STATION, RADIO, C42, NO 1

TECHNICAL HANDBOOK - TECHNICAL DESCRIPTION

This EMER must be read in conjunction with Tels H 442 Part 2 which contains figures and tables to which reference is made

Note: This Issue 2, Pages 1-19 and 1001, supersedes Page 0, Issue 2, dated 16 Apr 56, Pages 1-12, Issue 1, dated 1 May 55 and Pages 13, 14, 1001 and 1002, Issue 1, dated 18 May 56. The regulation has been revised throughout.

SUBJECT INDEX

Para

TRANSMITTER-RECEIVER C42, NO 1

Distribution - Class 1195 Code No 3

SUBJECT INDEX (cont)

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TRANSMITTER-RECEIVER C42, NO 1

Introduction

1. The Transmitter-receiver C42 is a frequency modulated v.h.f. transmitter-receiver primarily intended for vehicle use in forward areas. The set operates in the frequency band 36-60Mc/s with channels spaced by 100kc/s, ie 241 channels in all.

2. The set is designed to operate with two types of aerial system. The normal system is an 8 ft rod aerial mounted on a vehicle, connected via an Aerial tuning unit No 6 which is fitted such that it may be connected by a 14 ±2 in. lead to the aerial base; a 75Ω coaxial connector then connects the a.t.u. to the set. When additional range is required, an aerial of variable length fitted on to a 27 ft telescopic mast is provided. This mast may be attached to the vehicle or may be set up independently on the ground.

3. The range varies with siting but over normal terrain using full transmitter output and normal 8 ft rod aerials, ranges of 10-15 miles can be expected. This range should be doubled when using the elevated vehicle aerial. On low power send, the range will be 3-5 miles.

4. The set is generally used with a Radio control harness type 'A' or 'B'. The set will normally be the A-set in the harness as it includes an a.f. amplifier for crew intercommunication. For details of the Radio harness 'A' see Tels L 770-779 and of the Radio harness 'B' see Tels L 780-789.

BRIEF TECHNICAL DESCRIPTION
(Fig 2001)

Principles of operation

Receiver

5. The receiver is a double superheterodyne with a first i.f. of 6.0Mc/s and a second i.f. of 2.4Mc/s.

6. The receiver has one r.f. stage V1, whose tuned circuits are ganged to the transmitter tuning (RF). There are three r.f. tuned circuits, two, L1 and L3 coupled by L2, in the form of an over-coupled pair in the grid circuit of V1, and the third, L4, forming the grid circuit of the first mixer V2.

7. The first local oscillator V31 operates at 6.0Mc/s above signal frequency and is tuned by a variable inductor (inductuner), having a separate front panel tuning control (CHANNEL).

8. The mixer V2 feeds a single 6.0Mc/s i.f. stage V9 which is followed by the second frequency changer V13, consisting of a heptode frequency changer V13a and the triode section V13b, and 8.4Mc/s crystal-controlled oscillator.

9. The output of V13 is fed into a two stage 2.4Mc/s i.f. amplifier V14, V15. This i.f. amplifier is followed by two limiters V16, V17 which in turn drive the receiver discriminator V18, V19, hereafter referred to as the narrow discriminator. This narrow discriminator produces an a.f. output, a noise (10kc/s) output, and a d.c. output.

10. The a.f. output from V18, V19 is fed via a de-emphasis network to a conventional two stage a.f. amplifier V20, V21 and thence to the headphones of the installation. Negative feedback is incorporated to reduce the output impedance.

11. The noise output is fed to the squelch unit, which mutes the receiver in the absence of a signal. This unit employs three valves, V22, V23 and V24.

12. The d.c. output is used for automatic frequency control (a.f.c.) of the transmitter master oscillator (m.o.), and is also used to operate the tuning meter when the set is switched to either the CURSOR ADJ or CHANNEL ADJ position of SA.

Transmitter

13. The transmitter consists of a master oscillator V6, driver V7, and power amplifier V8, variably tuned over the range 36-60Mc/s. The master oscillator is frequency-modulated by a Ferrite reactor X1 in the anode of the modulator valve V5.

14. The input to V5 consists of d.c., obtained from the a.f.c. system, and the a.f. modulation from the two stage microphone amplifier V27 and V30. This microphone amplifier is controlled by an automatic modulation control (a.m.c.) system V28, V29, so that, regardless of the input level to the microphone, the output from the microphone amplifier is constant.

15. Two levels of r.f. power output are available, these are controlled by switch SB. The outputs are, LOW, approximately 0.5W, and HIGH, not less than 15W.

16. Automatic frequency control (a.f.c.) is obtained by controlling the modulator V5, the controlling voltages being obtained from the narrow discriminator in the receiver, and from the sidechain and wide discriminator network V10, V11, V12.

17. An audio frequency signal produced in the wide discriminator by demodulation of the transmitter signal, is applied as negative feedback to the modulating signal to ensure that the deviation remains constant over the whole tuning range of the set.

Intercommunication amplifier

18. The intercomm amplifier is a conventional fixed gain, two-stage audio amplifier with a fairly flat frequency response over the speech range, and has negative feedback to reduce the output impedance. The nominal output of the intercomm amplifier is 250mW.

Calibrator

19. Two crystal-controlled oscillator/harmonic generator circuits are provided to permit the set to be tuned accurately to any of the channel frequencies.

20. In the CURSOR ADJ position of SA, a 2Mc/s crystal oscillator/harmonic generator V4 is switched on and this feeds a spectrum of harmonics at 2Mc/s intervals into the grid of the receiver r.f. amplifier V1. The tuning meter M1 is connected to the output of the narrow discriminator and will give a centre zero indication when the receiver local oscillator is accurately tuned in to any 2Mc/s harmonic point. The one which is nearest to the actual frequency required is selected, the film scale

being used to identify it. The cursor on the scale is then adjusted so that the scale reads correctly at this point. Later sets may have a 1Mc/s crystal fitted and 1Mc/s tuning points.

21. The scale is then set sufficiently accurately to permit the required tuning signal to be identified without ambiguity. This signal is produced in the CHANNEL ADJ position of SA by a 100kc/s crystal oscillator/harmonic generator V3 which feeds a spectrum of harmonics at 100kc/s intervals into the grid of the receiver r.f. stage. The tuning meter is still connected to the narrow discriminator and will give a centre zero indication when the receiver local oscillator is accurately tuned in to any 100kc/s harmonic point. Since the scale has already been calibrated in the region of the required frequency (ie the cursor setting), the scale can be used to identify the required 100kc/s harmonic point.

