RADIO STATION UK/PSC 540 (SHORT RANGE COMMUNICATION AND RECORDING EQUIPMENT)

TECHNICAL DESCRIPTION

This publication contains information covering the requirements of levels 2, 3 and 4

BY COMMAND OF THE DEFENCE COUNCIL

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LIST OF ASSOCIATED PUBLICATIONS

Reference		Contents
AESP	5820-F-300-101	Purpose and planning information
AESP	5820-F-300-201	Operating information. Contains information covering the requirements of categories 2 and 3 and sub-categories 5-1 and 5-2 at level 1
AESP	5820-F-300-302	Technical description. Contains information covering the requirements of levels 2,3 and 4
AESP	5820-F-300-412	Installation instructions
AESP	5820-F-300-512	Fault diagnosis. Contains information covering the requirements of levels 2,3 and 4
AESP	5820-F-300-522	Repair instructions. Contains information covering the requirements of levels 2,3 and 4
AESP	5820-F-300-532	Inspection data. Contains information covering the requirements of levels 2,3 and 4
P44969		Production Edition CES UK PSC 540
P44968		Production Edition CES Installation Kit, EEV Mounting Kit for UK PSC 540
EMER Tels L 210 - L 219		Clansman V.H.F. Antennas
EMER Tels C 700 - C 709		Microphone assemblies
EMER Tels C 710 - C 719		Receiver assemblies
EMER Tels C 720 - C 729		Microphone and receiver combined assemblies
EMER Tels C 740 - C 749		Clansman Audio Accessories
Army Code No 61388 (Jun 76)		User Handbook for Clansman V.H.F. Antennas.
Army Code No 61172 (Apr 76)		User Handbook for Clansman Radio Control Harness.

INTRODUCTION

1 This publication contains information on the role, construction, main parameters and principles of operation of the UK/PSC - 540 Short Range Communications and Recording Equipment (Shoracre).

2 Details of associated publications are provided at preliminary pages (vii)/(viii).

ROLE AND PURPOSE

3 The purpose of Shoracre is to provide two way speech between Explosive Ordnance Disposal (EOD) teams and their incident control point. The latter can be either fitted in a vehicle (vehicle installation role) or can be man portable (general purpose role).

Vehicle installation role (Fig 1)

4 The equipments form a 430 MHz - 450 MHz u.h.f. radio-telephone system with facilities to record all conversations that take place. A Stand-Off Observer (SOO) and other assistants may be connected into the system as required.

5 The Disposal Operator (DO) has a hands-free 2-frequency fully duplex Operators Radio Unit (ORU) in which the transmitter and receiver operate continuously to give him the complete freedom of movement required without distraction by pressel switches or trailing leads. Alternatively the system can be used in the Press-To-Talk (PTT) duplex mode. Under typical conditions, a maximum range of 400 m is obtained.

6 The SOO has a similar ORU which operates in the PTT mode, allowing the DO priority use of the system. The SOO's transmitter frequency differs from that of the DO to prevent mutual interference. The SOO can switch his radio to full duplex if he has to take over from the DO.

