HF TRANSMITTER, MARCONI TYPE H1200

TECHNICAL DESCRIPTION

BY COMMAND OF THE DEFENCE COUNCIL

Ministry of Defence

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PREFACE
(Completely Revised)

New or revised leaves

Within each new or revised leaf provided to amend the publication, changes of technical import will be identified by a suitable indicator, such as a marginal rule or appropriate symbol. Such indicators will be omitted when the leaf is next reissued. When the whole of a Chapter is reissued by amendment action and the content is so changed or reoriented that the inclusion of amendment indicators would be impracticable, the note '(Completely revised)' will appear under the title of the Chapter affected.

This publication was originally AP 116E-0244-1A, Book 1, but was changed to AP 116E-0244-16, Book 1, and subsequently altered to AP 116E-0244-1A6A in August 1980 by Amdt. 15. No general revision of page captions have previously been undertaken but amendment from Amdt.15 onwards will carry the latest revised code.

ASSOCIATED PUBLICATIONS

AP 116E-0244-1B6B (T5577 Part 2)	HF Transmitter Type H1200 (30KW)	Maintenance

HAZARD WARNING

POLYCHLORINATED BIPHENYL

THE HF TRANSMITTER H1200 CONTAINS COMPONENTS IN WHICH POLYCHLORINATED BIPHENYL COMPOUNDS (PCB) ARE USED. THIS MATERIAL CAN BE HAZARDOUS TO HEALTH IF ITS DUST IS INHALED OR TOUCHED. NO ATTEMPT SHOULD BE MADE TO INTERFERE WITH, OR DISMANTLE A COMPONENT CONTAINING PCB UNLESS PRECAUTIONS ARE TAKEN AS DESCRIBED OVERLEAF.

PCB FORMS PART OF THE DIELECTRIC IN CERTAIN CAPACITORS, WHICH WILL BE FOUND IN THE FOLLOWING LOCATIONS:-

HF TRANSMITTER HTOO-1200Z SH.2 CIRCUIT REFERENCES C1, C7, C8, C9 UNIT 1. CIRCUIT REFERENCE C20 UNIT 2

HF TRANSMITTER HTOO-1200Z SH.3 CIRCUIT REFERENCE C11-C18 INCLUSIVE UNIT 1

AMPLIFIER RELAY UNIT T30-0979Z SH.3 CIRCUIT REFERENCE C1

AUTO TUNE UNIT T30-7080Z SH.2 CIRCUIT REFERENCE C1

POLYCHLORINATED BIPHENYLS

1. The Marconi Company wishes to draw its Customer's attention to the possible hazards recently recognized resulting from the use of Polychlorinated Biphenyls in some of the components used in the manufacture of the Company's equipment, and to advise on procedures for the disposal of components containing Polychlorinated Biphenyls which have finished their useful life and the action to be taken if there has been any spillage or contamination involving Polychlorinated Biphenyls.

2. Polychlorinated Biphenyls describe a group of synthetic chlorinated organic compounds in liquid and solid forms which are thermally stable and resistant to oxidation, acids, bases and other chemical agents and are resistant to biodegradation.

3. Many uses have been found for Polychlorinated Biphenyls in industry since they were first manufactured in 1929. They have been used in capacitors and transformers because they combine attractive dielectric properties with chemical stability and fire resistance. They have been widely used as fluids for heat transfer systems, hydraulic fluids, in adhesives, textiles and sealants, and in the manufacturing of printing inks and carbonless copy paper. The most common use is probably in capacitors used for power factor correction in fluorescent lighting circuits.

4. Polychlorinated Biphenyls are used in some large capacitors in Broadcast and High Power Communication Transmitters made by the Marconi Company. As a longer term aim the Company is seeking alternative components with different materials that overcome the shortcomings described whilst retaining the desirable performance and fire-resisting properties. In the meantime it is endeavouring to ensure that warning labels are fitted to all capacitors which contain Polychlorinated Biphenyls.

5. There is no hazard in the normal use of such capacitors, but in the unlikely event of any spillage the following recommendations for handling and disposal are advised:

(a) Wear rubber or plastic gloves, eye protection and prevent any skin contact with Polychlorinated Biphenyls.

(b) Absorb the Polychlorinated Biphenyls with cloth or paper towels, sand or sawdust.

(c) Transfer all absorbent material to a strong polythene bag and place in metal container.

(d) Clean area of spillage with clean towel and put in bag and container as above.

(e) Place gloves and any contaminated clothing in a bag, seal securely and place in metal container and securely seal.

6. The method of destroying Polychlorinated Biphenyls is by incineration at 1000°C in the presence of air and, because this produces a mixture of hydrogen chloride and chlorine, specially constructed furnaces with efficient fume scrubbers are necessary.

7. In the United Kingdom such a service is provided by Re-Chem-Biffa Waste Services of Re-Chem International Limited, Pontyfelin Industrial Estate, Pontypool, Gwent. Telephone: Pontypool 56231 or Telex 497781.

NOTE: If Polychlorinated Biphenyls come into contact with skin, the affected area must be washed immediately with soap and water. Report for medical attention.

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EQUIPMENT MODIFICATION LIST

This publication is technically up-to-date in respect of the modifications listed below.

POWER SUPPLY (5820-99-001-4169) T30-2072-01
Mod. No. 1886 to 1889 inclusive, A2251 A2435, A2621, A3586, A3661, A4594, A5514 A5911

RADIO FREQUENCY UNIT (5820-99-001-4168) T30-2071-01
Mod. No.1885, A2433, A2251, 1408, 1586, A2164, A2434, A2627 A2622, A2940 to A2942 inclusive, A3862, A4365, A6200, A6216

RECTIFIER AMPLIFIER POWER SUPPLY (5820-99-001-4165) T30-2093-02
Mod. No. A2427

CONTROL POWER SUPPLY (5820-99-194-1839) T30-2098-01
Mod. No. A3243, A4364

CONTROL, SELF TUNING OR AUTO TUNE UNIT (5820-99-001-4171) T30-7080-01
Mod. No. 1594, A2432, A3661, A4367, A4366

TUNE MOTOR HEAD (5820-99-194-1835) T30-2074-01
Mod. No. A5175

LOAD MOTOR HEAD (5820-99-194-1836) T30-2074-02
Mod. No. A5176

POWER SUPPLY, STABILISED (5820-99-194-1837) T30-2217-01
Mod. No. 1936

CONTROL UNIT POWER SUPPLIES (5820-99-223-5738) T30-0300-02
Mod. No. 1884, A3477

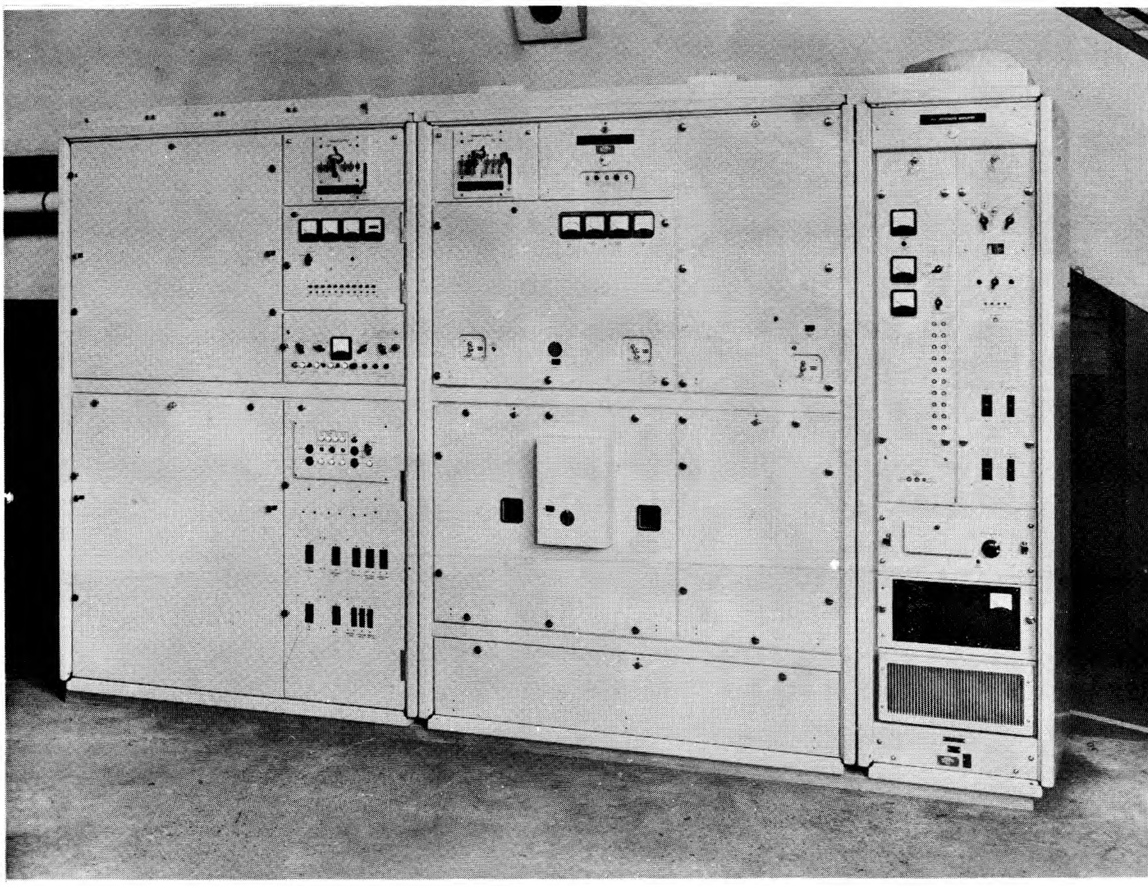
AMPLIFIER RELAY CONTROL (5820-99-222-9349) T30-0979-04
Mod. No. A3363, A5119

RELAY UNIT (5820-99-194-1824) T30-7482-01
Mod. No. A3244, A4622

AMPLIFIER METER (5820-99-194-1823) T30-2261-01
Mod. No. A7306

AMPLIFIER RELAY CONTROL (5820-99-194-1822) T30-1936-01
Mod. No. A7191

COMPARATOR SIGNAL OR FEEDBACK & AUXILIARY UNIT (5820-99-194-1827) T30-7487-01
Mod. No. A2162, A1594



HF Transmitter H1200 Photo. No.69842

H.F. TRANSMITTER TYPE H1200 (30 kW)

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Chapter 1

H.F. TRANSMITTER TYPE H1200 (30 kW)

INTRODUCTION

1. The H1200 is a 30 kW p.e.p. linear-amplifier having a self-tuned final stage and untuned, wideband amplifiers for the earlier stages. When the drive frequency is changed, the self-tuning system operates to provide the correct tuning and loading within about 40 seconds. The output tuning and loading servos remain in operation at all times to ensure accurate adjustment of the amplifier in spite of changes in serial impedance as a result of varying weather conditions.

2. Only three variable tuning controls are used, (a) for matching the input to the final stage, (b) tuning and (c) loading the output circuit, thereby facilitating the adoption of fully automatic self-tuning techniques. In addition, the input level to the amplifier is automatically regulated. Maximum reliability is ensured by keeping the number of moving parts to a minimum.

3. The controls are operated by high quality transistorized servo systems which derive their inputs from tuning and loading error detector circuits in the amplifier.

4. The power supplies incorporate the latest techniques in silicon rectifiers and air-cooled transformer design, enabling all power components to be incorporated within the amplifier and avoiding the necessity for special accommodation facilities.

LM

Chapter 2

EQUIPMENT CHARACTERISTICS

Frequency range:	4-27.5 MHz
Services:	i.s.b, s.s.b, f.s.k, f.s. diplex, c.w. on/off (dependent on type of drive).
Output power:	30 kW p.e.p. on i.s.b, 20 kW on c.w. on/off and f.s. telegraphy, $\left.\begin{matrix}+0.7\\-0.5\end{matrix}\right\}$ dB when auto-tuned.
Harmonic radiation:	Less than 50 mW below 30 MHz. An external lowpass filter is included to reduce the level of harmonics above 30 MHz.
Output impedance:	50Ω unbalanced, max. v.s.w.r. 2:1
Noise level:	(a) More than 30 dB below carrier level (carrier normally -26 dB to -16 dB relative to p.e.p.) for components up to 200 Hz either side of carrier. (b) More than 50 dB below p.e.p., for all components of a single tone up to -6 dB relative to p.e.p.
Non-linear distortion:	All i.ps better than -36 dB relative to either of two equal tones for any power level up to full p.e.p.
Pilot Carrier Compression:	Less than 1 dB for any level of single frequency signal up to -6 dB relative to p.e.p.
Input from drive:	25 mW minimum, 3W maximum c.w. in 75Ω at radiated frequency. (37.5 mW to 4.5W p.e.p.)
Suitable drives:	H1600 series
Power Supply:	380/440V, 3-phase, 4-wire, 50 or 60 Hz (as ordered).
Power supply variation:	Voltage ±1%. (The amplifier will normally work from an AVR which gives a ±1% output variation for an input mains variation of +6% to -14%). Frequency ±2½%
Power consumption:	Mark 65 kVA, space 26 kVA, i.s.b. 55 kVA, P.F. 0.93

EQUIPMENT CHARACTERISTICS

Climatic conditions: $45^{\circ}C$ dry heat, $40^{\circ}C$ at up to 90% humidity, maximum altitude 8000 ft.

Dimensions:	Height	Width	Depth
	7 ft*	12 ft	2 ft 6 in
	(213 cm)	(366 cm)	(76 cm)

*not including filter or directional coupler.

Units: H1200

The Transmitter H1200, Amplifier RF HT00-1200-02, 5820-99-107-0242 consists of three Cabinets as shown in the Frontispiece photograph No.69842:

Cabinet 1: Rectifier & Control Unit T30-2072-02, 5820-99-519-1319
Cabinet 2: Amplifier Radio Frequency T30-2071-02, 5820-99-519-1320
Cabinet 3: HF Wideband Amplifier H1000, HT00-1000-04, 5820-99-519-1321

The contents of the Cabinets are distributed as follows: (Refer Book 2 Chap.5 Fig.137).

UNIT	DESCRIPTION	CABINET
1	Power Supply T30-2072-01 5820-99-001-4169	1
2	RF Unit T30-2071-01 5820-99-001-4168	2
3	Control Power Supply T30-2098-01 5820-99-194-1839	1
4	Control Unit Power Supplies T30-0300-02 5820-99-223-5738	1
5	Amplifier Relay Unit T30-0979-04 5820-99-222-9349	2
6	Control Self Tuning or Auto Tune Unit T30-7080-01 5820-99-001-4171	1
	6.1, 6.2, 6.3 Relay Amplifier T30-1936-01 5820-99-194-1822	
	6.4 Meter Amplifier T30-2261-01 5820-99-194-1823	
	6.5 Relay Unit T30-7482-02 5820-99-194-1825	
	6.6 Feedback & Aux Unit T30-7487-01 5820-99-194-1827	
	6.7*, 6.8, 6.9 (BLANK)	
	6.10, 6.11, 6.12 Servo Amp Unit T30-1934-01 5820-99-194-1829	
	6.13 Relay Unit T30-7482-01 5820-99-194-1824	
	6.14 (BLANK)	
	6.15 Switching Unit T30-7489-01 5820-99-194-1828	
	6.16 Relay Unit T30-7482-03 5820-99-194-1826	
	*Note: Refer Chap.4 Paras.146, 147 and Chap.7 Paras.167, 168	
7	Rectifier Amplifier Power Supply T30-2093-02 5820-99-001-4165	1
8	Coupler RF Output T30-0991-02 5820-99-001-4166	2
9	Power Supply, Stabilised T30-2217-01 5820-99-194-1837	1
10	Discriminator Phase, T30-1969-02 5820-99-194-1832	2
11	Relay Box T30-2998-01 5820-99-194-1833	2
12	Indicator Control T30-5878-01 5820-99-001-4170	1
13	1 kW Drive Unit (HF Wideband Amp H1000) 5820-99-519-1321 (See AP116E-1207-16 for sub-units 13.1 to 13.21)	3
14	Discriminator Input Tune T30-7562-01 5820-99-001-4172	2
15	Coupler RF Input T30-9114-01 5820-99-001-4173	2
16	Relay Assembly (Extended Control Unit)T30-9723-01 5820-99-194-1834	1
17	Aerial Interlock T31-1212-02	1

Valve List:
V1 BR1161 (CV9343)

Chapter 3

GENERAL DESCRIPTION & PRINCIPLES OF OPERATION

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Chapter 3

GENERAL DESCRIPTION & PRINCIPLES OF OPERATION

General Description

1. The H1200 amplifier consists of three cabinets joined together side by side.

2. The left-hand cabinet (Cabinet 1) contains the power supplies and control circuits for the Final Valve and further control circuits for the automatic control of the overall amplifier. All the power components are air-cooled and the only external components are the fan and an automatic voltage regulator. The rectifiers are silicon.

3. The centre cabinet (Cabinet 2) contains the Final Valve of the amplifier with its input and output circuits. Five controls are associated with this stage, two range-switches driven by a.c. induction motors and three tuning controls driven by servo motors.

4. The narrow cabinet on the right-hand side (Cabinet 3) is the H1000 Wideband Amplifier. This accepts a signal from the drive unit and amplifies it up to the 800 watt level without any tuning controls.

5. Access to cabinets with safety is provided by a key interlock system in which supplies must be switched off and earthed before a key can be obtained. Once a key is taken out of the isolator switch the switch cannot be closed and neither can the earthing be disconnected. Such a key used to unlock and remove a panel becomes trapped in the lock of that panel as long as the panel is off.

6. As stated in Chap.1 Paragraph 2, the H1200 employs fully automatic self-tuning techniques. This is performed by the Auto Tune Unit situated in Cabinet 1; and the unit also provides facilities for comprehensive monitoring of the voltages involved in the automatic tuning.

7. Immediate manual control of the amplifier is available without the need for any mechanical disconnection. It is necessary only to switch from Automatic Control to Manual Control. The range switches can then be turned by means of a handle provided and tuning can be achieved using the handles which are permanently connected to the tuning elements.

8. Cooling air for Cabinets 1 and 2 enters at top of Cabinet 1 through air filters. Air for cooling Cabinet 3 is drawn in through an air filter in the lower part of that cabinet. All the air from Units 1 & 2 finally passes down through the anode fins of the Final Valve situated in cabinet 2 and the hot air is exhausted straight out of the cabinet.
Cable entry can be either to the top or the bottom of the amplifier for mains supply and for connections to an extended control unit.

9. Complete control over the functions of the H1200 can be achieved from associated equipment housed in a drive and control room.

GENERAL DESCRIPTION &
PRINCIPLES OF OPERATION

10. Only front access is necessary and the amplifier may therefore stand against a wall or back to back with other similar amplifiers.

Principles of Operation Block Diagram Fig.101

11. The H1200 Amplifier comprises three wideband amplifier stages and a tuned final stage all contained in three cabinets. Cabinets 1 and 2 have double compartments. Cabinet 3 has a single compartment. In cabinet 3 is housed the input attenuator, a 3W wideband amplifier and a two stage 1 kW wideband amplifier. This single cabinet is a complete equipment in itself having power, control and protection circuits all fitted. Cabinets 1 and 2 house the power supplies and control and protection circuits for the tuned Final Stage valve (V1) the final r.f. amplifier.

12. The 3W wideband amplifier is a standard unit known as the H1001 and has a separate Technical Manual AP116E-1208-16. The 1 kW wideband amplifier is also a standard unit and has a separate Technical Manual AP116E-1207-16. Reference will be made to these other manuals in describing the overall equipment but, in general, information which they contain will not be repeated.

13. The tuned final stage 2V1 is a linear amplifier, having a cathode input circuit, anode tuning control, anode loading control and range selection. The circuit is a conventional grounded grid circuit using a triode valve with an 11V filament and a 12 kV anode supply.

14. All the Tuning and Loading controls are tuned by servo-motors. Any servo-motor when in motion generates a signal which is fed back to its servo amplifier to avoid overshoot and continuous hunting of the control about the required position.

15. Two induction motors turn camshafts which press contact fingers on the coils, to select the various range positions. The energising of the induction motors is basically controlled by the servo-motor MG3 (The Input Tune servo).

Typical Servo System

16. The servo-system used in this equipment is an 'Error Correction' system; a pick-up is taken from the output of a particular circuit and fed to a comparator. This comparator is also fed with a reference signal, which may be a d.c. voltage or a pick-up from the input of that particular circuit. The comparator output is fed to a servo amplifier which drives a servo-motor until the setting of the circuit is correct.

17. Negative feedback derived from a Tacho-generator on the servo motor shaft is applied to the servo amplifier to prevent overshoot as the correct setting is reached.

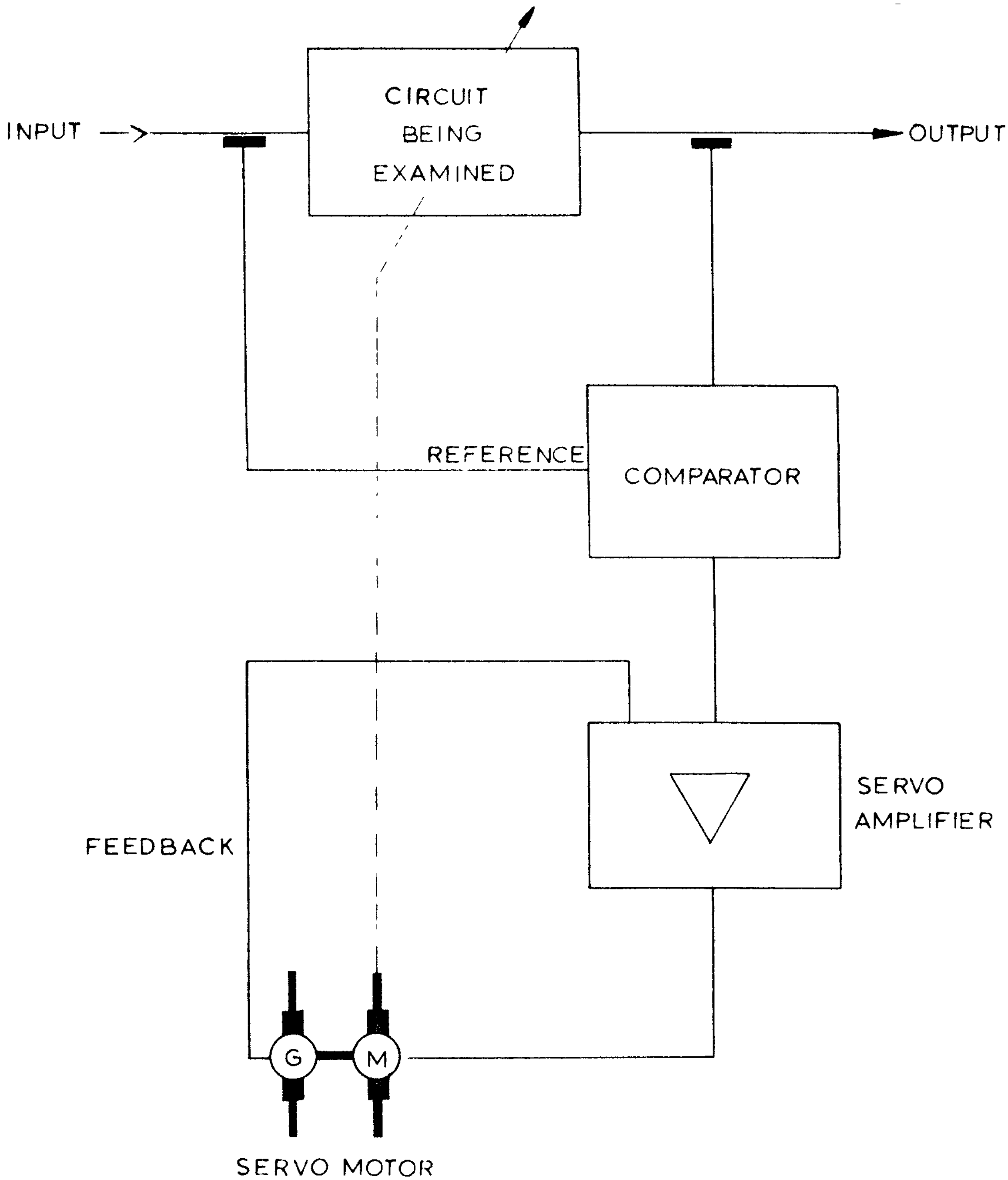

FIG.1 TYPICAL SERVO CIRCUIT

GENERAL DESCRIPTION & PRINCIPLES OF OPERATION

H1200 Servo Systems Flow Diagram Fig.101

18. The auto-tune system operates by sampling the signals at points in the amplifier chain and comparing them either with a reference voltage or the input signal. See Fig.101.

19. The three wideband amplifier stages require no attention from the auto-tune system as the technique permits the amplification of any signal through the amplifier as long as it is within its frequency range. However, the stages could trip to lockout by being overdriven while misterminated, i.e. final stage untuned, and therefore, during tuning, the drive input level must be controlled to a level at which a complete mismatch can be tolerated. It is at this point that the auto-tune system starts. The amplifier, instructed to go through its tuning sequence, calls for a Tuning Signal from the drive.

20. From the Flow Diagram it can be seen that the first question asked in the system is "Is the coarse level correct ?" The drive level is compared with a d.c. reference level and the answer produces one of two reactions NO or YES. If NO is the answer the signal is then proved to be "too high" or "too low" and the answer fed to the servo amplifier which instructs the level servo-motor to correct the error. The error will be corrected, and the answer from the comparator will be YES whereupon the circuit will be isolated and the Input-Tune comparator will ask the question "Is the cathode circuit matched to the resistive load ?". Once again the answer will be NO or YES.

21. If the answer is NO then again the question High or Low impedance will be asked and the servo amplifier energises the cathode circuit (Input Tune) servo motor to correct the error.

22. The Input Tune circuit covers the whole frequency range of the amplifier in one sweep. There is thus a particular mechanical position of the control shafts in this unit for a particular frequency.

23. This fact enables coarse information, for initial settings of the anode tuning and loading controls, concerning an incoming frequency, to be derived from the cathode circuit.

24. A cam-shaft, associated with microswitches, causes the range motors to select the Range containing the frequency. Once the Range is selected, a relay peculiar to that Range causes the Tuning Capacitor to assume a mean position for that Range.

25. A multi-turn variable potentiometer geared to the Input Tune Unit provides positional information for the Loading Capacitor via its Servo Control.

26. On the input circuit completing its tuning and the comparator output becoming YES, the dummy load is switched out of the circuit (the input circuit motor is disconnected) and the drive input connected to the valve cathode, to commence the third stage of tuning, i.e. fine

tuning and loading and output level adjustment.

27. The anode tuning and loading comparators will ask "Is the tuning correct ?" Where NO is the answer they energise the servo motors to correct the error until the answer is YES.

28. The anode tuning and anode loading controls are effectively in series, with the tuning control taking precedence. The anode tuning phase-discriminator determines the phase difference between the anode and cathode r.f. voltages and controls the adjustment of the tuning capacitor to obtain zero phase difference. The anode loading comparator then compares the amplitudes of the anode and cathode r.f. voltages and controls the adjustment of the loading capacitor until a preset ratio, corresponding to the correct loading of the final stage valve, is obtained. As the tuning and loading adjustments are interdependent the tuning and loading capacitors continue to be adjusted in turn until the phase discriminator and the loading comparator both indicate the correct conditions.

29. A further Level Comparator asks "Is the output level correct ?" Where the answer is NO the input attenuator is adjusted as before by the same servo-motor (the COARSE LEVEL COMPARATOR IS OUT OF CIRCUIT and will not affect the system at this stage).

30. When the answer is YES from the Tuning, Loading and Output Level Discriminators the amplifier is tuned and traffic may then be fed into the drive equipment and so into the amplifier.

Emergency Manual Tuning

31. All the tuning and loading controls, including the range switches and the input variable attenuator, are coupled to manual controls on the front of the transmitter so that if a fault should occur in the servo control system the transmitter can be manually tuned. The small number of controls makes it possible to retune the transmitter manually in about 2 minutes.

Switching Sequences

32. The auto-tune switching sequence occurs automatically when the transmitter is started up and another automatic sequence comes into operation when the transmitter is switched off. The transmitter can also be switched to a 'standby' condition, with the main h.t. off but the filament and auxiliary supplies on, either from the transmitter or from the extended control panel.

Chapter 4

CONTROL SYSTEM

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Chapter 4

CONTROL SYSTEM

GENERAL

1. The starting-up of the H1200 is dependent firstly on mechanical protection devices (keys) and secondly on electrical interlocks (switches) and each stage must be complete before the next stage is begun.

2. To protect the user, the equipment must be completely closed up before power can be applied. This is ensured by a system of locks, keys and a key panel mechanically interlocked to the mains isolator switches; each cabinet being covered separately.

3. Locking all the panels in position and returning the keys to the key panel and locking them, frees the action of the mains isolator switch and traps the keys.

SWITCHING TO AVAILABLE (A condition displayed on an extended control unit)

4. After the amplifier has been locked and all the circuit breakers set to ON, the a.c. three phase supply may be switched-on to all three cabinets by 1SA. It should be noted that the single Wideband Amplifier (W.B.A.) cabinet has its own power supplies independent of the other two cabinets but once its mains isolator 13.2SA is switched to ON and the Local/Remote switch 13.2SB set to REMOTE, control is passed completely to the switching circuits of the other two cabinets.

5. It should also be noted that the LOCAL/REMOTE switch on the W.B.A. merely passes control from its own cabinet to the overall control system, but the LOCAL/REMOTE switch on the main rectifier cabinet (3SA) will extend the overall control system to an External Control Unit. Thus for normal operation and for this explanation the Wideband Amplifier switch (13.2SB) will be considered in the REMOTE position and the rectifier cabinet switch (3SA) will be in the LOCAL position.

6. Setting the Unit 1 mains isolator 1SA to ON energises the following supplies:-

(a) The indicator lamp supply 3T1 (lighting the A.C. ON lamp 3ILP1 immediately).

(b) The lamp combining unit supply (Unit 12).

(c) The control circuit supply (Unit 4).

(d) The feeder amplifier supply (Unit 5).

(e) (When AUTO operation has been selected) all the auto-tune supplies in Unit 1 and the 33V stabilized supply unit (Unit 9).

7. Setting the Unit 2 mains isolator 2SA to ON extends the control of mains switching to the final h.t. contactor 1FHC.

8. Setting the Unit 13 mains isolator 13.2SA to ON the following supplies are energised in that cabinet.

(f) Wideband amplifier 50V d.c. control supply.

(g) The auxiliaries contactor 110V a.c. control supply.

(h) The main h.t. contactor 110V a.c. control supply.

9. The energising of all these supplies will cause further circuits to be energised to perform set functions.

10. These circuits are:-

(a) Feeder trip preparation (relay 5RLA energised)

(b) Auto-Tune supplies ON (contactor 1ATC energised)

(c) Frequency tuning sequence initiated (FC and CL relays energised)

(d) Anode Tuning and Loading motors disconnected (relay 6.13TR energised)

(e) Tune/Traffic line set to Tune.

(f) The cathode circuit (relay 2RLA energised)

11. The object at this stage of switching is to set the equipment to the first stage of auto tune, i.e. the coarse level condition with a "tune" drive input level. (This is normally a single tone signal at -10 dB relative to p.e.p.). The coarse level condition includes operating the frequency change relays (6.5FCA and 6.13FCB.

12.	5RLA	Contacts set as follows. (Refer to Figs.102 & 103)
	5RLA1 (23H)	Opens in the feeder trip line to 3FTD (21F).
	5RLA2 (26F)	Closes to extend the final h.t. slave relay control line.
13.	1ATC (7C)	Contacts set as follows. Refer to Fig.102
	1ATC1) 1ATC2) (7C) 1ATC3)	Close to energise the auto tune power circuits.
	1ATC4 (13A)	Closes to energise the AUTO lamp circuit on the Lamp Combining Unit.

1ATC5 (17A) Closes to extend the lamp supply earth to 6SKTF13 of the Auto Tray.

14. 2RLA (40C) Contacts set as follows. (Refer to Fig.104).

2RLA1 (46D) Closes to connect the cathode circuit to the final stage (F.S.) valve.

15. The remainder of the relays are operated through transistor switch circuits as follows.

Initial Coarse Level Setting

16. When the amplifier control supplies are first switched-on, as previously stated, certain circuits of the amplifier are energised immediately. These circuits include most of the transistor logic switching circuits in the W.B.A. cabinet and a description is given in the relevant manual T.5574. Other circuits energised are the auto-tune system transistor switching circuits which set-up the COARSE LEVEL (C.L.) condition. (Fig.105 shows the circuit involved). These circuits form part of the Switching Unit which is described in Chapter 7.

17. The C.L. transistor switch is operated by the application of either of two voltages to the base of transistor 6.15VT1 (one for ON and one for OFF). These voltages are the result of applying an earth (or not) to the potentiometer 6.15 R1/R2 (8G & H). From Fig.105 it can be seen that no earth connection is present in this state (3RCA2 (8D) being open),

18. This results in the energising of relay 6.16CLA(12F).

6.16CLA1 (11E) Closes to lock-on the Coarse Level (C.L.) condition until the Input Tune condition is established when the C.L. is set-up.

6.16CLA2 (8E) Opens to insert the relay amplifier contacts 6.3RLA3 and 6.1RLA3 in series with the 3RCA2 contact. These contacts ensure that when 3RCA2 closes (when the transmitter is switched-on) the transistor switches will not change over until the Coarse Level setting is complete. They are open if the Level Control wiper is moving (6.1RLA3) or at its end stop (6.3RLA3).

6.16CLA3 (14B) Closes to energise the second and third coarse level relays 6.16CLB and 6.16CLC.

6.16CLA4 (15C) Closes to energise the frequency change relays 6.5FCA and 6.13FCB.

19. 6.16CLB & 6.16CLC(14B) contacts set as follows:-

6.16CLB1 } (6E & F Fig.106) 6.16CLC1 }	Both change over and feed the output of the input level comparator to the sero system and to the relay amplifier Unit 6.3.
6.16CLB2 (4B)	Opens across the wideband amplifier H.T. ON (REMOTE) switch 1FHC6.
6.16CLB3 (2C)	Opens in the AUTO tune interlock circuit (see also Fig.103) to isolate the final h.t. slave relay 3FHS from the control supply.
6.16CLB4 (16D Fig.112)	Changes over to light the SET COARSE LEVEL lamp 6ILP5.
6.16CLC2 (3G)	Opens to isolate further the transistor switch 6.15VT15 to hold the threshold relay (6.13TR) energized when 6.5FCA2 changes over, thus ensuring the operation of 6.13TR on the coarse level condition.
6.16CLC3 (9H)	Closes to discharge the delay capacitor 6.15C4.

20. 6.13FCB (18A) Contacts set as follows:-

6.13FCB1(13C Fig.112)	Changes over in the extended control indicator lamp circuit to show the TUNING condition remotely.
6.13FCB2 (11G Fig.106)	Changes over to connect the output of the Input Servo amplifier at 6.12PLA(11) to the control winding of the 'level' servo motor 13.19MG1.
6.13FCB3 (15E Fig.112)	Changes over to prepare the SETTING O/P LEVEL lamp circuit (6ILP3).
6.13FCB4 (17C)	Closes to energise 6.5FCA (ensures that it operates after 6.13FCB.

21. 6.5FCA Contacts set as follows:-

6.5FCA1 (16C)	Closes to extend the "hold-on" supply path of the frequency change relays.
6.5FCA2 (2F)	Changes over to connect -22.5V, derived in the switching unit, to the TUNE/TRAFFIC switch in the drive, setting it to TUNE and also prepares the threshold relay (6.13TR) switching circuit (for the 2nd and 3rd stages of Auto Tune).

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	6.5FCA3 (5B)	Closes to extend the by-pass loop across the wideband amplifier H.T. ON remote switch 1FHC6 (so that the Drive h.t. can be switched on whilst tuning without the main h.t.).
	6.5FCA4	Not used.
22.	6.13TR (6F)	Contacts set as follows:-
	6.13TR1))(12D 6.13TR2)Fig.108)	(Connected as changeover contacts). Change over to isolate the O/P of the anode tuning Servo Amplifier from the servo-motor, and earths the control winding of the servo-motor, thus both sides are earthed.
	6.13TR3)(12F) 6.13TR4)Fig.109)	(Connected as changeover contacts). Change over as do 13TR1 and 13TR2 but in the anode loading circuit.

23. The result of all these relays operating during the AVAILABLE sequence is to set-up the initial coarse level condition. This condition causes the coarse level servo system to adjust the input level attenuator to the minimum attenuation position as there is no output from Unit 13-21; it being switched off.

Coarse Level Operation (Refer to Fig.105)

24. Whilst the AVAILABLE sequence is taking place the COARSE LEVEL servo system will start to adjust the input level. There is no input to the comparator pick-up from the output of the 3W W.B.A. (it being switched off), and this being compared with the d.c. reference voltage derived across 13.20RV2 from the +33V supply, will give a maximum error output in the sense which calls for an increase of signal. The auto attenuator therefore will run to its end-stop at minimum attenuation.

25. As already stated CLB1 and CLC1 are operated, therefore the error output is fed to both the servo amplifier (Unit 6.12) and the relay amplifier (Unit 6.3). The input to the servo amplifier drives the servo motor and the input to the relay amplifier energises relay 6.3RLA.

6.3RLA1 (9E)	Opens to extend the break-in the earth line to the transistor switch 6.15VT5. See Fig.105.
6.3RLA2 (15D)	Closes across 6.16CLA4 to hold on the frequency change relays.
6.3RLA3 (8D)	Opens to extend the break in the earth connection to the transistor switch 6.15VT1. See Fig.105.
6.3RLA4	Not used.

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26. The level servo-motor Tacho-generator winding produces an output as the motor turns. This is a feedback output of constant frequency which is fed via an attenuator in Unit 6.6 to the servo amplifier unit (Unit 6.12) to combine with the main signal and reduce the amplifier output as the error is reduced, in a manner which avoids overshoot or hunting.

27. This feedback signal is also applied to the relay amplifier (Unit 6.1) to energise relay 6.1RLA (18A) when the servo-motor is running.

6.1RLA1 (9D)	Opens to extend further the break-in the earth line to the transistor switch 6.15VT5 (in series with 6.3RLA1).
6.1RLA2 (17D)	Closes across 6.16CLA4 to ensure the hold on of the frequency change relays. (In parallel with 6.3RLA2).
6.1RLA3 (8E)	Opens to extend further the break in the earth connection to the transistor switch 6.15VT1 in the switching unit (in series with 6.3RLA3).

28. When the minimum attenuation end limit switch operates, the control winding is de-energised, since the limit switch simply arranges for both sides of the control winding to be at the same potential. Also as the motor is not turning the Tacho-generator output is zero so the relay amplifier 6.1 is de-energised and its contacts return to the rest position.

29. This leaves 6.3RLA (8F) operated and the amplifier is locked-on coarse level selection, i.e. CLA, B & C operated.

SWITCHING TO ON (Refer to Fig.102)

30. The amplifier can be started at any time after switching-on the control supplies, in which case some of the following operations would operate in parallel with those just described. For ease of explanation, however, it will be considered that the amplifier is in the state quoted above, i.e. 6.3RLA, 6.16CLA, 6.16CLB, 6.16CLC, 6.5FCA and 6.13FCB all operated.

31. Pressing the START switch 3SC(4D) energises relays 3RCA and 3RCB(4E).

3RCA1 (4D)	Closes across the START switch to lock-on 3RCA and 3RCB when the START switch is released.
3RCA2 (30C)	Having ensured a start in the 1st stage of Auto Tune (the Coarse Level setting condition) closes to prepare the input tune control circuit for operation when coarse level setting is completed, see Para.40.
3RCA3 (4E)	Closes to switch on the 1 kW Wideband Amplifier, it being the W.B.A. REMOTE MAINS ON switch in this arrangement.

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3RCA4(19G)	Closes to by-pass the H.T. START switch (3SD) on auto-tune (it has no effect when MANUAL tuning is used).
3RCB1(5E)	Closes to energise the fan contactor 1FC.
3RCB2(15F)	Closes to extend the supply line of the auxiliary supplies contactor 1ASC.
3RCB3(6C)	Opens to isolate the air-hold circuit (used only when switching off).
3RCB4(6A)	Opens to extinguish the OFF lamps in the Extended Control Unit.

32. 1FC(5G) The fan contactor operates.

1FC1)) 1FC2)(14D)) 1FC3)	Close to energise the external blower.
1FC6(13D)	Closes to switch on the internal blower if it is fitted.
1FC4(6D)	Closes to extend the air-hold control circuit.
1FC5(5E)	Closes to short circuit 3RCB1 without effect; it is associated with the air-hold circuit.

33. When 1FC1, 2 & 3 close to energise the external blower it starts to draw cooling air through the equipment; as pressure builds up across the final valve switch 2SC (15E) closes to extend the 50V supply to the filament pilot relay 3FP via the filter air switch 2SZ (15E).

N.B. *2SZ is across the air filters (which are on the roof of Unit 1) and opens if they become choked up.*

34. 3FP(15G) Operates and:

3FP1(15E)	Closes to energise the auxiliary supplies contactor 1ASC via 2SA4 (part of unit 2 Mains isolator).
3FP2(15A)	Closes to switch on the Air Lamp 3ILP2.

35. 1ASC(16G) The auxiliary supplies contactor operates and

1ASC1(16C)	Closes to energise the filament supply and hour-meter.

	1ASC2) 1ASC3) (17C) 1ASC4)	Close to energise the bias supply
	1ASC4(27C)	Closes to extend the 50V supply to the delay relay 3FD (Fig.105).
	1ASC6(16A)	Close to light the auxiliary supplies lamp 3ILP3.
	1ASC7(22G)	Closes to extend the feeder trip circuit to 3FTD.
36.	3FTD(19D)	The delay relay operates after its set time delay and
	3FD1(20D)	closes, to extend the 50V supply to relay 3FHL(19E) ready for the h.t. to be switched on by the H.T. Start Switch 3SD when locally controlled, or will start the h.t. switching circuit when remotely controlled or auto-tune operation is selected.

Coarse Level Setting Sequence (Refer to Fig.105)

37. On the amplifier being started.

3RCA3	Closes to switch on the auxiliary supplies in Unit 13. In so doing it switches on the a.c. supply to the Unit 13.21 which becomes operative and gives an output when it has had time to warm up. A sample of this output is fed to the input level comparator and results in an output from the servo-amplifier to the control winding of the auto attenuator servo-motor 13.19MG1 reversing its previous direction and operating the circuits as previously described (Paras.25-28).

38. When the servo motor has set the input to the correct position, relays 6.1RLA and 6.3RLA release and complete an earth path through 6.15R1, 6.1RLA3, 6.3RLA3, 3RCA2, 17RLB2 and the synthesizer decade switches. This switches on transistor 6.15VT1 (8G).

39. After a short delay set by the transistor switching circuit relay 6.16ITD will initiate the Input Tune sequence (see Para.40).

Input Tune Sequence (Refer to Fig.105)

40. At the completion of the coarse level setting the Input Tune sequence is established. During this condition Unit 13 h.t. is switched on, the cathode circuit is tuned, the anode range is selected, the W.B.A. h.t. is switched on, coarse information is fed to the anode circuits and the coarse level circuits are isolated.