22. Having tuned the receiver local oscillator to the correct frequency, the next step is to tune the remaining r.f. circuits. In the TUNE R.F. position of SA, the set is switched to send (but the transmitter power amplifier (p.a.) stage is inoperative), and the tuning meter is connected to the wideband discriminator circuit, the low impedance of the meter to earth effectively earths the grid of the reactor valve V5 and renders the a.f.c. inoperative. The transmitter m.o. is then tuned so that its frequency is exactly that of the receiver, which is of course still operating, and this is indicated by centre zero on the tuning meter, ie the discriminators are producing no d.c. voltages.

<u>Power supplies</u>

23. The set receives its power supplies from either a Supply unit, vibratory, No 12, 12 or 24V, (Tels K 100-109 or Tels K 150-159), or from the Supply unit, transistorized, No 1 (Tels K 700-709).

24. The actual voltages supplied to the set from the power supply units are:-

(a)	175V d.c.	-	Receiver and transmitter h.t. supplies
(b)	350V d.c.	-	Transmitter p.a. h.t. supply (high power).
(c)	6.3V a.c.	-	Intercomm amplifier heaters
(d)	6.3V a.c.	-	Receiver heaters
(e)	12.0V a.c.	-	Transmitter p.a. heaters
(f)	6.3V a.c.	-	Transmitter heaters
(g)	6.3V a.c. balanced to earth	-	Transmitter a.m.c. unit heaters
(h)	24V d.c.	-	Set relays and fan
(j)	Battery d.c.	-	To control socket SKT2F and fan via send/receive relay contact RL3-2

(k) 12V a.c. - Set lamps

(l) 12.5V d.c. - Microphone amplifier and a.f.c. diodes heater supply

25. A voltage control signal from the harness attached to the set is fed through the set to a slave relay in the power supply unit. This slave relay controls transformer tap connections which tend to keep supply voltages constant despite considerable changes of input voltage to the power supply units.

26. An earth is returned to the p.s.u. when the set is at SEND HIGH POWER. This operates a relay which completes the 350V supply circuit to the set.

Construction

27. The set is contained in a die-cast aluminium case which is finned to assist cooling. It is approximately 14 in. wide, 8.1/2 in. high and 14.1/4 in. deep, is fully sealed and can be used anywhere in the world.

28. The equipment, when mounted on a suitable shock absorbing carrier, is capable of being operated in wheeled or tracked vehicles at altitudes up to 10,000 ft. The equipment may be transported by air at altitudes up to 25,000 ft and parachute dropped using standard dropping equipment.

29. The set is constructed of nine sub-units, as follows. (The abbreviations shown in brackets were the previous designations of the sub-units.)

(a) Front panel assembly.

(b) Transmitter-receiver sub-assembly (r.f. unit) 5820-99-949-0657.

(c) Intermediate frequency unit (1st i.f.) 5950-99-949-0835.

(d) Intermediate frequency unit (2nd i.f.) 5950-99-949-0839.

(e) Oscillator and scale assembly (c.f.o.) 5820-99-949-0659.

(f) Amplifier and motor assembly (a.f.) 5820-99-949-0586.

(g) Amplifier audio frequency (i.c.) 5820-99-949-0768.

(h) Squelch unit (squelch) 5820-99-949-0587.

(j) Control modulator (a.m.c.) 5820-99-949-0705.

30. With the exception of (a), these sub-units are carried on two wiring trays, interconnection between the sub-units being made by means of soldered links. These are carried in bakelite blocks secured to the sub-units and wiring trays. For details of these connections see Fig 2523 and 2524 and Table 2510 and 2511.

31. The set employs 'bookform' construction. Two 'A' brackets are secured to the front panel by means of four Allen screws. The heads of these screws are accessible from the front panel, but are capped to prevent their accidental release by unauthorized persons. The wiring trays are hinged at the apex of the A brackets and are secured in place by means of No 2 BA captive screws. For servicing purposes the wiring trays can be opened out, giving easy access to all components and sub-units. A spring loaded catch, which is automatically operated when one of the trays is fully opened, locks the units together in the opened position, this prevents the trays accidently falling and causing damage to the equipment and/or mechanic's fingers.

32. The main tuning drives are carried on the rear of the front panel, one employing a conventional dial, the other employing a 35 mm film scale approximately 96 in. in length. These drives couple to the tuning capacitor and inductuner by means of fork stops and pegs and hence no screws or pins need be removed when taking off the sub-units.

33. All the control knobs are the heavy duty collet or 'bootproof' type.

34. The set operates at an internal temperature of approximately 35°C above outer ambient temperature. For this reason QUICKLIME desiccators are used in the set. QUICKLIME desiccator containers are dyed RED. QUICKLIME desiccators cannot be reactivated, neither can their condition be checked by any colour or other indication. Therefore new desiccators will be fitted each time a set is resealed in its case. Silica Gel desiccators will not be used as they give up their moisture at a temperature below the possible operating temperature of this set.

35. An air circulating fan is built into the set to eliminate hot spots.

36. Two 3/4 in. 20 t.p.i. unified thread plugs are fitted in the rear of the case. These may be used for seal testing and for attachment to the Oven drying, tels, when drying the equipment.

Controls

37. The controls mounted on the front panel consist of the following:-

Switch SA	CURSOR ADJ	Receive condition, 2Mc/s crystal in circuit. Dial light on, tuning meter connected to narrow discriminator output.
	CHANNEL ADJ	Receive condition, 100kc/s crystal in circuit. Dial light on, tuning meter connected to narrow discriminator output.
	TUNE R.F.	Transmit condition, no p.a. anode volts, tuning meter connected to modulator grid. Dial light on.
	OPERATE	Set functioning normally. Dial light off.

Switch SB	HIGH	Connects 350V to p.a. anode and screen grid.
	LOW	Connects 175V to p.a. anode and screen grid.
Switch SC, NOISE	ON	Muting circuit not operating.
	OFF	Muting circuit operating.
CURSOR ADJUSTER		Mechanical drive to adjust cursor setting.
Tuning drives	CHANNEL	Adjust 36-60Mc/s in 241 channels. (Receiver 1st local oscillator). Fitted with LOCK lever.
	RF	Adjust r.f. circuits. Fitted with LOCK lever.
Meter M1		Tuning meter.
SQUELCH RV4		Adjusts sensitivity of squelch circuit.
Dial lamp ILP1		Illuminates dials during setting up.
SIGNAL lamp ILP2		Operated by squelch relay, fitted with an iris dimmer.
Socket SKT2		Connections to control harness.
Plug PL1		Connections from power supply unit.

