1

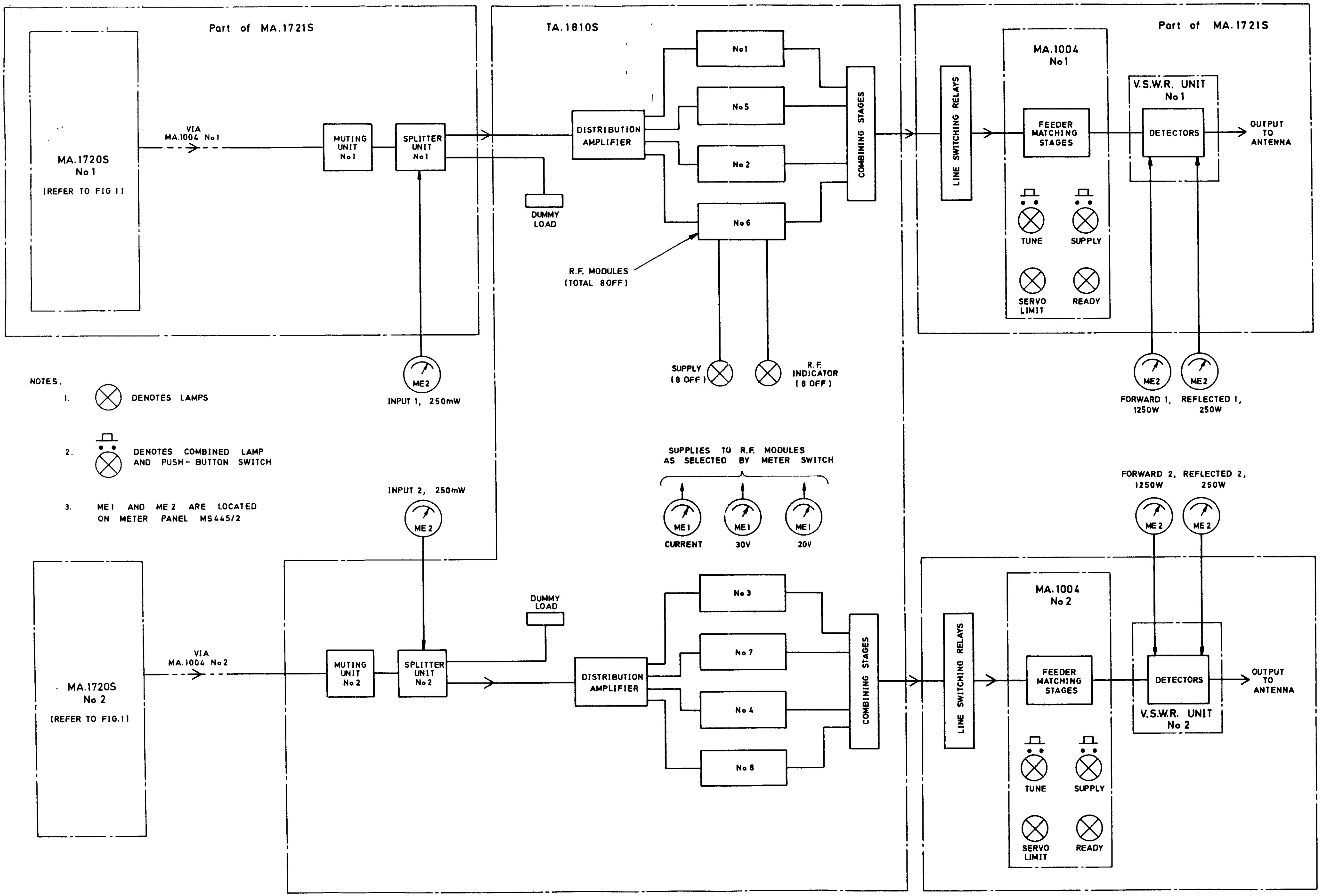



Fig. 2 **Metering points diagram: dual-drive** Fig. 2