41. When 6.16ITD is energised to establish the Input Tune condition

6.16ITD1 (15B)	Closes to energise the input tune relays 6.5ITA, 6.13ITB and 6.13ITC.
6.16ITB2 (15D)	Closes across 6.16CLA4 to hold the frequency change relays 6.13FCB and hence 6.5FCA when 6.16CLA4 opens (see 6.16ITD2 below).
6.13ITC3 (3C)	Opens in the auto-tune interlock circuit in series with and to replace 6.16CLB3 which closes (see 6.16ITD2). (These contacts ensure that the main h.t. is held off during the CL and IT stages of Auto Tune).
6.13ITB1 (9D)	Opens to ensure that the amplifier stays in the Input Tune condition until servos have stopped by inserting in the transistor switch (6.15VT5) switching circuits relay contacts 6.1, 6.2 and 6.3RLA2 (see Fig.105).
6.16ITD3 (12D)	Refer to Fig.106. Changes over to connect the output of the Input Tune tacho-generator winding to the feedback input of the servo amplifier (6.12), disconnecting the level tacho-generator winding at the same time.
6.5ITA1 (7E)	Changes over to connect the output of the Input Tune comparator to the input of the servo amplifier 6.12, disconnecting the Input Level comparator at the same time.
6.5ITA2 (12B Fig.107)	Changes over to connect the Anode Tuning Coarse information to the Anode Servo Amplifier (see Fig.107).
6.5ITA3 (4B Fig.107)	Changes over to connect the Anode Loading Coarse information to the Anode Loading Servo Amplifier (see Fig.107).
6.ITA4 (16E)	Changes over to connect the output of the Input Tune tacho-generator winding to the input of the relay amplifier unit 6.1, disconnecting the level tacho-generator winding at the same time.
6.13ITB3 (11B)) 6.13ITC2 (12G)) 6.13ITC1 (12H))	All change over to connect the input tune motor control winding in place of the input level motor control winding in the output of the servo amplifier.
6.13ITB4 (15D Fig.112)	Changes over to light the INPUT TUNING lamp 6ILP2.

6.13ITC4 (14E)	Changes over to release 2RLA and energises 2RLB (the dummy load relays).
6.16ITD2 (11E)	Opens to remove the locked-on path to the coarse level transistor switch 6.15VT2 and thus de-energises 6.16CLA. This in turn de-energises 6.16CLB and 6.16CLC and all their contacts return to the rest condition. Those circuits energised by these relays, which are required in subsequent tuning procedures have been energised by the IT relays (see Fig.105).
6.16CLB2 (4B)	Closes to switch on Unit 13 h.t.
2RLA1 (46D Fig.104)	Opens to isolate the cathode circuit of the final stage valve.
2RLB1 (46D Fig.104)	Closes to connect the output of the input circuit to the dummy load 2R16/2C31.

42. This dummy load represents the load which the final valve will present to the input circuit when it is properly tuned and loaded. As yet it is in no such state and would present quite a random load impedance to the Input Tune Circuit. The Input circuit is adjusted into the dummy load therefore and then its servo motor is de-energised.

Input Tune Operation

43. The IT relays now set-up the input circuit feeding into a resistive load and, as Unit 13 is on, the Input Tune comparator is now receiving the two signals for impedance comparison. The output of the comparator is fed through the servo amplifier (Unit 6.12) to the input tune servo motor and energises it, turning it towards the no-error position. As in the case of the Input Level motor the tacho-generator winding gives an output to feed both the servo amplifier and the relay amplifier (Unit 6.1). Relay 6.1RLA is energised and operates as described in Para.27.

44. This proceeds until zero error is found and the servo motor comes to rest. The input tune is also responsible for setting the coarse anode tune and loading including selecting the correct frequency ranges on the various coils of the output circuit.

Coarse Tuning Selection (Refer to Fig.107)

45. As the Input Tune servo-motor turns, the following will also be taking place. When 6.5ITA2 (12B) changes over to connect the coarse Tuning information a voltage derived from a bridge network is fed to the Anode Tune Servo Amplifier. The bridge comprises 2RV4 and resistors 11R1-R6 and the output voltage is set by the selected range relay. As the output voltages are specific to each range the servo amplifier will tell the servo-motor to move to a set position.

46. When 6.5ITA3 (4B) changes over to connect the coarse Loading information a voltage derived from a further bridge network is fed to the Anode Loading Servo Amplifier. The bridge comprises 2RV5, 2RV6 and one of the resistors 11RV1-RV5, depending on the range selected. In

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this case it will be noted that 2RV6 is driven by the Input Tune servo-motor and 2RV5 is driven by the loading servo-motor so the coarse setting of the loading coil is relative to the input tune setting and will be near the final required setting.

Range Selection (Refer to Fig.104 lower right-hand corner.)

47. As the input tune servo motor 2MG3 rotates it drives the range selection cams; if the frequency is in the range already selected no change of Range will be caused. It can be seen from the diagram that Range 1 is selected by the cam marked RANGE 1-2. If the required radiated frequency is in range 4 then the cams will rotate. When range 1-2 cam reaches the end of range 1 the switch 2SQ will change over. When 2SQ changes over it removes the short circuit path across relays 11RMT and 11RML (2SE1 in series with 2SQ across 11RMT and 2SK1 in series with 2SQ across 11RML).

48. As a consequence of this relays 11RMT and 11RML are energised.

RMT1	Closes to complete the neutral return path of the tuning range motor 2IM1 (see Fig.102 square 7G).
RML1	Closes to complete the neutral return path of the loading range motor 2IM2 (see Fig.102 square 7G).
RMT2)) RML2)	Open in series to isolate further the input tune switching circuit (see Fig.105 square 9A).

49. Thus at this point 2MG3 is turning, operating microswitches 2SR and 2SS at their changeover points. 2IM1 and 2IM2 are also turning; these motors also have cam-operated microswitches attached. These are in 11RMT (48F) and 11RML (52F) shorting circuits and in the range relay selection circuits.

When the Input Tune servo motor reaches its correct position it stops, leaving 2SQ, 2SR and 2SS changed over. 2IM1 and 2IM2 turn on, opening and closing their microswitches (2IM1 - 2SE to 2SH and 2IM2 - 2SK to 2SN). When 2SH1 and 2SN1 close the short circuit across relays 11RMT and 11RML will be re-established via the common return path (back contact of 2SS and the front contact of 2ST).

50. With the short circuit re-established 11RMT and 11RML return to the rest position switching off the range motors.

51. The second contacts of the microswitches have also completed a supply path to the range 4 relay 11RRD and this becomes energised, consequently its contacts operate.

11RRD1	Closes in the main h.t. interlock circuit (see Fig.103 RANGE RELAY INTERLOCKS square 23D) to permit 3FHL to be energised.

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11RRD2 (8E Fig.108)	Closes to select the correct resistor for the range for use in the Variable Gain Amplifier Unit 6.6 at plug 6.6PLC(1).
11RRD3 (6E Fig.107)	Closes to supply the coarse information to the anode loading servo system.
11RRD4 (12E Fig.107)	Closes to supply the coarse information to the anode tuning servo system.

Position Summary

52. To appreciate fully the overall system it will be understood from the previous paragraphs that a number of circuits are operative during input tuning namely:

(a) Unit 13 h.t. switching.

(b) Input tuning - (servo-systems working).

(c) Range selection.

(d) Power switching.

Final Tuning Loading and Output Level Setting

53. The end of the Input Tuning sequence comes when transistor switch 6.15VT5 is switched OFF again. This will happen when 6.3RLA1, 6.2RLA1, 6.1RLA1, 3FHL3, 13.2ST6, 11RML2 and 11RMT2 are all closed, putting an earth on its base (see Figs.104 and 105).

54. As soon as the earth line is completed i.e. when the input circuit is tuned, the Input Tune relays will be de-energised and 6.51TA, 6.13ITB, 6.13ITC and 6.16ITD will all revert to the rest condition. Refer to Fig.105.

6.16ITD1 (15B)	Opens to de-energise the IT relays 6.5ITA, 6.13ITB and 6.13ITC.
6.13ITB2 (15D)	Opens to de-energise the frequency change relay 13FCB. However, 13FCB is slow-to-release due to the capacitors across it, and this gives sufficient time for the Relay Amplifier contact 6.2RLA2 associated with the Anode Tune Tacho-generator to operate (as the Tuning Motor starts to move). This maintains the FC relays energised.
6.13ITC3 (3C)	Closes in the auto interlock circuit completing the supply path to the Final H.T. slave relay 3FHS to energise it (Fig.105).
6.13ITB1 (9D)	Closes to replace the relay amplifier contacts 6.1RLA-1, 6.2RLA-1, 6.3RLA-1 (Fig.105).
6.16ITD3 (12D)	Changes over to reconnect the output of the input level tacho-generator to the servo-amplifier (Unit 6.12).

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5ITA1 (7E Fig.106) Changes over to connect the output of the output level comparator to the input servo-amplifier (Unit 6.12).

5ITA2 (12B Fig.107) Changes over to reconnect the Anode Tuning fine information to the Anode Tuning Servo Amplifier.

5ITA3 (4B Fig.107) Changes over to reconnect the Anode Loading fine information to the Anode Loading Servo Amplifier. Refer to Fig.106.

5ITA4 (16E) Changes over to reconnect the output of the input level tacho-generator to the relay amplifier (Unit 6.1).

13ITB3 (11B) (All change over to reconnect the input level servo
(motor control winding to the servo amplifier (6.12)
13ITC2 (12G) (leaving the control winding of the input tune servo-
(motor shorted out.
13ITC1 (12H) (

13ITB4 (16D Fig.112) Changes over to light the SETTING O/P LEVEL lamp and extinguish the INPUT TUNING lamp.

13ITC4 (14E Fig.105) Changes over to de-energise 2RLB and re-energise 2RLA.

16ITD2 (11E Fig.105) Closes to prepare the COARSE LEVEL transistor switching circuit, 6.15VT2-4, for the next overall sequence.

2RLA1) 46C (Closes to reconnect the output of the input circuit
) Fig. (to the F.S. valve cathode and
2RLA2) 104 (Opens to disconnect the resistive load.

55. The amplifier will be ready to set the output level and tune and load the anode circuit when its main h.t. is switched on (6.13ITC3 above and Para.56). In a manual tuning procedure tuning and loading is done progressively, i.e. a little tuning, a little loading, a little tuning etc. The servo systems operate in the same manner and only one will be in progress at any instant.

Switching the main h.t. on

56. When manually tuning the amplifier the h.t. can be switched on as soon as the time delay set by FD is completed.

57. On auto-tuning the amplifier h.t. will be switched on by the control circuit which is continuous from the pressing of the START button When the Range has been selected during the Input Tuning Sequence one of the range relay contacts will prepare the h.t. switching line, of which the delay switch 3FD1 forms a part. As the h.t. is finally switched by the slave relay 3FHS its supply line must be complete. In this are contacts of the Auto Tune Interlocks (Fig.105), the Aerial Feeder Trip contact 5RLA2, the Aerial Interlock Relay contact 17RLA1, the Range Relay Interlocks and external interlocks. At the completion of the Input Tune Sequence all the interlocks will be complete and the h.t. will be switched on as follows.

CONTROL SYSTEM

Refer to Fig.103.

58. The closing of the RANGE RELAY INTERLOCKS extends the 50V control supply to relay 3FHL thus energising it.

3FHL (19E) Is operated and held on by the subsequent action of 1FHC5 (provided the equipment is safe and without faults).

3FHL1 (26G) Closes to extend the 50V supply to 3FHS and energise it. This 50V is not only supplied via the interlock circuit as is 3FHL but also via further interlock contacts in the feeder trip unit (Unit 5) and the auto tune tray (Unit 6).

3FHL2 (27C) Closes to extend the 50V supply to the biasing windings of trip relays 3HTR and 3STR; it also energises the slave relays 3HTS and 3STS.

3FHL3 (31C) Closes to complete the earth line to the I.T. Transistor switch, so switching off the Input Tune sequence and starting the Fine Tuning Sequence.

59. 3FHS (26G) The final h.t. slave relay operates. 3HTR, the h.t. current trip relay, and 3STR the transformer secondary current trip relay are biased towards the operate condition.

3FHS1)
)(29G) Close in series to complete the earth return path of 1FHC to energise it.
3HTS1)
)
3STS1)

NOTE: 3FHS1 will not close and h.t. cannot be switched on if the Feeder Amplifier relay 5RLA remains un-energised or the Auto Tune Interlocks are not complete.

60. 1FHC (29E) The h.t. contactor operates and:-

1FHC1)
) Close to apply the 3-phase mains to the h.t. trans-
1FHC2)(32B) former 1T1 via the closed mains isolator 2SA.
)
1FHC3)

1FHC6)(4B Fig. 105) Closes to replace the contacts of the frequency change and coarse level relays, as the Unit 13 remote H.T. ON switch.

1FHC5 (20F) Closes to lock-on 3FHL and replaces the h.t. start push button on local control or 3HRP3 on remote control.

1FHC7 (19A) Closes to light the H.T. ON lamp 3ILP5.

	1FHC4 (22G)	Opens in the h.t. restoration circuit removing the short circuit from relay 3HRP, thus energising it.
61.	3HRP (22G)	The h.t. restoration priming relay operates causing
	3HRP1 (22F)	to open - further extending the open circuit across 3HRP, and locking HRP on.
	3HRP2 (23F)	Closes to extend the thermal element circuits of the h.t. restoration circuit.
	3HRP3 (19F)	Opens in the remote control circuit. When remote operation is used it replaces the h.t. start switch.
	3HRP4 (9B Fig.105)	Closes across unit 13 h.t. contactor interlock, to avoid when a trip occurs, switching back to the Input Tune condition while the three shot system is in action.

Anode tuning and loading setting

Refer to Fig.108.

62. When the h.t. is switched on the Anode Tuning Phase Discriminator is fed with a signal from the cathode circuit (now in tune) and a signal from the anode circuit (out of tune). The phases of the two signals are compared and the output fed via the variable amplifier (Unit 6.6), to the anode tuning servo-amplifier (see Chapter 7 Para.64).

63. The output fed to the Anode Tuning Servo Amplifier (Unit 6.11) energises the control winding of the Anode Tuning servo motor. As the motor turns the tacho-generator winding gives a feedback output to the servo-amplifier and an output to the relay amplifier (Unit 6.2) where relay 6.2RLA is energised.

6.2RLA1 (9D Fig.105)	Opens without effect (by-passed by 6.13ITB1).
6.2RLA2 (16D Fig.105)	Closes further to hold on the frequency change relays (see Output Level Setting & 6.1RLA2).
6.2RLA3 (6C Fig.109)	Changes over to isolate the output of the Anode Loading comparator so preventing its operation whilst tuning is taking place.

64. On the output of the Anode Tuning phase discriminator becoming zero the Tuning servo motor will stop and Relay Amplifier (6.2) circuit becomes de-energised. 6.2RLA contacts return to rest.

6.2RLA1	Closes without effect. (By-passed by 6.13ITB1)
6.2RLA2	Opens to isolate the supply path to the frequency change relays but they remain held on by the charge across 6.5C1 and 6.5C2 as when 6.13ITB2 opened.

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6.2RLA3	Changes over reconnecting the Loading comparator output via the Feedback and Auxiliaries unit to the Anode Loading Servo Amplifier (Unit 6.10) and thus to the Anode Loading servo motor control winding.

Refer to Fig.109.

65. The Loading motor turns and the tacho-generator winding gives an output which feeds back to the Servo amplifier and energises the relay amplifier (Unit 6.3) and therefore operates relay 6.3RLA.

6.3RLA1 (9E Fig.105)	Opens without effect (by-passed by 6.13ITB1).
6.3RLA2 (15D Fig.105)	Closes to hold on the frequency change relays (see Output Level Setting & 6.1RLA2).
6.3RLA3 (9D Fig.105)	Opens without effect (by-passed by 6.16CLA2).

66. As the loading changes so does the tuning and therefore the Tuning comparator gives an output, and due to relay contact-set, 6.2RLA3 (see Fig.109) is given priority and so the tuning and loading move progressively into a correctly tuned and loaded condition.

Output Level Setting

67. The output level is set by re-setting the input level using the same Servo system in order to achieve a specific value of r.f. anode volts. With the anode circuit off-tune the tendency is for the input level to be greatly increased to achieve the required volts; this is undesirable and therefore a level limit circuit is needed.

Level Limit

68. To turn the drive level up very high in the initial off resonance condition in an attempt to achieve the specified r.f. anode voltage would result in a high cathode current and over-dissipation in the anode. A level limit circuit is used to prevent this from happening and the operation of this circuit is described in Chapter 7.

Output Level

69. It will be seen from Fig.106 that the output of the Output Level Comparator is connected via 6.16CLB1 (normally closed) to the Input Servo Amplifier. Once again the input level is set-up until the comparator output is zero. During this period the relay amplifier controlled by the tacho-generator winding of the Level motor operates the relay 6,1RLA.

6.1RLA1	Opens without effect (by-passed by 6.13ITB1)
6.1RLA2	Closes to hold-on via 5FCA1 the frequency change relays 5FCA and 13FCB before the delay started by 13ITB2 opening has elapsed to de-energise them.
6.1RLA3	Opens without effect (by-passed by 6.16CLA2).

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CONTROL SYSTEM

NOTE: When an amplifier will not complete the final stage of the tuning sequence, due to the varying impedance of a swinging open wire feeder, Unit 6.7 is used to facilitate the switching through of the amplifier to the Tuning Complete sequence 60 seconds after the SETTING OUTPUT LEVEL has commenced. The control sequence for Unit 6.7 is given in para.145, 146.

70. On the anode circuit completing loading, tuning and level setting sequence relays 6.2 and 6.3RLA are de-energised, and the hold-on time for the frequency changing relays is exceeded and they also become de-energised.

6.13FCB1	(13C fig.112)	Changes over in the extended control indicator lamp circuit - Tuning Indicators.
6.13FCB2	(11G fig.106)	Changes over to isolate the output of the input servo amplifier (Unit 6.12) and earths the 'live' input to the level servo motor.
6.13FCB3	(15E fig.112)	Changes over to light the Tuning Complete Range.
6.13FCB4	(17C fig.105)	De-energises 6.5FCA.
6.5FCA1	(17C fig.105)	Opens to further isolate the supply path of the frequency change relays.
6.5FCA2	(2F fig.105)	Disconnects the -33V signal from the TUNE/TRAFFIC and THRESHOLD switching circuit, and connects it to the Anode Loading and Anode Tuning de-sensitizing circuits in the Feedback and Auxiliaries Unit (Unit 6.6). The TUNE/TRAFFIC switch is thus set to TRAFFIC and the threshold relay (6.13TR) switching circuit is disconnected from the -33V supply. A hold circuit in the Discriminator Unit (Unit 10) prevents the relay from being energised at this point.
6.5FCA3	(5B fig.105)	Opens to remove the by-pass loop across the Unit 13 H.T. ON Remote switch 1FHC6.

ANODE LOADING BISTABLE

71. In some cases where a new frequency is being set up, the anode tuning capacitor will be near-to-minimum capacity and the anode tuning control will attempt to tune the circuit by decreasing its capacity, but because of its position the capacitor will strike an end-stop before the circuit is tuned. In this state the anode volts will be low and not peaked at resonance - the normal condition when a π circuit is tuned. As the Loading Comparator output is a function of whether the anode volts are high or low, then the output under these circumstances would cause the loading servo motor to turn to increase the anode volts, i.e. increase the capacity and moving further out-of-tune.

72. To prevent this, secondary contacts of the anode tune motor limit switches are connected to a bistable circuit in Unit 6.6 to provide, during normal operation, an earth at 6.6PLA(10) and an open circuit at 6.6PLA(9). This condition provides a through path for the Anode Loading Comparator output to the Anode Loading servo Amplifier.

73. On the anode tuning end-stop being reached the switches 2SAG2 and 2SAH2 change over to provide an earth on 6.6PLA(9) and an open circuit at 6.6PLA(10). This reversal causes the bistable to change over, disconnecting the output of the Loading Comparator and connecting a 10V a.c. signal, whose phase relationship with the servo motor references supply causes the loading servo motor to decrease the capacity. When the decreasing capacity reaches a value at which the anode tuning discriminator finds the circuit in a condition where it can retune it, it takes command (through 6.2RLA3) to move its capacitor away from its end-stop to return the loading circuit to normal so that tuning and loading can proceed normally.

THRESHOLD RELAY

74. The threshold relay 6.13TR is held de-energised by an output from the discriminator unit as long as the amplifier output is above a certain minimum. If this minimum is reached for a certain time period then the relay will operate and isolate the servo motors; this prevents the servo motors drifting when no signal is applied to the amplifier, see Chap.7, para.118.

PROTECTION CIRCUITS

75. As previously stated this equipment is virtually a combination of two equipments, each having its independent switching circuit, which together form an overall control circuit. This also applies to the protection circuits which protect the equipment against faults which, if prolonged, would damage the equipment.

76. The Amplifier has seven h.t. tripping circuits, three in Unit 13 and four in the final stage. These do not include the interlock circuit which will also trip off the h.t. if it is broken.

77. Unit 13 trip circuits are:

(a) Air trip

(b) H.T. current trip

(c) S.W.R. trip

and a full description of their operation is given in the Manual AP 116E-1207-16.

78. The final stage trip circuits are:

(d) Air trip

(e) H.T. transformer secondary trip

(f) H.T. current trip

(g) Feeder trip

CONTROL SYSTEM

79. The circuits (a), (d) and (e) cause the equipment to be switched off and locked-out immediately a fault occurs; (b) and (c) cause Unit 13 only to be switched off and restarted by Unit 13 one-shot restoration circuit before locking-out if the fault is still present; (f) and (g) cause the main h.t. only to be switched off and restarted by the three-shot restoration circuit before locking-out if the fault is still present.

Unit 13 Air Trip

80. On an air fault developing, the equipment will be locked-out immediately by causing both the Unit 13 start and main h.t. contactors (13.2MS and 13.2ST respectively) to be de-energised. This has no effect in the overall control circuit as the interlock contact 13.2ST6 is by-passed by 3HRP4.

Unit 13 H.T. and S.W.R. Trip

81. If a fault occurs, the unit 13 h.t. or s.w.r. trip will attempt a one-shot restoration before locking-out if the fault is persistent. Its effect on the overall circuit is as follows:

82. On the first indication of a fault, unit 13 contactor 13.2ST (main h.t.) will be switched off opening 13.2ST6 without effect (by-passed by 3HRP4). Restoration takes place and the amplifier will continue to operate unless the fault persists, in which case 13.2ST will be de-energised, switching off the unit 13 and locking it off.

Final Stage Air Trip (Refer to fig.102)

83. This trip circuit comprises two switches each covering different aspects of the air flow. One, 2SC(15E), is closed by the pressure of air from the Fan; the other 2SZ(15E) opens when the air pressure across the air filter indicates that the filter is in need of cleaning.

84. The switches are in series and in the supply path to the filament pilot relay 3FP so that when either opens the pilot relay is de-energised.

3FP1 (15E) Opens to de-energise the auxiliary supplies contactor 1ASC and all the subsequent circuits become de-energised.

3FP2 (15A) Opens to switch off the AIR lamp 3ILP2.

When 3FHL3 and 3HRP4 open (9B fig.105), once again the switching unit earth is interrupted and the amplifier reverts to the Input Tune condition.

1FHC6 (4B fig.105) Opens in Unit 13 h.t. circuit and switches it off.

Final Stage Air Temperature Trip (Refer to fig.104)

85. The final stage valve is set in an air duct with cooling air being drawn down through it. To protect against a fault which causes the valve to overheat, a series of thermostats 2X1 to 2X9 (41F) have been arranged in the amplifier. 2X5 to 2X9 are mounted in the air outlet duct closing at the

temperatures shown against them; 2X1 to 2X4 are mounted in the bottom of Unit 2 in a temperature slightly above ambient and open when this temperature reaches the temperature shown against them. When the air flow is inadequate or over-dissipation in the F.S. Anode is occurring, the Amplifier will be tripped-off, e.g. when the room temperature is above 16°C and below 25°C (i.e. 2X1 open) a trip will be furnished when 2X6 closes at 73 °C, 2X5 having closed at 66 °C without effect. The remainder of the thermostats operate in a similar manner.

86. The effect of a trip is to put a short-circuit across terminals 2TS1 (22) and (23), see fig.103, square 22G.

87. Refer to fig.103. A short-circuit across the terminals 2TS1 (22) (23) will cause the air temperature relay (3AT) to be energised.

3AT2(26G)	Opens to de-energise 3FHS, and its contact 3FHS1 opens to de-energise the h.t. contactor 1FHC thus switching off the h.t. and via 1FHC6 Unit 13 h.t. (see para.60).
3AT4(25F)	Closes to energise the lock-out relay 3LOR.
3AT1(20G)	Closes to hold-on 3AT when the short-circuit is removed due to the cooling of the thermostats.
3AT3(20A)	Closes to light the AIR TEMP. trip lamp 3ILP8.

88. The operation of the lock-out relay is described under the h.t. current trip (see para.96 to 102).

89. The subsequent action of 3LOR2 de-energises 3FHL and 3HRP. Contacts 3FHL3 and 3HRP4 open to revert the amplifier to the Input Tune condition (see para.40).

H.T. Transformer Secondary Trip

90. The three-phase outputs of the secondary of the h.t. transformer are fed to the h.t. rectifier bank via three current transformers, one to each phase.

91. As current flows from the transformer a proportionate current flows in the current transformer secondaries. When an excessive current flows from the h.t. transformer the resultant current in the current transformers is used to energise the secondary trip relay 3STR(28G).

92. The operation of 3STR, adjustable by the variable resistor 3RV2, causes:

3STR1(28G)	To change over, removing the earth from the slave relay 3STS to de-energise it, and puts an earth on the display relay 3STD to energise it.

CONTROL SYSTEM

93. The operation of relays 3STS and 3STD causes:

3STS1(29G) To open to de-energise the h.t. contactor 1FHC, thus switching off the h.t. and through 1FHC6 the Unit 13 h.t.

3STD3(24F) Closes to energise the lock-out relay 3LOR.

3STD1(20G) Closes to hold-on 3STD when the excessive current is switched off by 3FHC1, 2 and 3.

3STD2(21A) Closes to switch on the secondary trip lamp.

94. As in the case of the Air Temperature Trip the subsequent action of 3LOR2 de-energises 3FHL and 3HRP and contacts 3FHL3 and 3HRP4 open to revert the amplifier to the Input Tune condition.

H.T. Current Trip (Refer to fig.103)

95. The output of the h.t. rectifier bank has a metering potentiometer across it and the main output to Unit 2 returns through 1R9 (30G). Thus the voltage drop across 1R9 is proportional to the h.t. current. When excessive current flows in 1R9 the voltage across it rises and this voltage is used to energise the h.t. trip relay 3HTR (27G).

96. The operation of 3HTR, adjustable by variable resistor 3RV1, causes:

3HTR1(26G) To change over, removing the earth from the slave relay 3HTS to de-energise it, and puts an earth on the display relay 3HTD to energise it.

97. The operation of relays 3HTS and 3HTD causes:

3HTS1(29G) To open to de-energise the h.t. contactor 1FHC, thus switching off the h.t. and through 1FHC6 Unit 13 h.t.

3HTD1(21G) Closes to hold-on 3HTD when the trip voltage is switched off by 1FHC1, 2 and 3.

3HTD2(21A) Closes to switch on the H.T. Trip Lamp 3ILP9.

1FHC1)
)
1FHC2)(32B) Open to de-energise the h.t. supply circuit.
)
1FHC3)

1FHC4(22G) Closes in the h.t. restoration circuit to energise the thermal relays 3HRB and 3HRC via relay set 3HRP2 (now closed). It also energises the lock-out integration thermal relay 3LIR which has a long time delay compared with 3HRB and 3HRC.

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1FHC5(20F) Opens to de-energise 3FHL. Although 3FHL3 opens the transmitter will be held in the fully tuned condition by 3HRP4.

1FHC6(4B fig.105) Opens without effect (by-passed by 3HRP4).

1FHC7(19A) Opens to extinguish the H.T. ON lamp.

3HRC1(23F) Opens without affecting the circuit (3HRA2 being open already).

NOTE: When 3HRC heater is de-energised this contact is the final link in the restoration of power to relay 3FHL via 3HRA2.

3HRB1(23E) Closes to energise the h.t. restoration relay 3HRA.

3HRA1(23E) Opens to de-energise the thermal relays 3HRB and 3HRC.

3HRA3(24E) Closes to hold-on 3HRA.

3HRA2(22E) Closes to extend the earthing circuit of relay 3FHL.

98. When the cooling cycle of 3HRC is completed its contact 3HRC1 closes to restore the earth to 3FHL, whose operation will cause the h.t.s to be reapplied by the normal switching sequence.

1FHC5(20F) Returns to its role of replacing the H.T. START switch.

1FHC4(22G) Opens to release the restoration relay 3HRA and the partially warmed integration relay 3LIR.

99. With the h.t.s reapplied to the equipment the fault which caused the excessive current may now have cleared and so the equipment will continue in service. The lock-out integration relay 3LIR will completely cool and return to the ready state.

100. Where the fault persists 3HTR will once again operate and the sequence as described will once again be repeated, but as 3LIR is energised in a partially heated state at the completion of this cycle it will be nearer to its operating point.

101. Reapplication of h.t. takes place again and if the fault has now cleared the equipment continues in service. With the persistent fault the restoration circuit will once again attempt to reapply power with 3LIR being even nearer to its operating point.

102. Reapplication of h.t. again takes place and if the fault has now cleared the equipment continues in service, if not the restoration circuit is energised but the heating of 3LIR has brought its operating time to less than the operating time of 3HRB and 3HRC. Thus after three attempts at restoration 3LIR(24F) closes to extend the earth circuit of the lock-out relay 3LOR(25E), thereby energising it.

3LOR1(25F) Closes to lock-on 3LOR.

3LOR2(19D) Opens to isolate 3FHL, and the restoration circuit from the 50V supply.

3LOR3(26A) Closes to switch on the LOCKOUT lamp.

Feeder Trip (Circuit Diagrams fig.103, 104, 113 & 114)

103. Fig.104. The r.f. output of the amplifier is fed by a coaxial feeder to the load via a directional coupler (Unit 8) from which outputs dependent upon forward wave and reflected wave power content are obtained (see fig.115).

104. These outputs are fed into Unit 2 (square 50B fig.104) where, in the switch positions shown, the forward power is indicated on the meter 2M4(53B) (and on the external meter if links LKA and LKB are properly set up). Depressing switch 2SX will indicate the reflected power on the meter(s).

105. Refer to fig.116. Sample signals from both these circuits are fed to the Amplifier Relay Unit (Unit 5) at 5SKTA(12) and 5SKTA(13) where the forward power will tend to hold relay 5RLA(9F) energised and the reflected power will try to de-energise it.

106. When the reflected power exceeds a predetermined level which represents 2.5 v.s.w.r. on the feeder, then 5RLA is de-energised. Refer to fig.103.

5RLA2(26F) Opens to de-energise the final h.t. slave relay 3FHS, its subsequent circuits switching off the amplifier and W.B.A. h.t.s.

5RLA1(23H) Closes to energise the feeder trip display relay 3FTD via 1ASC7.

107. The de-energising of the h.t. relay 1FHC causes the three-shot restoration circuit to operate as previously described in the H.T. Current Trip, para.95.

STOP AND RESET

108. To switch off or reset the amplifier from a lock-out condition press the STOP switch 3SB. The control circuits will return to the coarse level condition as 3RCA2 will open the earth switching line to the transistor switch VT1 in the switching unit (Unit 6.15).

109. All the auxiliary and h.t. supplies are switched off and the lock-out condition cleared ready for the restart if required.

Trip Lamp Reset (Refer to fig.103)

110. In the case of a successful restoration to normal operation by the 3-shot system, the Feeder Trip Lamp or H.T. Trip Lamp will remain lit (indicating that a fault has occurred but been cleared). These trip lamps

can be cancelled without interfering with the normal operation of the amplifier by depressing the Trip Lamp Reset switch 3SF(21E) which is a biased toggle switch.

Switching Off

111. The amplifier is switched off by pressing the STOP and RESET switch (3SB), which is in the supply path to relays 3RCA and 3RCB. This causes all the control circuits, after a 10-minute air-hold delay, to revert to the AVAILABLE condition. The amplifier state during this 10 minutes is that, with the exception of the fan circuit, all circuits are at AVAILABLE. Reswitching on may take place in this 10 minutes if necessary.

Air-hold (Refer to fig.102)

112. When the h.t. is ON contactor 1FC is energised and locked-on by 1FC5 and 3RCB1 in parallel. The air-hold circuit is prepared by 1FC4 awaiting the closing of 3RCB3.

113. When the amplifier is switched off 3RCA and 3RCB are de-energised.

3RCB3(6C)	Closes to heat, via 1FC4, the thermal delay relays 3AHB and 3AHC.
3RCB1(5E)	Opens without effect to ensure the correct operation of 1FC when next switching on.

114. The thermal relays heat up and 3AHC1(5F) closes across 3AHA1 after approximately ½ minute. The relays continue heating until 3AHB1(6E) closes after approximately 3½ minutes.

3AHB1(6E)	Closes to energise 3AHA(6G).
3AHA	Contacts set the following:
3AHA1(5F)	Opens without effect, 3AHC1 remaining closed due to the heat effect.
3AHA2(6E)	Closes across 3AHB to lock-on 3AHA.
3AHA3(6E)	Opens to switch off the heater supply to the thermal relays.

115. The thermal relays begin to cool and

3AHB1(6E)	Opens without effect: by-passed by 3AHA2.
3AHC1(6F)	Opens at the end of the 10-minute delay and switches off the fan contactor 1FC.

1FC1)
)
1FC2) (14D) Open to isolate the fan supply switching off the fan,
) subsequently low air pressure releases the filament pilot
1FC3) relay 3FP.

1FC4 (6D) Opens to de-energise relay 3AHA

1FC5 (5E) Opens to reset the 1FC switching circuit.

1FC6 (13D) Opens to de-energise the internal blower (if fitted).

3FP2 (15A) Opens to estinguish the AIR lamp.

116. The contact sets of 3AHA return to the rest condition and the amplifier is in the AVAILABLE condition.

FREQUENCY CHANGING

117. When the amplifier is in operation and it is desired to change frequency, it is only necessary to reset the decade frequency controls on the front of the Frequency Synthesizer Type H1500. The turning of these switches changes the bias conditions by a series of pulses on transistor switch 6.15VT1 causing the whole of the amplifier to shut down to the Coarse Level stage of auto-tune sequence. The amplifier begins to tune itself to the new frequency and to return to traffic on completion of tuning without further assistance from the operator.

Refer to Fig.105.

118. The transmitter-switching wafers of the decade switches in the synthesizer are make-break-make types so that two conditions are obtained (a) line open (b) line closed. Thus turning the controls has the effect of producing a series of pulses at the base of the switching transistors 6.15VT1 (8G). The transistor circuit is so arranged that a "line open" pulse switches off the transistor and this causes capacitor 6.15C1 (9F) to charge and then discharge through 6.15R6 and R7 to bias the amplifier 6.15VT2 for a period long enough to energise the coarse level relay 6.16CLA (12F) via the trigger circuit 6.15VT3 and VT4 (full description given in Chapter 7, Para.116).

119. Immediately the coarse level condition is established and locked-on the Input Level comparator output may indicate the setting is correct and the "line closed" pulse will endeavour to establish the Input Tune condition. However, a second delay circuit C3 (9G), R13 and R16 (Unit 6.15) will also have been charged on a "line open" pulse to hold amplifier VT5 in an ON state longer than VT2 is in the OFF state, therefore holding off the energising of relay 6.16ITD. This gives ample time for each switch to be set to its new position before the Input Tune condition can be established. However should the condition be established before all the controls have been set the next "line open" pulse will revert the system to coarse level by recharging the two capacitors.

SET COARSE LEVEL (MUTE) (Refer to Fig.105)

120. It is possible to warm-up the equipment prior to the receipt of incoming traffic, and then set to a standby condition whilst awaiting the traffic. This facility is provided by the SET COARSE LEVEL switch (6SH).

121. This is a toggle switch and when in the up position has no effect on the auto-tune circuit. When it is in the down position it provides a +33V supply to the base of the switching transistor 6.15VT1 and switches it OFF resulting in the Coarse Level and Frequency Change relays being energised and the Input Tune relays being de-energised. The +33V supply is used to override any switching changes which may take place in the base circuit and locks the condition on.

122. The facility is also available at the Extended Control Unit in the STANDBY switch (SC) which connects the 50V supply to the switching transistor. In the auto tray is fitted a 1.5 kΩ resistor 6R5 (7G) for dropping this 50V to 33V so that the transistor base voltage is the same from either source.

123. To clear the condition the appropriate switch must be released (set to normal).

INPUT TUNE

124. Whilst testing and setting-up the transmitter it is necessary to hold the Input Tune condition. This facility is provided by the SET INPUT TUNE toggle switch (6SD). It provides, via 6SH, +33V to the bases of transistors 6.15VT2 and 6.15VT5 to hold both transistors OFF resulting in the coarse level relays being de-energised and the Input Tune and Frequency change relays being energised.

125. To clear the condition the switch must be reset to the up position.

CHECK OUTPUT LEVEL

126. When the transmitter is on traffic the output level is not constantly adjusted but has been set as the final operation of tuning and loading. Where it may be considered that the output level is not correct (checking the reading on the power meter) it is possible to reset it. This facility is offered by the SET OUTPUT LEVEL switch (6SC). The switch, when down, connects the 50V control supply to the frequency change relays and the final stage of tuning and loading is established with a TUNE signal called for from the drive and traffic interrupted.

INDICATOR LAMPS Circuit diagram: Fig.111

127. The equipment is fitted with various lamps indicating the state of the equipment and some of these are extended to the extended operating point. Some of these external lamps are paralleled with lamps in the main equipment and some are lit via the Lamp Combining Unit (Unit 12) and Relay Unit (Unit 16).

Extended Co...

128. The Extended Control Unit H1850 has si... ...te... as eight pairs arranged in four groups (a) AVAILABLE (b) STOP (c) ... (d) STANDBY.

Available (Refer to Fig.102 squares 8-14A)

129. This group contains the AUTO and AERIAL lamps. The AUTO lamps are lit via 16RLA1 (10B Fig.112). The AERIAL lamp may be lit via 17RLB1 as shown in Fig.177.

130. When the lamp supply is switched on by Unit 1 mains isolator 1SA the local/remote switch will, when set to REMOTE, connect this supply to the extended control unit via an interlock circuit. The interlock circuit contains 2SA5 a contact of the Unit 2 mains isolator, and a part of the auto/manual switch 6SA. In the AUTO position it also contains part of the SET COARSE LEVEL switch (6SH), the SET INPUT TUNE switch (6SD) and the CHECK OUTPUT LEVEL switch (6SC), the interlock contacts of the auto supply circuit breakers and a contact of the auto tune contactor 1ATC4. In the MANUAL position there are no interlocks beyond the AUTO/MANUAL switch and in the suggested MST system none are normally used.

Refer to Fig.111.

131. These two lines are connected to Unit 12 where they feed via rectifiers and smoothing capacitors the bases of either transistor VT1 or VT2 (depending on the method of tuning chosen). A third input, from the 50V control supply of Unit 13, is connected to a third transistor VT3 to switch it ON. (If the 50V supply is ON the W.B.A. can be switched on).

132. When VT3 is ON this effectively earths the commoned emitters of VT1 and VT2. thus the selected transistor conducts and its collector load relay (16RLA) is energised, resulting in lighting the appropriate lamp.

133. When the setting and checking switches 6SH, 6SC and 6SD are operated on the front of the amplifier the AVAILABLE lamp is extinguished at the remote point.

Stop (Refer to Figs.110 & 112)

134. This group contains the OFF and LOCKOUT lamps. The OFF lamps are connected to the lamp supply of the final stage via 3RCB4 (see Fig.102, square ref.6A and Fig. 112) and are lit as soon as the mains isolator is closed. On the amplifier being switched on (STARTED) the lamp is extinguished as 3RCB4 opens.

135. The LOCKOUT lamps are energised from the 6V supply via relay contact 16RD1. The coil of this relay forms the collector load to either of two transistors in the Lamp Combining Unit and is energised when either transistor is on. One, 12VT4 has its base virtually in parallel with the amplifier LOCKOUT lamp and is therefore switched on when the lamp lights. The other 12VT5 has its base virtually in

parallel with Unit 13 H.T. TRIP lamp and is therefore switched on when that lamp lights. A second contact set of the relay (16RLD2) closes in the alarm circuit. See Para.142.

Start

136. This group contains the ON and FEEDER FAULT lamps. The relay 16RLC is connected as the collector load of 12VT7, whose base is fed in parallel from the amplifier lamp supply. The emitter is connected to earth via a contact of Unit 13 h.t. contactor when it is energised. Thus RLC is only energised when both h.ts are switched on but the lamps will not light owing to a contact of RLB in the Extended Control Unit. This relay is energised when the amplifier is tuning and so the lighting of the lamps corresponds to the state when the amplifier is ready for service.

Standby

137. This group of lamps contains the TUNING and STANDBY lamps.

138. The TUNING lamps are supplied from a changeover contact 6.13FCB1. Whilst Tuning is taking place, i.e. when the frequency change relays are operated, the 6V a.c. lamp supply lights the lamps and energises relay RLV (in parallel with the lamps). The contact set RLB1 opens in the lamp supply to the ON lamp, see Para.136.

139. The STANDBY lamps are paralleled with the Coarse Level lamps of the amplifier, see Fig.112, but have in series with them, in the Extended Control Unit, two switches one a pole of the START switch and the other a pole of the STANDBY switch. This arrangement ensures that the lamps will light only when the extended control unit is in control of the amplifier and when the STANDBY switch is operated.

RELAY ASSEMBLY (UNIT 16)

140. This unit, which is electrically inserted between Unit 12 and the extended control unit, accepts collector current signals from the indicator lamp combining unit (Unit 12) and uses them to energise four relays within the unit. The relay contacts are used to control the indicator lamps in the Extended Control Unit. (See Fig.112).

141. The four relays and associated components are mounted on a small metal chassis located high up on the right side of the final stage compartment (Unit 2). The connections are made to the unit via a multiway plug PLA.

Circuit Diagram Fig.112

142. The four relays RLA-D are connected between the -26V line (brought in on 12PLA(12) and the collectors of the switching transistors in the indicator lamp combining unit. The four diodes (MR1 - MR4) suppress any back e.m.f. which may be developed across the relay coils when the current flowing through them is switched off. All the relay contacts are connected between the 6V line and the Extended Control Unit providing signalling to the E.C.U. RLD2 is arranged between the 6V line and the buzzer (external to unit). Thus when the lockout relay RLD is energised the buzzer sounds in the transmitter room and an indication is sent to the E.C.U. If the buzzer is not required LKA should be removed.