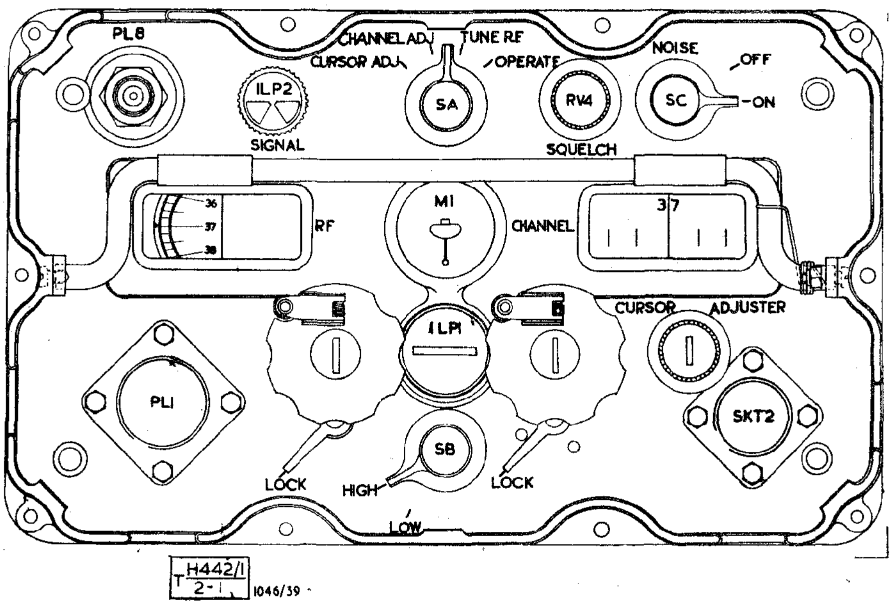

Fig 1 - TR C42 front panel controls

DETAILED TECHNICAL DESCRIPTION
(Fig 2502, 2504, 2505 and 2507)

Receiver

Aerial circuit

38. The aerial is connected to the coaxial plug PL8 and via the aerial relay contact RLA1 and calibrate relay contact RLB1 to the first tuning coil L1.

R.F. stage V1 (CV 4010)

39. An r.f. pentode is used as the r.f. amplifier, its input tuned circuit consisting of an overcoupled pair. These are L1, C3A, C1 and C2, and L3, C3B, C4 and C5 with L2 a tapped down inductive coupler. Coupling to the mixer is via C10 and C13.

1st local oscillator V31 (CV 2209)

40. A colpitt's type circuit is used for this, the grid and screen of a type CV 2209 r.f. pentode being connected across the tuned circuit L40, C161, C163, C164 and C165. A variable inductuner L40 is used for tuning, 2.1/2 turns of rotation covering the required range of 42-66Mc/s. The output circuit consists of a step-down wideband transformer T12. This output is fed via PL5/SKT5 to the mixer (V2) cathode resistor R11.

1st mixer V2 (CV 4010)

41. The input circuit of V2 consists of the tuned circuit L4, C3C, C12 and C14, fed via C10 from V1 on to a tap approximately half-way down L4. The tuned circuit is damped by R6, reducing the circuit Q to about one half. The overall selectivity which results is a bandwidth of approximately 400kc/s at 36Mc/s rising to 900kc/s at 60Mc/s, the gain remaining constant over the band.

42. The 1st l.o. V31 oscillates at a frequency 6.0Mc/s + signal frequency, mixes with the signal frequency and the difference frequency of 6.0Mc/s which is produced is selected by the circuit T9 primary and C16 which are tuned to 6.0Mc/s. This 6.0Mc/s signal is fed by the secondary of T9 via PL7/SKT7, SKT4/PL4 to the 1st i.f. stage.

1st i.f. V9 (CV 4010)

43. The input circuit of V9 consists of a tuned circuit L16, C181 and T19 secondary. This, together with the previous tuned circuit, is equivalent to a single overcoupled transformer, having a peak separation of 200kc/s. The anode circuit comprises a composite filter consisting of three tuned circuits in cascade, T10, T11, L22, C184, C190 and C195; these have a bandwidth of approximately 120kc/s at 6dB down. Some of this 1st i.f. signal is fed via C187 to the sidechain circuit for a.f.c., the action of which is described in para 65-69.

2nd mixer V13 (CV 2128)

44. This consists of a triode heptode type CV 2128. The triode section V13b acts as a Pierce type crystal oscillator oscillating at 8.4Mc/s. The anode circuit of V13b consists of T7 primary and C206 which are tuned to 8.4Mc/s, the output from

V13b being fed via T7 secondary into the mixer grid of the heptode section V13a. Mixing takes place and the 2.4Mc/s difference frequency is selected by the anode tuned circuit C201, T6 primary. The secondary of T6 forms an inductive link coupling via (SKT3 and PL3), to the 2nd i.f. amplifier.

2nd i.f. amplifier V14, V15 (CV 4010)

45. This is a two-stage amplifier employing r.f. pentodes. The input at 2.4Mc/s is obtained from the coupling winding of T6 which, together with L29 and C72a and b, forms a 2.4Mc/s tuned circuit. This circuit, together with that in the anode of V13a, forms an overcoupled transformer. The anode circuit of V14 is a 2.4Mc/s tuned circuit C74, T8 primary, inductively coupled by T8 secondary to V15 grid circuit L32, C78. These two tuned circuits form a similar overcoupled transformer to that between the second mixer V13a and the grid of i.f. amplifier valve V14. The anode circuit of V15 consists of the 2.4Mc/s tuned circuit L33, C79a and b, the output from this stage being capacity-coupled to the grid of the first limiter V16 via C81.

1st and 2nd limiter V16, V17 (CV 4010)

46. The grid circuit of the 1st limiter V16 consists of two resistors R79 and R81 in series. Two test points are provided, TP7 at the grid itself, and TP8 at the junction of R79 and R81. The first limiter V16 is resistance-capacitance-coupled to the second limiter V17 via R83, C85, R85. The anode circuit of V17 consists of a 2.4Mc/s tuned circuit L34, C87. Both limiters operate with zero bias and reduced anode and screen voltages, thus shortening the grid base and providing an effective limiting action.

A.F. or narrow discriminator V18, V19

47. This operates as a conventional Bond discriminator (see Tels A 013) employing two CV 4504 type diodes. The input circuit consists of the tuned circuit L35, C89, C90, fed from the anode of the second limiter V17, the 'offset' or unbalancing capacitor being C91. The output from the discriminator passes into a multi-section low-pass filter; three separate outputs being produced, as follows:-

(a) After the section R90, C92, C93 noise signals of about 10kc/s are taken off to the squelch unit.

(b) The second section R91, C94 feeds a.f. signals to the a.f. unit.

(c) From the junction of R90 and R91, the signal is taken into a further section R92, C95, the time constant of this being sufficiently long to produce virtual d.c. This output is fed to the wide discriminator in the a.f.c. circuits and in the calibrate positions of SA to the tuning meter M1.

A.F. unit V20, V21 (CV 4010)

48. The a.f. output from the narrow discriminator is fed via a de-emphasis network R101, 102, 103, 104, C101, 102, 103 to preset gain control RV1, which forms the grid circuit of V20. The amplifier is a conventional two-stage resistance-capacitance-coupled amplifier employing two CV 4010 type pentodes, coupling between them being effected by C106. A certain amount of negative feedback is introduced by connecting

the anodes of V20 and V21 by a 1MΩ resistor R108, this has the effect of reducing the output impedance. The output is fed to the phone sockets via the output transformer T1.

Squelch V22, V23, V24

49. Noise signals are fed from the narrow discriminator via C122 and the coarse squelch control RV2 to the first squelch amplifier valve V22 (CV 4010). The anode circuit of V22 is a 10kc/s tuned circuit consisting of a coil L39, in a ferroxcube pot, and a capacitor C123. This valve acts as an amplifier for noise signals in the region of 10kc/s.

50. These 10kc/s amplified signals are fed via C125 to the rectifier, a type CV 4504 diode V23. The cathode of V23 is given a delay bias from the voltage dividing chain R125, R126 and the front panel squelch control RV4.

51. The front panel SQUELCH control RV4 varies the delay bias on the cathode of the diode V23, thus controlling the cut-off point of V24, and setting the level of carrier which will operate the squelch circuit.

52. The rectified negative voltage is filtered through a long time constant circuit R123, 124, 127, C128 and applied to the grid of the CV 4010 type pentode V24. This negative voltage cuts off the valve and the relay RLD in its anode circuit is released.

53. When a signal is received the receiver is quieted, the 10kc/s noise components are greatly reduced in amplitude and the bias voltage produced by the diode V23 decreases. This causes V24 to conduct and RLD to operate. The contacts of RLD then perform the following functions:-

(a) RLD1 unmutes the a.f. amplifier V20 by removing the earth from its anode.

(b) RLD2 lights the signal lamp ILP2.

(c) RLD1 earths pin E of SKT2. (This is termed 'rebroadcast earth' and is used during automatic rebroadcast to operate the send relay of the other radio set.)

54. The squelch circuit will of course operate when the receiver picks up its own transmitter signal. Contact RLC4 of the send/receive relay is connected in series with the rebroadcast connection from RLD1 so that the rebroadcast earth is made only on receipt of a true received signal.

Transmitter

Microphone amplifier and automatic modulation control (a.m.c.), V27, V28, V29, V30 (Fig 2)

55. The first microphone amplifier consists of a type CV 4015 r.f. pentode V27. The audio frequency input from the microphone is fed to the control gird of V27 via the microphone transformer T4 and the pre-emphasis network R141, 142, 143, C141, 142. The output at the anode of V27 is split. One path is via C150 and the pre-set modulation level control RV3 to the grid of V30, the other path is via C146 and R152 to

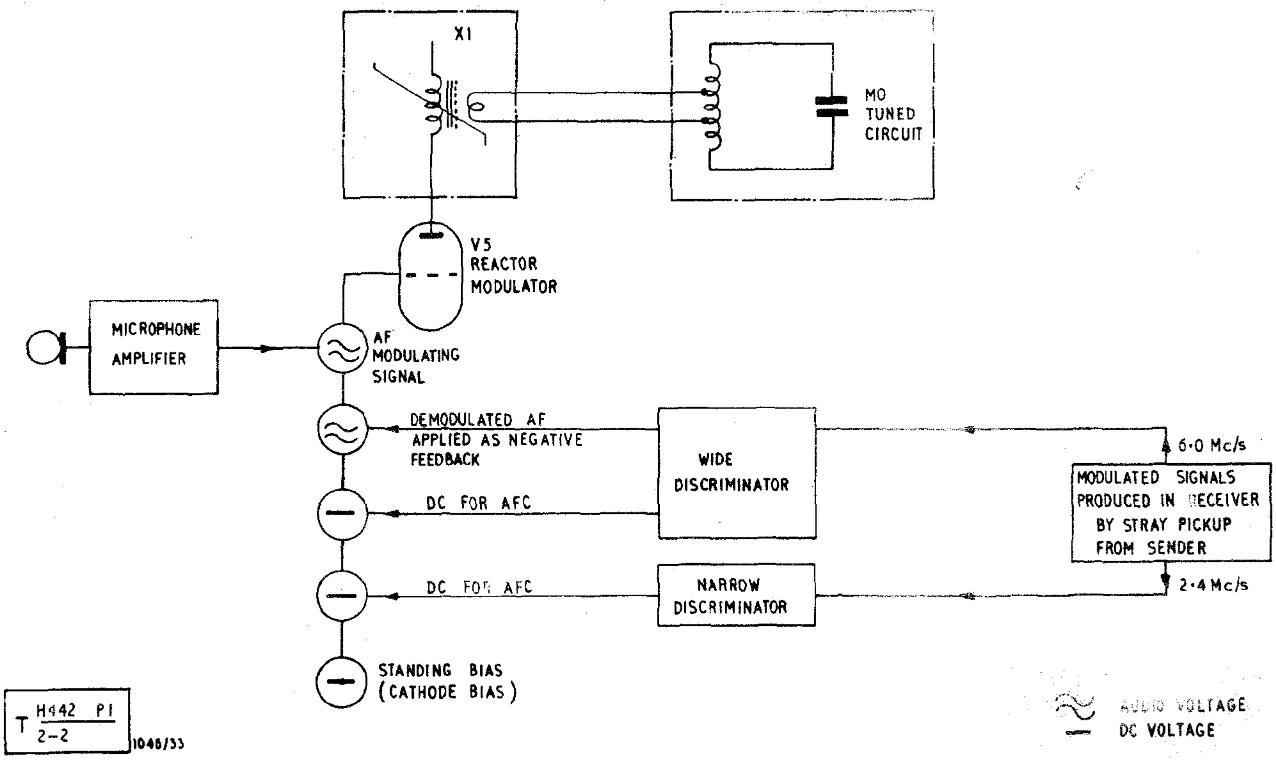

Fig 2 - Modulation and a.f.c. - simplified diagram

the grid of the control amplifier valve V28, a CV 4010 pentode. The use of pre-emphasis and de-emphasis improves the signal/noise power ratio. This is more fully dealt with in Tels A 013.

56. The modulation level is effectively maintained at a constant level by the action of V28 and V29. The modulation signal after amplification by V28, is fed via C148 to the primary of the intervalve transformer T5 which has a step-up ratio of 1:2. The secondary output of T5 is rectified by the diode V29 and the resultant negative voltage, developed across R144, is applied as bias to the control grid of V27, thereby reducing the gain of this stage. The time constant of R144 and C149 is such that the a.m.c. bias is proportional to the average modulation level but does not follow rapid fluctuations of modulation, such as occur between words in a transmission. The rectifier V29 cathode has a delay bias applied to it from the network R156, R157 across the 175V h.t. supply. Thus no gain control action takes place until the microphone input level reaches a value above which the compression action operates and the gain of the amplifier is reduced in proportion to the input. In this way, provided RV3, the modulation level, is correctly set, the sender deviation is limited to ±15kc/s.