CONTROL SYSTEM

AERIAL INTERLOCK (UNIT 17)

143. Unit 17 is located at the top of the central vertical partition in Unit 1 (see Fig.137). It contains relays RLA and RLB, connected in parallel, and a 75Ω resistor R1 as shown in Fig.176. The purpose of the unit is to prevent the operation of the amplifier when it is not connected to an aerial; the release of RLA and RLB during tune or traffic conditions will cause the amplifier to be held in the first stage of auto tune.

144. The energising supply for the relays is via two wires (50V and earth), either or both of which may be switched by the feeder switch units. Fig.177 shows a particular use of the aerial interlock unit with the Marconi H1410 aerial exchange. The energising path for the aerial interlock relays will vary with local requirements. The 50V source can be obtained from 1TS4(69) and applied to 1TS4(63) via any interlock system devised, in which case 1TS4(64) may be connected directly to earth. Alternatively, the earth path can be switched and 50V connected directly to the relays, or both 50V and earth may be switched as in Fig.177. Whichever system of energising the relays is used, the relays will be energised only when an aerial is connected to the r.f. output of the transmitter. The function of the relay contacts in Unit 17 are as follows:

(a) 17RLA1, which is in series with the range relay interlocks and external interlocks (see Fig.103) inhibits the operation of 3FHL and thus the 'HT ON' sequence described in Para.58, unless 17RLA is energised.

(b) 17RLA2 applies the r.f. drive signal to the input of the wideband amplifier (Unit 13), in its operated condition, or to resistor 17R1 in its released condition.

(c) 17RLB1, when operated, applies a +6V signal to energise lamps ILP3 and ILP4 on the Extended Control Unit indicating that an aerial is connected to the output of the transmitter.

(d) 17RLB2 is in series with the synthesizer decade switches and 3RCA2 (see Fig.105 and Fig.105A). In the released condition it prevents the earth signal being applied to the base of transistor 6.15VT1 to initiate the input tune sequence, thus holding the transmitter in the first stage of auto tune (standby).

145. The provision of Aerial Interlock facility was introduced by Mod A1889, to which Figs.105A and 176 refer.
A further improvement in the performance of the H1200 has now been introduced by Alteration 3 to Mod A1889, to which Fig.176A refers.
Due to the known variations in local requirements the actual wiring necessary to implement Alteration 3 will have to be identified on individual sites. Furthermore, the Note in the Alteration 3 leaflet explains the exact purpose of the desired improvement, and the procedure which applies.

RELAY UNIT (UNIT 6.7)

Refer Figs.141, 178.

146. When an amplifier will not complete the final stage of tuning due to the varying impedance of a swinging feeder, Unit 6.7 is used to switch the amplifier to the Tuning Complete sequence 60 seconds after the Output Level sequence is

commenced. (See para.67-69).

147. When the Setting Output Level lamp lights, 6.7RLA being in the same circuit, is energised:

6.7RLA1	Closes to extend a 50Vd.c. supply to the heater circuit of 6.7RLC and 6.7RLD.
6.7RLD	Closes immediately with no effect; 50V supply to the frequency change relays extended via 6.7RLB3.
6.7RLC	15 seconds after RLA is energised 6.7RLC contacts close and energise 6.7RLB.
6.7RLB1	Opens to remove the 50V from the heater circuit of 6.7RLC and 6.7RLD.
6.7RLB2	Closes to hold on 6.7RLB.
6.7RLB3	Opens with no effect; 50V supply to the frequency change relays extended via 6.7RLD.
6.7RLB4	Changes over to bypass 6.2RLA3, making the circuit from the Anode Loading comparator to the Loading Servo Amplifier (Unit 6.10) (see para.64).
6.7RLD	60 seconds after 6.7RLA has operated 6.7RLD cools down and opens its contacts, thereby removing the 50V supply from 6.1, 6.2 and 6.3RLA2 in the line to the frequency change relays 6.5FCA and 6.13FCB, switching the amplifier to Tuning Complete. (See para.70.)

Chapter 5

POWER UNITS

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Chapter 5

POWER UNITS

RECTIFIER AND CONTROL UNIT (UNIT 1)

DESCRIPTION   Circuit Diagram Figs.102 to 104

1. This is the left-hand cabinet and contains components of the power and control circuits. To give good accessibility to components they are mounted in plug-in units with only large and general components in the cabinet.

The unit's main functions are:-

(a) as a junction unit

(b) as an a.c. distribution unit

(c) as a h.t. power supply unit

(d) as a bias supply unit

(e) to house the auto-tune unit (Unit 6) and control unit (Unit 3)

Junction Unit

2. The unit is the connecting point for all external and inter-unit cables except the input r.f. cable. The external cables may be connected either at the top or bottom of the cabinet, 1TS4 or 1TS6 respectively. 1TS4 and 1TS6 connections 1 to 25 are for the ancillary equipment such as Extended Control Unit Type H1850, 100 kc/s Modulator Type H1503 and the Frequency Synthesizer Type H1500.

3. The external cable apertures are covered with rubber which must be pierced to pass the cables through; this limits the air leaks.

A.C. Distribution

4. The majority of circuit breakers and power contactors is mounted in this unit together with the main a.c. isolator. All these components form part of the control circuits; the Control Circuits description explains their operation (see Chapter 4).

H.T. Power Supply   (Fig.103)

5. The h.t. power supply is a three-phase full-wave rectifier delivering 12 kV. The heavy items such as the transformer and smoothing choke are mounted in the base of the cabinet with the silicon rectifier banks mounted on cylindrical formers above them.

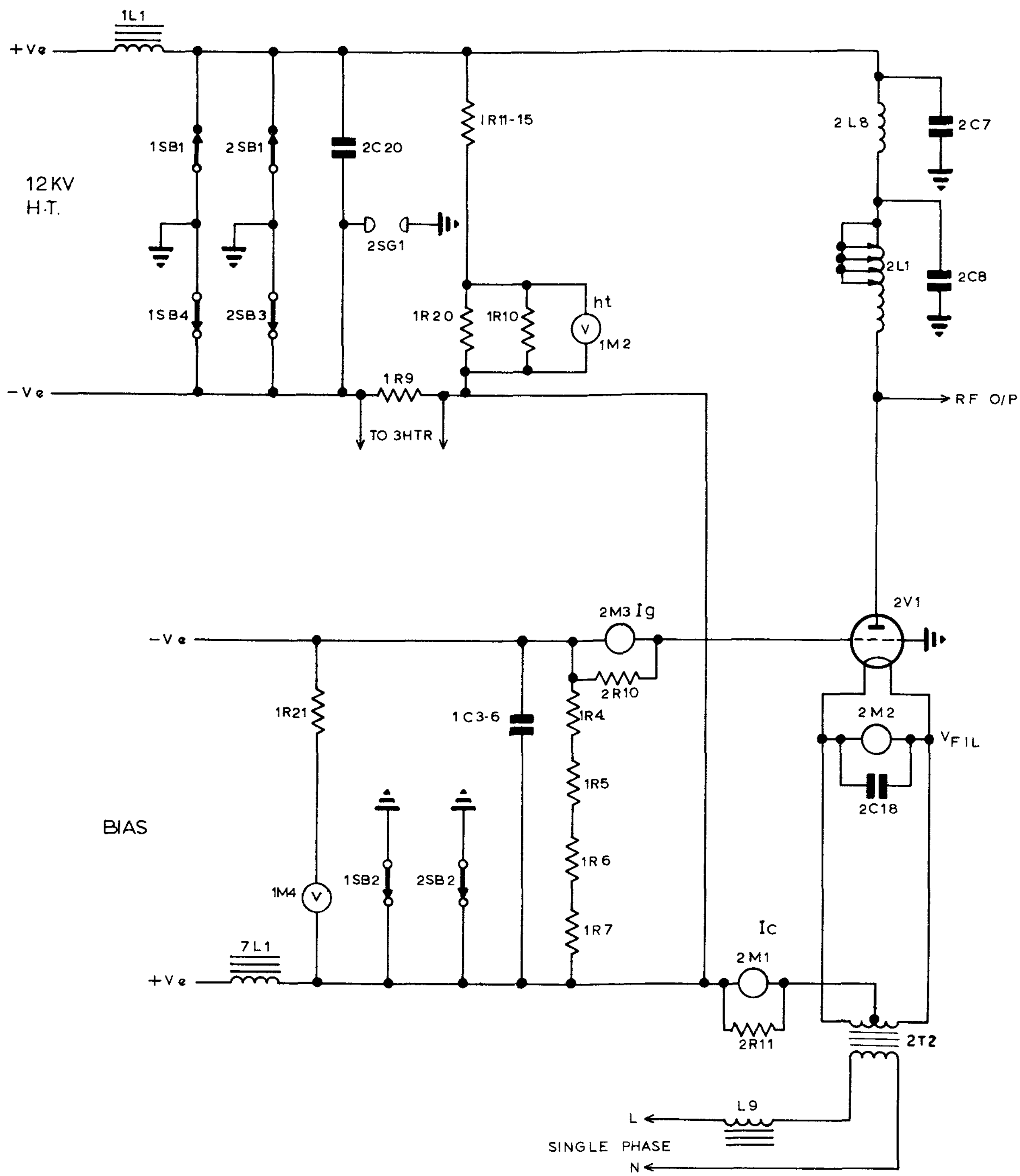

Fig.1 HF TRANSMITTER H1200 VALVE SUPPLIES T30-7511 Sh.8
FUNCTIONAL DIAGRAM. Issue 1

GM

6. The circuit is fitted with transient voltage suppression components *1C7 to 1C9 and 1R16 to 1R18. The supply has a number of protection circuits associated with it both directly and indirectly. Two directly associated with it are:

(a) the transformer secondary trip, and

(b) the h.t. rectifier trip

Transformer Secondary Trip (Fig.103)

7. This circuit is energised from the commoned outputs of the current transformers 1T3 to 1T5, mounted above the h.t. transformer, to operate relay 3STR when the transformer output current becomes excessive. The operating point is set by variable resistor 3RV2. Also fed from the common output of the current transformer is the Level Limit (relay 6.5LL) switching circuit (cathode current reference voltage. (See Chapter 7, para.128).

H.T. Rectifier Trip (Fig.1)

8. 1R9 is in the d.c. return path to the rectifier. Across this resistor are connected relay 3HTR and adjusting resistor 3RV1. Excesssive current drawn from the source increases the current through 1R9 and the increased voltage drop across it energises 3HTR and trips off the h.t. (see Chapter 4, para.95).

Earthing and Output (Fig.1)

9. The final stage valve 2V1 is connected in a grounded grid arrangement where the grid is at earth potential both to r.f. and d.c. This causes both the cathode and anode to be positive with respect to earth. Thus the bias and h.t. supplies are connected in a shunt arrangement to avoid the necessity for the h.t. current to flow through the bias supply. A low impedance source for the bias voltage is ensured by the resistors 1R4 to 1R7 as a bleed across the bias rectifiers.

10. A simplified circuit is shown in Fig.1, from which it can be seen that the h.t. is connected between anode and cathode and the bias between grid and cathode. It can also be seen that the cabinet earthing switches (1SB and 2SB) earth the outputs of the h.t. and bias supplies when the amplifier (power supplies switch) is earthed.

11. The h.t. smoothing capacitor 2C20* (h.t. -ve side) is fitted with a spark gap to protect the bias supply against a h.t. short-to-earth fault. The spark gap which is set to 500V breakdown and is capable of high energy dissipation prevents any damage resulting from this fault.

WARNING. CAPACITORS * CONTAIN PCB. BEFORE HANDLING SEE WARNING FOLLOWING PREFACE TO THIS HANDBOOK.

Bias Supply (Fig.102)

12. The bias supply is a three-phase full-wave rectifier circuit producing 107-127V at 2.5A. The silicon rectifiers and smoothing choke are mounted in a separate unit (Unit 7).

13. The output is fed to Unit 2 as described in para.9 h.t. supply.

CONTROL UNIT (UNIT 3)

GENERAL Circuit Diagram Figs.102 and 103

14. This unit is the fundamental part of the H1200 control circuit and contains lamps, switches and relays of that circuit, and as such is completely described in the Control Circuit description (see Chapter 4).

15. The unit is mounted in unit 1 in the lower right-hand door. All components are accessible from the rear, as the component layout shows (see Fig.138 Part 2), the unit being made of two hinged chassis.

CONTROL CIRCUIT SUPPLY UNIT (UNIT 4)
Identity T30-0300-02 & 03

GENERAL

16. This unit is a multi-purpose unit and is used to supply power for control circuits.

17. The unit provides two outputs:

(a) Output 1 for 'closing and holding' of the 'High speed break' type contactor such as used for main h.t. switching.

(b) Output 2 is to provide a 50V d.c. supply for energising the control relays etc.

DETAILED Circuit Diagram Fig.113

18. Output 1 is rated at 16 joules which is derived from the 4000 μF capacitance discharge and 4.2 volts d.c. at 2.1 amps continuously. It is designed to provide a large burst of energy required for closing the h.t. transformer primary contactor and then to provide the energy required to hold the contactor 'ON' without overloading its coil winding. (The contactor has a high-speed releasing characteristic).

19. In the 'holding' condition, when supplying a load of low resistance, the current is effectively constant. This has the advantage of maintaining constant ampere-turns on the operating coil, irrespective of resistance.

20. The circuit of Output 1 consists of a silicon diode rectifier bridge circuit directly connected to a bank of 'photo flash type' electrolytic capacitors (4000 μF).

21. The rectifier is fed from the secondary winding 'A' of transformer T1 via l.f. choke L1; the choke has the effect of limiting the current on the input (a.c.) side of the bridge and hence on the output, thus protecting the rectifiers from over-current conditions.

22. The rectifier, when switched 'ON' with the output open-circuited, will charge the 4000 μF capacitance up to a peak voltage of 92 volts. When the capacitance is fully charged, current ceases to flow until such a time as a load is applied across its output terminals; TS1(6) and TS1(7). As the normal load is only 2 amps (approx.), the required large burst of energy is supplied by the capacitance.

23. As the supply is unable to replace the capacitative energy as fast as it is being discharged into the load, the output voltage falls rapidly to the holding value due to the limiting action of choke L1. Choke L1 has been proportioned so as to cause the output to remain limited, i.e. 4.2 volts at 2.1 amps. (L1 is provided with tappings for operating at 60 c.p.s)

24. Resistor R5 prevents sparking on the contacts of the earthing switch of the Amplifier.

25. Output 2 is 50V at 0.75 amps d.c. full load and is used to supply control relays and other control circuits.

26. The circuit consists of a silicon diode rectifier bridge circuit fed from the secondary winding 'B' of transformer T1. The rectifier output is smoothed by the action of l.f. choke L2 and capacitors C7 and C8.

27. Resistor R4 is used as a bleed resistance to improve the regulation of the rectifier over its working range. Resistors R3 and R2 with capacitor C6 and resistor R1 with capacitor C1 are used as surge suppression circuits and it is important that they are correctly connected.

Refer to Circuit Diagram Fig.102.

28. A mains circuit breaker (1CBB), fitted in the parent equipment, effectively protects the transformer (T1) and the circuit is self-protected beyond choke L1 by the limiting action of the choke.

29. Protection for output 2 rectifier is provided by an instantaneous trip coil (E & F) in the mains circuit breaker which is d.c. operated and connected in the negative line of the output.

POWER UNITS

±33V STABILIZED POWER SUPPLY (UNIT 9)
(Identity T30-2217-01)

GENERAL

30. This unit supplies two stabilized voltages each at 33V with respect to earth, but of opposite polarity. The stabilized outputs are for use with various units of the auto-tune systems of the Marconi self-tuning amplifier equipments.

MECHANICAL

31. The unit is built around its transformer T1, offset by pillars and insulation where required. The transformer has a 3-phase star-connected primary winding A, B & C, each winding being tapped for 380, 400, 415 & 440V. There are two secondary windings, each delta-connected with terminals marked a2, b2 & c2 and a4, b4 & c4 which are situated at the back left-hand side of the transformer and all the terminals covered by a 'safety' cover.

32. The transformer is fitted in the parent equipment cabinet by four screws and distance pieces, with the variable controls facing the front of the Amplifier. Each control is fitted with a spindle locknut and a spindle cover.

33. These controls are the variable resistors RV3, RV4 and RV1, RV2, which are used for ADJUST RIPPLE & SET LEVEL for the +33V and -33V outputs respectively. Above these controls is the terminal strip TS1 for the -33V outputs and the earth connection.

34. Behind these controls, mounted on pillars, is the printed board assembly which carries most of the components forming the circuits, excluding transistors VT3 & VT6 and capacitors C2, C4, C5 & C6, the latter being on the left-hand side of the unit.

35. Transistors VT3 & VT6 are mounted on heat sinks which are mounted on insulator studs on the back and front frameworks of the transformer.

ELECTRICAL Circuit Diagram Fig.114

36. The input to the unit is a 380/440V, 3-phase, 50 or 60 c/s supply and its two outputs are +33V and -33V with respect to earth.

37. Transformer T1 has a star-connected primary and two delta-connected secondaries. Each secondary supplies a similar 3-phase, full wave rectifier circuit, the outputs of which feed two stabilizing circuits.

38. As the two stabilizing circuits are similar, only the -33V circuit is described.

39. The output impedance (and ripple) of the full-wave rectifier circuit is reduced by capacitor C5.

40. Transistor VT3 is in series with the load and is driven by VT2, the two transistors forming a high gain pair. R5 provides current for VT2 to maintain its current gain (which varies with current) when the base current of VT3 is low.

41. The reference voltage applied to the emitter of VT1 is derived from the voltage across C5 via a two-stage Zener stabilized circuit comprised of resistor R1, Zener diodes MZ1 & MZ2 and R2 & MZ3.

42. A proportion of the output voltage, across C2 & R7, is taken from the potentiometer formed by MZ4, MZ5, MZ6 and MZ7 and variable resistor RV2 and R6 to the base of VT1. VT1 collector current, which is dependent upon the difference in voltage between its base and emitter is fed via R4, which also feeds the base current to VT2, therefore an increase in collector current of VT1 decreases the base current of VT2. C1 reduces the tendency to oscillate at high frequency. C2 is required for circuit stability when an inductive load is applied. R7 provides a minimum load current.

43. If the output voltage tends to go more negative, VT1 base goes more negative causing an increase in its collector current which decreases the base current of VT2 and VT3. Therefore the collector-emitter resistance of VT3 increases and causes a drop in the output voltage, i.e. the voltage becomes more positive. This counteracts the initial increase and, as the gain of the amplifier is high, good stabilization results.

44. Further negative feedback is applied to base of VT1 via R3 and RV1 (ADJUST RIPPLE) to reduce the 300 c/s ripple on the output, RV1 being used for this adjustment.

45. RV2 (SET LEVEL) provides adjustment of the output voltage.

46. Zener diodes MZ4-MZ7 pass any output voltage variation to VT1 base with only little attenuation, thereby maintaining the good stabilization.

INDICATOR LAMP COMBINING UNIT (UNIT 12)

(Identity T30-5878-01)

GENERAL Circuit Diagram Fig.111

47. The H1200 Amplifier has various indicator lamps to show the state of the equipment. In this equipment there are two methods of energizing lamps:-

(a) in the W.B.A. - by logic circuits finally using a transistor collector current, and

(b) in the final stage by conventional relay contacts from a 6V a.c. supply.

POWER UNITS

48. When the control of the equipment is passed to an Extended Control Unit these indications are also extended. This unit combines the two systems for those lamps on the Extended Control Unit indicating a combination of functions which are partly in the W.B.A. and partly in the main amplifier.

49. The unit also contains a -26V power supply unit.

ELECTRICAL

50. The unit is made up of a number of transistor switch circuits, with the relays of the Relay Unit (Unit 16) forming the collector loads. The collector supply is -26V from the internal power supply.

51. As with all transistor switch circuits the base voltage is used to control the transistor operation. It will be remembered that the final stage lamps are a.c. lit and thus the paralleled output to the combining unit is also a.c. To be able to use this as transistor base voltage a rectifier and a capacitor, and where necessary a dropper resistor, are inserted in the base circuit.

52. One circuit, the MANUAL/AUTO circuit, varies from the others in that the W.B.A. must have the Mains supply on before anything can happen in the H1200, thus there are three transistors, two connected as described but their emitters are commoned as collector load to the third transistor. When this third transistor conducts, i.e. it has a base voltage derived from the W.B.A. 50V supply (therefore indicating the W.B.A. is on) then the collector-emitter junction conducts and the two commonded emitters are earthed. An input (base voltage) to either will switch them on as previously described.

POWER SUPPLY

53. This is a full wave rectifier delivering -26V for use as the collector supply. The output voltage can be set by a variable resistor RV1 in the a.c. input to the transformer.

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Chapter 6

R.F. CIRCUITS

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Chapter 6

R.F. CIRCUITS

FINAL STAGE R.F. UNIT (UNIT 2)

GENERAL Circuit Diagram Figs.102 to 104

1. Unit 2 houses the final r.f. amplifier 2V1, the servo-motors which rotate its tuning components and a number of units which are associated with its operation.

2. The final amplifier is a single valve linear amplifier operating in a grounded grid circuit, the grid being directly at d.c. earth. The circuit comprises an input directional Coupler, a cathode tuned circuit, an anode πL tuned circuit and an output Coupler. Both the anode variable capacitors are vacuum types as also are the variable capacitors in the cathode tuned circuit.

3. The r.f. input from the driving amplifier (Unit 13) is fed to the input directional coupler (Unit 15) where a d.c. output derived from the reflected power coupler feeds the Level Limit (relay 6.15LL) switching circuit (drive reflected power). A sample of the r.f. forward power is fed to the monitor plug 2PLM.

4. The main output of the coupler is fed to the cathode tuned circuit (2C10, 2C11 and 2L6) from which sample signals are fed to the Input Tune Discriminator (Unit 14). The output of the tuned circuit is connected via one of two relay contacts to either a resistive dummy load (2R16 and 2C31) or the cathode of the valve. The reason for this is that during Input Tuning the input circuit requires to look into a constant load which is equivalent to the valve when properly tuned and loaded.

5. When the input circuit is matched to this impedance (tuned) then 2RLB1 opens to disconnect the constant load and 2RLA1 closes to connect the valve circuit, after the Input Tune servo-amplifier has been disconnected leaving the input tune circuit set in the position selected.

6. The tuned circuit components 2C10, 2C11 and 2L6 are driven by the servo-motor 2MG3 during the tuning cycle and cover the whole of the frequency band of the amplifier in one sweep. As this is so, it has a particular mechanical position per frequency and coarse information can therefore be obtained from this circuit. A multi-turn potentiometer 2RV6 gives positional information to the loading capacitor 2C4 and cams in association with microswitches and range relays give positional information to the tuning capacitor 2C1 and the range switch motors 2IM1 and 2IM2 (see Chapter 4, para.49).

7. The anode tuning and loading circuits are conventional circuits with pick-up points for their servo systems which control servo-motors

2MG1 and 2MG2; these drive 2C1 and 2C4 respectively.

8. The anode tuning and loading servo systems are switched on at the end of the Coarse Level sequence but are de-sensitized when the transmitter is switched to the traffic condition (see Chap.7, Paras.63-69). De-sensitizing the servo systems reduces the wear which occurs if they are allowed to respond to every variation in the traffic signal, while allowing them to compensate adequately for changes in aerial impedance. The output coupler (on the roof of Unit 2) passes signals proportional to forward and reflected feeder power to the amplifier relay (Unit 5) which trips the h.t. off when the v.s.w.r. exceeds 2.4:1.

HEATER SUPPLY

9. The valve heater supply is derived from transformer 2T2 which is connected to the blue phase via choke 2L9, variable resistor 1RV1, contact 1ASC1 and the circuit breaker 1CBE. Choke 219 limits the inrush of current on switching on and hence limits the filament current. 1RV1 adjusts the heater voltage, 1ASC1 switches the supply on and 1CBE protects the amplifier against overloads in this circuit.

ANODE AND COIL CONNECTIONS

10. The anode connector to the valve is a copper strip held in position (encircling the anode) by a spring clip. The band is fixed at the top rim of the anode above the maker's label.

11. The contact finger camshafts are fitted with dampeners to prevent overshoot when the contact loads differ with range-changing. This particularly applies to the change between range 5 and range 1 where on range 6 a number of contacts are in contact with the coil presenting a heavy load, and on range 1 where no contacts make with the coil, thus presenting a light load.

VALVE INSERTION

12. The cabinet is fitted with winch runners in the cathode compartment of the final stage to permit the use of a winch to insert or remove the valve. The grid deck with its fitted components can be easily removed and the valve hooked to the winch by the holes in the anode ring.

REFLECTOMETER TEST/CONTROL ASSEMBLY

13. The forward and reflected rectified outputs from the Output Coupler (Unit 8) are fed to terminals 2TS11(2) and (4) respectively while the common earth line is connected to 2TS11(1).

14. The switch 2SY is the FORWARD/REFLECTED power switch which causes POWER meter 2M4 to indicate either forward or reflected power; the probe not connected to the meter is loaded to an equivalent degree by a resistance network (2R5, 2R6). The power indications are set by 2RV3 and 2RV1; these preset resistors being set-up during initial setting-up and requiring no further adjustment.

15. Provision is made for a remote power meter, similar to that in the amplifier, to be connected; normally it forms part of the Extended Control Unit. To connect it, links 2LKA and B are removed, one from between 2TS10(5) and (6) to extend the remote meter connection and the other from between 2TS11(5) and (6) to remove the short-circuit across resistors 2R13/2R14 and connects this pair in series with 2R5 and 2R6.

16. The NORMAL/TEST switch (2SX) selects the input to the Amplifier Relay (Unit 5). In the NORMAL position the coupler output is connected to Unit 5. In the TEST position a d.c. supply from Unit 5 is connected to 2TS10(3) and 2TS10(1) to supply the two potential divider chains 5R4, 2R8, 2R9 and 2R7, and 5R3, 2R4, 2R3 and 2RV2 (RV2 is in parallel with 2R4 and 2R3). The setting of RV2 is adjusted to simulate a v.s.w.r. trip of approximately 2.5:1, i.e. reflected power about 18.5% of the forward power (see Fig.116).

17. To ensure that the Amplifier Relay is maintained operative during switch transition periods (of 2SX or 2SY) 2R3/2R4 and 2R7/2R9 hold-on the switching transistors 5VT1 and 5VT2.

DIRECTIONAL COUPLER (UNIT 8)

(Identity T30-0991-01)

DESCRIPTION Circuit Diagram Fig.115

18. The directional coupler is designed as a test-length for use in 50.5 ohm, 2 in., rigid coaxial feeder. It supplies, via two probes, rectified voltages to be applied to a meter to give indications of forward and reflected power. The rectified voltages can also be used to actuate trip circuits when the v.s.w.r. reaches an undesirable level. The unit is designed for use in coaxial feeders carrying mean powers of up to 30 kW.

19. There are two probes (couplers) set to respond to the forward and reflected waves respectively. These consist of a combined capacity and inductive pick-up. The capacity pick-up responds to the voltage on the inner while the inductive pick-up responds to the current on the inner. For each probe the capacity pick-up gives a similar output. It is possible, however, to reverse one pick-up coil relative to the other so that in the case of one probe the capacity and inductive voltages add to each other while in the other case they are in opposition.

20. The probe intended to indicate reflected power is adjusted so that the voltages are in opposition when the current flow is towards the load, and so that they are equal when the feeder is correctly terminated. Such a condition leads to zero output and corresponds to zero reflected power.

21. For any other condition of feeder termination current will be reflected from the load and travel back in the reverse direction and a standing wave of voltage is also created. The probe which is balanced

for zero output on a matching load can no longer have a zero resultant from its voltage and current pick-ups. The resultant voltage created is rectified and causes current to flow in a sensitive meter. By a suitable calibration of the meter, it can be made to indicate reflected power.

22. The forward power probe has the same type of capacity and inductive pick-up from the inner. The two voltages are arranged to add together for the case of current travelling towards the load. The resultant voltage is rectified and causes current to flow in the same sensitive meter - one probe output or the other being selected by means of a switch.

23. The closer to the inner, the greater the degree of coupling and hence the greater the output voltage from a probe for a given power flow. The penetration of the probes is adjusted therefore to give a predetermined amount of coupling. Both probes are adjusted to the same coupling so that their outputs can be indicated on the same meter scale.

24. It is also possible to rotate the probes and this alters the voltage produced by the inductive coupling. By such an adjustment it is possible to set up the probe used to indicate reflected power to read zero when the feeder is matched. This means that this probe is not responding to the forward power and the better this zero the better is what is known as the 'directivity' of the coupler.

25. Both probes are followed by a frequency compensation and rectifying network (R1, C1 and MR1) and (R2, C4 and MR2). In the X1 (reflection probe) line a voltage doubling circuit (C8 and MR4) follows the frequency compensation circuit; then in both X1 and X2 (forward) lines there follows a single stage capacity input filter, comprising C2, C3 and R3 or C5, C6 and R4. Following this filter in the reflected line only is amplitude linearizing circuit MR3, C7 and R5. Both the circuits use a common earth. The rectified voltages from X1, X2 and earth are passed to the test/control panel.

AMPLIFIER RELAY UNIT (UNIT 5)

(Identity T30-0979-04 and 06)

GENERAL Circuit Diagram Fig.116

26. This unit is a multi-purpose unit whose circuit is designed to replace relays operating under marginal conditions.

DETAILED

27. The amplifier relay unit comprises two similar differential d.c. amplifiers each employing three pairs of transistors. D.C. coupling is employed between stages, which are long-tailed-pair type to ensure d.c. stability. The transistors operate as a current amplifier, any change in current through the base to emitter circuit causing a much larger change in the current through the collector to emitter circuit.

R.F. CIRCUITS

28. Consider first the reflected power trip circuit. VT1 and VT2 form a high-voltage gain amplifier circuit with a high-input impedance. The two d.c. voltages derived from the directional coupler are compared and the voltage difference amplified. VT3 and VT4 form a d.c. bistable flip-flop circuit with positive feedback through resistors R9 and R10. VT5 and VT6 give a high-power gain to operate relay RLA (VT6 collector load).

29. When the input to VT2 goes positive with respect to the input to VT1, the input to VT4 goes negative. The emitter-to-collector current through VT4 starts to increase, causing VT4 collector to become more positive. This change is applied to VT3 base via R10, thus reducing VT3 emitter-to-collector current and causing VT3 collector to become more negative. This change is conveyed to VT4 via R9, thus increasing the negative bias original applied. The circuit changes rapidly until VT3 collector current has been reduced to zero and VT4 is saturated, i.e. its collector-to-emitter voltage has dropped to a very low value. The input to VT5 thus goes negative and the input to VT6 goes positive. VT5 thus becomes saturated whilst the current through the emitter-to-collector of VT6 is reduced to zero and the relay RLA is de-energized. This is the 'tripped' condition.

30. When the input to VT2 goes negative with respect to VT1 input, VT6 base becomes biased negatively to the emitter, a high current is drawn by VT6 via relay RL6, causing it to operate. The rapid switching of VT3 and VT4 ensures rapid and positive action of the relay. It also means that transistors VT3 to VT6 are normally in a low dissipation condition, except during the very short transition period. R5 in the emitter circuit of VT1 provides a bias to ensure that RLA is energized when both inputs to the amplifier are at earth potential, i.e. no 'tripping' occurs when there are no outputs from the directional coupler.

31. The diodes MR5 and MR6 prevents VT1 and VT2 saturating, as this would cause the input impedance to drop and alter the parent equipment power meter reading. The zener diode MZ3 and silicon diode MR7 across the relay RLA are used to keep the collector-to-emitter voltage swing across VT6 within its rating, but allow the reverse voltage across RLA to build up to the zener voltage (14V) when RLA is de-energized. This maintains a fast operation of the relay (approximately 7 milliseconds).

32. The low forward power alarm circuit operates in a similar manner to that described above. When the input to VT8 is negative with respect to VT7 input, RLB is energized and contacts RLB1 and RLB2 change over.

POWER SUPPLY

33. The unit has its own supply comprising a 33 +33V earthed-centre supply circuit.

34. Silicon diodes MR1 to MR4 are used in the earthed centre supply circuit. A suppression circuit, comprising resistors R16 and R17 and capacitor C2, is connected to the primary of the supply transformer T1, to prevent the occurrence of 'spikes' (transient high voltages) which

can be produced by switching circuits and damage the diodes. Capacitor *C1, together with resistors R16 and R17, acts as the first cell of the smoothing filter. Because the resistors are in the primary side of T1, the power rating of the transformer can be less than it would be if the resistors were in the secondary side. Zener diodes MZ1 and MZ2 and resistors R1 and R2 stabilize the supply voltage and act as the secondary cell of the smoothing filter, the diodes acting as large capacitors.

WARNING. CAPACITOR *C1 CONTAINS PCB. BEFORE HANDLING SEE WARNING FOLLOWING PREFACE TO THIS HANDBOOK.

OUTPUT MONITORING (UNITS 8, 2 AND 5)

35. The rectified output of the reflected power probe (8x1) is connected to 5VT2 base via the SET REFLECTED POWER potentiometer (2RN1), the NORMAL/TEST switch (2SX1) and plug 5PLA(13). The base voltage is determined, from the rectified output, by the potentiometer network 2R3 and 2R4, shunted by the power meter (2M4) or its equivalent resistance (2R5/2R6) depending on the position of the FORWARD/REFLECTED switch (2SY1). The rectified output of the forward power probe (8x2) is fed to 5VT1 base via the SET FORWARD POWER potentiometer (2RV3), the NORMAL/TEST switch (252) and plug 5PLA(12). The base voltage is determined in a similar manner to that of the reflected power by 2R9, 2R7 and 2M4 or 2R5/2R6.

36. The level of power output which causes relay 5RLB to operate is determinted by the relative potentials of the bases of transistors 5VT7 and 5VT8 (i.e. the value of resistor 2R8 and the setting of potentiometer 2RV4). The low output power alarm signal is given by relay contacts 5RLB1 and 5RLB2 via plug 5PLA (20, 21, 27 and 28).

37. The value of v.s.w.r. at which relay 5RLA operates (becomes de-energized) is determined by the value of 2R8.

38. If the v.s.w.r. on the feeder increases, the voltage from the reflected power probe gets more positive and hence 5VT2 base gets more positive. When this has increased by approximately +70 mV above 5VT1 base voltage, the relay 5RLA is operated (de-energized) and the transmitter is 'tripped' (the h.t. system is locked-out after attempting the 3-shot h.t. restoration system). Tripping removes all outputs from the coupler and the inputs to the bases of 5VT1 and 5VT2 become zero. The relay 5RLA will reset, as the bias resistor 5R5 causes the amplifier to trigger back to its normal 'operative' condition when 5VT2 base is less than +35 mV (approx.) above 5VT1 base.

RELAY UNIT (UNIT 11)

(Identity T30-2998-01 and 02)

DESCRIPTION Circuit Diagram Fig.117

39. This unit is mounted on the upper right-hand wall in Unit 2 and contains the range relays RRA to RRE and RMT and RML, which together form part of the auto-tuning circuits.

40. Relays RRA to RRE set the frequency range to be used and their contacts select preset circuits of the auto-tuning system. The relay coding corresponds to the range, i.e. RRA = range 1, RRB = range 2 etc., and their contact sets affect the same circuits:-

Set 1 complete the h.t. interlock circuit.

Set 2 sets the 'range' gain of the variable gain amplifier.

Set 3 sets the coarse loading information.

Set 4 sets the coarse tuning information.

41. Relays RMT and RML are normally short-circuited but are energised for -

42. RML1 and RMT1 to switch-on the range motors 2IM1 and 2IM2 when range selection takes place.

43. RML2 and RMT2 isolate the input tune switching circuits.

44. A full description of the operation of the circuit of which the relays form a part is given in Chapter 4, paragraph 40, Input Tune Sequence.

AUTO ATTENUATOR (UNITS 13.20)

(Identity T30-8319-01)

CIRCUIT DESCRIPTION Circuit Diagram Fig.118

45. This unit is made up of a series of fixed π-connected attenuator networks and a variable bridge-T connected servo-controlled attenuator network. It is used to control the drive input to the H1200 Amplifier.

46. The r.f. input is terminated in a 'T' network R2, R3 and R4. This is followed in series by eight two-way two-pole switches each connected to a fixed π attenuator network (switching them into or out of circuit). The final attenuator is a bridge-'T' network having two variable resistors driven by the Level servo system. This form of network is used because, while the attenuation can be varied, the impedance remains constant.

DIRECTIONAL COUPLER (UNIT 15)

(Identity T30-9114-01 & 02)

47. This is the H1200 input Directional Coupler fitted in the output feeder of the H1000 Wideband Amplifier. It is designed for use in a 50.5 ohm coaxial feeder and gives two outputs, an r.f. voltage proportional to the forward power and a d.c. voltage proportional to the reflected power. The r.f. voltage is used as a monitor signal and the d.c. voltage used in the reflected power clamp circuit during tuning the final stage, when the cathode circuit is switched from the matched

termination to the out-of-tune valve circuits (see Chapter 7, Para.132).

48. The Coupler comprises two current transformers, voltage doubling and capacity potential divider circuits. The two current transformers (T1 & T2) are identical and respond to feeder current flow. The transformer current flows through a load resistance and so produces a voltage which is either in-phase with, or 180° out-of-phase with the feeder current and proportional to it. The capacity potential dividers are connected to the feeder to produce a sample voltage proportional to the voltage on the feeder.

These two proportional voltages are added vectorially to produce a voltage proportional to either forward or reverse power in the feeder.

49. In the Forward Probe circuit the current transformer, T2, loaded by R6/R7 in parallel, produces the voltage proportional to the current in the feeder and in phase with it. The capacity potential divider C13 and C9/C8 produces the voltage proportional to the voltage in the feeder. These voltages are in-phase and therefore add, and the output fed to the monitor plug PLC via a resistive attenuator R9/R8 has a nominal 75 ohm output. L2 compensates for the lead inductance associated with C9/C8.

50. A similar circuit is provided by T1, R1, R2, C12, L1, C1/C2 and C3 in the reflected probe circuit but the two proportional voltages are out-of-phase and therefore subtract because the current transformer connections are reversed. The output is fed to a voltage doubling circuit MR1/MR2 followed by an R-C filter (C6, R4, C7). The d.c. output which is negative with respect to earth is passed to terminals TS1(1) and (2).

C4/R3 compensate for the frequency response of the rectifier.

Chapter 7

AUTO TUNE EQUIPMENT

List of Contents

Chapter 7

AUTO TUNE EQUIPMENT

AUTO TUNE UNIT (UNIT 6)

(Identity T30-7080-01)

GENERAL

1. The unit assembly consists of twelve sub-units together with control switches and is used in the Marconi self-tuning system of the H1200 amplifier.

2. The unit receives coarse information error signals and sets-up, via the servo system, the approximate 'tuning' and 'loading' conditions for the given input frequency, these positions being finally set-up by error signals from discriminator units, the final self-adjustments of the circuits gradually decreasing the error signal to a 'Nil', when the system will be at 'tune complete'.

MECHANICAL

3. The unit assembly is fitted on extension runners and is accommodated in a compartment of Unit 1.

4. The unit assembly is in the form of a box tray, divided by a transverse separator plate. Inside the front and rear of the tray and on both sides of the transverse plate are guide-rails to which fit the grooves on the back and front of each sub-unit, thus locating these units in their positions.

5. In front of each sub-unit, on the main tray structure, is a label bearing the identification of the general arrangement drawing of the sub-unit concerned.

6. At the bottom of the tray are sockets allied to the sub-units concerned into which the sub-unit plugs are 'push' connected. The inter-socket cabling is run on the underside of the tray as is most of the tray wiring.

7. At the rear of the unit are four plugs PLA, PLB, PLF and PLG which connect the unit to external circuits, via sockets carrying leads, each set of which is p.v.c. sleeved. Each set is fixed to the desk of the compartment such that the unit may be withdrawn on its extension runners without disconnecting the sockets.

8. Behind the front panel of the unit and fitted to the face of the tray is the resistor R1 and capacitor C1 of the switch-circuit of the

meter amplifier. On the right-hand side of this face, fixed to studs, is plug PLC in which the test wander socket SKTD is stowed when not in use elsewhere such as, plugs PLB (monitoring points of certain sub-units), PLD and PLH (discriminator monitoring points) while PLC monitors the various voltages as shown in tabular form on the front panel of the unit. PLD and PLH are fitted on studs fixed on the left-hand rear of the tray.

9. On the left-hand side of a narrow transverse saddle in front of the tray is the high/low test voltage switch SG. Adjacent to switch SG is the external meter sockets SKTJ and K. On the left vertical side of this saddle is a stowage jack JKB for the wander test plug PLE.

10. On the rear of the front panel, but controlled from the front face, are mounted the control and meter switches and various potentiometers for the setting-up, testing, etc. of the self tuning system. Also fitted are indicator lamps which show the service condition of the system. The monitoring meter is fitted on the front of the unit.

Sub-Units

11. Each sub-unit is made up of a metal framework inside which is mounted a printed board. The framework is fitted with a top cover in which are two 'Camlock' fasteners (press & turn 90°) which lock the unit in its position in the parent unit.

12. At the bottom of the unit is mounted a moulded plug, to which the circuit terminations of the board are connected. At the ends of the moulded plug is a pin which locates the moulded plug in its parent socket. On the framework are also two pins which prevent a unit being plugged in a wrong position.

13. A groove in the framework locates the unit in a vertical position in the parent unit.

14. In the top cover is a 'cut away' for the insertion of the monitor socket which connects to the board plug (edge connectors) PLB, the test points of which are identified by abbreviations. Also in the cover is a hole for screwdriver control of RV1.

15. The 'printed board' forms the circuitry. On the 'board' are mounted components, the end connections of which are generally connected to the 'printed wiring' by 'flow solder'.

ELECTRICAL

16. A description of the functions of this unit is detailed in this manual.

17. The front panel of the unit carries the controls enumerated below:-

(a) SERVICE SWITCH SA is comprised of a 3-ganged wafer switch, each wafer having three 1-pole, 3-way switch circuits, the wafer switches being identified as SA1, SA2 and SA3. The services available are MANUAL, AUTO and TEST-AUTO.

(b) MONITOR POSITION switch SB is a wafer switch, single pole, 11-way and connects the selected circuit to the meter amplifier range switch SE2(1) and the meter amplifier. Above the switch is a table showing the selected circuit switch positions.

(c) SET OUTPUT LEVEL switch SC is 2-pole, 2-way, used as single pole 2-way. It connects the +50V to relays 6.13FCB and 6.5FCA only, holding the amplifier in a SET LEVEL or check level condition.

(d) INPUT TUNE switch SD is a 2-pole, 2-way switch used as two single pole, 2-way switches SD1 and SD2.

(i) SD1 (normally open), closes to connect the +33V supply to the Input Tune switching circuits to change them over. This is the Input Tune condition.

(ii) SD2 (normally closed) opens the external auto available lamp interlock circuit.

(e) METER RANGE switch SE is a 2-ganged wafer switch, each wafer with a single pole, 12-way circuit.

(f) METER SELECTOR switch SF is a 2-ganged wafer switch, each wafer with a 2-pole, 6-way circuit.

(g) TEST SIGNAL switch SG with HIGH/LOW positions sets the output of the Test Signal Supply unit to either 50 mV or 200 mV.

(h) SET COARSE LEVEL (MUTE) switch SH is a 2-pole, 2-way switch used as two single pole, 2-way switches SH1 and SH2.