57. The resultant modulation signal is applied to the grid of V30 where further amplification takes place, and its output is taken via C153 to the wide discriminator V11, V12 and thence to the modulator or reactor valve V5 which is a type CV 4010 pentode.

Modulator V5 (Fig 2)

58. The modulator valve V5 controls the current in the primary winding of the Ferrite reactor X1 (see Tels A 013). The grid voltage of V5 consists of two a.f. components, the modulating signal and that derived by demodulation in the wide discriminator (para 59), and three d.c. components, two from the a.f.c. circuits and the standing bias produced by the voltage divider chain R22, R33, R23 plus the normal cathode bias produced in R23. Thus the anode current of the reactor valve consists of a controlled d.c. which is varied by the impressed a.f. modulation. In this way the inductance of the reactor X1 secondary is varied at a.f. about a mean value set by the standing d.c. bias present at the modulator valve grid.

59. The 1st i.f. signal is demodulated in the wide discriminator V11, V12 and the a.f. signal produced is then fed to the grid of V5 as negative feedback in order to maintain the deviation reasonably constant over the tuning band.

Master oscillator V6

60. The master oscillator is a type CV 133 triode connected in a cathode-coupled Hartley circuit, the tuned circuit consisting of L10, C3F, C35 and C55. Across part of L10 is tapped the secondary winding of X1. Thus as the inductance of X1 secondary varies at the a.f. modulation rate, so will the m.o. frequency vary at this a.f. rate about a mean value. The output from the m.o. tuned circuit is coupled from the cathode tap via C38, to the grid of the driver V7.

Driver V7

61. This is a type CV 2243 pentode which has an r.f. choke L11 as its anode load. In its cathode circuit is a 22Ω resistor R28 by-passed by C41; a test point TP3 is provided at the cathode for measuring the drive produced by the m.o. valve. Values of approximately 0.6V indicate satisfactory drive and 1.2V absence of drive. The output from the driver is fed via C43 to the power amplifier valve V8.

Power amplifier V8

62. The p.a. is a type CV 2220 pentode whose grid input circuit consists of L12, C3E, C49 and C54, L12 being returned to earth for r.f. by C42. The grid leak consists of R29, R30, a test point TP9 being connected to their junction and decoupled by C45. The test point is provided to measure the drive to the p.a. The p.a. is anode-choke loaded by L14 and C51 provides a parallel feed to the aerial circuit L15, C3D, C53, C50. A grid stopper R32, L17 is provided to prevent parasitic oscillation. Neutralising is effected by the small pre-set capacitor C3G.

63. The r.f. power is taken from a tap on L15 via the aerial relay contacts RLA1 to the aerial output plug PLB.

64. The p.a. h.t. supply on high power is taken from the 350V supply line. This supply is only present when the send/receive relay RLC is operated, its contact RLC3 operating a further relay in the supply unit, which completes the 350V supply circuit. On low power the p.a. h.t. supply is obtained via send/receive relay contact RLC1 from the receiver 175V supply line.

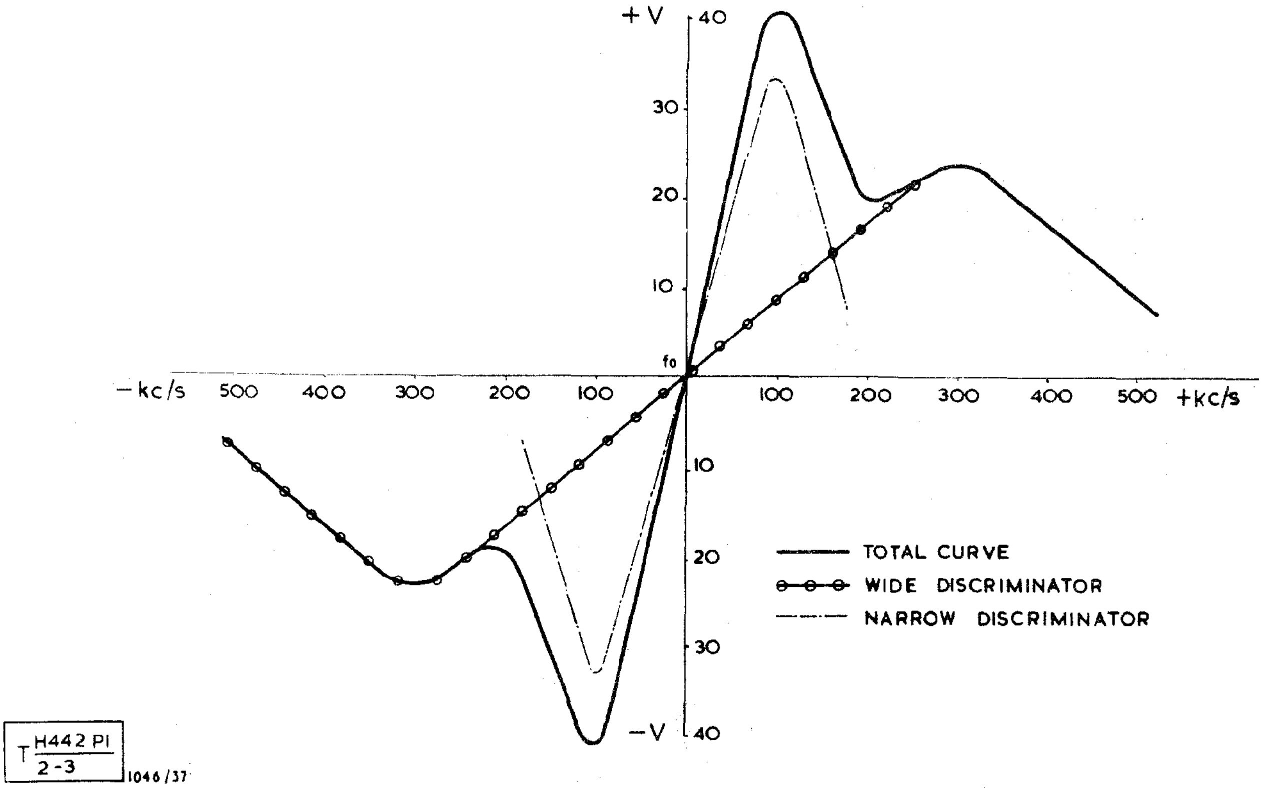

Fig 3 - Discriminator outputs - typical diagram

Automatic frequency control (a.f.c.) V10, V11, V12

65. The mean operating frequency of the master oscillator is set by the standing bias applied to the grid of the modulator valve, as described in para 58 and it will be seen that any variation in m.o. frequency can be corrected by the application of the necessary change of bias voltage to the grid of V5.

66. This control is effected by the summation of the d.c. voltages produced by the two discriminators (Fig 3). When the frequency difference between the m.o. and the receiver varies by amounts of up to 50kc/s, the narrow discriminator V18, V19 feeds a d.c. voltage back via R92 and the wide discriminator to V5 grid, this voltage is of such an amplitude and polarity that the m.o. frequency is corrected to the receiver frequency. At frequency errors above about 8kc/s, up to a maximum of approximately 500kc/s, the wide discriminator V11, V12 feeds a voltage to V5 to correct the m.o. frequency sufficiently to allow the narrow discriminator to carry out the final correction. The sensitivity or slope of the narrow discriminator is about six times as great as that of the wide discriminator, so that the accuracy to which the transmitter frequency is corrected depends largely on the narrow discriminator, whereas the wide capture range of the transmitter frequency is provided by the wide discriminator.

67. The signal inputs to the discriminators are produced by a small portion of the transmitter r.f. being picked up by the receiver and i.f. signals of approximately 6Mc/s being produced in the 1st i.f. V9 fed via C187 to the wide discriminator, and

frequencies of approximately 2.4Mc/s being produced at V17 and fed into the narrow discriminator.

68. The d.c. voltage fed to the grid of the modulator V5 is zero when the signal in the receiver produced by the transmitter is exactly on the centre frequency of the narrow discriminator, and is positive or negative when required to correct any error present in the transmitter frequency.

69. The polarity of the correcting voltages is determined by the unbalancing capacitors of the discriminators C196 and C91. Connecting these capacitors to the other end of the tuned circuits reverses the polarity of the discriminator outputs.

Sidetone

70. The sidetone heard in the headsets when transmitting is 'true' sidetone, ie some of the transmitter r.f. signal is fed by stray r.f. pick up into the receiver, here it is demodulated and fed to the headsets.

Intercommunication amplifier V25, V26

71. This is a conventional two-stage a.f. amplifier using type CV 4010 pentodes. The microphone input is transformer-coupled via T2 to the grid of V25. V26 is resistance-capacitance-coupled to V25 via R133, C132 and R137. The output is fed to the phone sockets via the output transformer T3. A resistor, R135, is connected between the anodes of V25 to V26 to provide negative feedback, thus lowering the output impedance.

72. The amplifier will deliver an output of 250mW with approximately 5% distortion.

Calibrator V3, V4

73. The valves V3 and V4 are connected as crystal-controlled Pierce oscillators of frequency 100kc/s and 2Mc/s respectively. The 100kc/s crystal XL1 is provided with a trimmer C22, which permits the variation of the generated frequency by ±15c/s and allows the 100kc/s crystal to be set against a standard reference frequency of exactly 100kc/s.

74. With switch SAd in the CURSOR ADJ position, V4 receives anode voltage, and the 2Mc/s harmonics permit the set to be tuned accurately to even megacycle points and the cursor set, so that the scale reads correctly at this point. When the cursor has been thus set, the scale is sufficiently accurate in the region up to 1Mc/s on either side of this point to permit 100kc/s crystal harmonics to be identified without ambiguity. When switch SAd is moved to CHANNEL ADJ, the 100kc/s oscillator V3 operates and allows the set to be tuned accurately to a particular 100kc/s channel.

75. Later production sets will be found with the 2Mc/s crystal replaced by a 1Mc/s crystal.

Tuning meter

76. In the CURSOR ADJ and CHANNEL ADJ positions of SA, the tuning meter M1 is connected via SAf across the narrow discriminator output, a null reading on the meter indicating that the i.f. is exactly that of the mid discriminator frequency.

77. In the TUNE R.F. position, the meter is connected to the wide discriminator output, and a null reading indicates that the d.c. output from the a.f.c. discriminator is nil, or that the m.o. frequency is exactly that to which the receiver is tuned. The switch SAc earths the earthy side of the wide discriminator and thus short-circuits the d.c. output from the narrow discriminator. The low impedance of the meter also effecitvely earths the grid of the modulator valve V5 so that no a.f.c. action can take place during the tuning procedure.

Temperature compensation

78. The m.o. and receiver r.f. circuits, the 1st receiver local oscillator and all the i.f. tuned circuits are compensated against temperature drifts by the use of suitable compensating capacitors. If it should be necessary to replace any capacitors in these circuits it is important that an exact replacement type is used. The driver and p.a. tuned circuits do not require compensation since they are broadly tuned. Note that N030 means negative change of capacitance of 30 parts per million/per ^{o}C rise in temperature. Similarly a P100 capacitor would have a positive change of capacitance of 100 parts per million/per ^{o}C rise in temperature, eg a 1000pF N030 capacitor will fall in capacitance by $\frac{30 \times 1000\text{pF}}{10^6}$ per ^{o}C rise in temperature.

Diode heater circuits

79. Type CV4504 diodes may be run at reduced heater volts without impairing their efficiency, but at this lower voltage the 'hum' which they introduce into the set is considerably reduced. Therefore, to keep 'hum' to a minimum, resistors (R93, 130, 162) are inserted in the heater circuits of V29, 18, 19, 23.

Heater voltages

80. The waveform of the heater voltages (when fed from a d.c. power supply unit) will consist of a series of pulses of approximately 108 p/s. The voltage may, therefore, only be accurately measured by using a thermal or suitable moving iron type instrument. If an Avometer is used it will read approximately 0.5V high (6.3V = 6.8V on an Avo on 12V a.c. range). This is however only a rough guide, the Avo reading being dependent upon the make/break ratio of the vibrator contacts.

Ferrite beads

81. A number of ferrite beads will be found throughout the set. These are small beads of ferrite which are slipped over the wiring of any circuit which is liable to parasitic oscillation. They are devices which tend to damp the circuit, preventing oscillation at high parasitic frequencies.

Hum

82. To reduce the hum present in the set on send the microphone amplifier valve V27 and the a.f.c. diodes V11 and V12 are supplied with a d.c. heater supply from the power supply unit.

TUNER, R.F., AERIAL, NO 6

Introduction

83. Tuner, r.f., aerial, No 6 permits the station to be used over the frequency band 36-60Mc/s with a standard 8 ft rod aerial.

84. The tuner forms part of the vehicle installation and will normally be mounted near the aerial base.

BRIEF TECHNICAL DESCRIPTION

Principles of operation

85. The Tuner, r.f., aerial, No 6 is designed to match the output cable impedance of 70Ω to the effective impedance of the 8 ft aerial on the vehicle at the frequency used. A collins type coupler is used but, by using a link mechanism, matching and tuning are obtained with a single front panel control, which should be adjusted to give maximum reading on the built-in meter.