(i) SH1 (normally open), closes to connect the +33V supply to the Coarse Level switching circuits to change them over. This is the Coarse Level condition.

(ii) SH2 (normally closed), opens the external auto available lamp interlock.

NOTE: *For details of these switches see 'Tables' on drawings of meter amplifier unit.*

Variable Resistors

18. (a) RV1. SET OUTPUT LEVEL; adjusts the signal reference level to the output level comparator circuit of the discriminator unit (Unit 10).

(b) RV2. TEST SIGNAL potentiometer, applies an a.c. test voltage at mains frequency via the wander TEST PLUG PLE. The control gives zero output in its centre position while increasing outputs of opposite phase dependent on whether it is rotated in a clockwise or counter-clockwise direction.

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This enables the servo-motors to be driven via their servo amplifiers at varying speeds in either direction.

(c) RV3, SET S/C ZERO. This variable resistance is used with the meter amplifier Unit (6.4), when the input to the amplifier is short circuited.

(d) RV4. SET O/C ZERO. This potentiometer is also used with the meter amplifier, when the input to the amplifier is open circuited.

(e) For detailed information of the use of RV3 and RV4 above, see Paragraphs 43 and 44.

Test switch

19. Behind the front panel is switch SG, the high/low test voltage switch. It is a 2-pole, 2-way, normally closed, opening to include resistors R2 and R3 in the test voltage supply line (10-0-10V a.c.).

20. The full circuit diagram for the test signal supply and the diagram of potentiometer rotation are given in Para.62 of this chapter.

RELAY AMPLIFIER (UNITS 6.1, 6.2 & 6.3)

(Identity T30-1936-01 & 02)

GENERAL

21. The unit consists of a 4-pole changeover relay preceded by a transistorised amplifier and operates from a low level a.c. signal at 50 or 60 c/s. As such it is normally used in the control circuits of the Marconi self-tuning amplifier equipments where the output of the tacho-generator of a servo motor-generator combination can actuate relay contacts to create or maintain a circuit condition when the motor generator is running.

22. Provision is made for operation on a d.c. input.

ELECTRICAL (Circuit Diagram Fig.122)

23. This unit is primarily intended to operate a relay from a low level a.c. (50 or 60 c/s) signal.

24. The level at which operation occurs is adjustable by potentiometer RV1 to any value between 20 and 200 mV, the differential being approx. 5 mV (the differential being the difference in level between the input voltage required to close the relay and the voltage required to open the relay).

25. Test jack JKA enables an a.c. input to be applied for test purposes, but the voltage must not exceed 5V r.m.s. at this point.

26. The four changeover contacts of the relay are connected to plug PLC for various external requirements.

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Amplifier Stage

27. VT1 and VT2 form an a.c. amplifier having a single input to VT1 and a push-pull output. Emitter feedback is provided by R4 and R5, modified by thermistors TH1 and TH2 to reduce the dependence of the gain upon temperature changes. The input impedance is approx. 15 kΩ.

28. Good temperature stability is assured by the large value of the common emitter resistor R6. Also the base of VT2 is connected to earth via the same d.c. impedance as VT1 (R3-R2) and is earthed to a.c. by C4. C1, R1 and C2 form a r.f. filter on the input.

29. The push-pull output is coupled via C5 and C6 to a bridge rectifier, comprised of MR1-MR4, which feeds a filter containing C7, R13 and C8 and a load resistor R14. A small amount of forward bias is applied to these diodes which is derived from the +33V supply across MR5 and MR6. In this way the diode temperature coefficients are balanced out and do not appreciably affect the bias current. The negative supply to VT1 and VT2 is stabilized by MZ1 and R10.

Differential switching circuit

30. The six transistors VT3-VT8 form a d.c. differential switching circuit. When the positive voltage applied to VT3 base is less than that applied to VT4 base the relay RLA is de-energised when wired as shown in Fig.122.

31. The positive rectified output from the first stage is applied to VT3 base. The potential on VT4 base is derived from the +33V via R11 and MZ2 and is adjustable by the potentiometer formed by R12 and RV1.

32. VT3 and VT4 form a long-tailed pair for temperature stability (they are also mounted in common heat sink, for this reason).

33. The collectors are decoupled by C9 and C10 to prevent oscillation and the output is directly coupled to a second long-tailed pair amplifier with regenerative feedback provided by R19 and R20. This feedback ensures positive triggering action on the relay RLA and also maintains the output transistors VT7 and VT8 in either the 'saturated' or 'cut-off' condition, thus reducing the dissipation. MR7 and MR8 prevent excessive positive base to emitter voltage on VT5 and VT6.

Output

34. VT5 and VT6 are directly coupled to the output stage comprising VT7 and VT8. R24 is the collector load for VT7 and RLA for VT8. R23 maintains the correct bias voltage, MR9 prevents the back e.m.f. from building up across the relay coil when it is de-energised and exceeding the collector base voltage rating of VT8.

METER AMPLIFIER (UNIT 6.4)

(Identity T30-2261-01 & 02)

GENERAL

35. This unit comprises a two stage linear amplifier and various resistors which, together with an external meter and switches, forms a comprehensive multi-range meter which is used to monitor voltages.

ELECTRICAL (Circuit Diagram Fig.123)

36. The unit consists of various range resistors and a two-stage linear amplifier with an input impedance that is set to 10 kΩ, using variable resistance RV1 and R11.

37. The output drives an external 100 μA, 1000Ω meter and gives f.s.d. for 10 mV input, to the amplifier.

38. To allow for various voltage readings, resistor networks are switched in series with and in parallel with the input impedance by the meter range switch SE.

SE1 & SE2 Position	Meter Range f.s.d.	Resistor network
3	32 mV	R1 in series with amplifier unit
4	100 mV	R1 + R2 in series with amplifier unit
5	320 mV	R1 + R2 + R3 in series with amplifier unit
6	1V	R1 + R2 + R3 + R4 in series with amplifier input
7	3.2V	R1 + R2 + R3 + R4 in series with amplifier input shunted by R5.
8	10.0V	R1 + R2 + R3 + R4 in series with amplifier input shunted by R6
9	32V	R1 + R2 + R3 + R4 in series with amplifier input shunted by R7
10	100V	R1 + R2 + R3 + R4 in series with amplifier input shunted by R8
11	320V	R1 + R2 + R3 + R4 in series with amplifier input shunted by R9
1	Set short-circuit (S/C) zero	
2	Set open circuit (O/C) zero	

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39. The amplifier input connections are at PLB1 and PLB2 (PLB2 is earthed externally in the parent unit).

40. Resistor R10 and crossed diodes MR1 and MR2 act as voltage limiters.

1st Stage

41. Transistors VT1 and VT2 (mounted on a heat-sink) form a 'long-tailed' pair circuit. Resistors R38 and R39 are used to maintain the voltage gain so that it is less affected by the variation of transistor parameters. Capacitor C6 prevents oscillation.

42. The amplifier line voltage is dropped by R21 and decoupled by electrolytic capacitor C1.

43. The bias to VT2 is supplied from the amplifier line via R14 and R15 while that of VT1 is adjustable by a 100 kΩ external variable resistor, (6RV4, connected to PLB3 and 4) and fed via R12. 6RV4 allows for inequalities in the Ib/Ic characteristics of VT1 and VT2 and is set-up with the input to the amplifier open-circuit (i.e. constant current supplies to the bases).

44. The collector load resistors are R18 and R19; an external 25 kΩ potentiometer is used (together with an additional resistor R20 if required) for differential adjustment of these collector loads. The 25 kΩ external potentiometer 6RV4 is used to correct for inequalities in the Vb/Ic characteristics of VT1 and VT2 and is set-up with the input of the amplifier short-circuited.

2nd Stage

45. The first stage drives a similar amplifier stage, with emitter feedback resistors R23 and R24 to ensure that it does not appreciably load the former stage.

46. The amplifier is fed from an isolated d.c. supply, which is provided by rectifying the a.c. supply, using a bridge rectifier comprising MR11 to MR14 and capacitor C4 and is stabilized to approx. 17 volts by MZ1, MZ2, MZ3 and resistor R33. The a.c. is supplied from a 50V screened secondary winding of an external transformer via a 1 kΩ external resistor.

A.C. Metering

47. When used for a.c. measurements, RV3 is connected between the emitters of VT3 and VT4 thus varying their gain by varying the amount of emitter feedback and is used for the a.c. calibration. The meter, however, is driven by the output of the full wave bridge rectifier which is capacity coupled by C2 and C3 to VT3 and VT4 (also mounted on heat-sinks).

48. Forward bias for the bridge rectifier diodes is provided and adjusted by RV4. The diodes MR3 and MR4 are used in this circuit to reduce the temperature dependence of the bias current. To compensate for the

variation in diode efficiency with amplitude of signal, the diodes MR9, MR10 and resistor R29 are connected across the meter terminals and R28. (PLB(12) and (13)).

49. An external 560 kΩ resistor and a 6 μF (2 μF min.) d.c. blocking capacitor are used on the a.c. ranges. The resistor serves to correct the change of input impedance when used on a.c. and to maintain it at 10 kΩ.

50. Capacitor C5 is used to prevent a.c. feed, by capacitative action through the mains transformer, from appearing in an undesirable degree at the input terminals. The positive line is not earthed in the unit so that it is unnecessary for one side of the input to the amplifier to be earthed.

D.C. Metering

51. When measuring d.c., the meter is connected via a variable resistor RV2 between the two emitters of VT3 and VT4. RV2 is used to calibrate the amplifier d.c. measurements. The collector loads R25 and R26 (and therefore the collectors) are connected together by wafer SF3, when taking d.c. measurement. This causes the collector voltage to remain independent of the input voltage and prevents limiting on the transistor which is conducting more heavily.

52. In order to reverse the polarity on d.c., wafer SF2 is used to reverse the actual 100 mA meter connections (i.e. the amplifier works on a signal of the opposite polarity).

Circuit for Setting-up Input Impedance

53. To set-up the input impedance, a -33V supply is connected to PLA12. The meter selector switch SF is set to 'REF' and the -33V is applied, via R34, to the meter to give a current of approx. 60 μA (Wafer SF1). When SF is switched to 'CAL', the amplifier is connected as a -ve d.c. meter and the input applied via R36 from the -33V which is divided in the ratio of the resistive values of R37, R35 (approx.). The values are so arranged that when RV1 is adjusted to give a 10 kΩ input impedance to the meter amplifier, then the meter reading is equal to that obtained on the 'REF' position.

RELAY UNIT (UNIT 6.5)

(Identity T30-7482-02, 05)

GENERAL

54. The unit houses three 4-pole changeover relays and a time delay circuit which are used in the sequencing controls.

55. The three relays and the two capacitors are mounted on a horizontal platform fitted across the framework, with their terminals protruding down through the platform.

56. The three relays are of the 'sealed' type.

ELECTRICAL Circuit Diagram Fig.124

57. The unit contains three 4-pole changeover relays ITA, FCA and LL, and a delay circuit comprised of resistors R1 and R2 and electrolytic capacitors C1 and C2.

58. Resistors R1 and R2 permit the use of 50V rated capacitors and allow the nominal 50V supply to the relay (FCA) to rise above this value. The capacitors hold relay FCB energised for approx. 1.0 second after the 50V is removed and hence FCA via 6.13FCB4.

59. Some contacts of the relays are inter-connected while other contacts are connected to the plugs PLA and PLB, to complete various sequencing switching circuits of the self-tuning amplifier.

60. Sockets JKA, JKB and JKC are used to inject a 50 c/s signal for checking purposes.

FEEDBACK AND AUXILIARIES UNIT (UNIT 6.6)

(Identity T30-7487-01)

ELECTRICAL Circuit Diagram Fig.125

61. The unit is comprised of seven separate circuits:-

(a) Resistors R1, R2, R3 and R4, potentiometer law correction. (Part of test signal supply circuit).

(b) Transistor changeover switch.

(c) Variable gain amplifier.

(d) Anode tune)
(e) Anode load)
(f) Input tune) Feedback networks
(g) Input level)

Test Signal Supply

62.

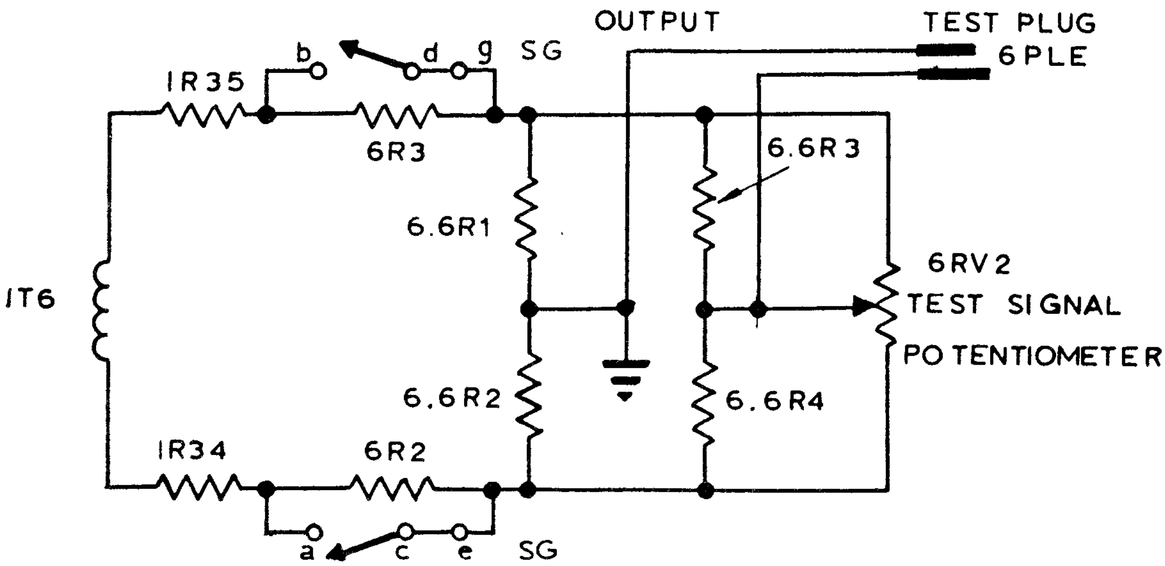


FIG.1 FULL CIRCUIT FOR TEST SIGNAL SUPPLY

(a) R1 and R2 drop the voltage at the ends of 6RV2 to the required maximum.

(b) The operation of the low/high switch 6SG increases the output voltage by a factor of 4. (50 mV-200 mV).

(c) R3 and R4 are shunted across each part of 6RV2, the test signal potentiometer, and shape the linear potentiometer to a curve of the form shown in Fig.2, thus giving a fine control of the voltage appearing at the output of the test lead between 0 and 10 mV, for the inputs to the servo-amplifier systems and relay amplifiers.

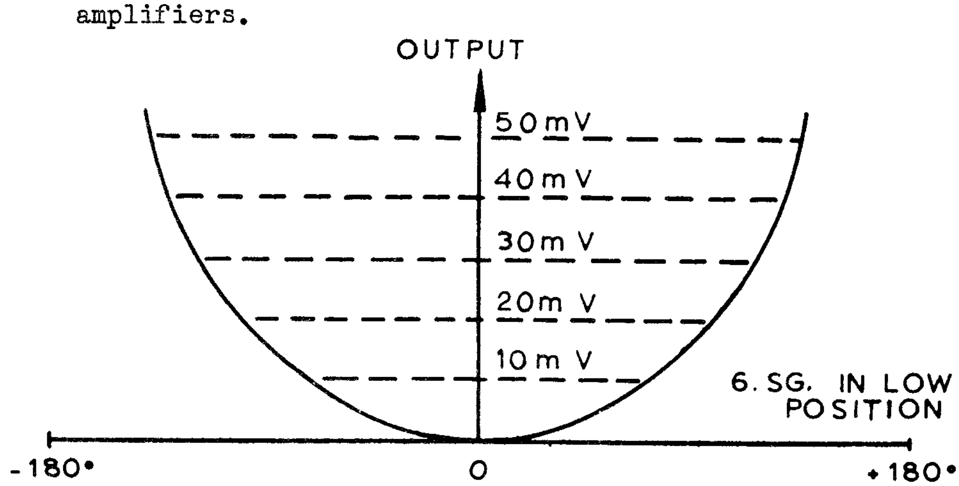


FIG.2 POTENTIOMETER ROTATION

Transistor Changeover Switch (Bistable)

63. Transistors VT1 and VT2 and associated components form a semi-conductor changeover switch which is operated by the anode tuning capacitor limit switches (2SAG2 and 2SAH2). The transistor switch connects either of two a.c. signals (a signal from the anode load comparator at PLA(8) or a 10V a.c. reference signal at PLA(6)) to the anode load servo amplifier via PLA(7). The purpose of the two signals is given in Chap.4, Paras.67-69. Fig.108 shows the normal condition of the limit switches which causes VT1 to be in saturation as PLA(9) is open circuit and VT2 to be cut off as its base is clamped to earth via PLA(10) and the limit switches. The resulting low collector-emitter resistance of VT1 earths the cathode of MR1 and the high collector-emitter resistance of VT2 allows current to flow through R6, MR2 and R9, holding the anode of MR1 at a negative potential with respect to earth, so that it is reverse biased. In this condition input signals from PLA(8) will be transmitted to PLA(7) with little attenuation unless the de-sensitizing circuit (VT4 and associated components) is switched on, but input signals from PLA(6) will be presented with a high series impedance to PLA(7), (MR1 reverse biased) and a low shunt impedance to earth (VT1 collector emitter junction in saturation). Conversely, when the limit switches earth PLA(9) and open circuit PLA(10), the above functions are reversed and a signal path is established from PLA(6) via C1, R5, MR1, and C2 to PLA(7) while the signal from PLA(8) is shunted to earth by VT2 collector-emitter junction. VT4, R46, R47, R38, R39 and C15 form a de-sensitizing circuit which attenuates the signal from the anode load comparator when a -33V signal at PLA(11) switches VT4 on. This signal is applied to PLA(11) via 6.5FCA2 by the release of relay 6.5FCA, when the transmitter is switched to the TRAFFIC condition. The de-sensitizing circuit then reduces the signal from the anode load comparator caused by variations in the traffic signal level which would otherwise cause the servo system to be readjusting continuously, thus incurring unnecessary mechanical wear.

Variable Gain Amplifier

64. The sensitivity of the Anode Tuning Phase Discriminator depends to a large extent on the level of F.S. anode voltage. When the output stage is considerably mistuned, sensitivity is very low, therefore an amplifier is required to increase the discriminator output to the servo-amplifier. On different ranges the discriminator sensitivity also varies due to the frequency and Q effects. Therefore a Variable Gain Amplifier, whose gain is dependent on the range and the F.S. anode voltage, is connected between the output of the anode tuning discriminator and the anode tuning servo motor.

65. The transistor VT3 and associated components form a variable gain amplifier with an input at PLA(14) and an output at PLA(15). Transistor VT5 and associated components at the input to this amplifier form a de-sensitizing circuit which attenuates the input signal from the anode tune discriminator to effectively de-sensitize the anode tune servo systems when the transmitter is in the TRAFFIC condition. It is operated by the same signal at PLA(11) as the de-sensitizer circuit for the anode load servo system (Para.63) and similarly prevents unnecessary mechanical wear in the anode tune servo system when the amplifier is in the TRAFFIC condition.

66. The gain of the Variable Gain Amplifier may be varied manually or automatically. The emitter resistance (R17, R18 and RV1) is only partially decoupled by capacitor C7 to allow a degree of a.c. feedback which can be varied to adjust the amplifier gain by adjusting RV1, without altering the d.c. conditions of the transistor. The gain of the stage may also be adjusted by varying the effective collector impedance which is done automatically.

67. The collector impedance at mains frequency is formed by R16, diode MR3, R19 and the servo amplifier input impedance (2.0 kΩ) in parallel (C5 and C4 being assumed of negligible impedance). R16 and R19 are of fixed resistance, but the impedance of the diode MR3 to low level a.c. signals is dependent upon the d.c. current through it. Thus, if a d.c. voltage is applied to PLC(10) any ripple being decoupled by R20 and C8, there will be a current in R19 and MR3. Therefore it is possible to control the impedance of MR3 and therefore the collector impedance and the gain of the amplifier, by varying the voltage at PLC(10).

68. The -33V signal at PLA(11) (present when the transmitter is in the traffic condition), is also used to control the collector impedance of VT3. The signal is potentially divided by R44 and R45, presenting approximately -8V at MR4 cathode and drawing current through MR3, R19, R20 and MR4. This clamps the Variable Gain Amplifier at a constant low gain.

69. The variation of the gain of the amplifier with a d.c. voltage is shown in Fig.3. The connection of external resistance from PLC(1) to earth enables the law relating to the amplifier gain to d.c. voltage to be modified. For curve with a 4.7 kΩ resistor across PLC(1) and earth, see Fig.3.

Servo System Velocity Feedback

70. The required termination of the tacho-generator (T-G) is 5 kΩ.

Anode Tuning and Loading

71. (a) Anode tune T-G output attenuation is provided by R27 and R28.

(b) R26/R25 provide the T-G output termination and also provide a potential divider for the 15 kΩ input impedance of the relay amplifier at PLC(7), such that the T-G output is divided across R26/R25 in parallel with 15 kΩ, i.e. approx. $\frac{1}{4}$ of the T-G output appears at PLC(7).

72. Anode loading T-G output attenuation and output termination are provided for in a similar manner as above by R24/R23 and R22/R21 respectively.

Input Tune

73. The input tune T-G output attenuation and output termination are provided for in a similar manner as above, by R32/R33 and R34/R35.

Input Level

74. (a) The input level control T-G has characteristics requiring no potential divider to feed the relay amplifier.

(b) Phase correction is provided by R30 and R31 and C9 while R29 provides a load for the tacho-generator.

SERVO AMPLIFIER UNIT (UNITS 6.10, 6.11 & 6.12)

(Identity T30-1934-01)

GENERAL

75. The unit comprises a four-transistor-directly-coupled amplifier driving a high-efficiency-bridge-connected output stage. It is driven by a square-wave error signal from a discriminator. To this signal is added a feedback signal in anti-phase as soon as the tacho-generator is rotated. The phase of the square-wave error signal relative to the motor reference supply will depend on whether the error detected by the discriminator is positive or negative.

DETAILED Circuit Diagram Fig.126

76. The error signal, a mains frequency square-wave, is fed to PLA(5) where it is connected via test jack JKA, resistor R25 and coupling capacitor C1 to the base of VT1. Resistor R1 (to earth) modifies the a.c. input impedance to 2 kΩ approx.

77. The feedback signal, a mains frequency sinewave in anti-phase to the square-wave, is fed to PLA(4) where it is connected via the coupling capacitor C1 to the base of VT1.

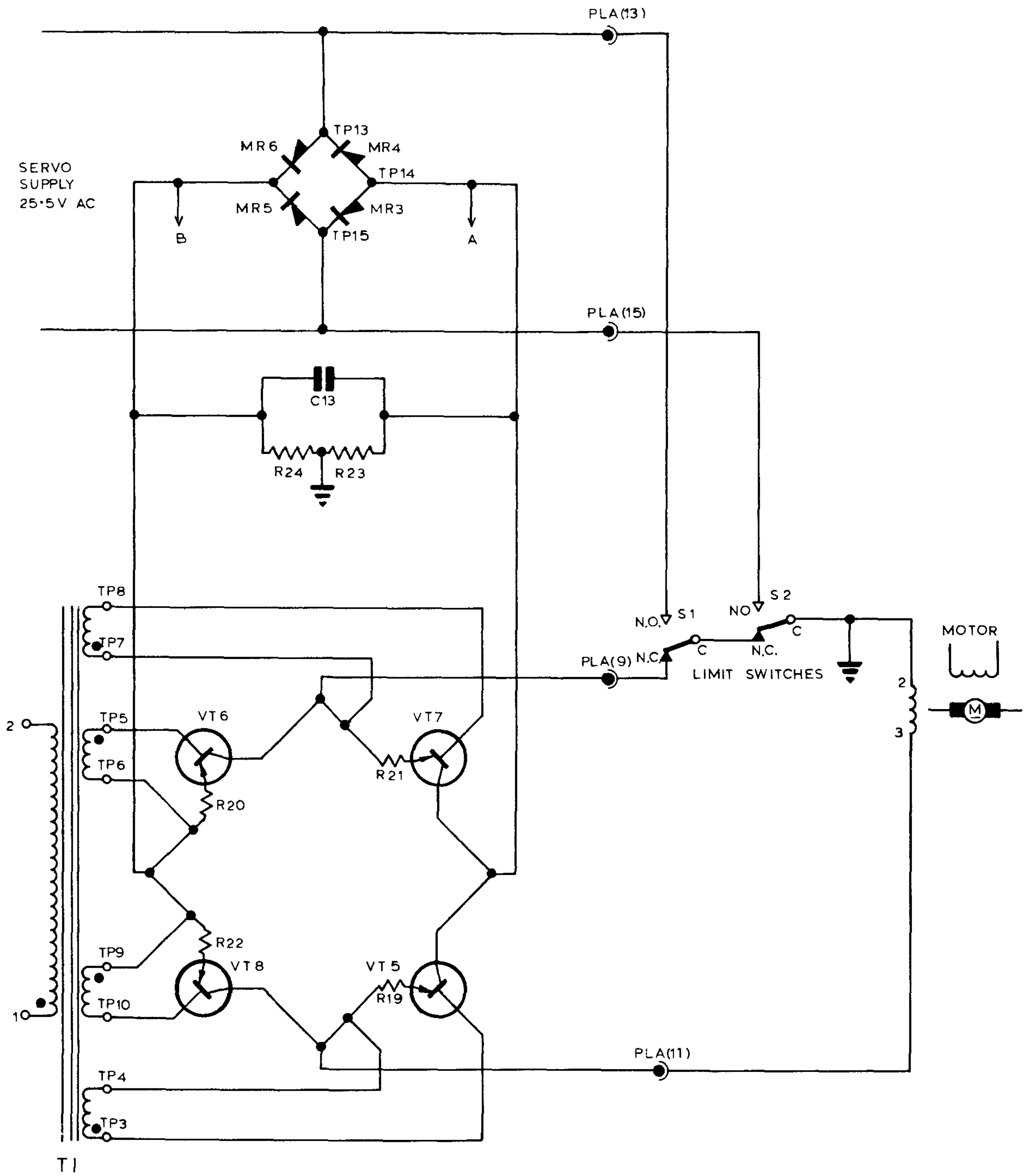


FIG.4 OUTPUT STAGE SIMPLIFIED CCT.
(SERVO AMPLIFIER)

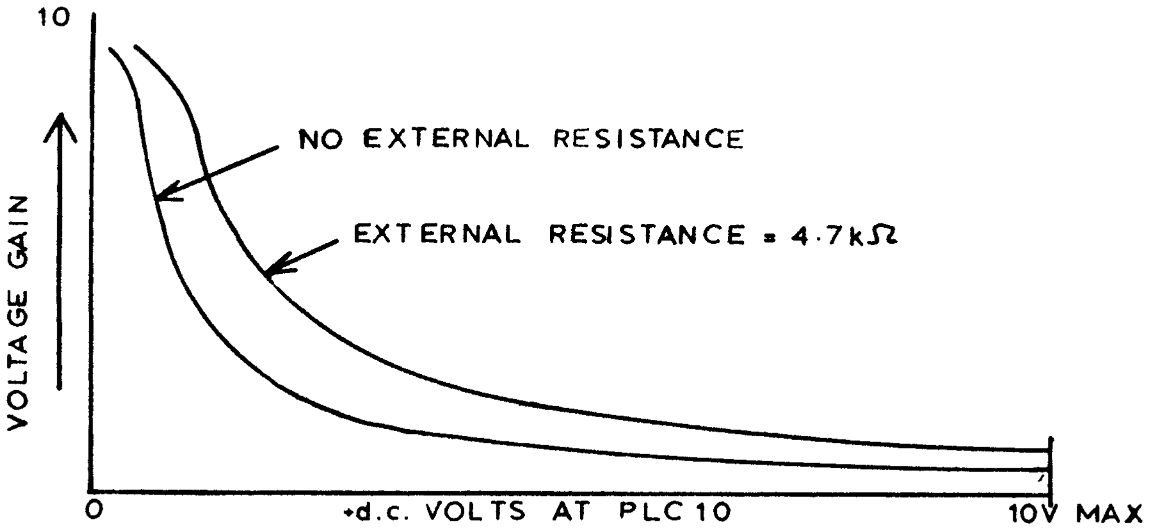


FIG.3 VARIATION OF VOLTAGE GAIN/VOLTAGE AT PLC10

78. The resultant of these two signals is amplified by the directly coupled amplifier.

Directly Coupled Amplifier

79. Transistors VT1, VT2, VT3 and VT4 form the directly coupled amplifier with a stabilized gain which is defined by the various feedback circuits R4, R12 and R17.

80. The negative supply to VT1 is dropped from the -33V line by resistor R7 and decoupled by capacitor C2.

81. Bias to VT1 base is provided by R5 and R2, while diode MR1 prevents excessive positive base-emitter voltage on VT1.

82. VT1 forms a common emitter amplifier, with emitter resistor R3 decoupled by C3 for d.c. stabilization and un-by-passed resistor R4 for a.c. gain stability.

83. VT1 collector is supplied by R6 and drives VT2 base; this stage VT2 gives a high voltage gain, as the emitter resistor R9 which gives d.c. stabilization is totally decoupled by capacitor C4.

84. VT2 collector is supplied via resistor R10 and drives VT3 base. Diode MR2 prevents excessive base-emitter voltage on VT3. Zener diodes MZ1 and MZ2 prevent the negative collector-base voltage exceeding 11.5V. Resistor R12 is un-by-passed and increases the input impedance of VT3 thus reducing the loading on VT2 stage as well as stabilizing the a.c. gain of VT3 stage; R11 and C5 provide d.c. stabilization.

85. The feedback resistor R8 stabilizes the overall gain (both a.c. and d.c.) of VT1, VT2, giving a constant voltage a.c. gain of approx. 100 to VT3 base.

86. VT3 collector is supplied via R13 and drives VT4 base via Zener diode MZ3, which controls the d.c. potential and presents a low impedance to a.c. The emitter feedback is provided by R17 and d.c. stabilization is provided by R16 and C6.

87. Resistor R26 is in series with the monitoring lead, to safeguard against damage to the monitoring meter, by accidental connection of PLA(8) and PLA(9) by the insertion of the monitoring socket.

88. The VT3 collector load is the primary of transformer T1, which, together with capacitors C7, C8, C9 and C10 forms a tuned circuit at 60 c/s. These capacitors paralleled by C11 and C12 form a tuned circuit for 50 c/s. (The change in circuit is made by use of a link connection between terminal posts TP40 and TP41).

Output Stage See Fig.4

89. The transformer (T1) has four similar secondaries, each driving one of four transistors, VT5 to VT8, connected in a bridge arrangement. These drive voltages to the transistors are phased in pairs, VT5 and VT6 driven in-phase with each other and in anti-phase to VT7 and VT8. Emitter feedback is provided to each transistor by resistors R19, R20, R21 and R22.

90. The Servo Supply (25.5V a.c.) rectified by the bridge rectifier MR3-MR6 is not smoothed and is fed to opposite corners of the transistor bridge (R23, R24 and C13 form a damping circuit against oscillations). Across the opposite corners of the bridge is connected the control winding of the servo-motor (via the limit switches).

91. When the comparator produces an error signal it subsequently provides a sinewave input at T1 primary. This signal causes VT5 and VT6 to conduct for one half-cycle and VT7 and VT8 for the other half-cycle as follows. When TP13 is positive w.r.t. TP15 then current flows through MR6 to the transistor bridge where, depending on which transistors are ON, say VT5 and VT6, then VT6 conducts and passes the positive half cycle to the motor winding where the return path comprises VT5 and MR3.

92. When VT7 and VT8 are ON then TP15 would be positive w.r.t. TP13 the two inputs being in-phase, current would flow through MR5, VT8 to the opposite end of the motor control winding. The return path in this case would be via VT7 and MR4.

93. This results in a sinusoidal output being fed to the control winding of the servo-motor; sinusoidal because of the unsmoothed a.c. from the rectifier bridge.

94. Reference should be made to Fig.5 for an explanation of these circuits.

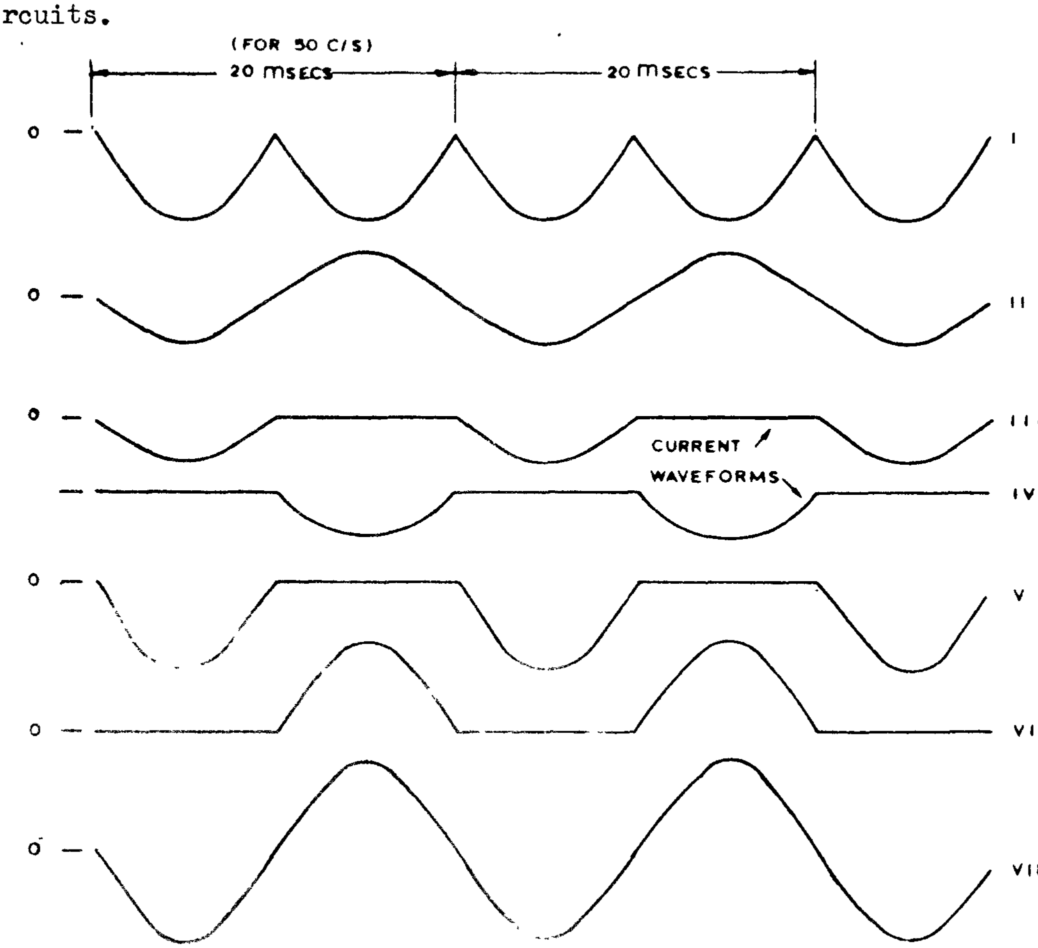


FIG.5

Curve No.	Representation
(i)	Voltage at 'A' with respect to 'B', i.e. rectifier output.
(ii)	A.C. voltage across T1 primary T1(1) and T1(2) (i.e. the amplified error signal). Due to the direction of the winding this voltage is in-phase with the voltage at TP3 with respect to that at TP4 and TP5 with respect to TP6, but out-of-phase with that at TP8 with respect to TP7 and TP10 with respect to TP9.
(iii)	Base currents of VT5 and VT6.
(iv)	Base currents of VT7 and VT8. Assuming base currents are sufficient to saturate the respective transistors during the whole half-cycle that they exist, each transistor has ideally NO volts across it for certain half-cycles. We then obtain curves (v) and (vi).
(v)	Voltage at 'A' with respect to Earth.
(vi)	Voltage at 'B' with respect to Earth.
(vii)	Output =(v) + (vi), because (v) shows a negative voltage at the same time as VT5 and VT6 are conducting (saturated) and similarly (vi) shows a positive voltage when VT7 and VT8 are conducting. The voltage (v) + (vi) thus appears at the output (across the motor control winding).

Limit Switching

95. When the servo-motor reaches an end stop it operates a microswitch which switches off the motor supply. This microswitch also prepares the circuit for an anti-phase error signal to reverse the motor.

Refer to Fig.4

96. The output stage allows the servo-amplifier to be switched so that it no longer supplies an output to drive the motor in the 'dangerous' direction, but when the error phase input changes the amplifier will work quite normally and drive the component away from this extremity.

97. S1 and S2 represent the clockwise and counter-clockwise limit switches and the diagram Fig.4 shows a simplified servo-amplifier output stage.

98. S1 and S2 are shown in the <u>un</u>-operated condition when the output stage is working normally, VT6 collector earthed via S1 and S2, and the motor control winding (pin 2) is also earthed and thus connected to VT6 collector.

99. When S1 changes over at the limit, VT6 collector is disconnected from earth and T2(1) is earthed. When S2 changes over at its limit, VT6 collector is again disconnected from earth but T2(2) is earthed.

100. Disconnecting VT6 collector from earth prevents VT6 and VT7 from operating and the earthing of one end of T2 causes VT5 and VT8 to act as a phase-sensitive switch, giving an output for one phase of a.c. supply input only.

101. Assuming that the servo-motor is moving towards S2, with S1 operated, then the following waveforms appertain to the beginning and end of travel; note this is not the normal procedure but will explain the limit switch operation.

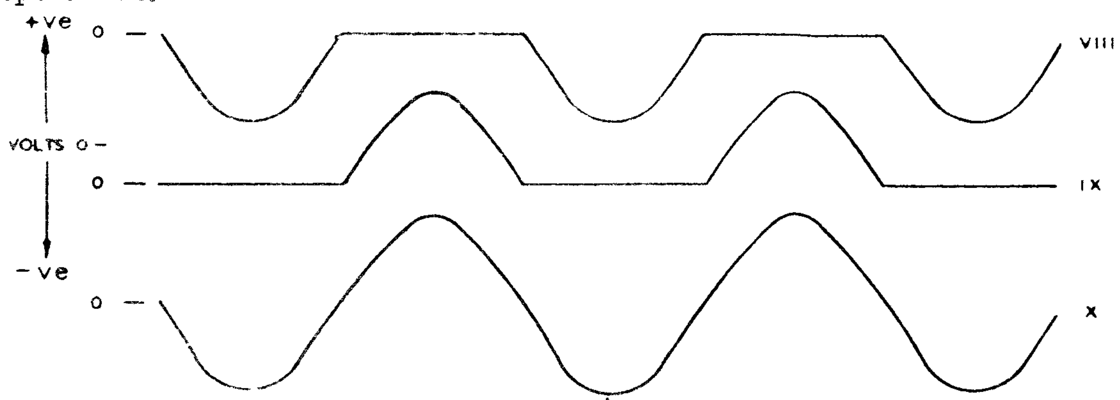


FIG.6

Curve No.	Representation
(viii)	Voltage at 'A' with respect to earth when S1 operated.
(ix)	Voltage at 'B' with respect to earth when S1 operated.
(x)	Output, with S1 operated. Note this waveform is the normal operating waveform but is delivered from only part of the two bridges. When the limit switch returns to rest, the output remains the same but the full bridge circuit is in use (as described in para.89).

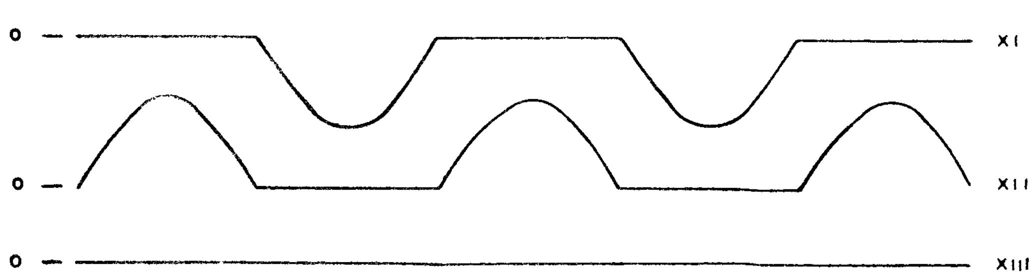


FIG.7

102. When the servo-motor reaches the S2 limit then the following waveforms appertain.

Curve No.	Representation
(xi)	Voltage at 'A' with respect to earth, S2 operated.
(xii)	Voltage at 'B' with respect to earth, S2 operated.
(xiii)	Output with S2 operated. During the half-cycles in which base current is present in VT5 (see (iii)), there is no collector to emitter voltage on VT5 (because there is no collector to earth voltage (see (xi)). Similarly, when VT8 has base current (see (vi)), there is no collector to emitter voltage (because there is no emitter to earth voltages (see (xii)). Consequently there is no collector current in either of these two transistors throughout a cycle and hence they make no contribution to the output current. This is due to the fact that a particular side of the rectifier output is earthed via S2. Because the junction of VT6 collector and VT7 emitter is isolated from earth, these two transistors have no effect on the output current, which is thus zero.

RELAY UNIT (UNIT 6.13)

(Identity T30-7482-01 & 04)

GENERAL Circuit Diagram Fig.127

103. The unit contains four sealed relays ITB, ITC, FCB and TR which forms part of the H1200 auto tune system which is discussed in the control circuits description, Chapter 4.

SWITCHING UNIT (UNIT 6.15)

(Identity T30-7489-01 & 02)

GENERAL Circuit Diagram Fig.128

104. The switching unit comprises four transistor switching circuits for operating four relays of the H1200 auto-tune system. These relays are the coarse level relay 6.16CLA, the input tune relay 6.16ITD, the threshold relay 6.3TR and the level limit relay 6.5LL. In addition the unit produces a -22.5V switching voltage for use in the drive equipment to control the TUNE/TRAFFIC switch.

105. The unit uses the +33-0 -33V supply from Unit 9 and two circuits operate at 0 to +33V and the other two 0 to -33V.

106. All four circuits operate on the same principle. In each individual circuit the last two transistors operate as a d.c. amplifier with a large amount of positive feedback provided by a common emitter resistance.

107. As the circuits are all similar, only that of VT2, VT3 and VT4 will be described in detail.

108. VT3 and VT4 form a monostable circuit with VT4 being supplied with base current via R11 and hence a collector current flows through VT4 via R12 and the relay, operating the relay. This is the normally stable condition of VT3 and VT4. A potential is thus established on the emitter of VT3 due to the VT4 current flowing in R12, and if the base of VT3 were open-circuit, then VT3 would be in a cut-off condition.

109. The state of VT3 is in fact controlled by VT2, the base of which is used for controlling the overall circuit. When VT2 conducts, VT3 is held in a cut-off condition and VT4 is provided with base current via R11 and R12.

110. If the potential of VT2 base is raised from an external source, VT2 will cut-off and base current will start to flow in VT3, accompanied at the same time by collector current in VT3. The emitter-collector impedance of VT3 diverts the base current from VT4 which cuts off and the relay is de-energised.