Construction

86. The t.r.f. is contained in a cast desiccated sealed box, the overall dimensions of the unit being 7.1/8 in. wide x 5 in. high x 6.1/8 in. deep (including the tuning knob). Mounting lugs are provided on the top and rear of the case as alternative fixings to brackets on the vehicle.

87. Components are mounted above and below a tray which is fixed to the front panel by two triangular brackets. The two-gang capacitor (C9a, C9b) is driven through anti-backlash gears from the tuning knob on the front panel and its rotor is pinned to the gearing so that maximum capacitance and 0 on the tuning indicator coincide. Drive for the single variable (C8) is taken from C9, through a link mechanism consisting of a crank arm, held by Allen screws on C9 rotor spindle, and a similar but shorter crank on C8 rotor spindle. The extremities of the cranks are joined by a straight bar on swivel pins so that, by rotating the tuning knob, C8 will move according to a predetermined law in relation to C9.

Controls
(Fig 2526)

88. The controls and connections on the front panel are:-

Tuning control	Tuned for maximum output. A plate calibrated 0-10 gives an indication of approximate frequency setting.
LOCK	Locks the drive mechanism when unit is adjusted.
PLA	A pattern 4 r.f. coaxial plug for connecting via 70Ω cable to the radio set.
AE	A porcelain insulated threaded aerial terminal.
EARTH	A threaded earth terminal.

DETAILED TECHNICAL DESCRIPTION
(Fig 2526)

89. The input to the t.r.f. is connected via a coaxial cable to the output of the radio transmitter which consists of a tank circuit with the coil tapped at 70Ω to match the impedance of the uniradio cable. The output of the t.r.f. is connected to a standard 8 ft rod aerial which will present a varying impedance dependent mainly

upon the frequency used but also on the method of its mounting on the vehicle. A set of average impedances, experimentally obtained, is given in Table 1. Figures at 60Mc/s are given for two mountings.

Frequency (Mc/s)	Equivalent load of aerial	
	Conductance G (mhos)	$\frac{\text{Susceptance B}}{\text{W}}$ (pF)
36	3.3	-5.3
40	3.0	+3.1
42	2.6	+9.0
46	2.3	+9.3
50	2.0	+14.6
54	2.1	+23.3
60	6.1	+26.6
60	7.5	+27.6

Table 1 - Equivalent aerial impedances

90. To match the cable impedance (70Ω) to the aerial impedance (Table 1) and to achieve optimum power transfer, a tuned auto-transformer is used. The input is fed via C1 to a tap on L1 while the whole of L1 is tuned by variable capacitor C9, (C9a and C9b in parallel). The effective transformer ratio of L1 is altered by a variable capacitor (C8) across the input of the t.r.f. This capacitor is driven from C9 by the linkage described in para 87 and is adjusted, together with the trimming capacitor (C7), so that when L1, C9 and the aerial are resonant, the effective transformer ratio of L1 is such that approximately correct matching is achieved. By careful adjustment this condition is met over the frequency band.

91. A metering circuit is included so that the unit may be tuned to give maximum output. A portion of the voltage developed across the tuned circuit (L1, C9) is fed through a small capacitor (C2) to two variable inductors (L2, L3). These are broadly tuned and are adjusted so that across L3 the rectified reading on the meter will be substantially constant over the band. MR1 is a germanium diode and indication is given by measuring the current through a resistor (R1, 27kΩ). C4 and C5 bypass any r.f. The negative terminal of M1 is connected to earth via L4, the coaxial cable and part of the radio set tank coil so completing the detector circuit. This is done so that, on remote tuning, another meter may be connected to give an indication at the control point. An r.f. choke (L4) and decoupling capacitor (C6) are fitted to isolate the r.f. tuned circuit from the metering circuit.

SIMULATOR, AERIAL TUNING

Introduction

92. The Tuner, r.f., aerial, No 6 normally matches the TR C42 to an 8 ft rod aerial mounted in a particular position on a vehicle. This matching will not be correct for an installation in a classroom and damage to the output stage can result. To avoid this, and unwanted radiation, the output of the TR C42 is fed to a Simulator, aerial tuning.

BRIEF TECHNICAL DESCRIPTION

Principles of operation

93. A 75Ω resistive dummy load is used to absorb the TR C42 transmitter output. Part of the voltage developed across this load is tuned and metered to simulate the operation of the T.R.F. No 6. Sufficient radiation for demonstration purposes may be obtained by connecting an aerial to the simulator.

Construction

94. The unit is housed in a sealed cast alloy case approximately 7 in. wide x 5 in. high x 6 in. deep. Controls and layout are as far as possible identical to the T.R.F. No 6. Because of this similarity the simulator front panel is coloured battleship grey for ease of identification. The nine carbon resistors forming the dummy load are clip-mounted above and below a paxolin panel and paralleled by soldering to two metal plates.

Controls

95. The front panel controls consist of:-

Tune	Capacitor tuning drive
LOCK	Locks tuning drive
PLA	Coaxial input for Station, radio, C42
AE	Threaded terminal for aerial connection
EARTH	Threaded terminal for earth connection

DETAILED TECHNICAL DESCRIPTION
(Fig 2528)

96. The input to the simulator from the TR C42 is connected via coaxial cable to PLA and thence to a 75Ω load consisting of nine 2.1/2W non-inductive resistors (R3-R11) in parallel.

97. Across this load a tuned circuit, consisting of L1 and variable capacitor (C1a and C1b) is connected in series with R2. R1 damps the tuned circuit so that the indication of power output on M1 (0-500μA), obtained by the rectified current through germanium diode MR1 and R12, is approximately the same as that obtained using Tuner, r.f., aerial, No 6 in a standard installation. C2 connected across the gang capacitor gives the correct tuning capacitance swing for the frequency band. C3 and C4 are r.f. bypass capacitors.