111. The positive feedback effect of R12 is accentuated by the fact that R11 has a very much greater value of resistance than that of the relay winding. When VT4 is conducting, R12 is at one end of a potential divider consisting of the relay resistance, the conducting transistor VT4 and R12. In the other state of the circuit, the potential across R12 is very much less, being produced again by a potential divider of which R12 forms a part, but this time with R11 as the major part.

112. Thus, as VT3 begins to be switched on by the base potential being brought below that of its emitter, the process is accelerated as the potential across R12 rapidly drops.

113. The switching action between the two states is very rapid, therefore, and high collector dissipations which could exist in intermediate conditions are avoided.

COARSE LEVEL SWITCH

114. This switch employs four transistors VT1 to VT4; VT1 is common to the Input Tune switch.

115. The base voltage of VT1 is used to produce the two switching conditions as follows. The base is biased by potentiometer chain R1 and R2 across the +33V supply; R1 is not permanently connected having a series of external switches between it and earth. It is the closing or opening of this line which gives the two switching base voltages.

116. The coarse level relay is energised when the switching line is open and bias is derived from the +33V line via R2. The bias holds VT1 in an OFF condition when there is no collector to emitter current and so current flows through R3 (VT1 collector load) MR2, R7, R6 and R8 providing a base voltage to VT2. This voltage is sufficient to switch VT2 on.

117. C1 and R7 form a hold-on delay as the circuit is energised in the normal way by short pulses (the duration of which is the length of time to turn an oak switch from one position to the next). When a pulse appears it charges C1 which then takes more than 20 msecs to discharge through R7, therefore the base of VT2 is biassed to the ON condition for greater than 20 msecs.

118. When VT2 is ON there is collector to emitter current flowing so that R9 and R10 form a potential divider to supply the base of VT3 which, with VT4, forms a trigger circuit described in paragraphs 108-113.

119. Relay CLA takes approximately 20 msecs. to operate and when it does one of its contacts inserts R5 across R3, MR2, R7 and R6 and a new base voltage, that of R5 and R8 junction, replaces the C1 decaying voltage to hold VT2 ON and thereby hold CLA on isolating the circuit from changes which have taken place in VT1 circuit.

INPUT TUNE SWITCH

120. A second output from VT1 collector via MR1 charges C3 in the same manner as C1 is charged (para.117) and transistor switch circuit comprising VT5, VT6, VT7 and VT8. This circuit is similar to the coarse level circuit but has an extra amplifier, and so instead of the relay being energised, it is de-energised. When the coarse level has been set-up the bias on VT1 base is derived from R1 and R2 to switch it on. This change does not affect the coarse level switch.

121. MR1 no longer conducts and C3 discharges through R13 to switch VT5 OFF; this reacts on VT6, VT7 and VT8 which are identical circuits to VT2, VT3 and VT4, therefore resulting in 6.16ITD being energised. A contact of 6.16ITD is wired into the hold-on circuit of VT2 and therefore as soon as ITD is energised CLA is de-energised.

THRESHOLD SWITCH

122. This transistor switch circuit comprises VT9, VT10, VT11 and VT15. VT9, VT10 and VT11 are connected in a circuit similar to VT2, VT3 and VT4 and operate in a similar manner to energise the threshold relay 6.13TR.

123. VT15 is an amplifier with two separate base voltage circuits. One base voltage is derived from the potentiometer network R41, RV1 and R30 and a contact of relay 6.5FCA. This contact either connects the potentiometer chain across the -33V supply or not. An open circuit switches VT15 OFF causing VT11 to be ON, thus energising the relay.

124. The second base voltage circuit is from the discriminator unit (Unit 10) where a voltage dependent on the r.f. output level is derived. When the amplifier is in service breaks in transmission remove the control which the signal normally imposes on the Tune and Load servo-motors. During such breaks, any unbalance in discriminator biasing currents will produce small error signals and there may well be sufficient to cause the controls to drift slowly away towards an end-stop.

125. To prevent this happening, the Threshold Relay connects the TUNE and LOAD servo-motors to their amplifiers only when a significant level of r.f. voltage exists on the anode. When no such signal is present, the motors are de-energised.

126. Breaks in transmission of short duration do not operate the Threshold Relay due to the time constant of C5/R29.

127. When a break occurs C5 will be charged and VT15 be ON, C5 will discharge through R29 and hold VT15 ON. The decaying voltage will be reflected through amplifier VT9 and on it reaching the critical point of the trigger, the trigger will change over to energise the relay.

LEVEL LIMIT SWITCH

128. This circuit provides a 'virtual' end-stop to prevent the level servo-system increasing the drive level and causing excessive final stage cathode current during the final stage of tuning.

129. The circuit, comprising VT12, VT13 and VT14, derives its control from the rectified signal of the h.t. transformer secondary current transformers. (The a.c. secondary current of the h.t. transformer is closely allied to the final stage cathode current and circuit-wise it avoids the difficulties of positive bias which exists on the actual cathode). The circuit is a trigger circuit similar to VT3 and VT4 operating a relay. VT12 is an amplifier in which the base to emitter junction is biased from the +33V supply because of the low level input.

130. As the a.c. secondary current is unsmoothed the output of the amplifier has a similar character. To prevent this ripple operating the trigger C6 smooths VT13 base voltage.

131. The relay contacts provide the same connections as those normally created by the max-signal-limit-switch of the level control. When closed it prevents movement of the level control in the increase signal direction at a cathode current of about 2.5 amps. However, as with the limit switches, it still allows the level control to reduce the signal as the circuit comes into tune.

DRIVE REFLECTED POWER CLAMP

132. The W.B.A. is fitted with a s.w.r. trip circuit which functions at about 140 watts reflected power. During final stage tuning, when the cathode circuit is switched from the matched dummy load to the out-of-tune valve circuit, the anode volts will be low and the level servo

system will commence to increase the level. If this were permitted then the 140 watts reflected power would be exceeded and the W.B.A. would trip off.

133. To prevent this, the level limit switch circuit is used; a second input to the base of VT12 will cause the trigger VT13 and VT14 to operate as described in paras.106 to 113 when the input coupler reflected power output shows a reflected power of 80 watts.

RELAY UNIT (UNIT 6.16)

(Identity T30-7482-03 & 06)

GENERAL Circuit Diagram Fig.129

134. This unit contains four sealed relays CLA, CLB, CLC and ITD which form part of the H1200 auto-tune system.

135. Resistors R1 and R2 form a potential divider to the input of the servo amplifier. This cuts down the signal into the servo amplifier while maintaining a large signal into the associated Relay Amplifier.

136. The relays are connected with the auto-tune system and their operation is discussed in the control circuit description.

DISCRIMINATOR UNIT (UNIT 10)

(Identity T30-1969-02 & 03)

DESCRIPTION

137. This unit is fed with r.f. voltages from various tuning circuits of the amplifier and converts them to low voltage square wave a.c. error signals which are eventually used to operate the servo-motors in the amplifier. In the unit are three separate discriminators each energising a separate circuit, and as the circuits are similar the Anode Tuning Discriminator, will be described and the differences between it and the others discussed later. The unit also contains two circuits from which control voltages are derived.

Anode Tuning Discriminator Circuit Diagram Fig.130

138. This circuit is a phase discriminator which compares the phase of the r.f. signal at the final stage (F.S.) anode with the phase of the signal at the cathode.

139. The r.f. potential of the F.S. anode is connected via a pick-up capacitor 2C29, to 10PLA(7) where it feeds the primary of the phase transformer T1 to earth.

140. The windings of T1 give a 2:10 + 10 step-up in voltage and the secondaries are each terminated with two paralleled 120Ω resistors (R1-R4), each pair across part of the potentiometer RV1. This

potentiometer is used to balance the two circuits across the secondaries of T1.

141. The load resistors R1-R4 throw a resistive impedance of approximately 1.2Ω across the primary, which in conjunction with the capacity of $\frac{1}{2}$ pF (approx.) from the anode, produce voltages across each secondary of T1 which are shifted in phase from the anode voltage by 90°.

142. The cathode pick-up is fed to 10PLA(4) via an external 0.4 pF trimmer capacitor 2C27, which is shunted by a resistor 2R15, to provide a small low frequency phase correction. This pick-up provides a voltage at the centre point of T1 secondaries, that is in-phase with the cathode/earth voltage.

143. The amplitude of the r.f. potentials appearing at terminals 4 and 7 of T1 are obtained by additions of vectors and are converted to d.c. to be subtracted to give a signal proportional to the error (see Fig.8). This sketch also shows the square wave error signals, the derivation of which is described in paras.149 and 150.

144. The r.f. outputs at terminals 4 and 7 of T1 are fed via blocking capacitors C2 and C3 to the voltage doubling rectifier MR1 to MR4 which have r.f. decoupling provided by C14 to C17 and are biassed in the forward direction with a current of 8.0 μA approximately obtained from the +33V or -33V supply according to diode polarity.

145. For MR1 and MR2 the current is obtained from the -33V supply (PLB(1)) and the potentiometer chain R12, MR15 and RV3; RV3 setting the current and MR15 providing some temperature compensation. MR3 and MR4 have a similar circuit from the +33V supply.

146. As these two pairs of diodes may not be perfectly matched in rectification efficiency, a preset resistor RV2 is fitted to allow a balance to be achieved when setting-up. The output of MR3/MR4 is reduced by a fixed ratio (R16/R17) while the output of MR1/MR2 is reduced by an adjustable ratio (RV2 and R13).

147. These reduced outputs are fed via equal resistors R14 and R15 to a summation point and the monitor output plugs PLC(5) and PLC(6) via C42/L1 and C43/C2 providing r.f. decoupling against external pick-up.

148. At the summation point a time delay is introduced by capacitor C28 to prevent rapid fluctuations in error signals which would be produced by modulation of the r.f. signal, i.e. ON/OFF keying. Also at this point the crossed diodes MR22 and MR23 are fitted to limit the excessive transient error voltage, this can be produced when the amplifier is keyed since the rise time of the two diode circuits is not identical.

NOTE: *vr2 at PLC5* *vr1 at PLC6*

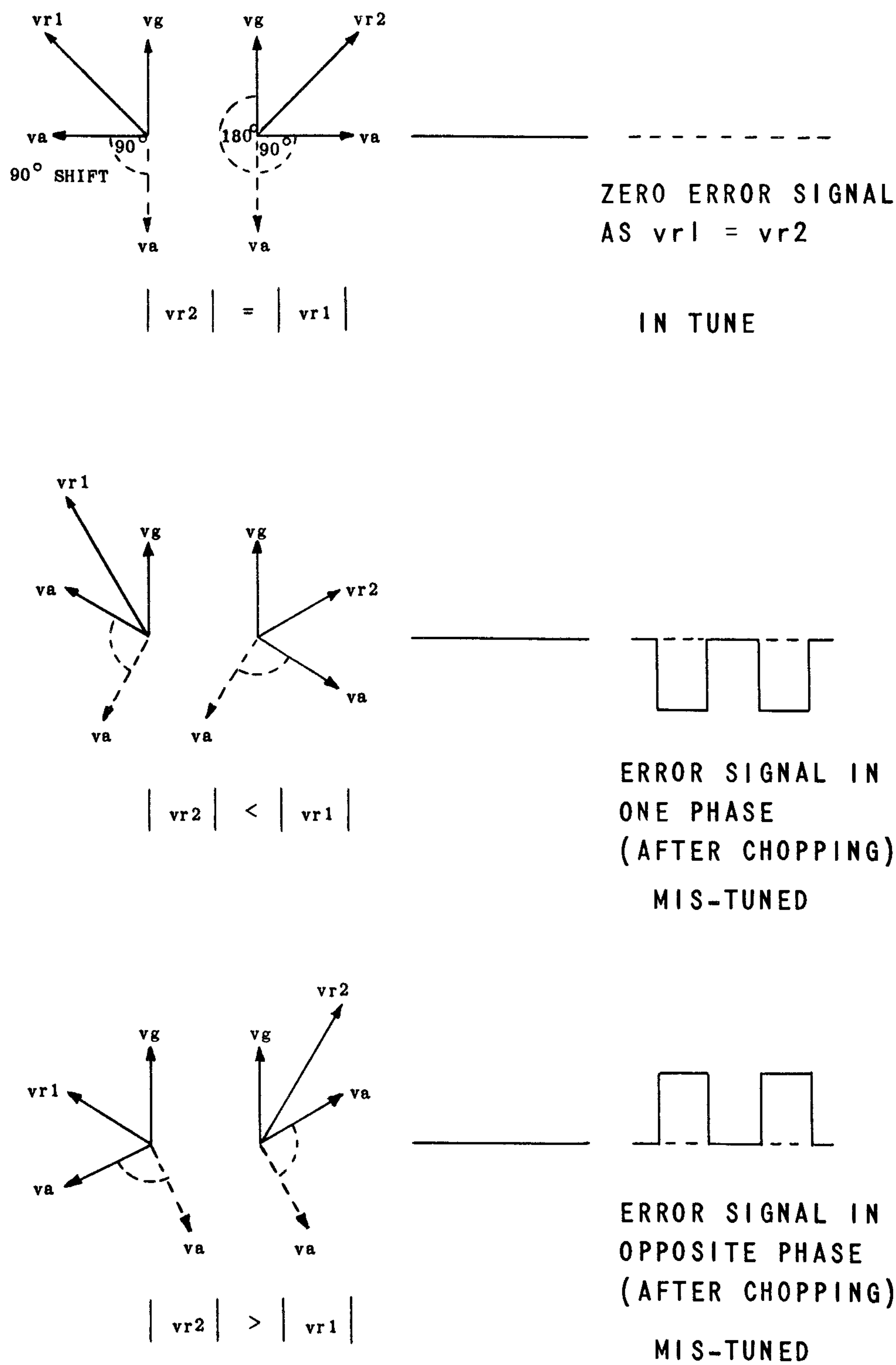


FIG.8 ERROR SIGNAL VECTORS

149. From the summation point the error signal is applied to the chopper transistor VT1 via R23. VT1 is used in the inverted connection in order to achieve a low 'offset' voltage and is switched by applying a clipped current waveform to its base via R18. This waveform is obtained from a 20V r.m.s. sinewave that is applied between PLB(4) and earth. The supply is limited by the Zener diodes (MZ1, MZ2 and R11).

150. The chopper circuit is an ON/OFF switch; alternately (every other half-cycle) shorting the error signal to earth or allowing it to pass. This converts the d.c. error signal into the form of a mains frequency square wave which is applied to the error amplifier VT2, via the blocking capacitor C29.

151. The error amplifier VT2 is a common collector (emitter follower) and this has a voltage gain of almost unity, but provides a low output impedance to the servo-amplifier.

152. The +33V is connected via R19 and C31 and C32 are r.f. decoupling capacitors. The discriminator output is coupled to PLC(7) via C30.

153. The output at PLC(7) is a mains frequency square wave and this may be either of two square waves that are in anti-phase depending on the error signal input. This is important as it is the phase relationship of the error signal to the servo-motor reference supply that will dictate the direction of motor rotation.

Other circuits

154. The r.f. potential of the F.S. anode is also connected via a pick-up capacitor (2C30) to PLA(11). This pick-up capacitor, together with C7, forms a major capacity potential divider circuit which supplies four circuits:-

(a) anode loading comparator

(b) output level

(c) variable gain amplifier control voltage

(d) r.f. threshold switch control voltage

Anode Loading Comparator

155. The input to the anode loading comparator from the major capacity potential divider is frequency compensated by the divider formed by C5, C6 and R6, giving high frequency boost type of compensation, the junction of C5/C6 feeding the voltage doublers MR7/MR8.

156. The second input to the anode loading comparator is the r.f. potential of the F.S. cathode which is capacity coupled (2C28) to PLA(9) with C4 and R5 completing a frequency compensated potential divider, giving a high frequency boost. The junction of C4/2C28 feeds the voltage

doubler MR5/MR6. In this circuit it is unnecessary to balance out the inequalities of the rectifiers.

157. The chopper and error amplifier circuits fed by MR5 to MR8 are similar to those described in para.149.

Output Level Comparator

158. The input to the output level comparator from the major capacity potential divider is frequency compensated by the divider formed by C8/R8 and C9/R7, giving a low and high frequency boost. The junction of C8/C9 feeds the doublers MR9/MR10 with C22 and C23 as decoupling capacitors.

159. The second input to the output level comparator is a reference voltage that is developed across the potential divider R43, R38 to 6RV1 and 6R4 (R38 shunted by 6RV1 and 6R4). 6RV1 is the SET LEVEL preset control in the Auto Tray. The two voltages are monitored via PLB(6) and PLB(7).

160. The output of MR9/MR10 and the reference voltage from R38 are fed via the equal resistors R35 and R37 from which point the circuit is similar to the anode tuning.

Variable Gain Amplifier Control Voltage

161. The sensitivity of the Anode Tuning phase discriminator depends to a large extent on the level of the F.S. anode voltage. When the output stage is considerably mistuned the sensitivity is very low, therefore an amplifier is required to increase the discriminator output to the Servo amplifier. On different ranges the discriminator sensitivity also varies due to frequency and Q effects and so the gain of the amplifier must depend on the Range and F.S. anode voltage (see also paras.64-69).

162. The input to the variable gain amplifier control rectifier from the major capacity potential divider is frequency compensated by the divider formed by C10, C11 and R9 giving a high frequency boost. The junction of C10/11 feeds the doublers MR11/MR12 which are biased from the -33V supply and output to PLB(9) via r.f. decoupling against external pick-up, L7/C48.

R.F. Threshold Switch Control Voltage

163. The input to the r.f. threshold switch rectifier from the major capacity potential divider is frequency compensated by the divider formed by C12, C13 and R10. The junction of C12/C13 feeds the doublers MR13 and MR14 and the circuit operates in the same manner as the Variable Gain circuit outputing to PLB(10).

DISCRIMINATOR UNIT (UNIT 13.20)

(Identity T30-7328-01 & 02)

GENERAL Circuit Diagram Fig.131

164. This is the input level discriminator and is mounted in the W.B.A. cabinet with the auto-attenuator. The chopper and error amplifier circuits are similar to the Anode Tuning Discriminator described in para.138 and the remainder of the circuit is similar to the output level discriminator described in para.158.

The two compared signals are derived:

(a) reference - from a potentiometer RV2 from the +33V supply and

(b) error signal - from the output of the 3W W.B.A.

via frequency compensating network and diodes MR3 and MR2, this circuit being biased from the -33V supply.

165. As with the Anode Tuning Discriminator the unit has positive and negative monitoring points.

DISCRIMINATOR UNIT (UNIT 14)

(Identity T30-7562-01)

166. Circuit Diagram Fig.132.

This is the input tune discriminator and is mounted on the input assembly with the input tune servo-motor. Its circuit is very similar to the anode loading comparator described in para.155.

AUTO TUNE EQUIPMENT

RELAY UNIT (UNIT 6.7)
(Identity T31-6720-01)

GENERAL

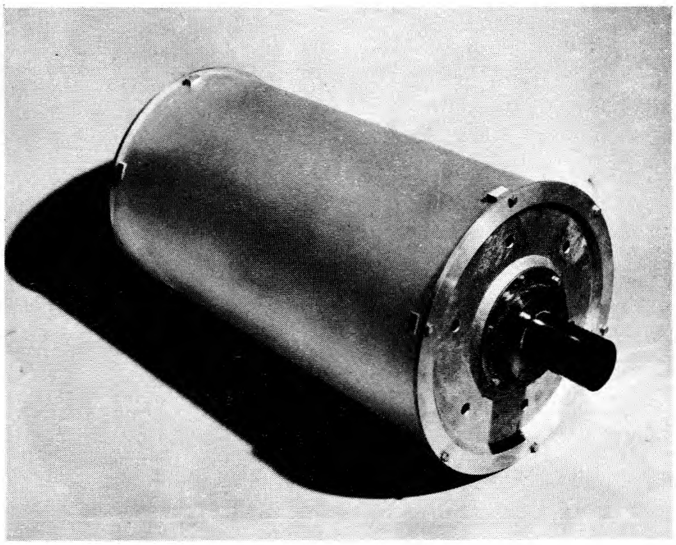
167. The unit consists of two four-pole changeover relays, two thermal delay relays, an electrolytic capacitor and a rectifier, which function as a time delay switching circuit and form part of the sequencing controls. The components are mounted on a bracket fitted in a standard book unit for the Auto Tune Tray. (Refer Fig.141).

CIRCUIT DESCRIPTION (fig.178)

168. The circuit MR1, C1 and RLA (only one contact-set used) is paralleled with the SET OUTPUT LEVEL lamp circuit. When the lamp circuit is energised, RLA operates and a 50V supply is made through the heaters of the thermal delay relays RLC and RLD. Those relays are set to provide two time delays, 15 seconds and 60 seconds, RLC based on the heating time and RLD on the cooling time. The operative points for the contacts are RLC1 closing after 15 seconds and RLD1 opening after 60 seconds. A description of the control circuits is given in Chap.4.

117360 1182/189/1 P&GS 6/79 CONT.1273

41·5-110 Mc/s Harmonic Filter



This Filter is designed to reduce Harmonics between 41.5 and 110 Mc/s, which originate in a transmitter for the range 2 to 27.5 Mc/s. It is a three section low-pass type, using a concentric assembly to provide the required capacitance.

The Filter, which is not adjustable is designed for insertion into 2" coaxial feeder and must be sited close to the transmitter in the outgoing aerial feeder.

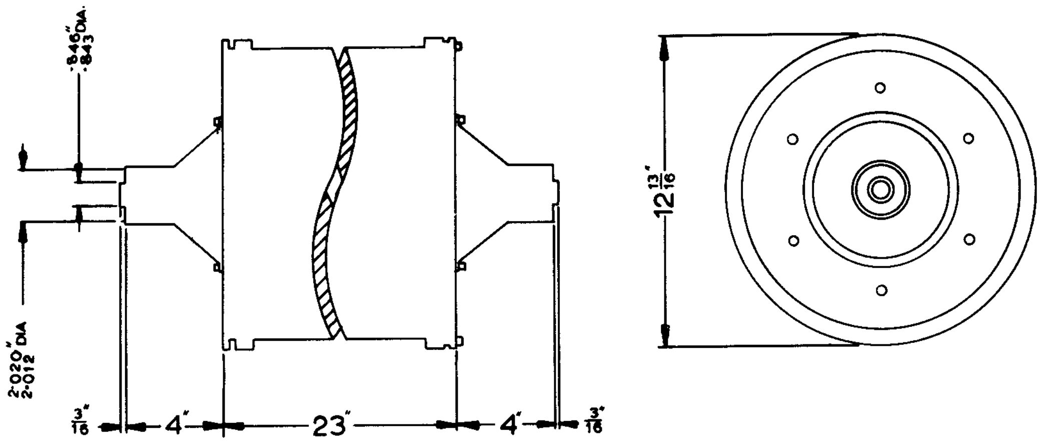
For effective filtering the associated equipment must be arranged so that no spurious radiation can occur, e.g. efficient decoupling of the power supply for the transmitter, aerial masts and stays taut and free from corrosion.

DATA SUMMARY

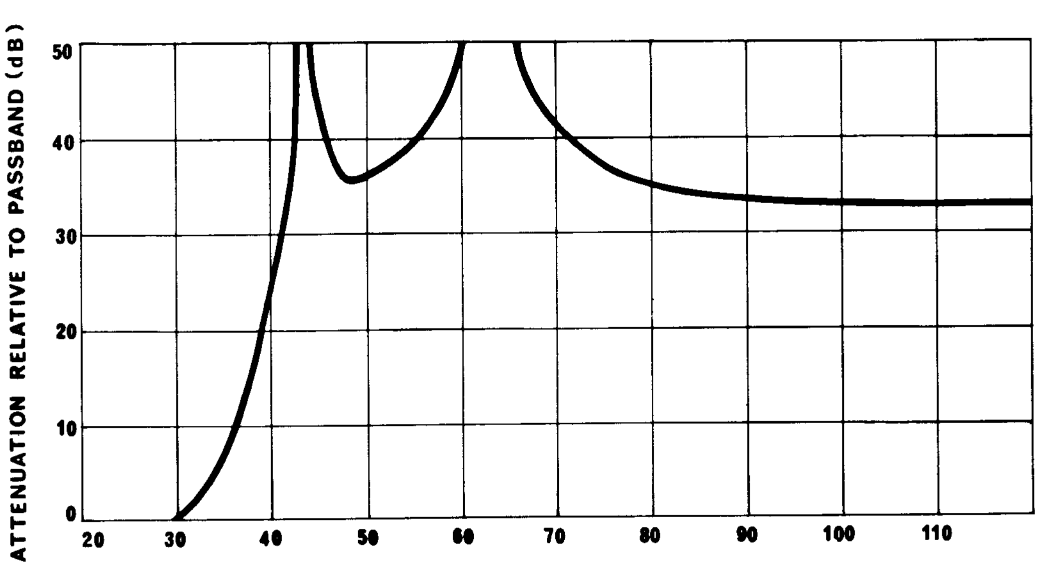
Pass band	2 to 27.5 Mc/s
Insertion loss	Less than 0.05 dB
Attenuation in Band 41.5 to 100 Mc/s	At least 30 dB
Input and output impedance	51 ohms
Power handling capacity	30 kW at 2:1 V.S.W.R.

F1297-01 GPO 2" coaxial feeder end fixings
F1297-02 Marconi Standard 2" coaxial feeder end fixings

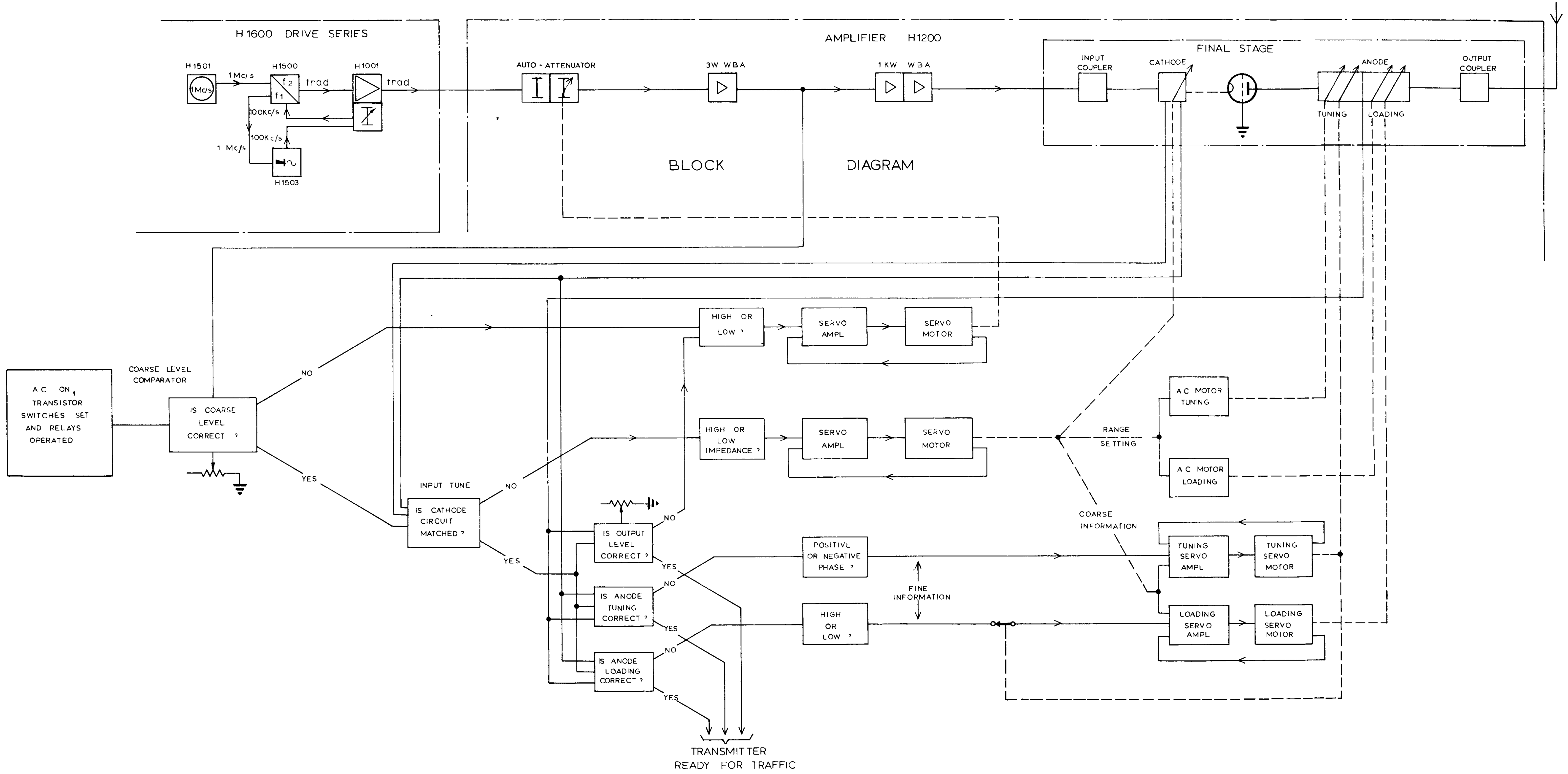
F1297



·846" DIA
·843
2·020" DIA
2·012
3/16"
4"
23"
4"
3/16"
12 13/16"



ATTENUATION RELATIVE TO PASSBAND (dB)
50
40
30
20
10
0
20
30
40
50
60
70
80
90
100
110
FREQUENCY (Mc/s)



T30-7511 SH. 1
ISSUE 2

H F TRANSMITTER H.1200.

FLOW & BLOCK DIAGRAM FIG 101

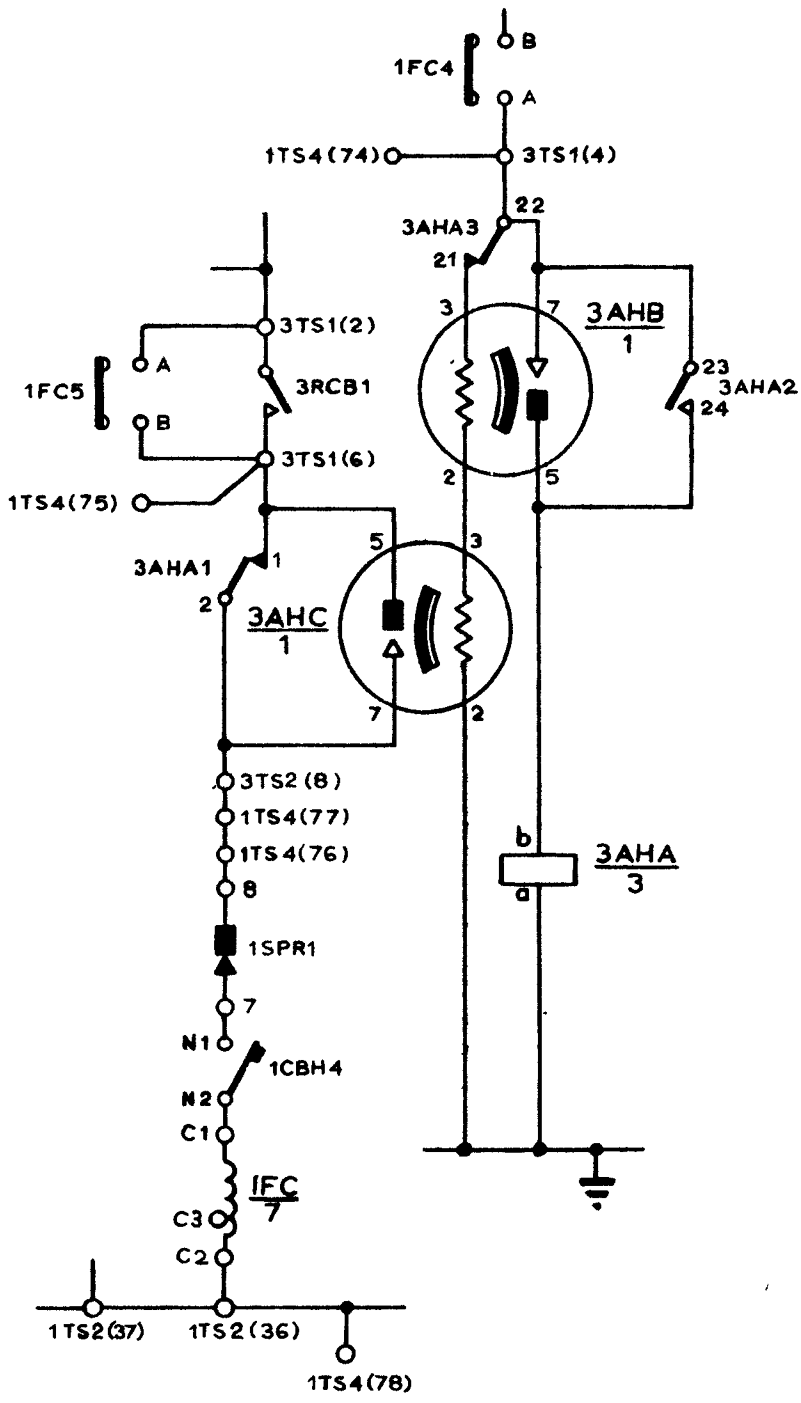
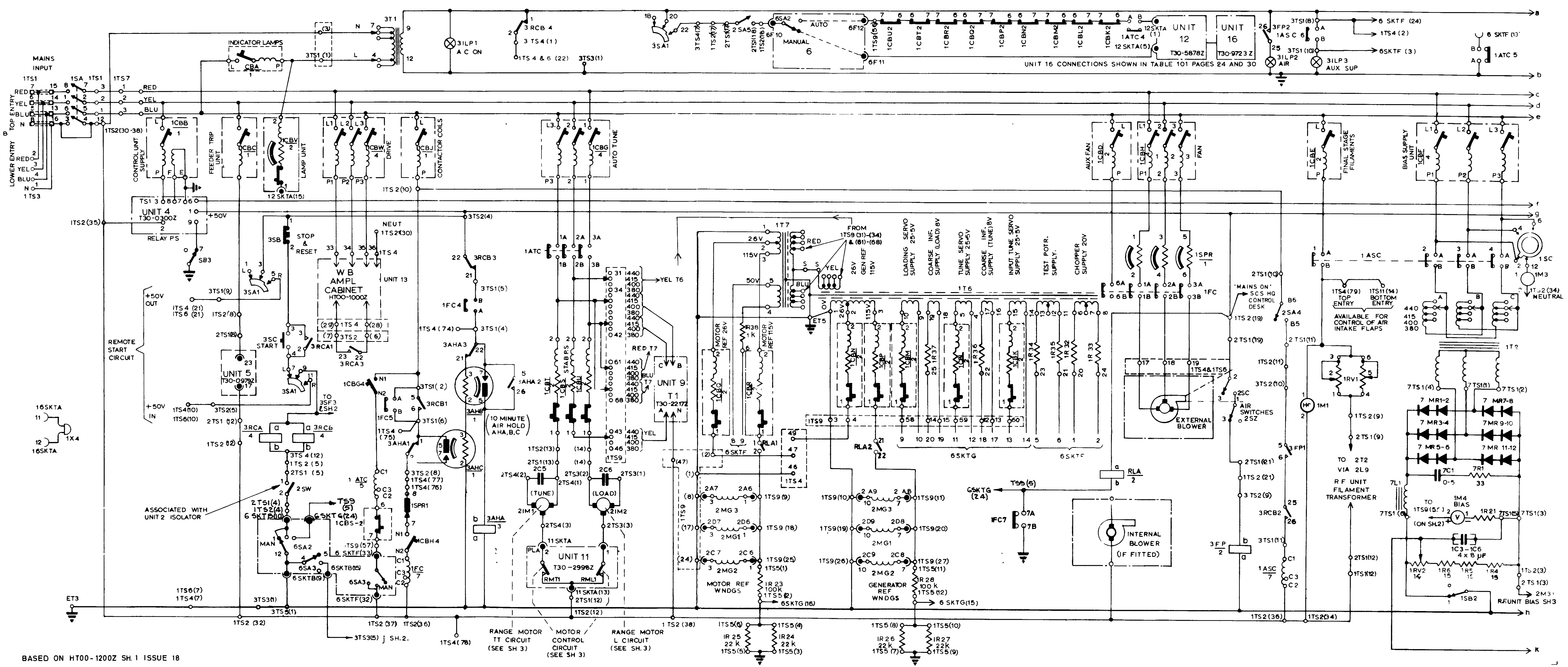


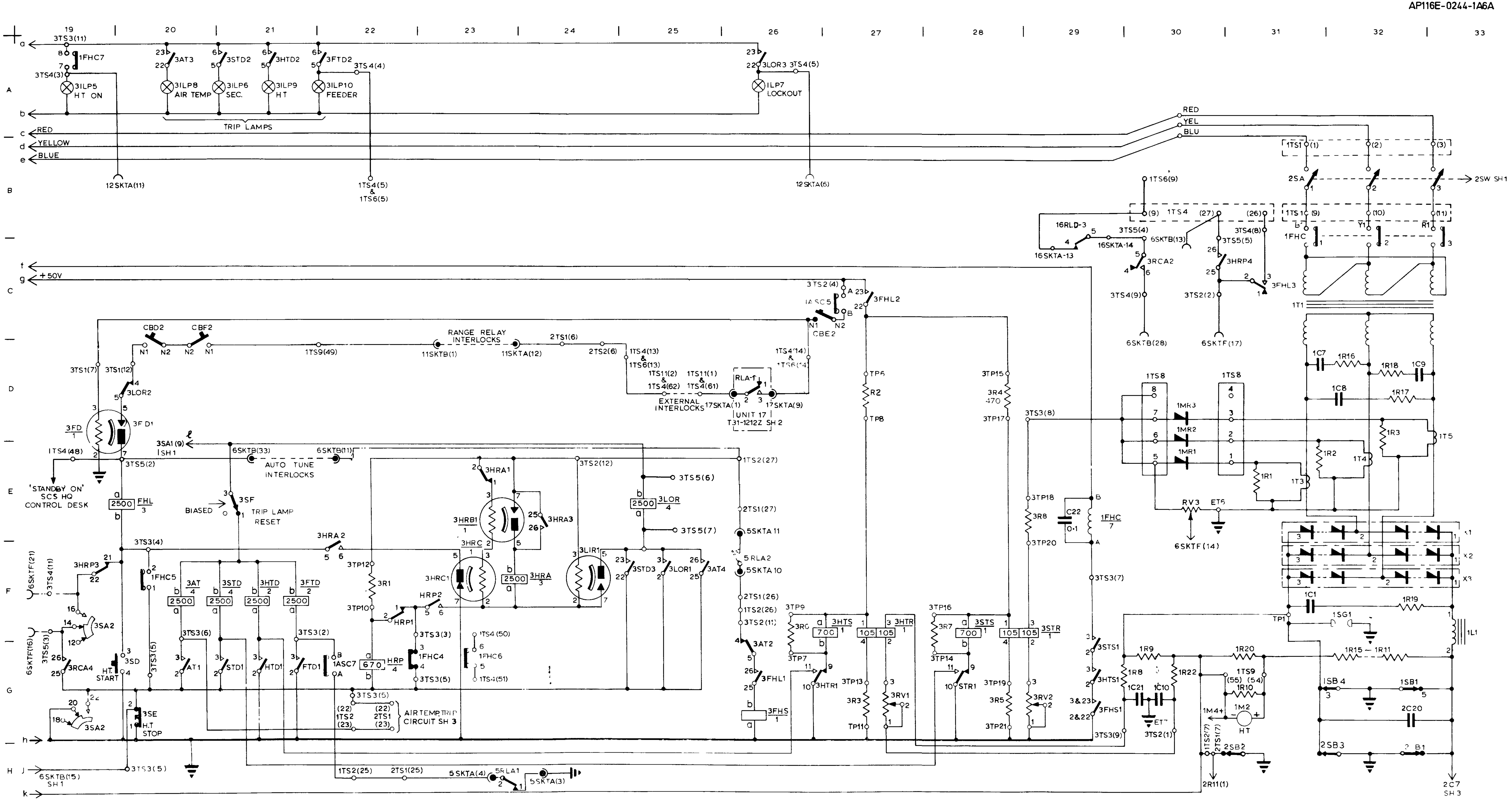
FIG.102A

Modification No.1886 to the region of the circuit located at 5 and 6, E to H in Fig.102 is shown above. The modification entails connections to 1TS4(74) to (78), connecting 1TS4(76) and 1TS4(77) into the link between 1SPR1(8)and 3TS2(8).



BASED ON HT00-1200Z SH.1 ISSUE 18

H.F Transmitter HT00-1200: circuit



BASED ON HT00-1200Z SH 2 ISSUE 19

FIG 103

Aug 84 (Amdt 17)

H.F Transmitter HT00-1200: circuit

FIG 103

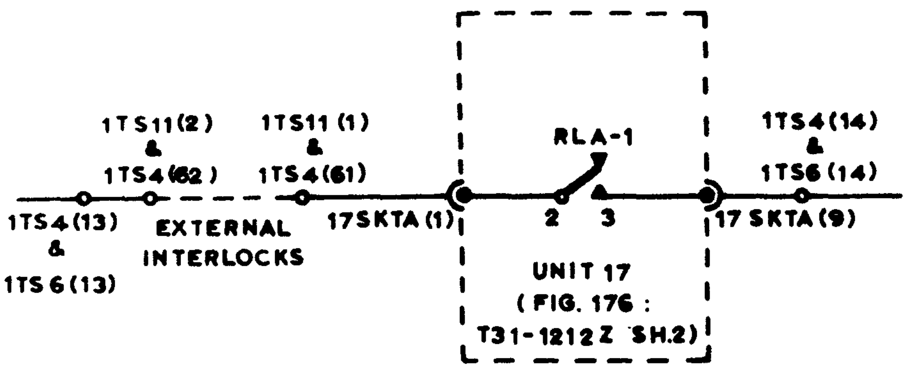


FIG.103A

Modification No.1889 (provision of aerial interlock facility) entails the change in circuit Fig.103 shown above. Location 26D on Fig.103.