Note: The next page is Page 1001

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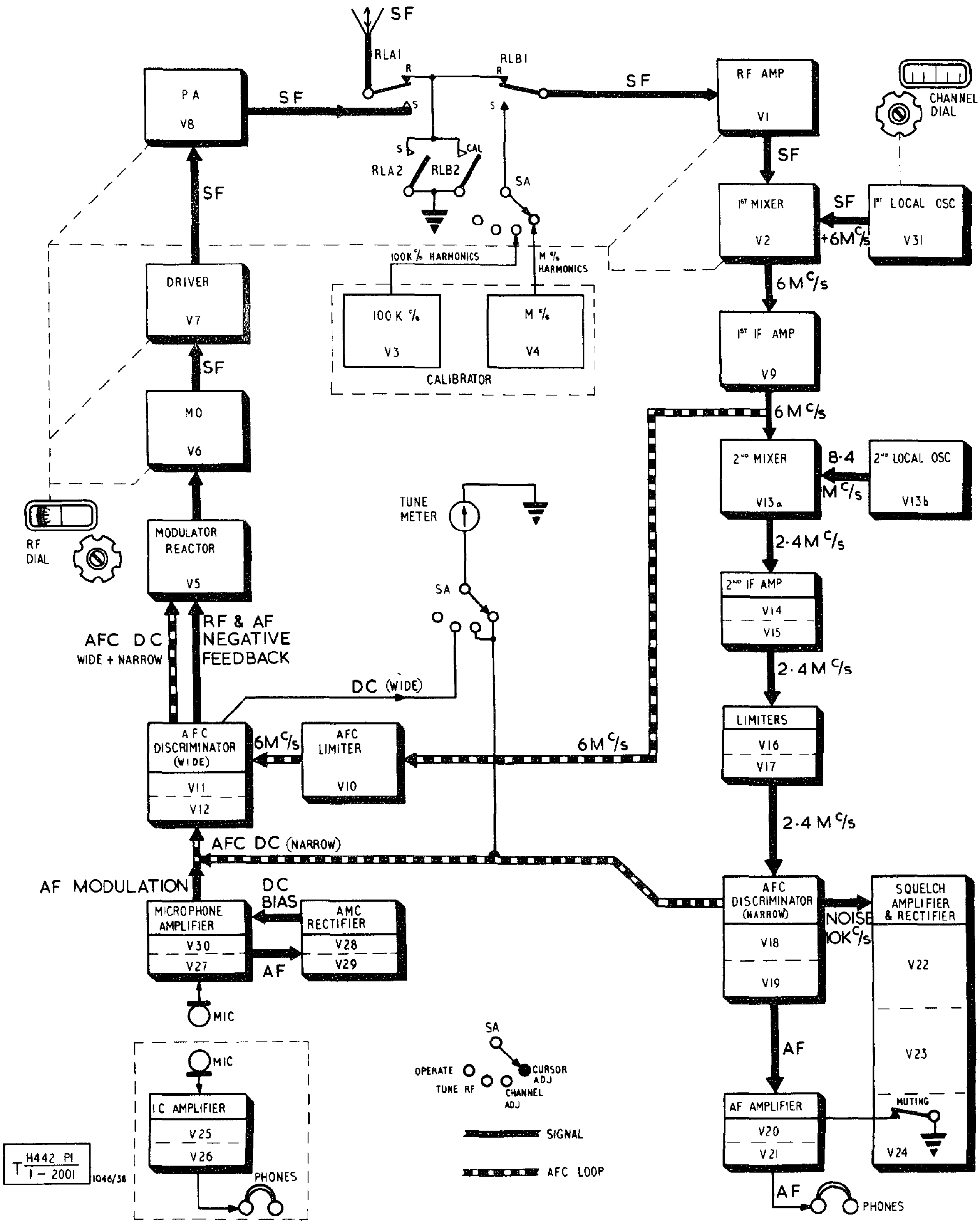

Fig 2001 - Block diagram of TR C42

END OF PART 1

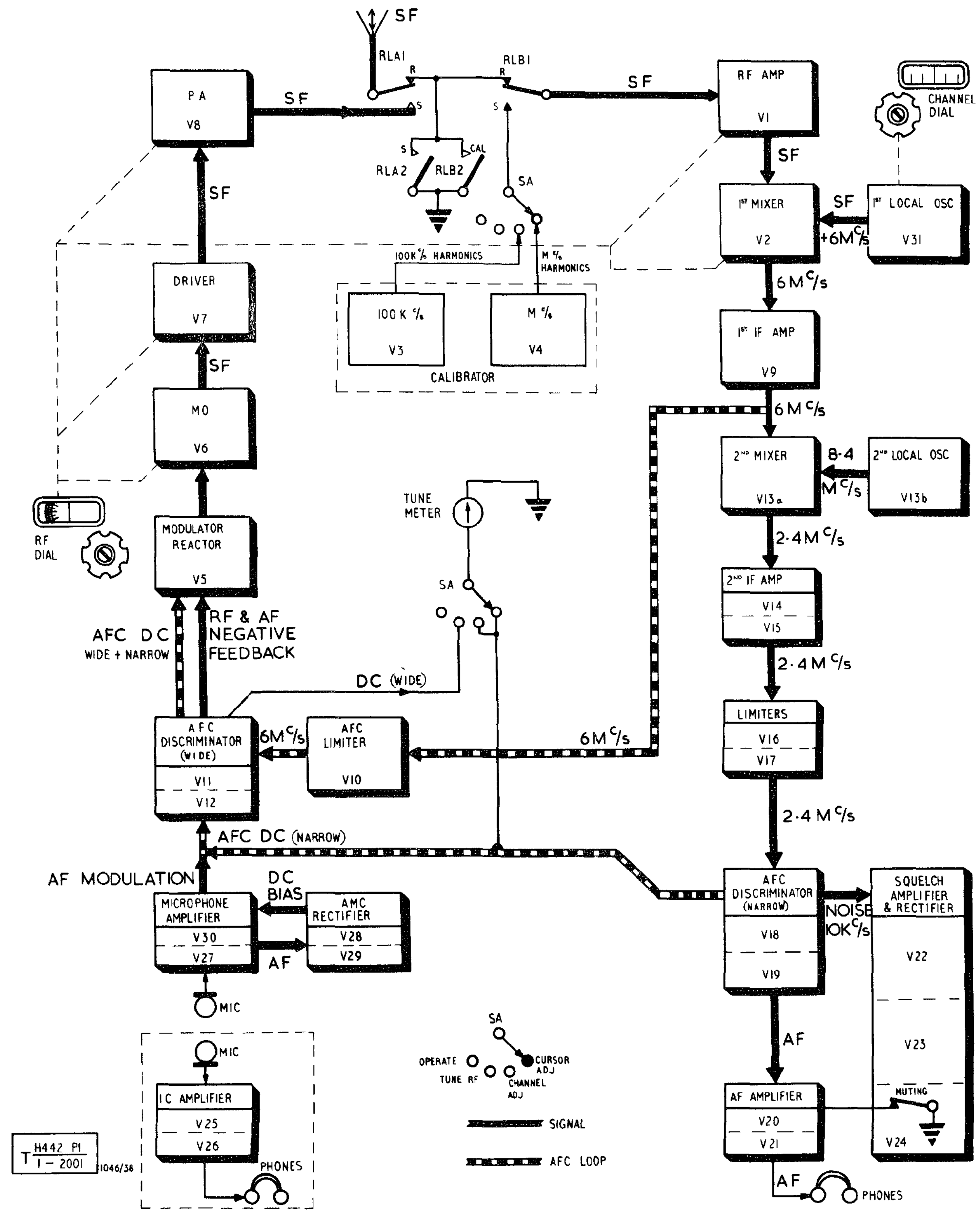

Fig 2001 - Block diagram of TR C42

END OF PART 1