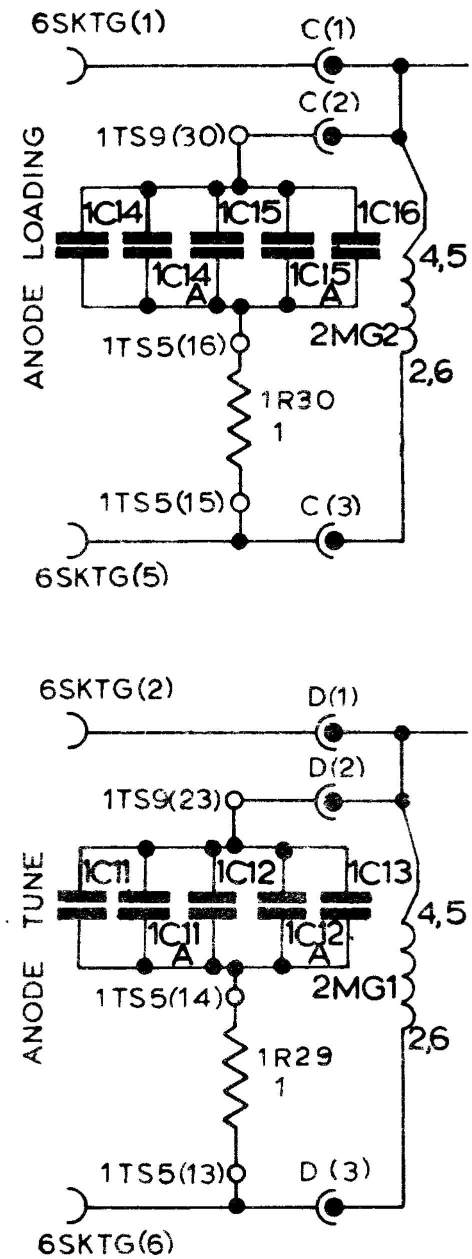
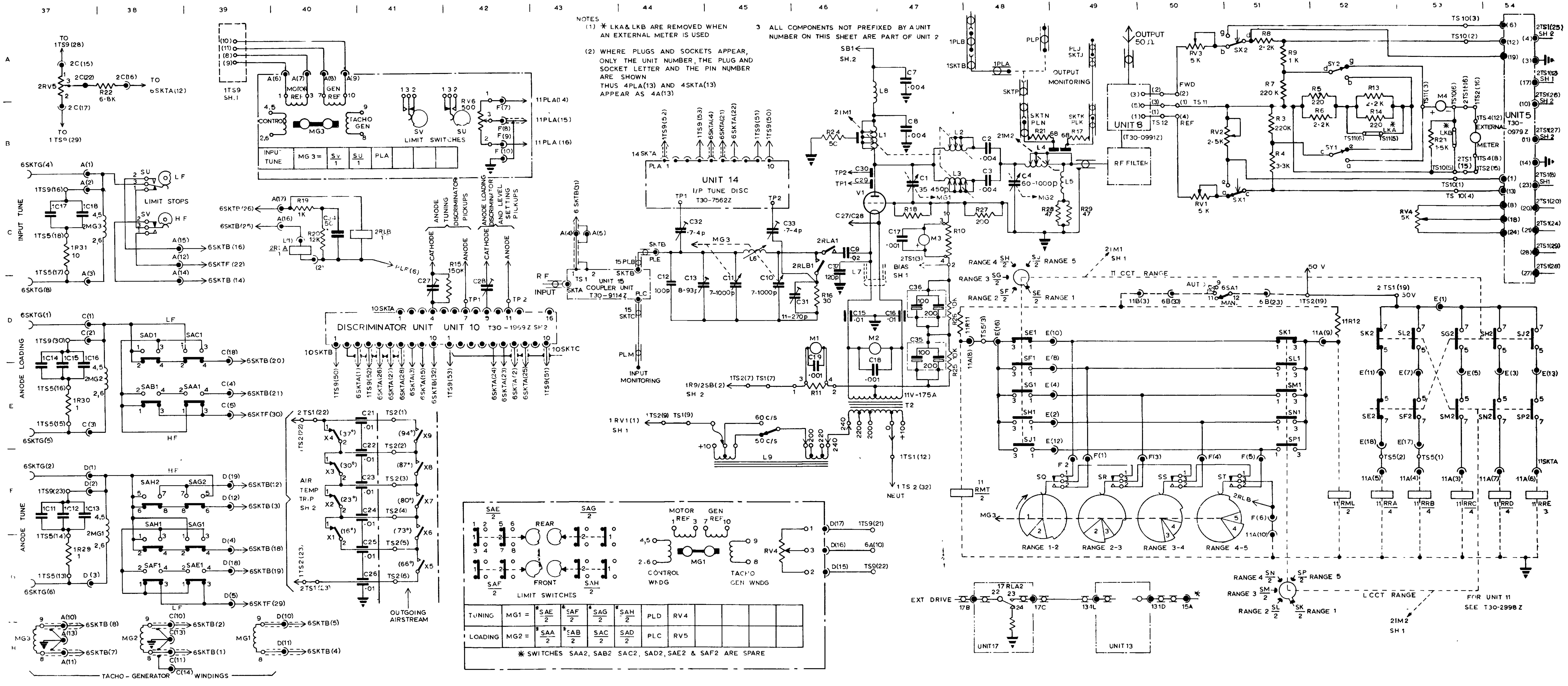


Fig.104A Modification No.A4594
Two assemblies of five capacitors
fitted to replace C11 to C16

WARNING. CAPACITORS CIRCUIT REFERENCES 1C11-1C16 INCLUSIVE CONTAIN PCB. BEFORE HANDLING SEE WARNING FOLLOWING PREFACE TO THIS HANDBOOK.



HT00-1200Z. SH. 3
ISSUE 13

H.F. TRANSMITTER HT00-1200

CIRCUIT FIG. 104

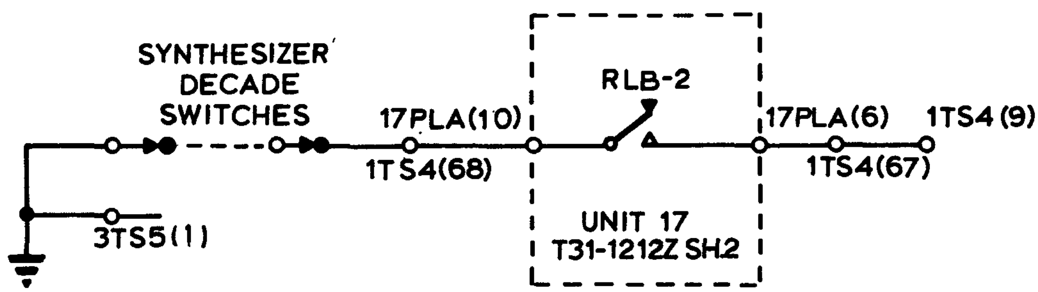
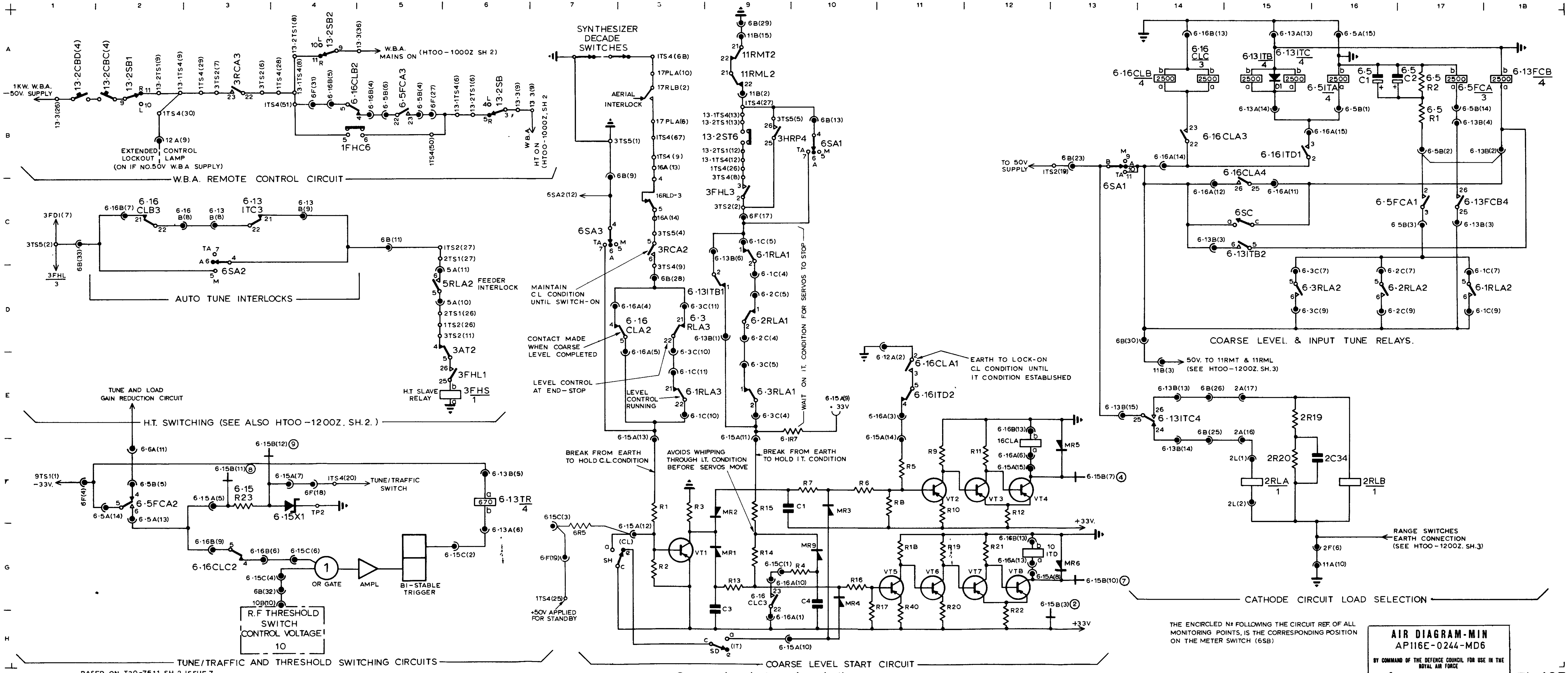


FIG.105A

Modification No.1889 (provision of aerial interlock facility) entails the change in circuit Fig.105 shown above. Location 8C on Fig.105.

Refer Fig.176A for Alteration 3 to Mod.A1889.



THE ENCIRCLED Nº FOLLOWING THE CIRCUIT REF. OF ALL MONITORING POINTS, IS THE CORRESPONDING POSITION ON THE METER SWITCH (6SB)

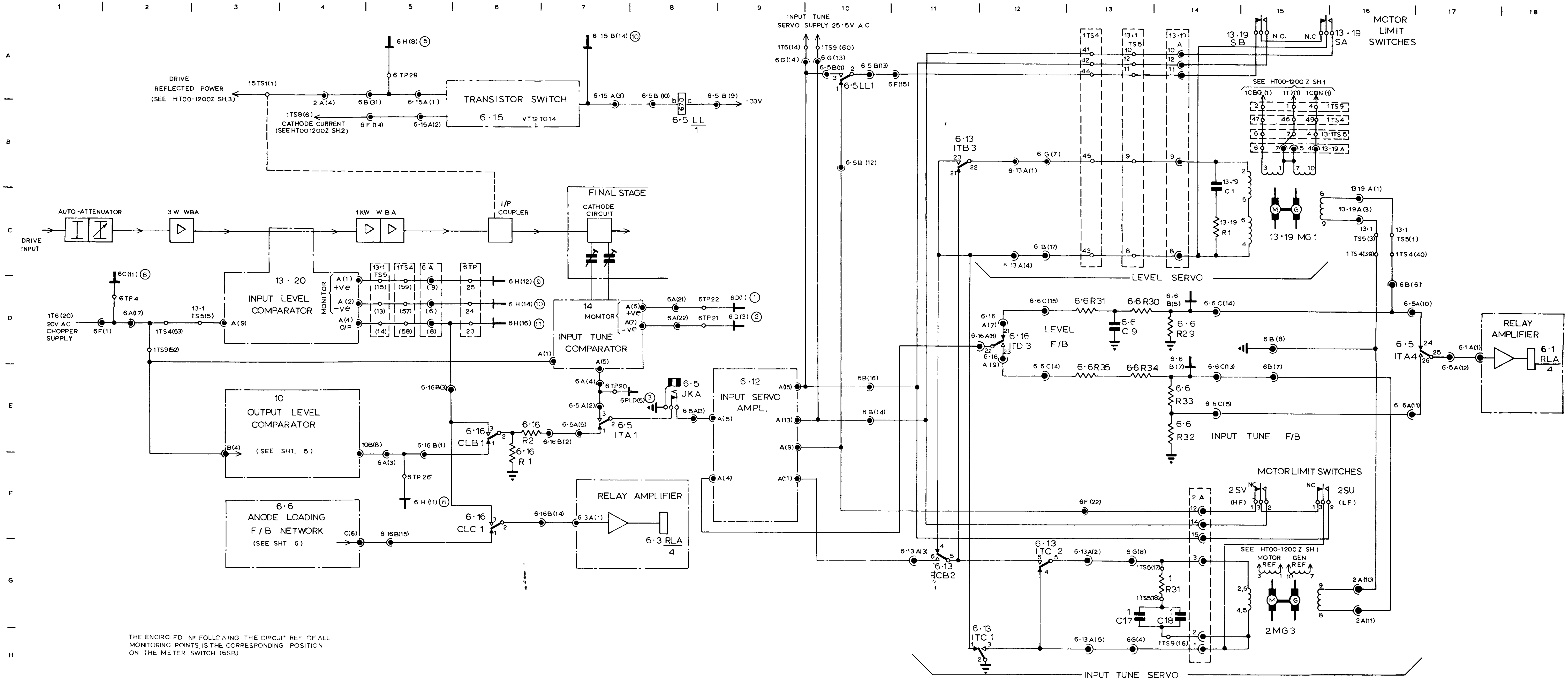
AIR DIAGRAM-MIN
AP116E-0244-MD6
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
ISSUE 2 Prepared by MOD(PE)

Fig.105 BASED ON T30-7511 SH.2 ISSUE 7

Course level: functional diagram

Amdt.14, Nov. 78

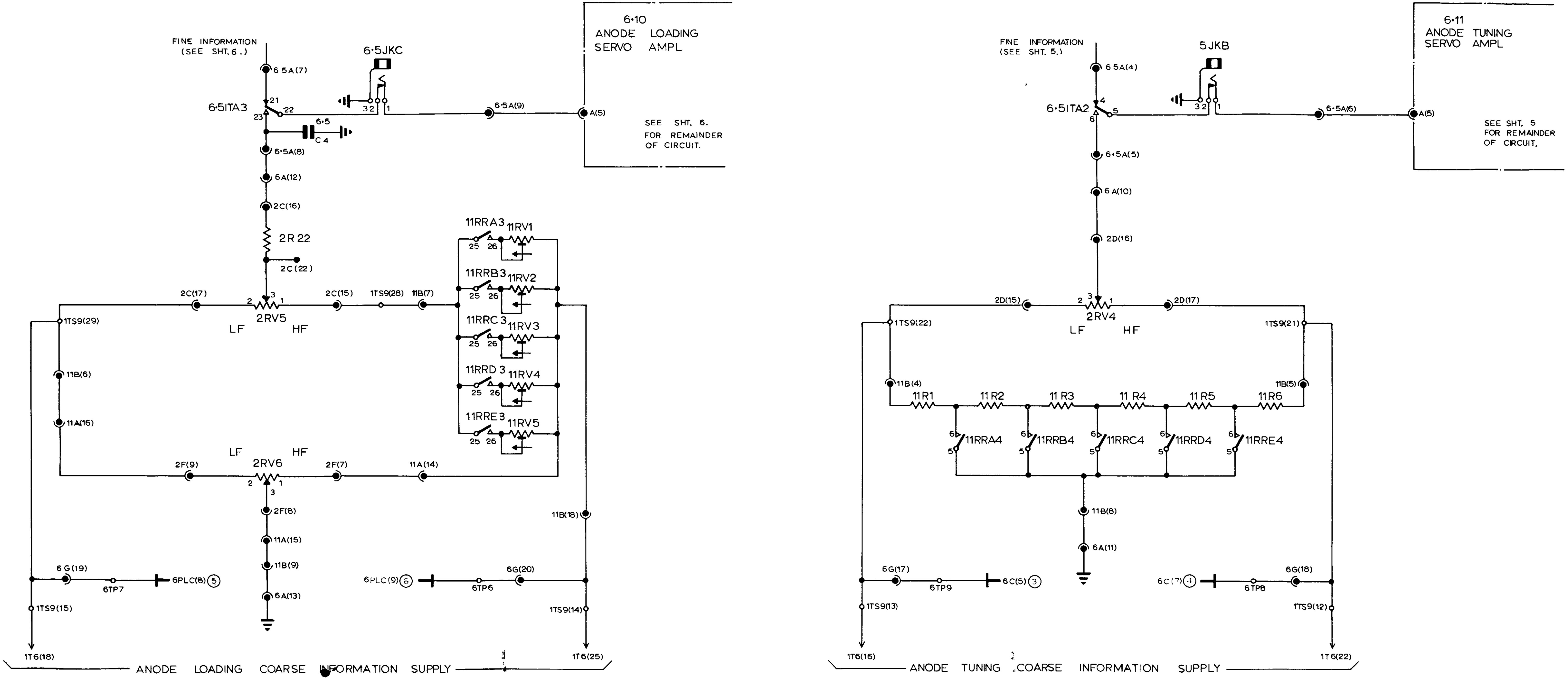
Fig.105



HF TRANSMITTER H.1200

COARSE LEVEL & INPUT TUNE FUNCTIONAL DIAGRAM

FIG 106



ANODE LOADING

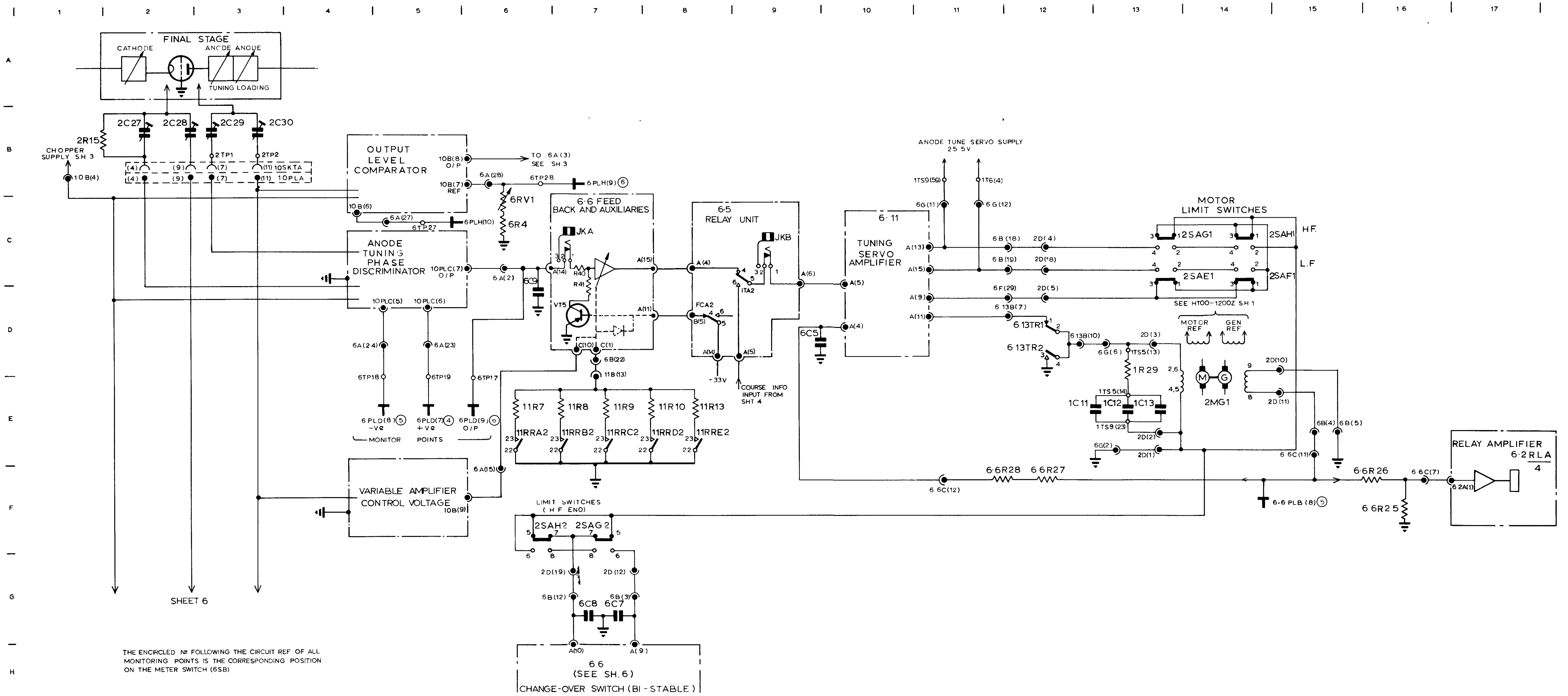
ANODE TUNING

T30-7511 SH.4
ISSUE 2

THE ENCIRCLED № FOLLOWING THE CIRCUIT REF OF ALL MONITORING POINTS, IS THE CORRESPONDING POSITION OF THE METER SWITCH (6SB)

H. F. TRANSMITTER H1200

COARSE INFORMATION FUNCTIONAL DIAGRAM FIG.107

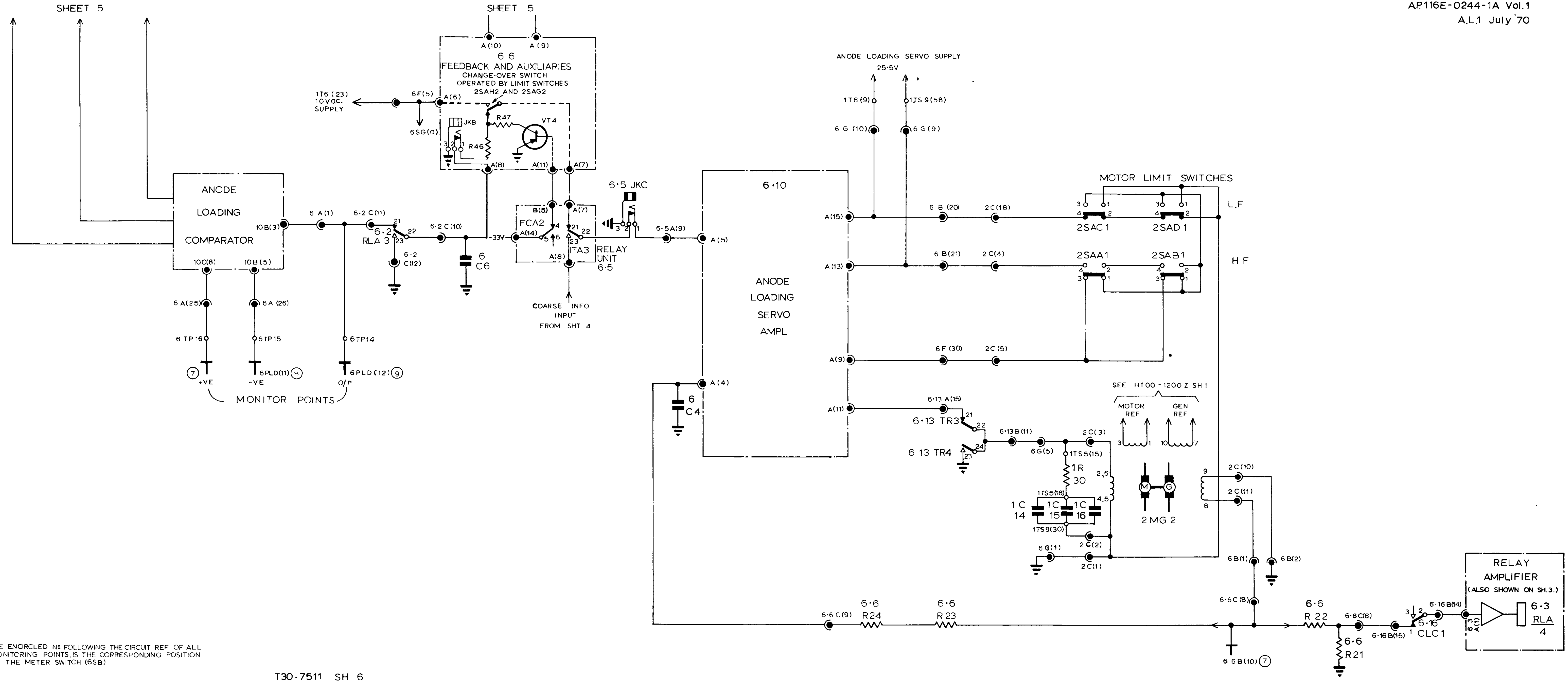


THE ENCIRCLED № FOLLOWING THE CIRCUIT REF OF ALL MONITORING POINTS IS THE CORRESPONDING POSITION ON THE METER SWITCH (6SB)

H.F. TRANSMITTER H.1200

ANODE TUNING FUNCTIONAL DIAGRAM

FIG.108

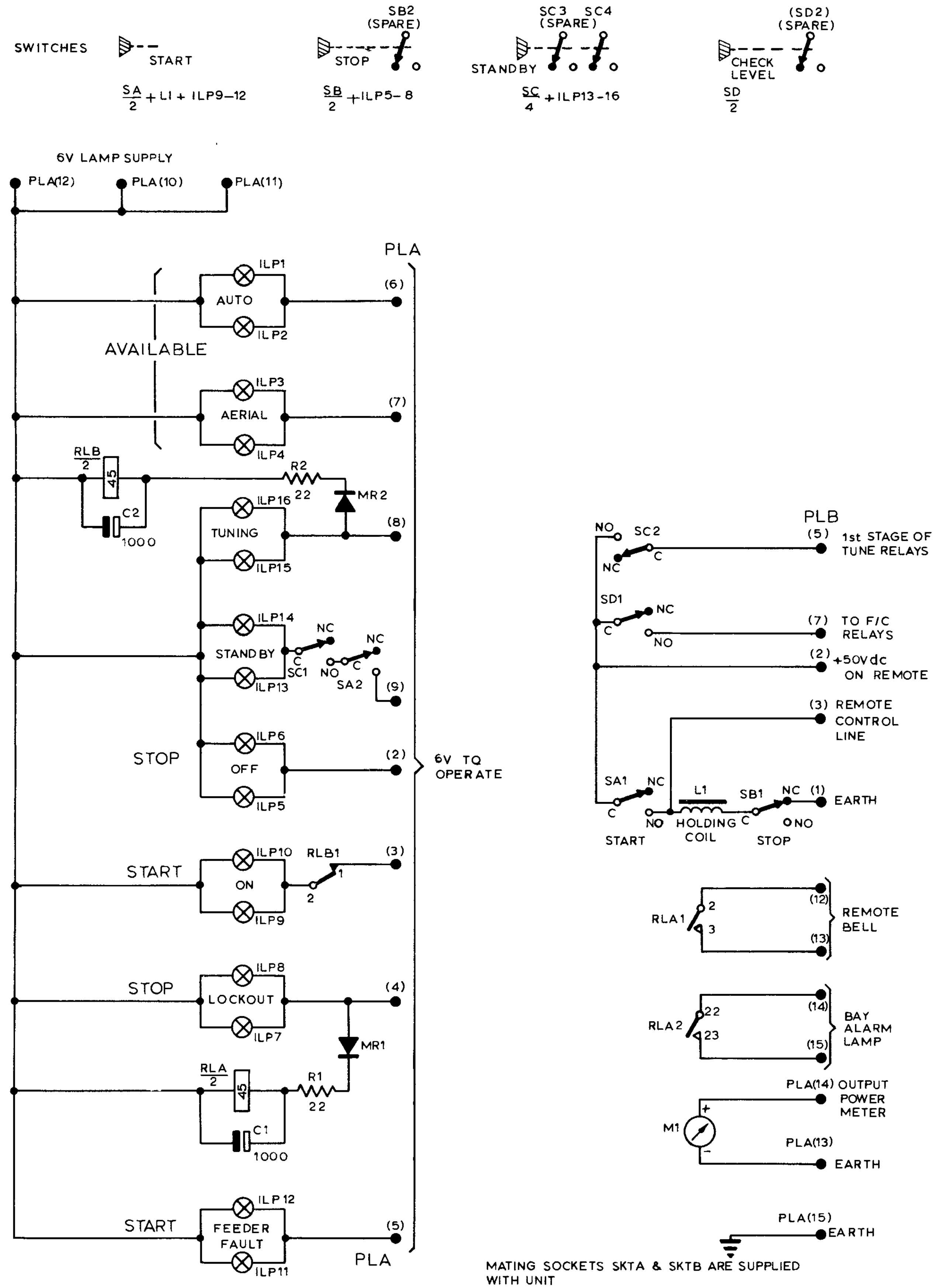


THE ENCIRCLED № FOLLOWING THE CIRCUIT REF OF ALL MONITORING POINTS, IS THE CORRESPONDING POSITION ON THE METER SWITCH (6SB)

T30-7511 SH 6
ISSUE 5

H.F TRANSMITTER H.1200

ANODE LOADING FUNCTIONAL DIAGRAM FIG.109

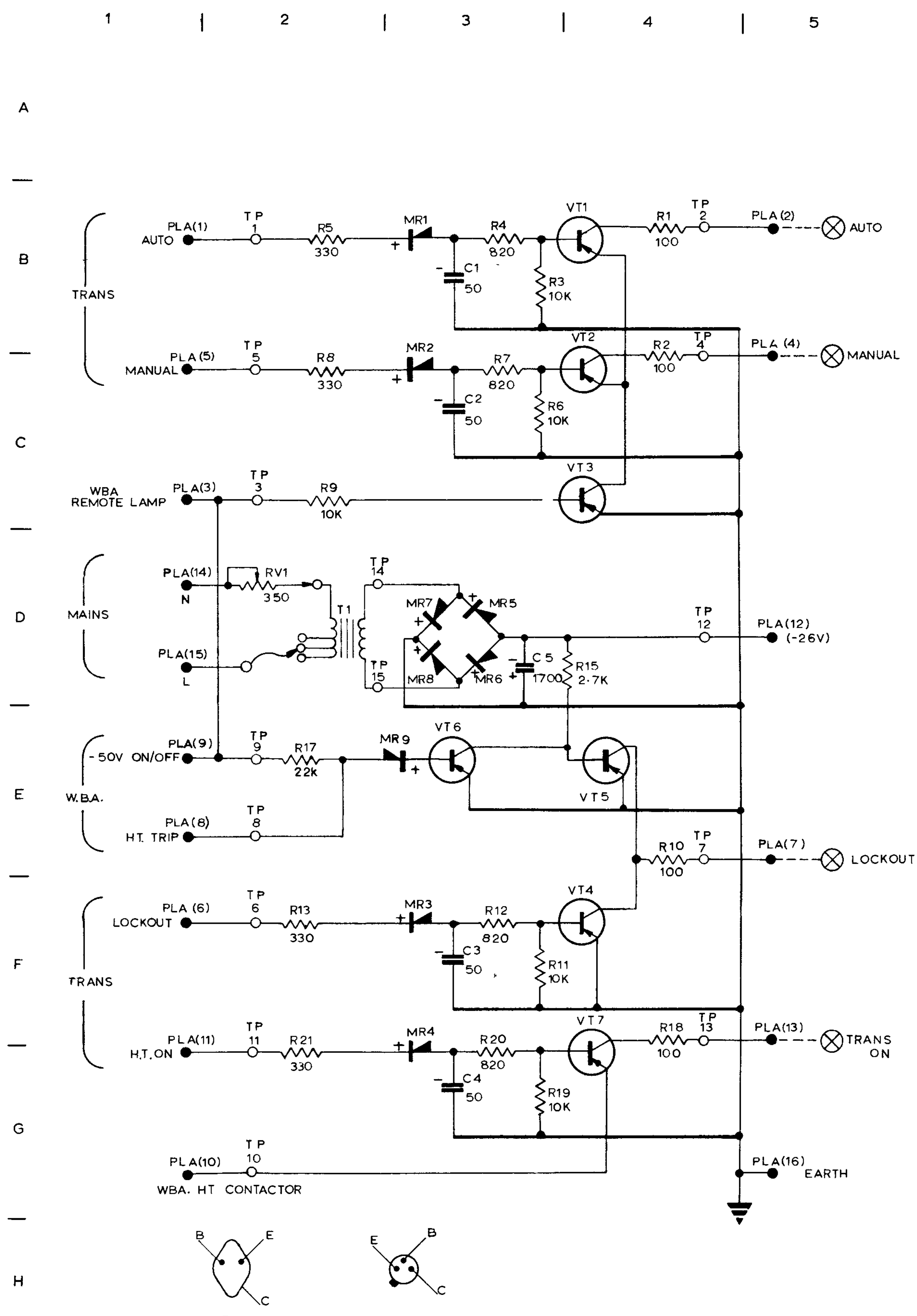


MATING SOCKETS SKTA & SKTB ARE SUPPLIED WITH UNIT

EXTENDED CONTROL UNIT
FOR H1101/H1200/H1103

HTOO-1850Z SH1
ISSUE 4

FIG. 110

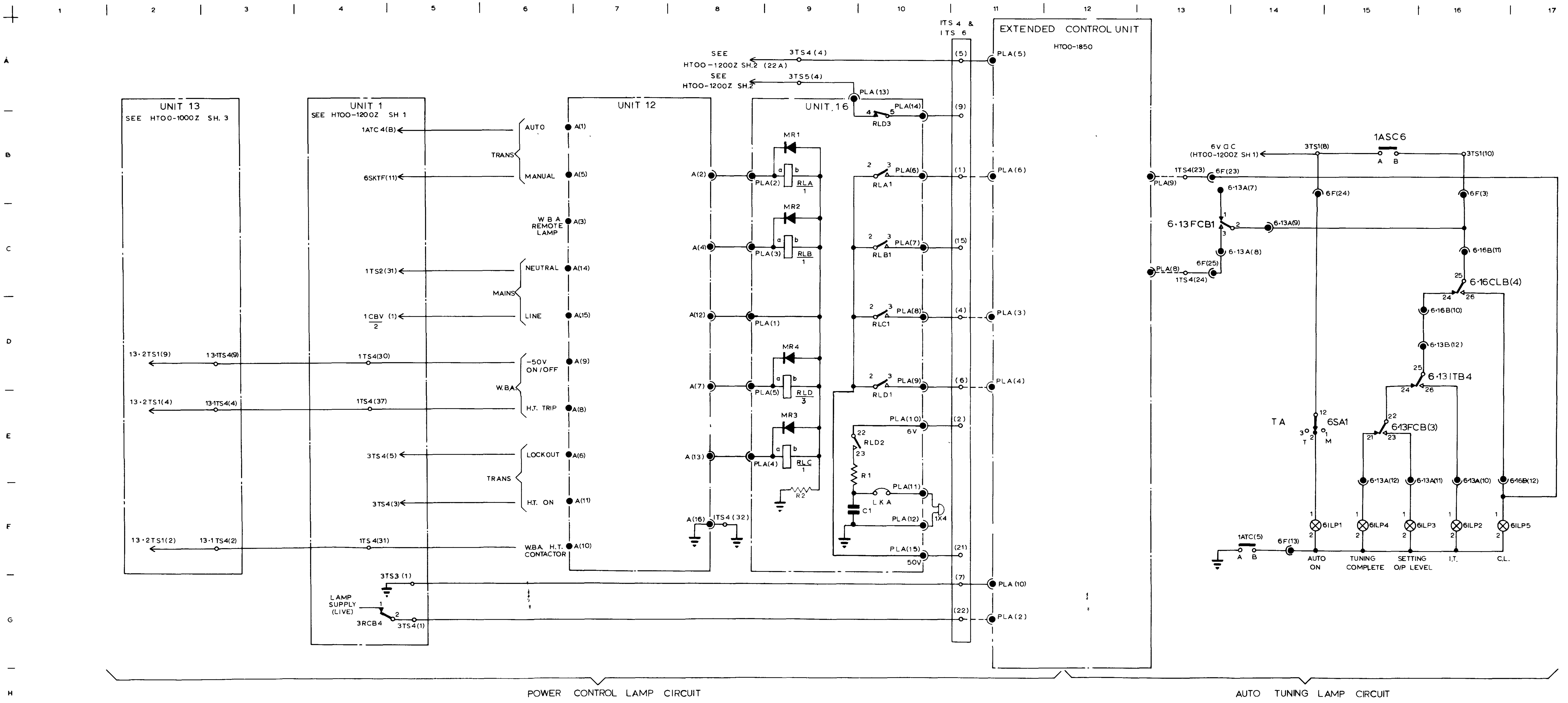


INDICATOR LAMP COMBINING UNIT

T30-5878-01,-02 CIRCUIT.

FIG 111

T30-5878 Z SH 1
ISSUE 4



Indicator lamp : circuits

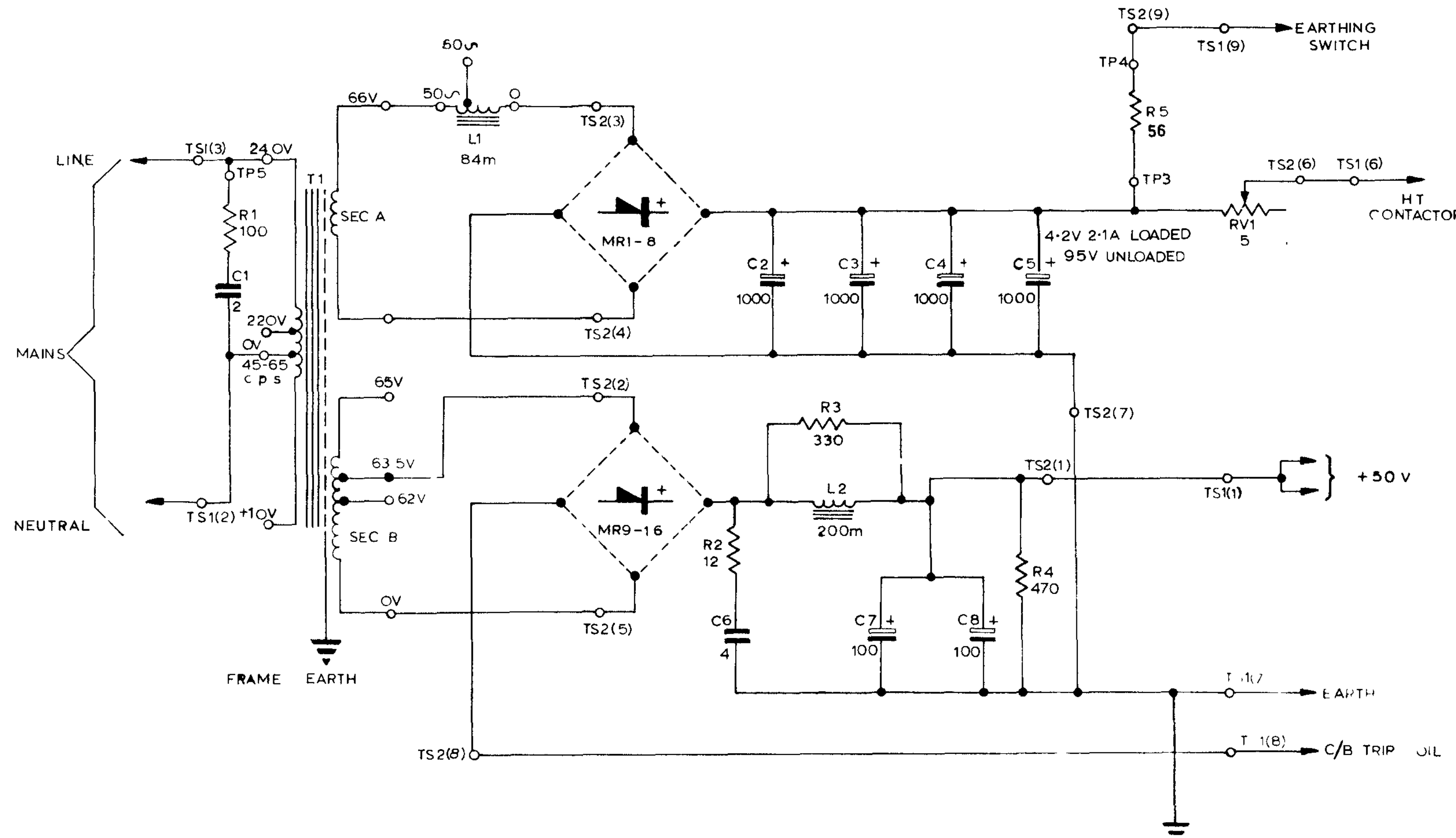
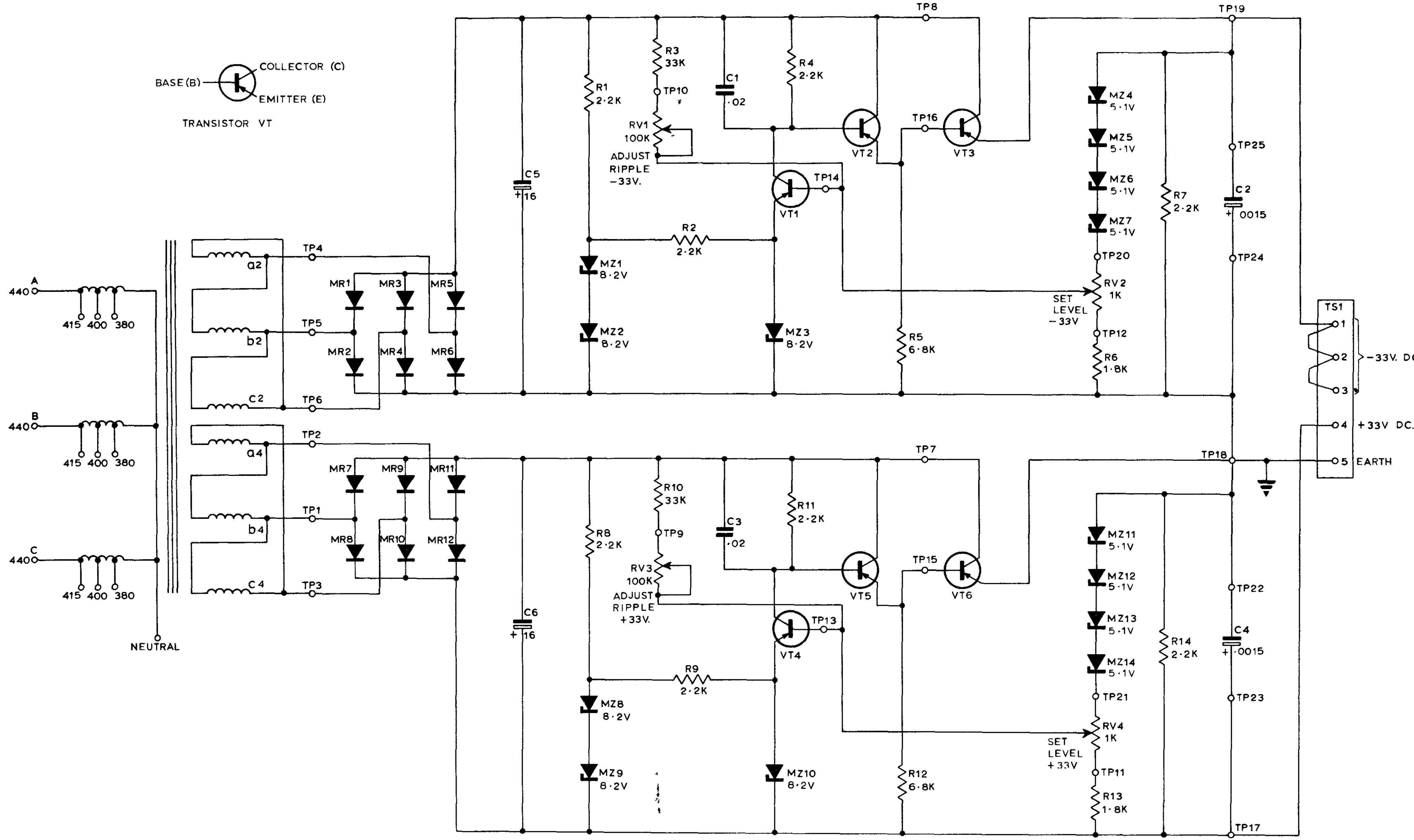


Fig.113. Control circuit supplies unit,T30-0300-02,03: circuit

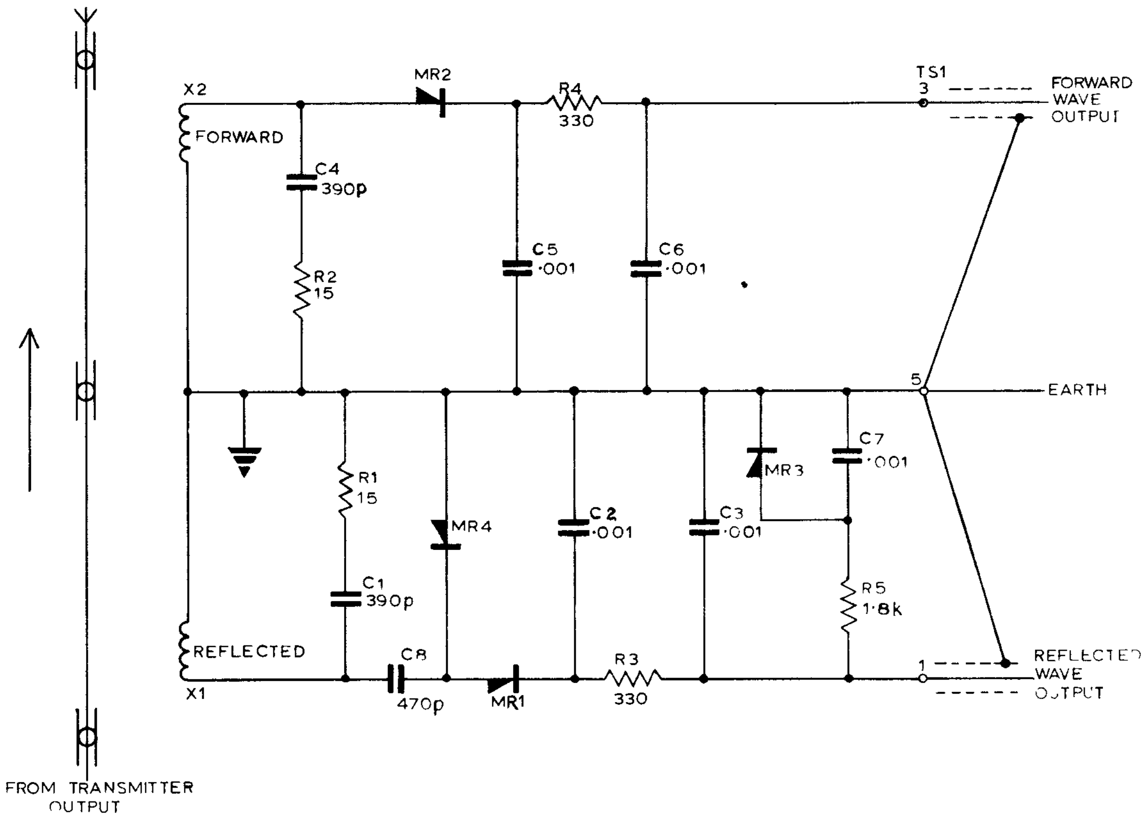
Amdt 13,Nov.78



T30-2217Z. SH. 1.
ISSUE 2

±33V STABILIZED POWER SUPPLY

T30-2217,-01,-02 CIRCUIT FIG. 114



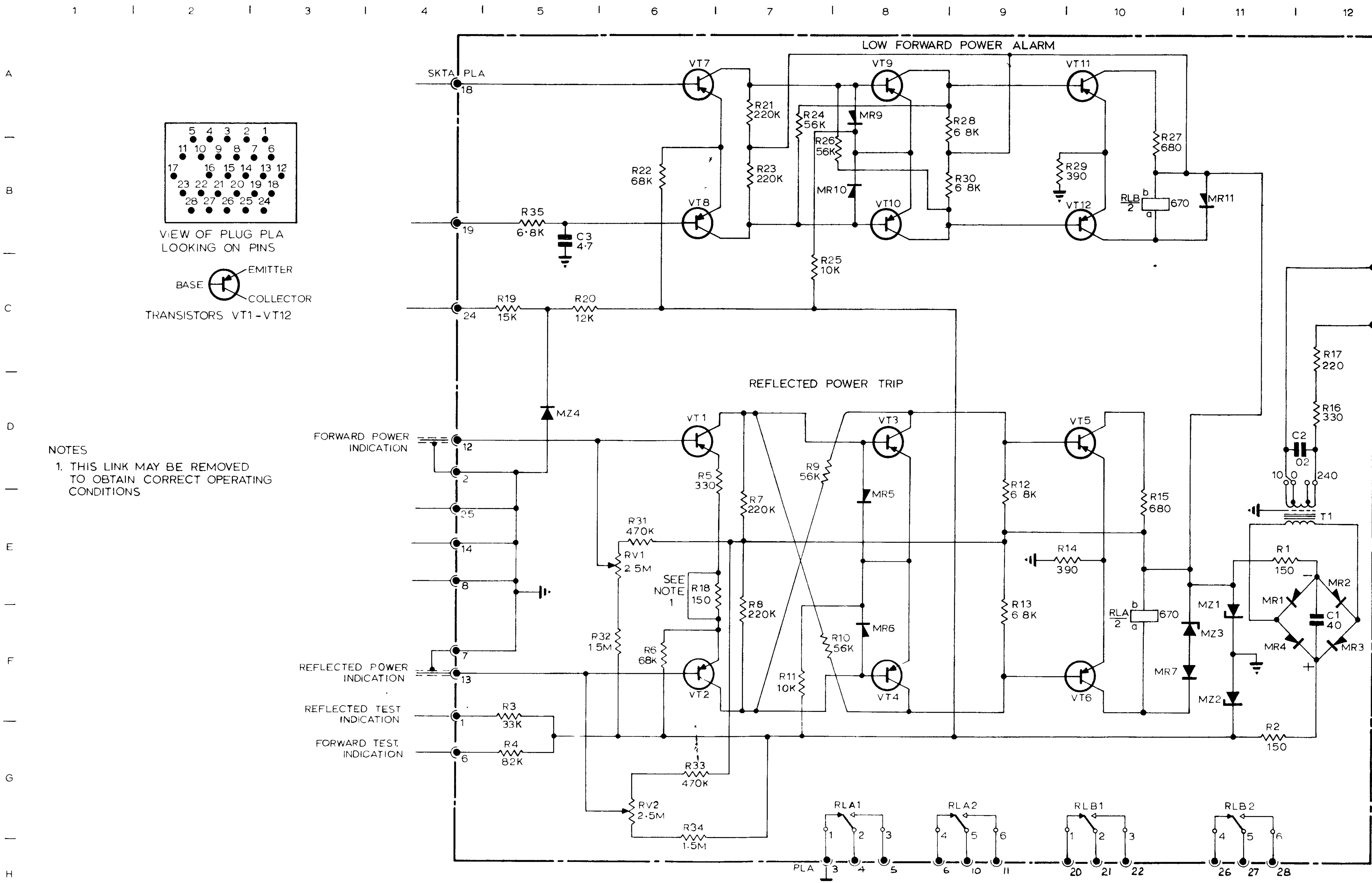
COUPLER UNIT

T30-0991-01,-02,-03 CIRCUIT

T30-0991Z SH1

ISSUE 5

FIG 115

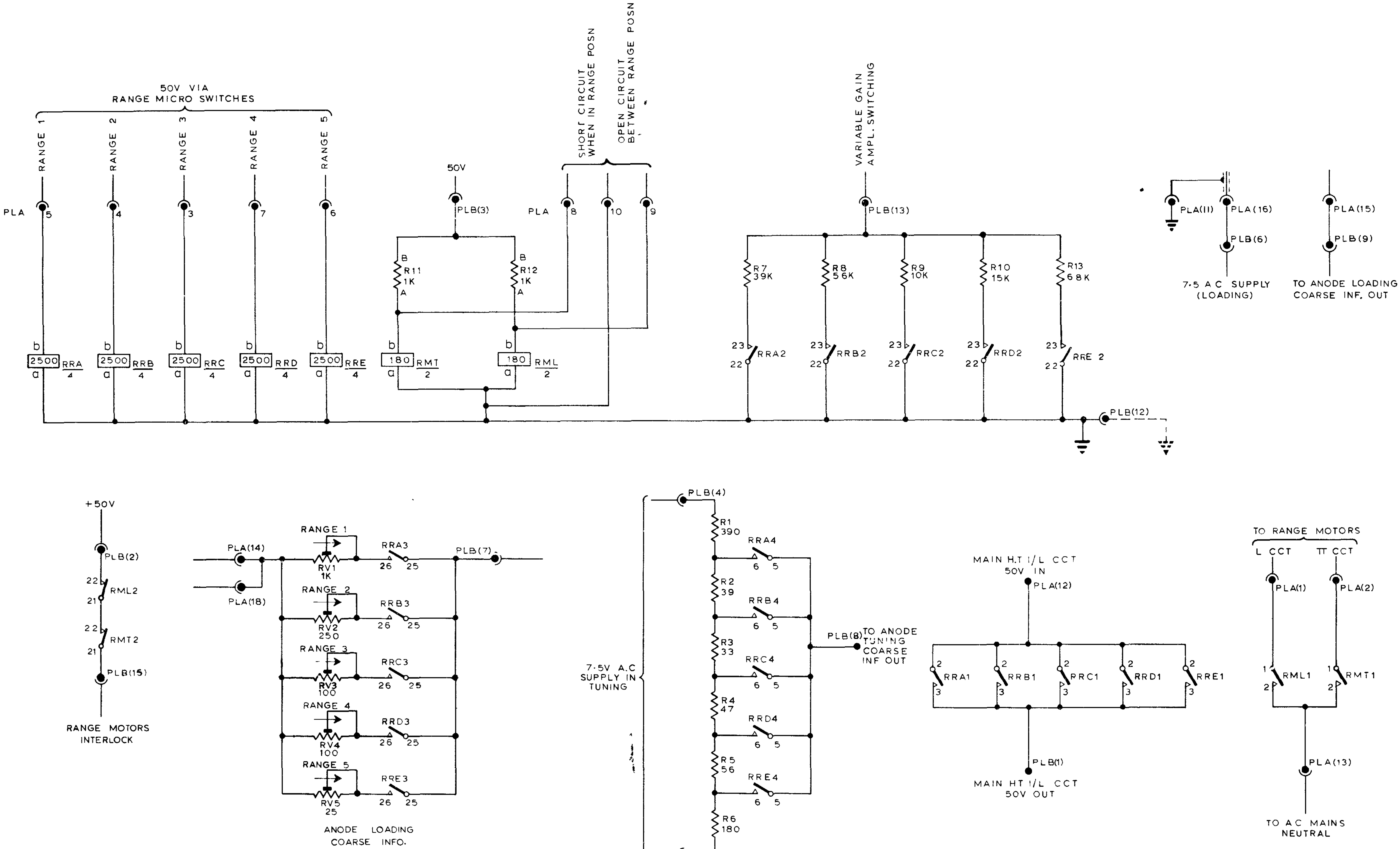


NOTES
1. THIS LINK MAY BE REMOVED TO OBTAIN CORRECT OPERATING CONDITIONS

BASED ON
T30 - 09792 SH 3

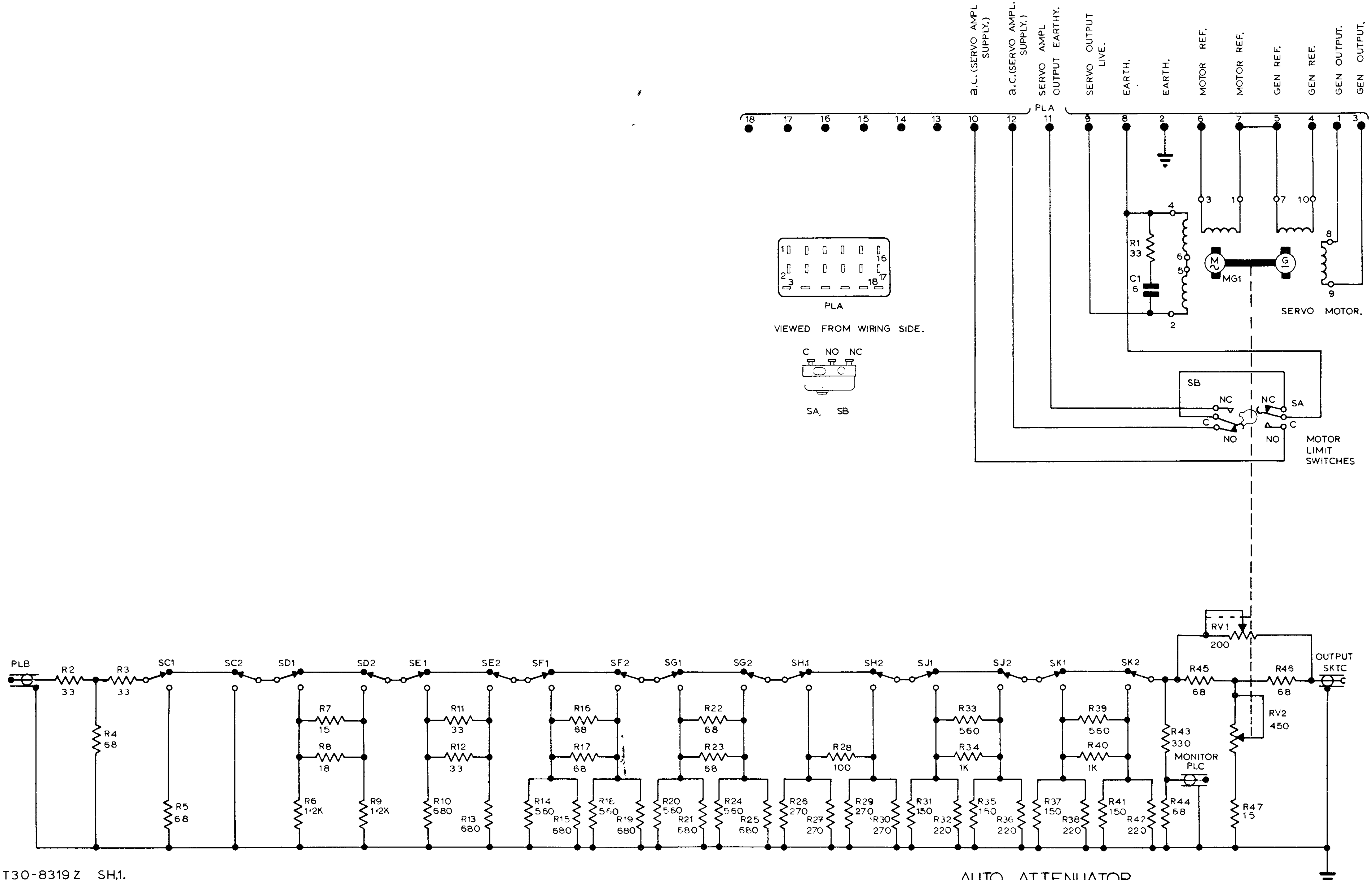
AIR DIAGRAM-MIN
AP116E-0244-MD17
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
ISSUE 1 Prepared by MOD(PE)

AMPLIFIER, RELAY UNIT
T30-0979-04 & 06 CIRCUIT FIG. 116



T30–2998Z SH. 1.
ISSUE 6

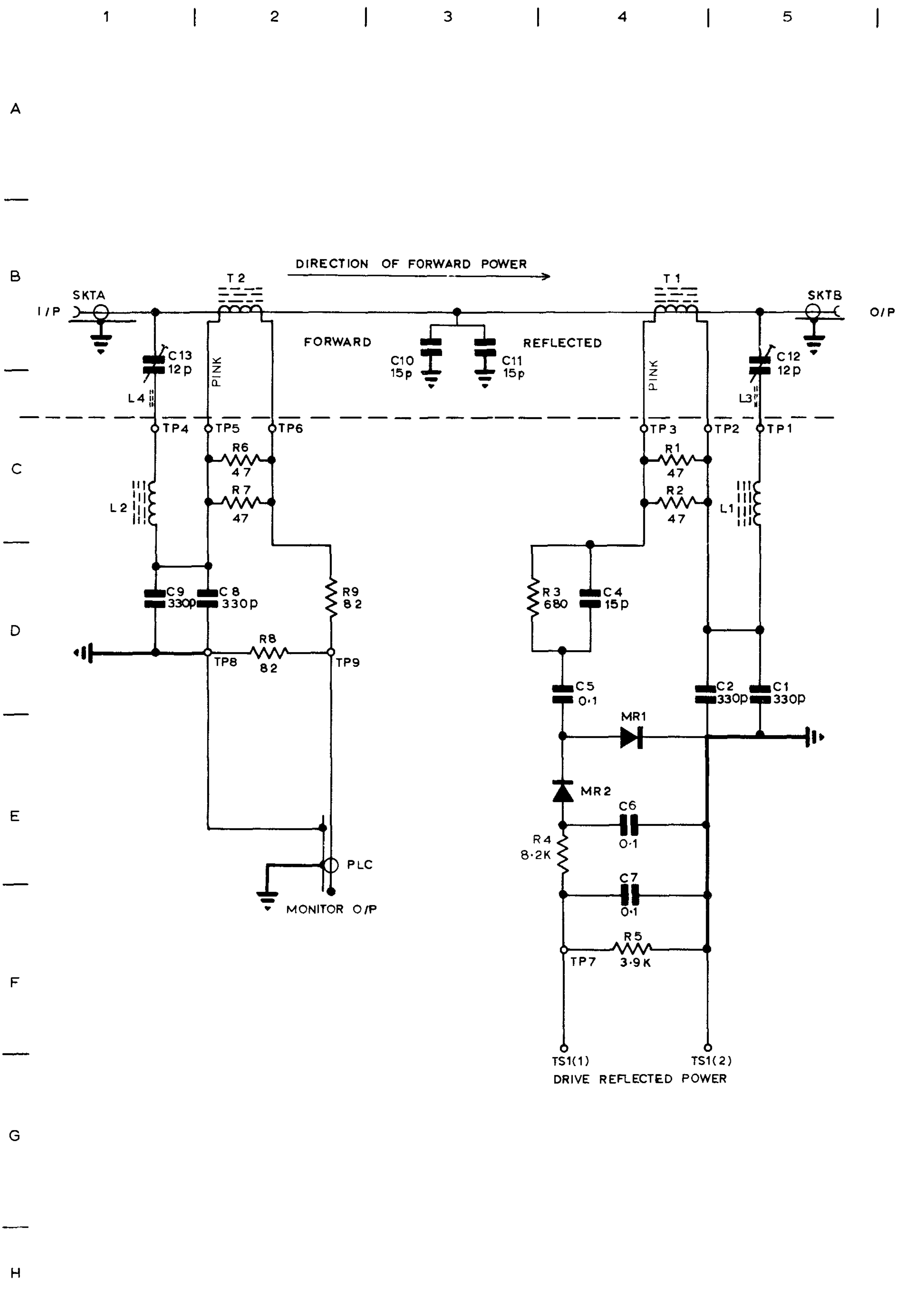
RELAY UNIT
T30-2998-01,-02 CIRCUIT FIG 117



T30-8319 Z SH.1.
ISSUE 2

ATTENUATOR.

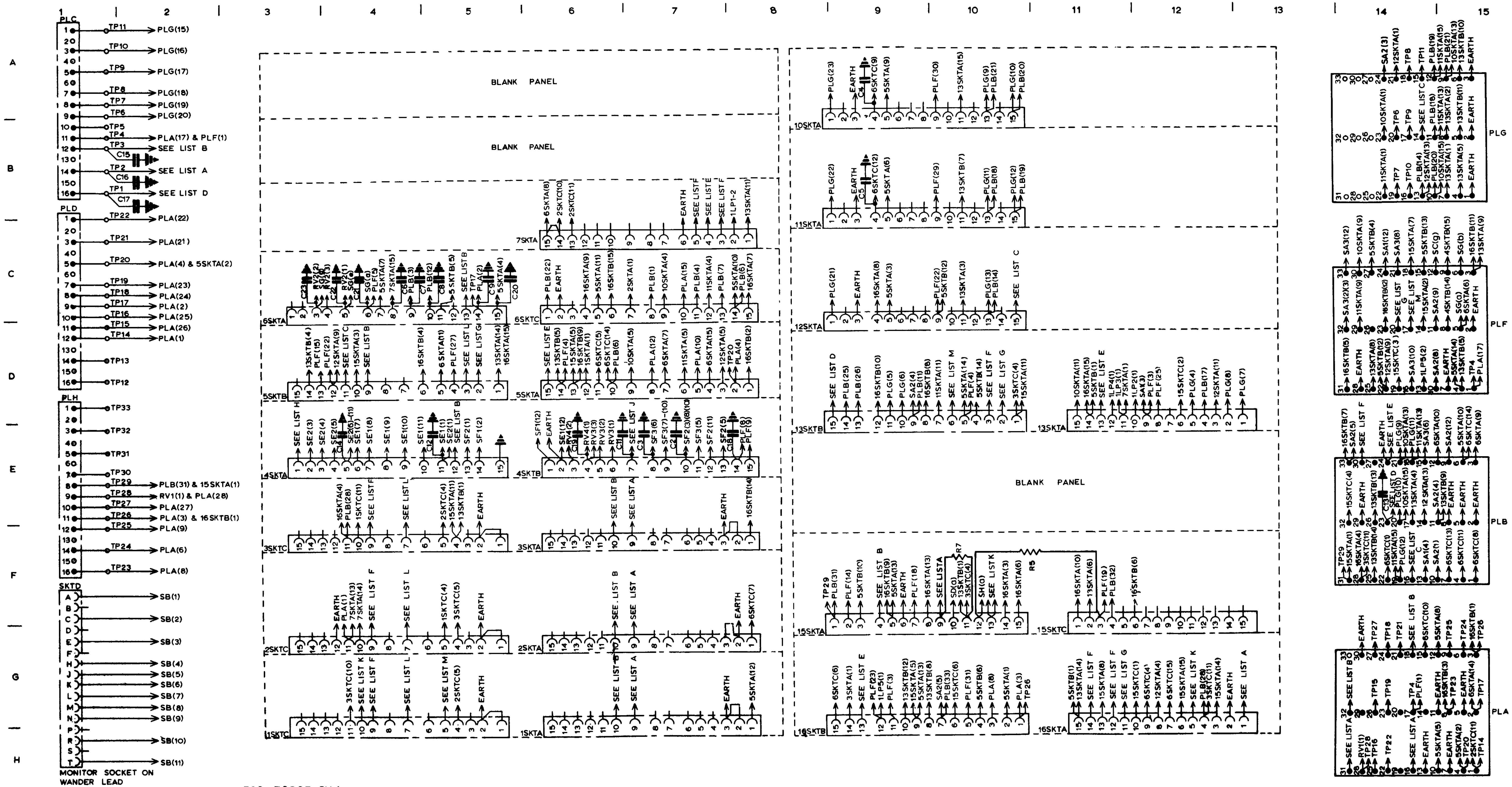
AUTO ATTENUATOR
T30-8319-01;02 CIRCUIT. FIG. 118



T30-9114Z SH1
ISSUE 5

COUPLER UNIT T30-9114-01,-02. CIRCUIT.

FIG 119

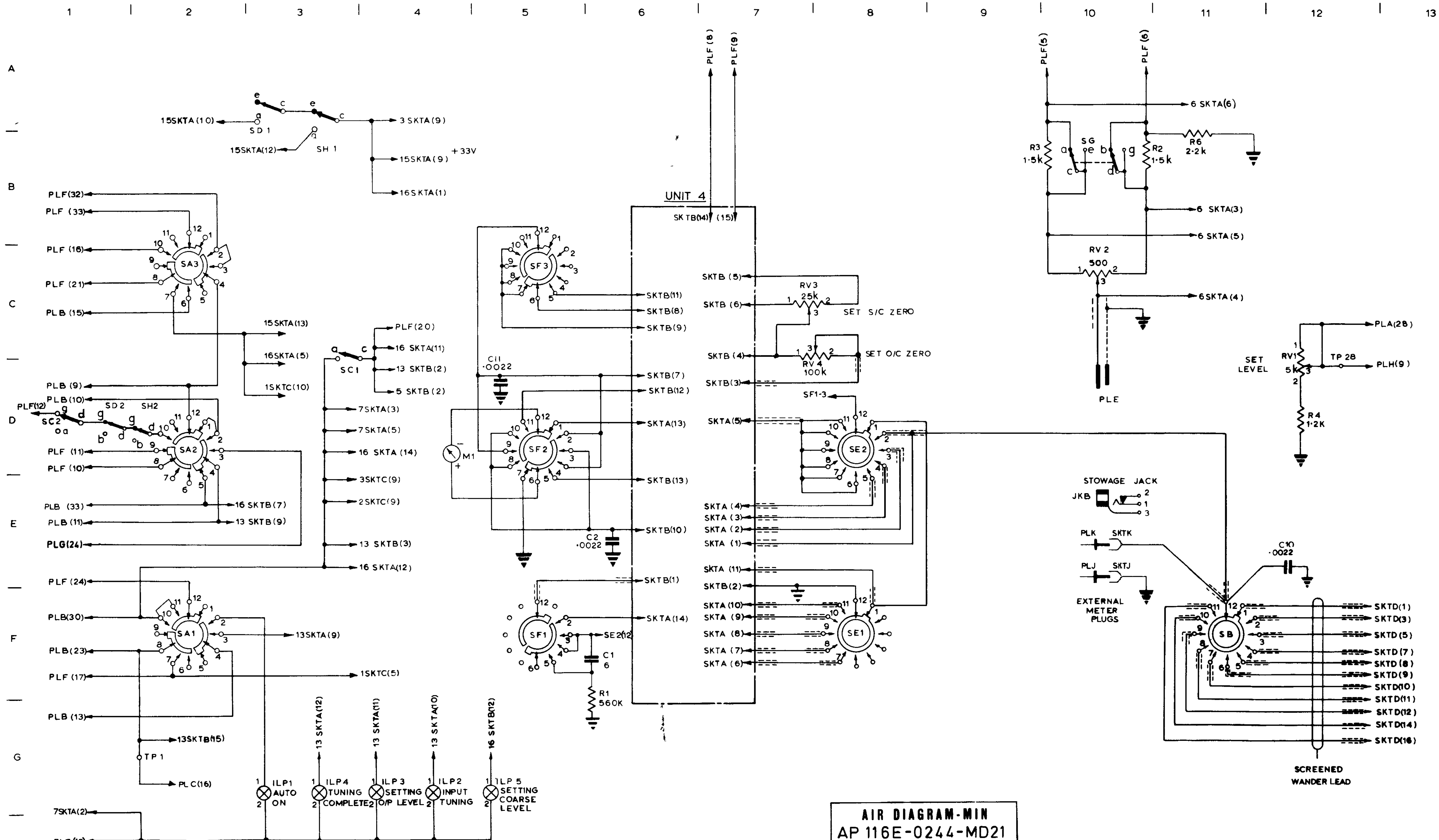


T30-7080Z. SH.1.
ISSUE 13

LISTS OF MORE THAN 3 INTERCONNECTIONS

A	B	C	D	E	F	G	H	J	K	L	M
PLA(16) PLA(31) TP2 3SKTA(9) 2SKTA(9) 1SKTA(9) 15SKTA(9) 16SKTA(1) SH(c)	PLA(32) 3SKTA(10) 4SKTA(12) PLA(18) 6SKTA(13) 2SKTA(10) 1SKTA(10) TP3 15SKTA(4) 5SKTB(9)	PLB(16) PLG(14) 12SKTA(15) 5SKTB(11)	PLB(23) TP1 SA1(8) 13SKTB(15)	PLB(24) 16SKTB(13) 5SKTA(15) 13SKTA(13) EARTH 7SKTA(4)	PLB(30) 16SKTA(12) 13SKTB(3) SC(a) 2SKTC(9) 3SKTC(9) 16SKTA(14) SA1(10)(11) 7SKTA(3) 7SKTA(5)	PLF(20) 5SKTB(2) 13SKTB(2) SC(c) 16SKTA(11)	4SKTA(1) SE2(2) SB(12) JKA(1)	4SKTB(7) SF2(2) SF2(4) SF2(9) SF3(12)	15SKTA(13) SA3(7) 1SKTC(10) 16SKTA(5)	5SKTB(3) 3SKTC(7) 2SKTC(7) 1SKTC(7)	PLF(17) 1SKTC(5) 13SKTB(6) SA1(7)

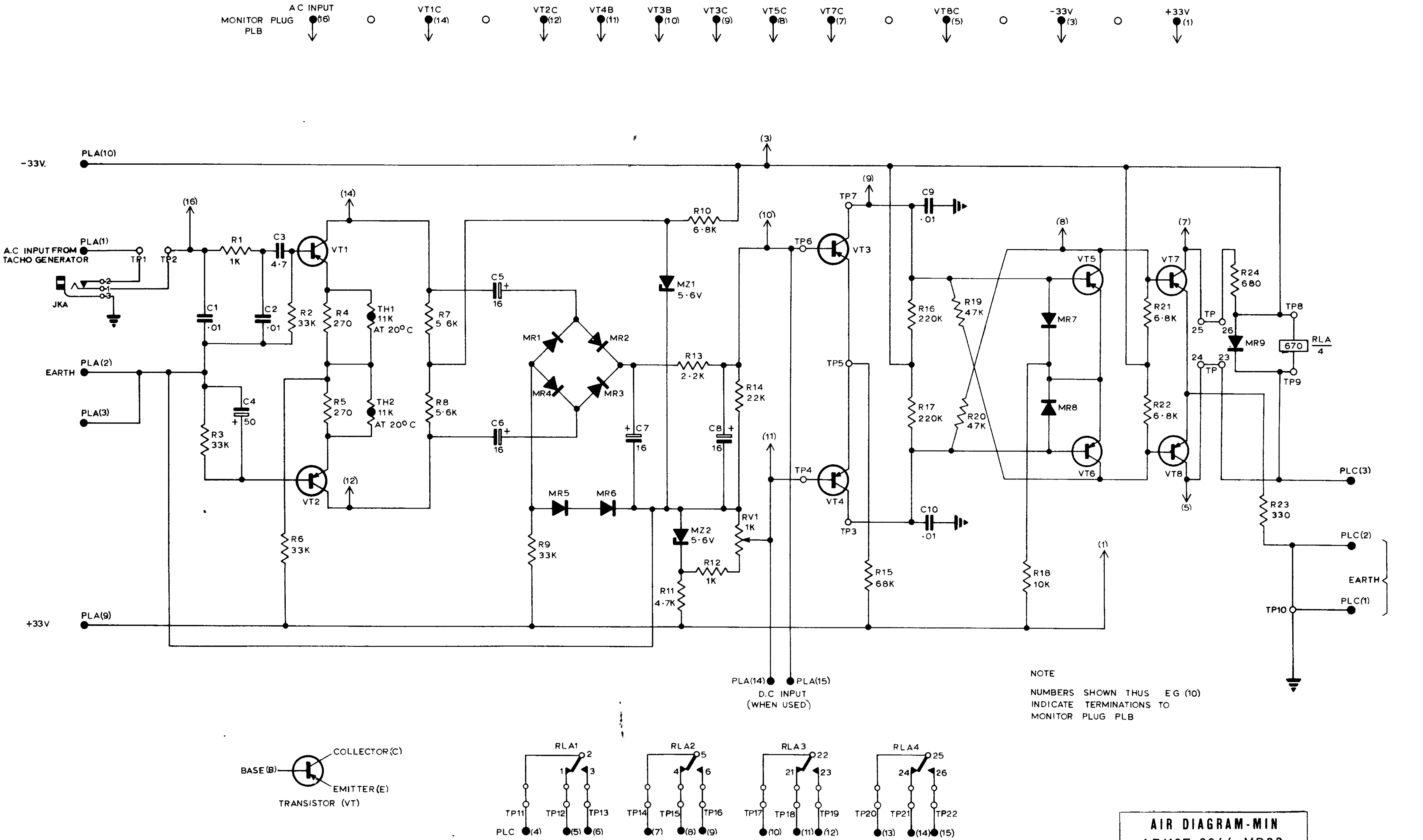
AUTO TUNE UNIT T30-7080-0102 CIRCUIT FIG.120



T30-7080 Z SH 2
ISSUE 14

AIR DIAGRAM-MIN
AP 116E-0244-MD21
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
ISSUE 2 Prepared by MOD(PE)

AUTO TUNE UNIT
T30-7080-01,-02 CIRCUIT. FIG.121



BASED ON T30-1936Z SH.1 ISSUE 7

AIR DIAGRAM-MIN
AP116E-0244-MD22
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
ISSUE 2 Prepared by MOO(PE)

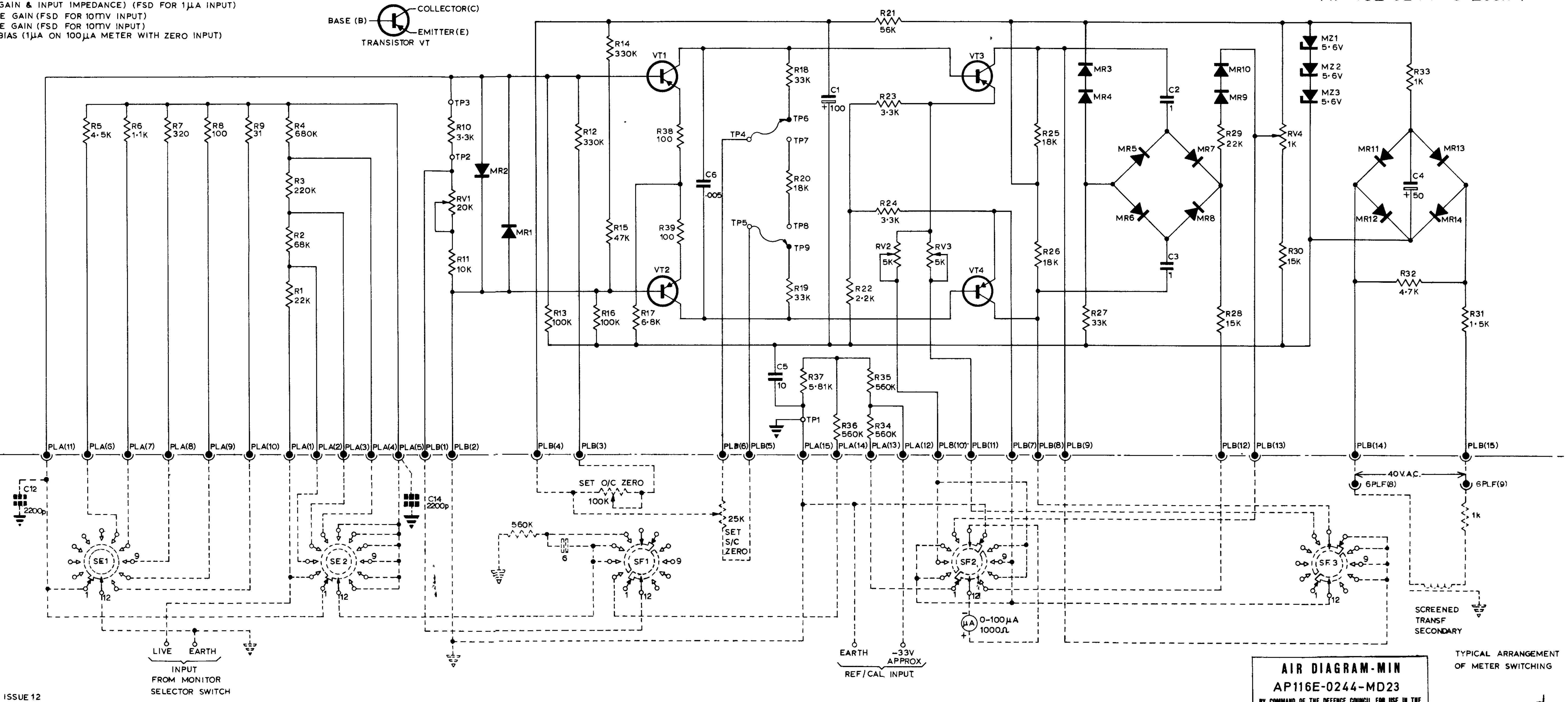
Fig.122 Relay amplifier, T30-1936-01,02: circuit Fig.122

RV1 CAL (SET CURRENT GAIN & INPUT IMPEDANCE) (FSD FOR 1μA INPUT)
RV2 PRESET D.C. VOLTAGE GAIN (FSD FOR 10mV INPUT)
RV3 PRESET A.C. VOLTAGE GAIN (FSD FOR 10mV INPUT)
RV4 PRESET RECTIFIER BIAS (1μA ON 100μA METER WITH ZERO INPUT)

SE METER RANGE
12 SET O/C ZERO
1 SET S/C ZERO
2 10mV
3 32mV
4 100mV
5 320mV
6 1·0V
7 3·2V
8 10V
9 32V
10 100V
11 320V
(SHOWN IN POSITION 1)

SF METER SELECTOR
1 REFERENCE (REF)
2 CALIBRATION (CAL)
3 + DC
4 – DC
5 AC
6 OFF
(SHOWN IN POSITION 1)

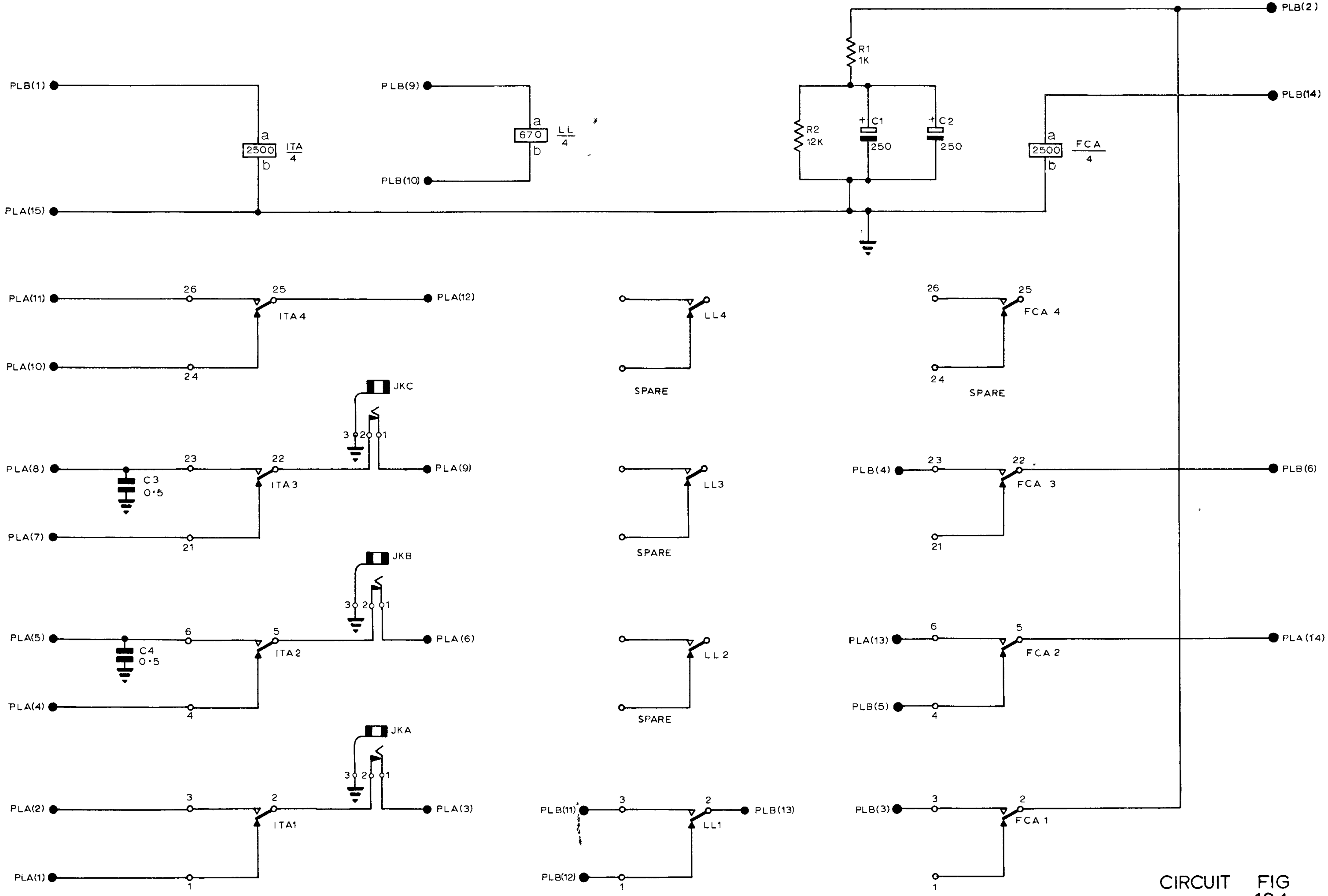
NOTE
S/C = SHORT CIRCUIT
O/C = OPEN CIRCUIT



BASED ON T30-2261Z SH.1 ISSUE 12

AIR DIAGRAM-MIN
AP116E-0244-MD23
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
ISSUE 2 Prepared by MOD(PE)

Meter amplifier, T30-2261-01,02: circuit



CIRCUIT FIG 124

RELAY UNIT
T30-7482-02,-05

T30-7482Z SH 2
ISSUE 5

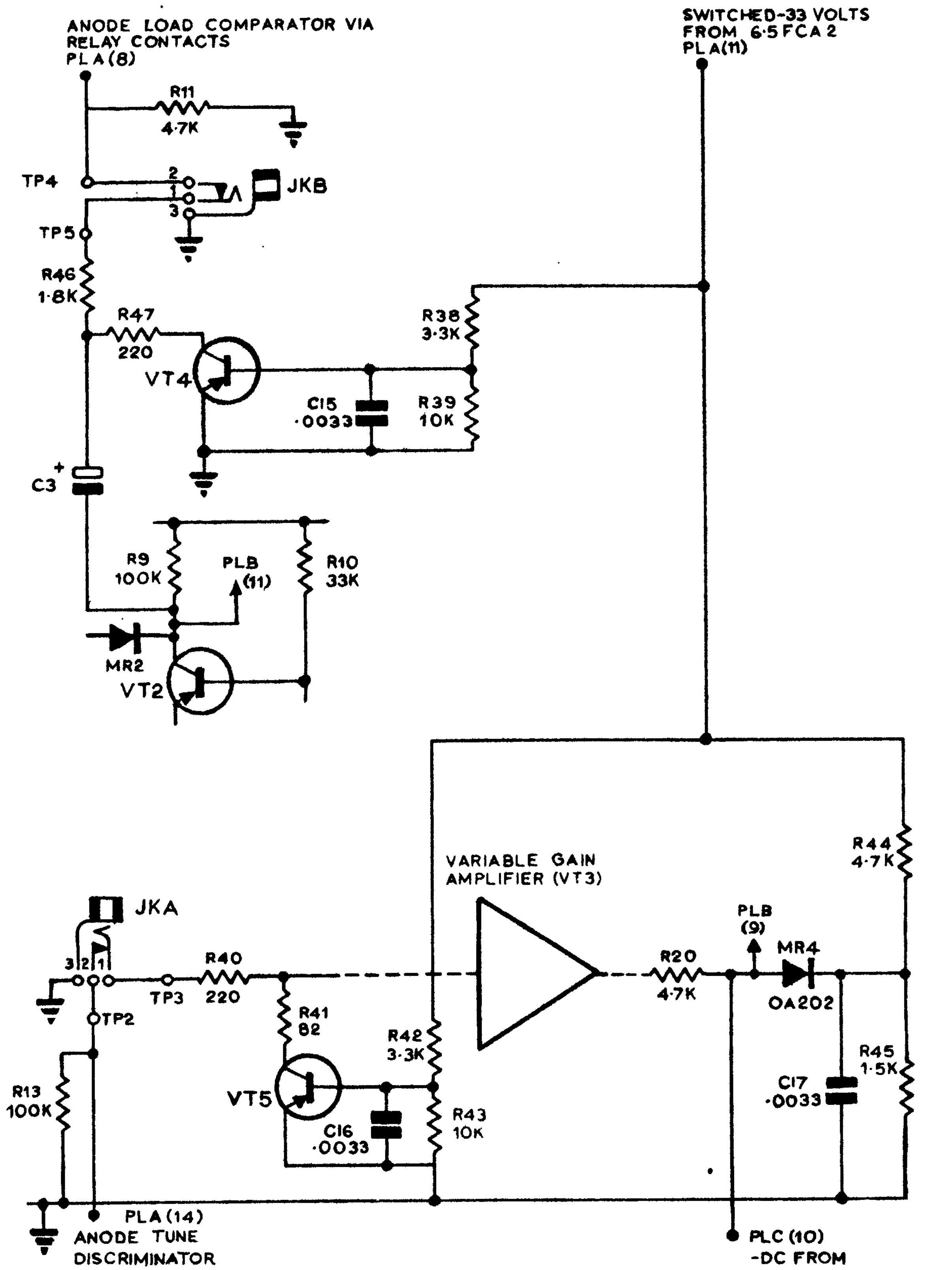
FEEDBACK & AUXILIARIES
(Refer to Master Components List T5577)
Cross Reference List
for T30-7487Z-Sh.1 (Fig.125 & 125A)

Ref.	No.	Ref.	No.	Ref.	No.	Ref.	No.	Ref.	No.	Ref.	No.	Ref.	No.	Ref.	No.
C1	82	JKB	319	PLB	✱	R10	420	R23	424	R36	409	RV1	550	TP11	603
C2	82			PLC	316	R11	414	R24	424	R38	742			TP12	603
C3	80					R12	414	R25	408	R39	740			TP13	603
C4	80	MR1	195			R13	422	R26	414	R40	744	TP1			
C5	84	MR2	195	R1	471	R14	391	R27	421	R41	482	TP2	603		
C6	80	MR3	195	R2	471	R15	380	R28	421	R42	742	TP3	603	VT1)	660
C7	80			R3	447	R16	386	R29	416	R43	740	TP4	603	)	662
C8	82			R4	447	R17	402	R30	418	R44	741	TP5	603	VT2)	660
C9	39	MZ1	197	R5	410	R18	405	R31	417	R45	743	TP6	603	)	662
C15	70	MZ2	197	R6	414	R19	381	R32	405	R46	745	TP7	603	VT3)	659
C16	70			R7	420	R20	381	R33	413	R47	744	TP8	603	)	661
C17	70			R8	395	R21	405	R34	426			TP9	603	VT4	667
		PLA	316	R9	395	R22	413	R35	426			TP10	603	VT5	667

MISCELLANEOUS ITEMS

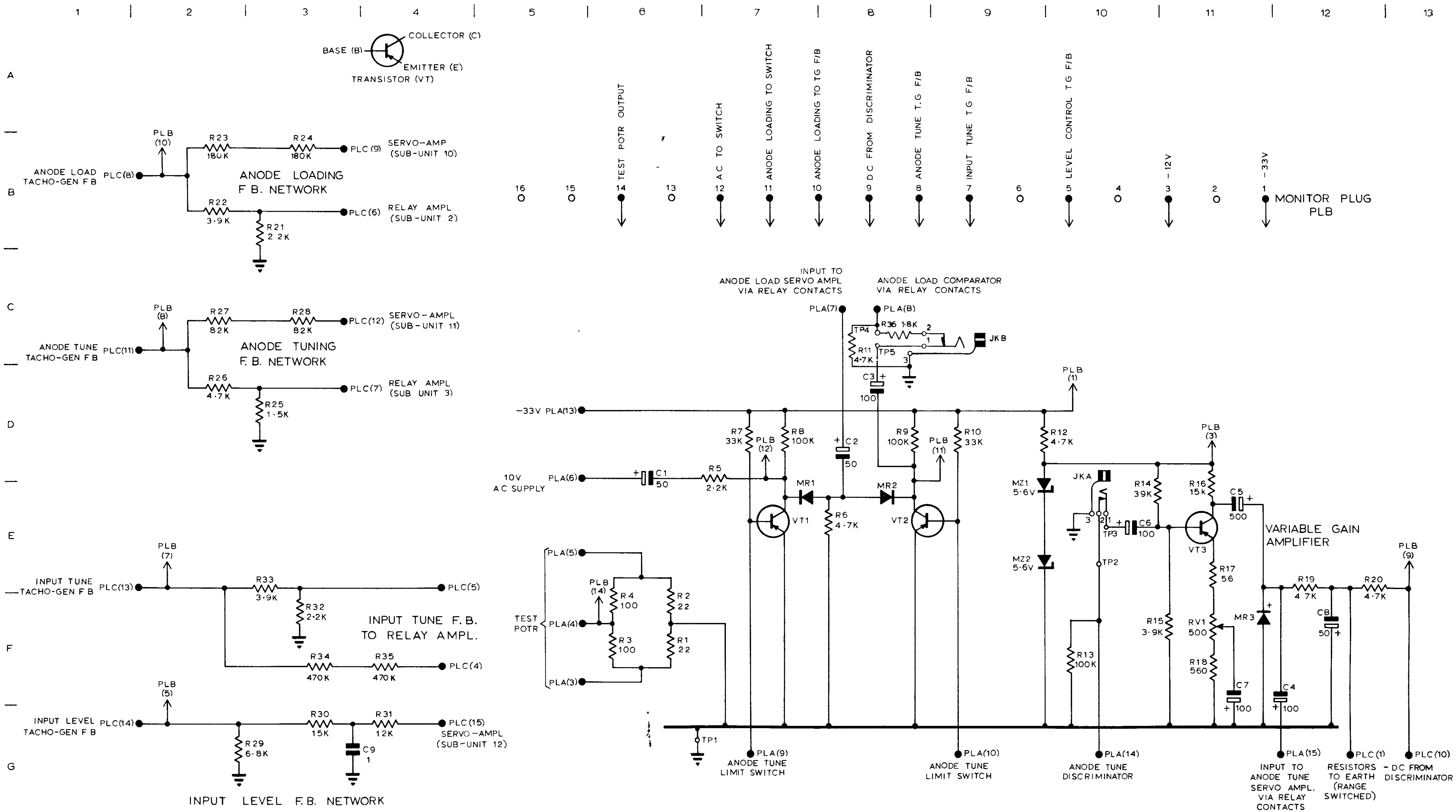
Board assy.	No. 25
Board assy.	No.747
Clip	No.677 + ∅̸
Clip	No.678 ø ≬
Insulator	No.251 θ
Spacer	No.746 §
Transistor	No.664 ∅̸
Transistor	No.667 ≬
Transistor	No.679 +
Transistor	No.666 ø

✱ Part of No.25
\+ For VT1,VT2 No.660
ø For VT1,VT2 No.666
∅̸ For VT3 No.659
≬ For VT3 No.661
θ For Board assy. No.747
§ For VT4,VT5 No.667



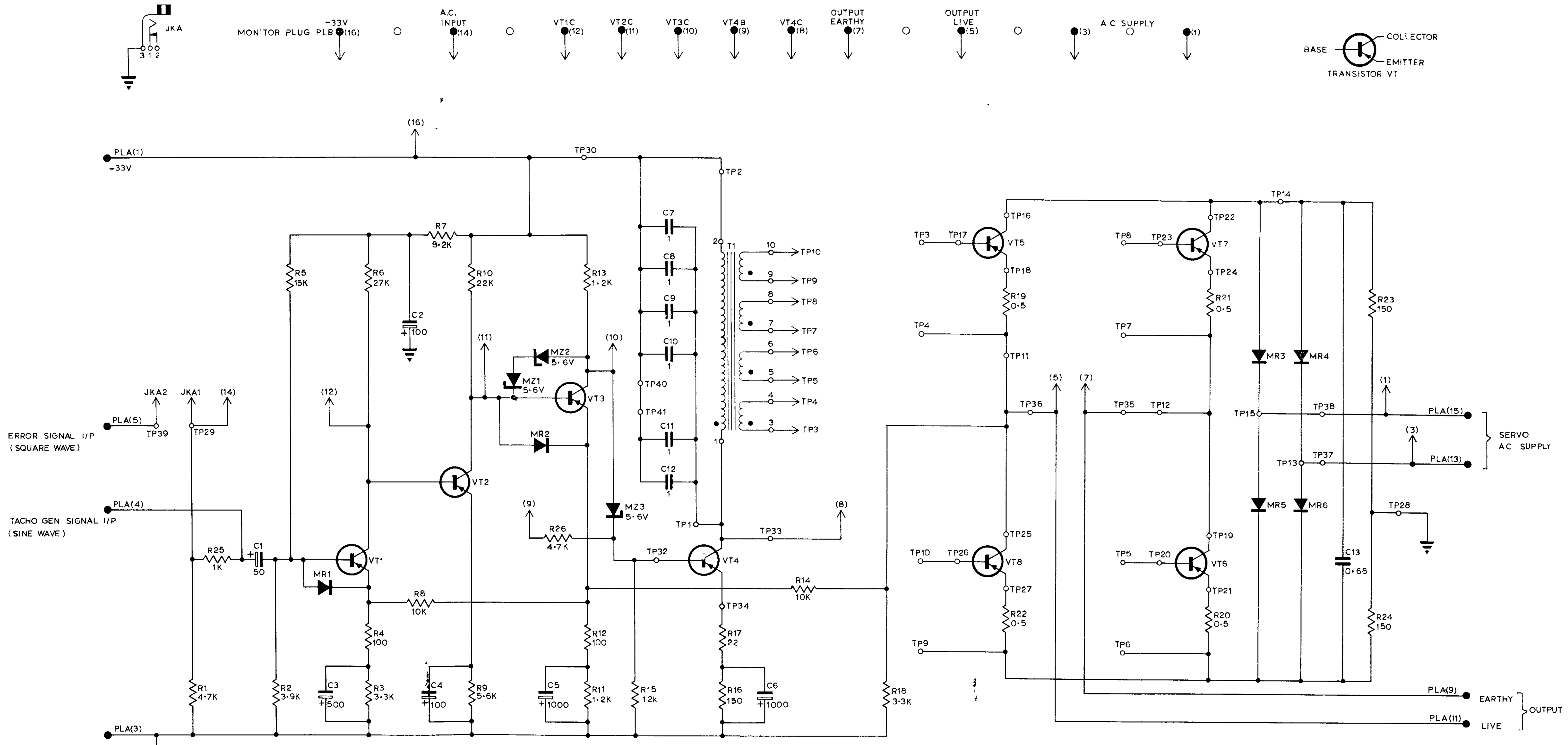
FEEDBACK AND AUXILIARIES UNIT
CIRCUIT CHANGES DUE TO MODIFICATION No 1594 FIG. 125A

(To Face Fig 125)



T30-7487Z. SH.1
ISSUE 4

FEEDBACK AND AUXILIARIES UNIT
T30-7487-01, 02 CIRCUIT FIG.125

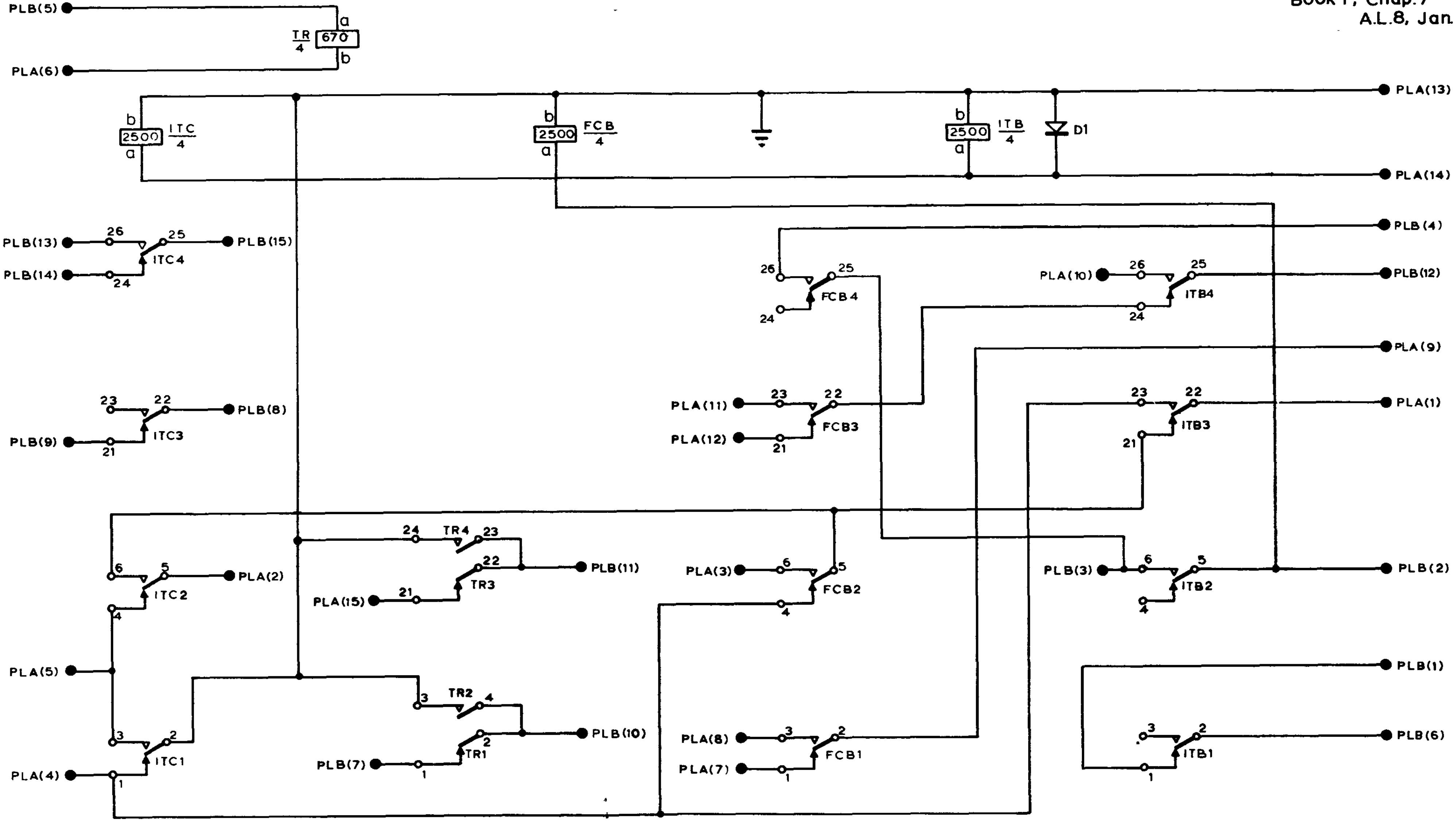


T30-1934Z SH. 1
ISSUE 5

SERVO-AMPLIFIER T30-1934,-01,-02

CIRCUIT FIG. 126

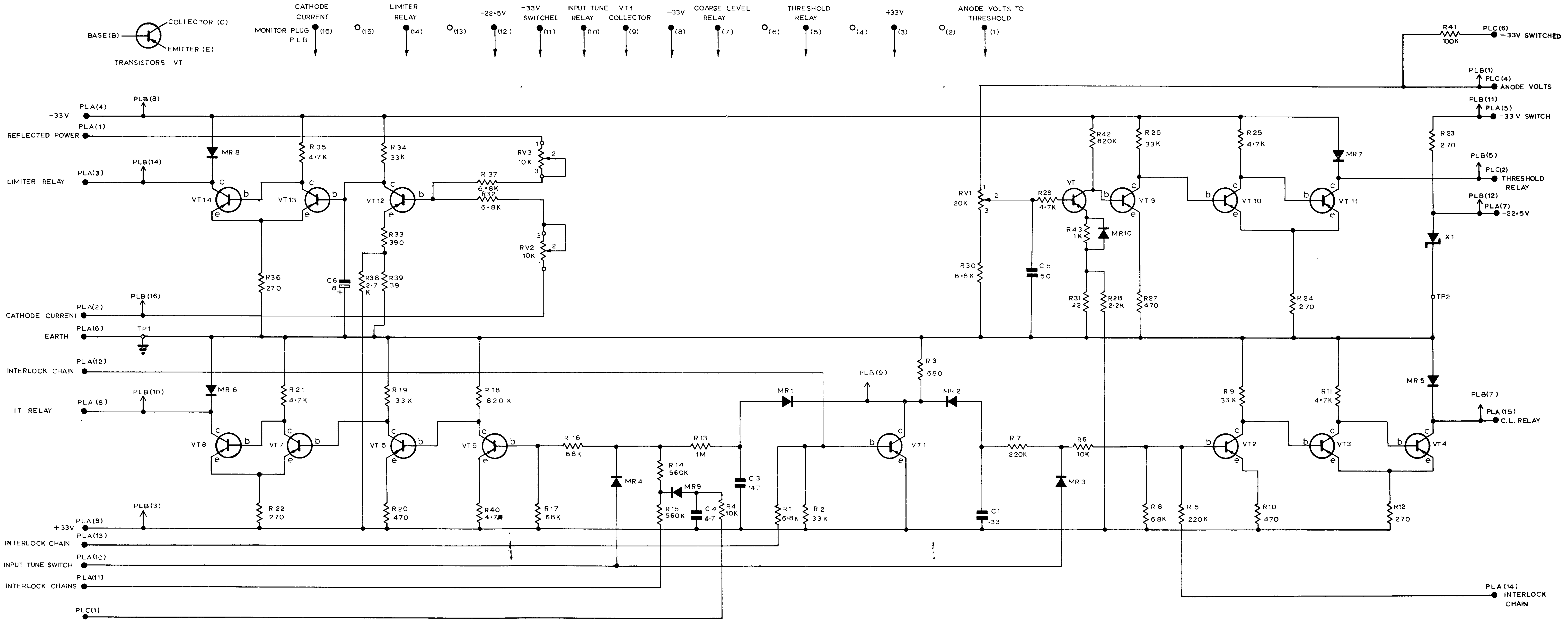
NOTE
NUMBERS SHOWN THUS – E G (14) INDICATE TERMINATIONS TO MONITOR PLUG PLB



RELAY UNIT

T30-7482-01,-04 CIRCUIT FIG.127

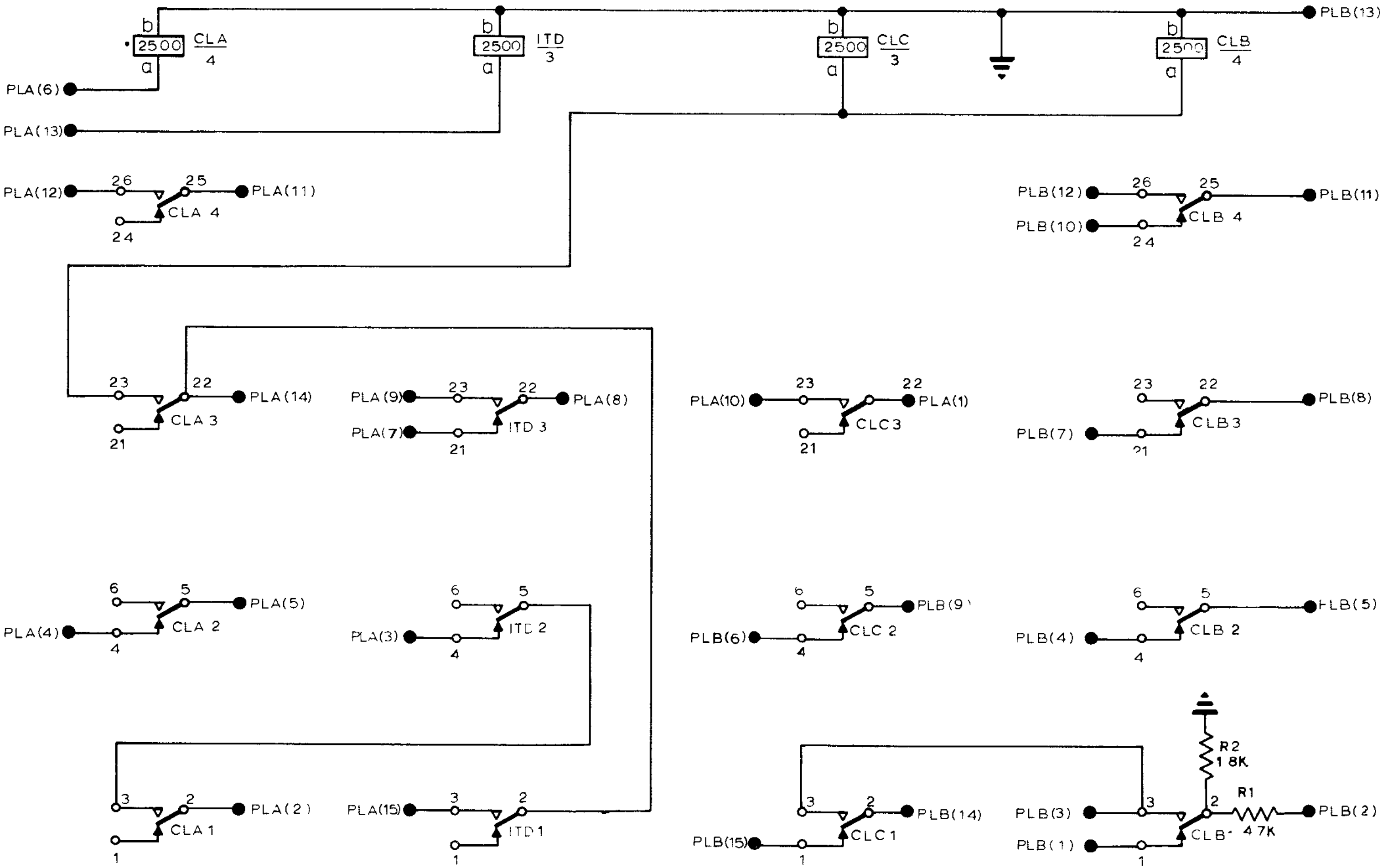
T30-7482Z SH. 1.
ISSUE 6



T30-7489 Z SH 1
ISSUE 3

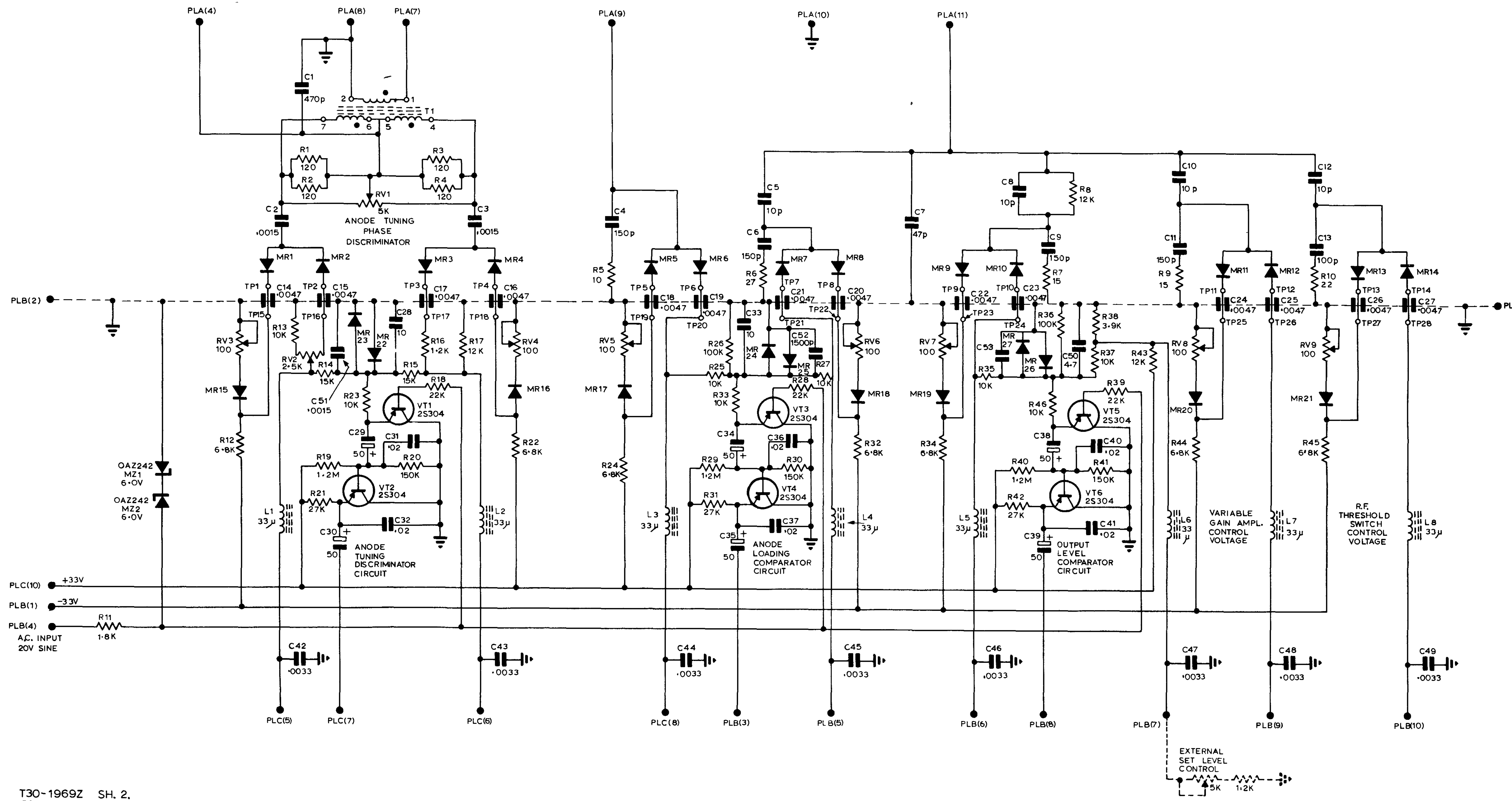
SWITCHING UNIT T30-7489-01,-02

CIRCUIT FIG. 128



T30-7482 Z SH 3
ISSUE. 3

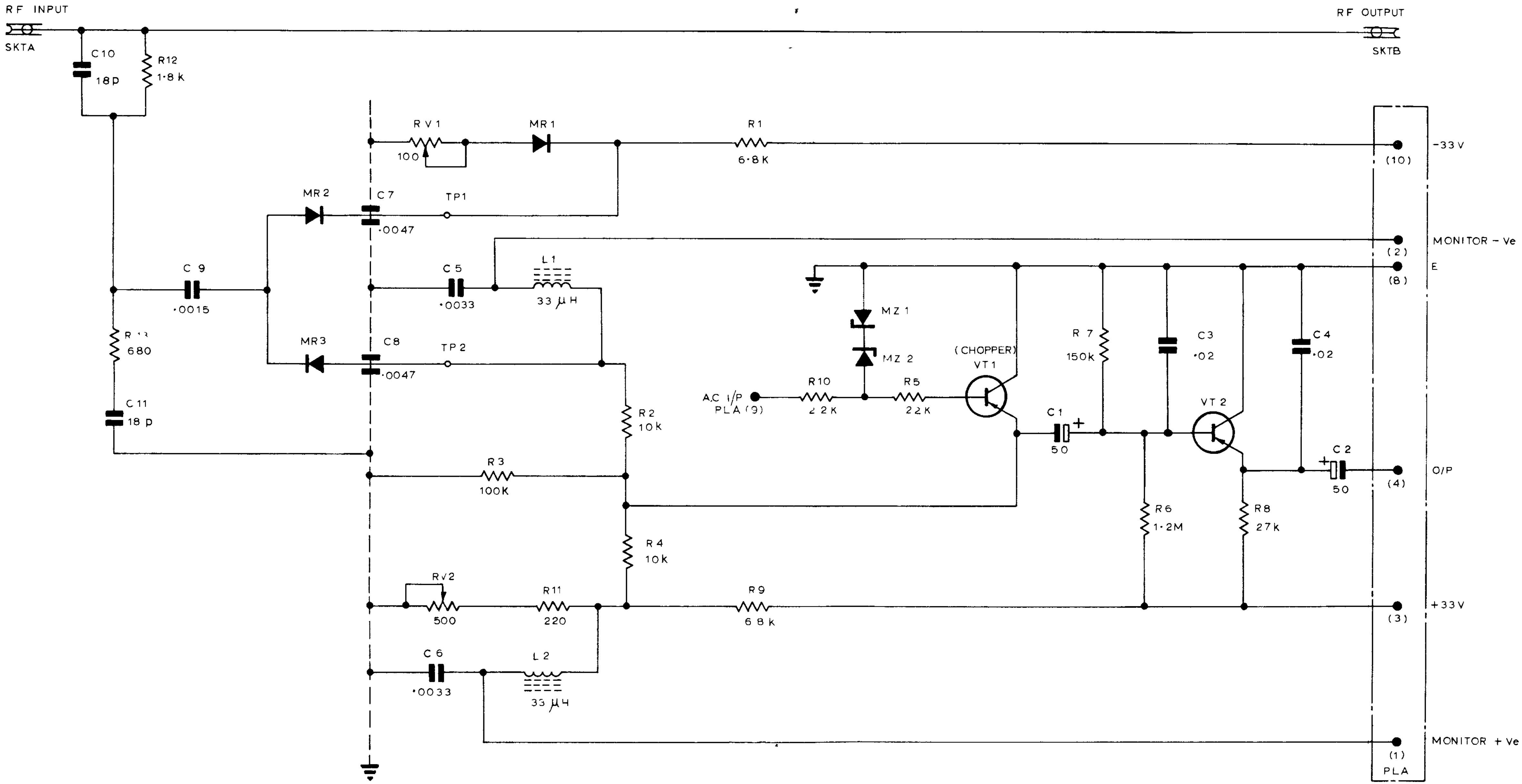
RELAY UNIT
T30-7482-03,-06 CIRCUIT FIG. 129



T30-1969Z SH. 2.
ISSUE 5

DISCRIMINATOR UNIT T30-1969-02;03

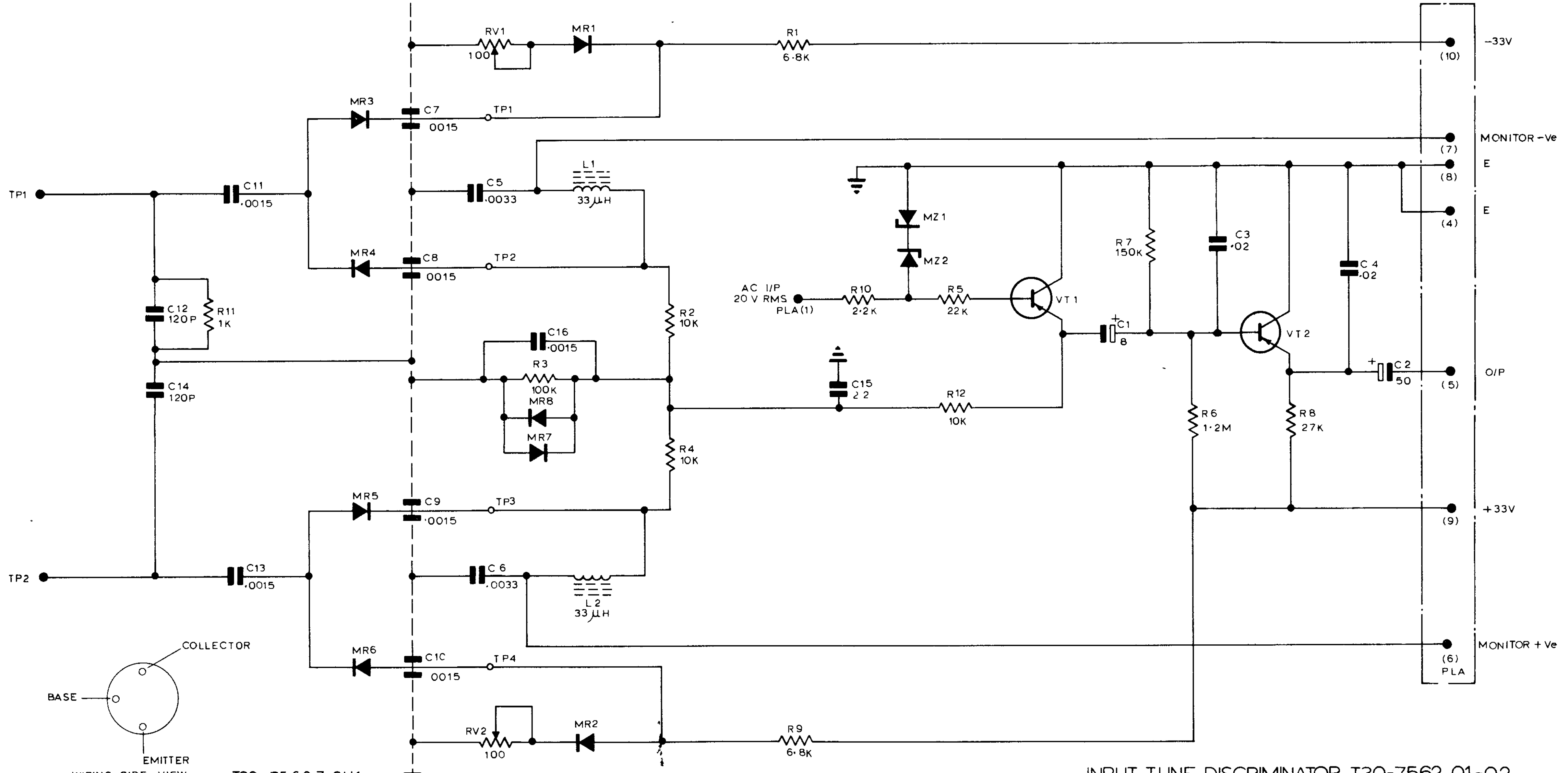
FIG 130



T30-7328 Z SH1
ISSUE 2

DISCRIMINATOR UNIT
T30-7328-01, -02

CIRCUIT FIG.131

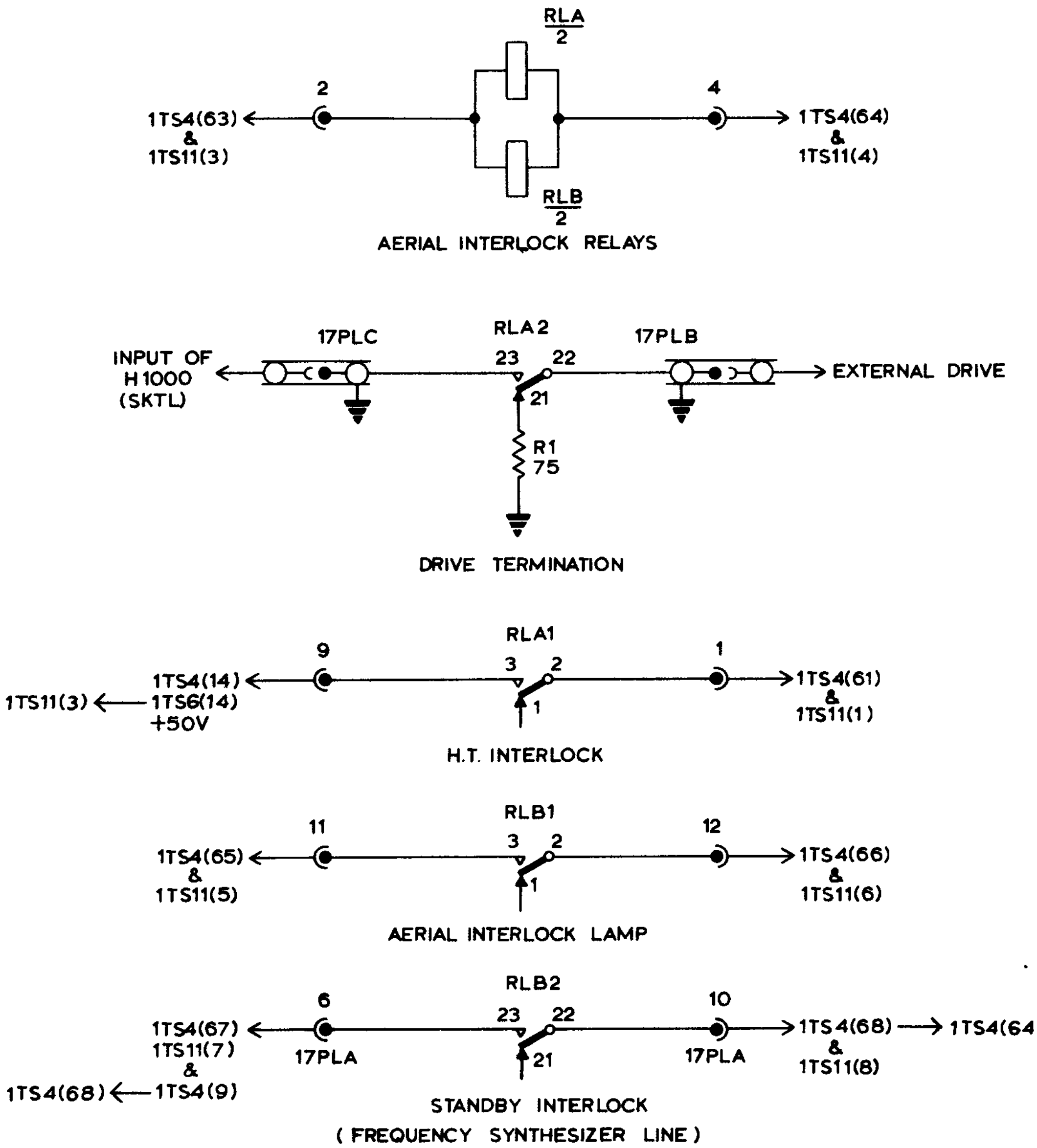


WIRING SIDE VIEW
VT1 & VT2

T30-7562 Z SH1
ISSUE. 4

INPUT TUNE DISCRIMINATOR T30-7562-01,-02
CIRCUIT.

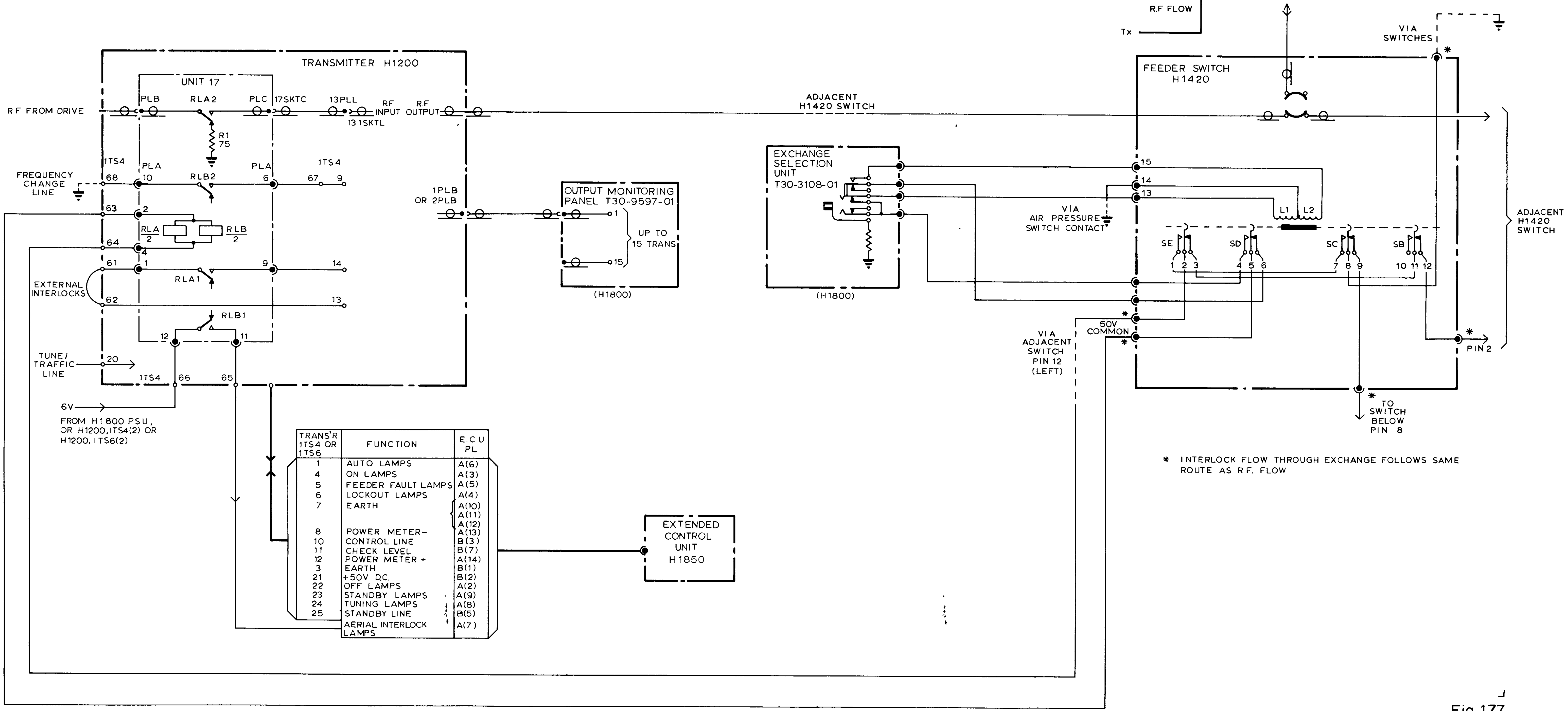
FIG 132



POST MOD A1889 ALT.3

BASED ON T31-1212Z SH.2 ISSUE 2

Fig.176A. Unit 17, aerial interlock, T31-1212-02 : circuit



TRANS'R 1TS4 OR 1TS6	FUNCTION	E.C.U PL
1	AUTO LAMPS	A(6)
4	ON LAMPS	A(3)
5	FEEDER FAULT LAMPS	A(5)
6	LOCKOUT LAMPS	A(4)
7	EARTH	A(10) A(11) A(12)
8	POWER METER−	A(13)
10	CONTROL LINE	B(3)
11	CHECK LEVEL	B(7)
12	POWER METER +	A(14)
3	EARTH	B(1)
21	+50V D.C.	B(2)
22	OFF LAMPS	A(2)
23	STANDBY LAMPS	A(9)
24	TUNING LAMPS	A(8)
25	STANDBY LINE	B(5)
	AERIAL INTERLOCK LAMPS	A(7)

Fig.177

BASED ON T31-1345 SH.4 ISSUE 3

Fig 177

H1200/H1410/H1850: functional diagram