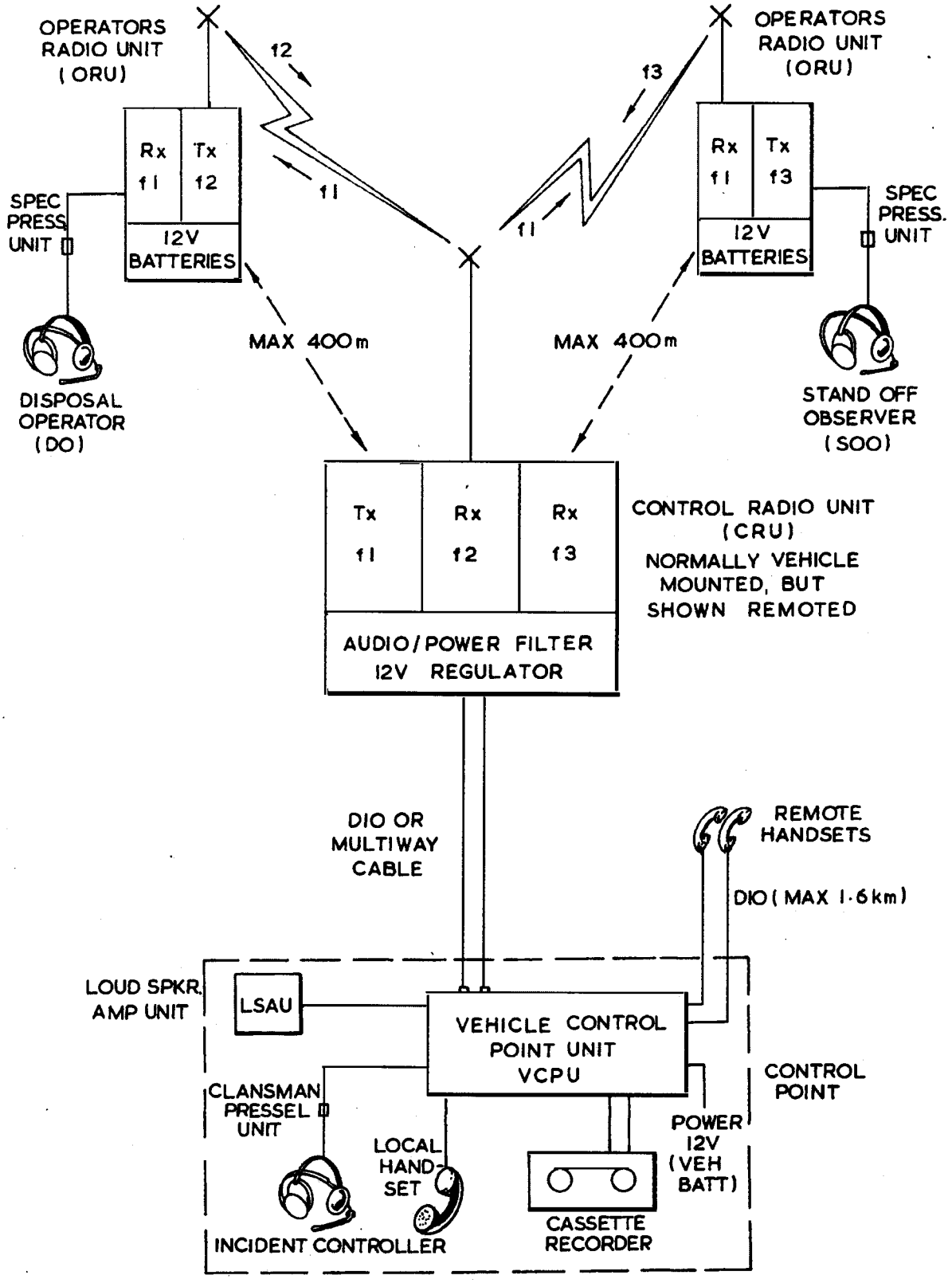

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Fig 1 Vehicle installation role: Schematic diagram

7 Additional SOO's or other assistants can be connected into the system using remote handsets at the end of a D10, or similar cable link.

8 All conversations on the system are passed to the Vehicle Control Point Unit (VCPU) which is installed in the EOD vehicle, and powered from the vehicle battery. The VCPU supplies audio and power to the cassette recorder which is installed beside the VCPU. A loudspeaker system providing 1 W output for Public Address (PA) purposes is fitted in the vehicle. The loudspeaker system can be remotely used on a D10 link if required.

9 Radio communication is maintained with the DO and SOO by means of the CRU. The CRU is normally clipped into the EOD vehicle alongside the VCPU and in this position uses an antenna mounted on the roof of the vehicle. A cable link between the CRU and the VCPU carries power and audio.

10 Where the limited range of the equipment and nature of EOD incident dictates, the CRU may be unclipped from its mounting plate in the vehicle and placed in a position where radio communications between the DO and SOO can more easily be maintained. A short whip antenna is fitted to the CRU in this role.

11 The distance between the CRU and the vehicle mounted VCPU can be extended up to a maximum of 400 m by using D10 or similar cable. Power for the CRU and the audio signals are passed along this same cable so that when the DO and SOO receive "over-the-air" real sidetone, it confirms that their signals are reaching the control point.

General purpose role (Fig 2)

12 In this role the system provides communication between a pair of searchers and a team leader. Each searcher has an ORU which can be operated in full duplex or PTT mode as required.

13 The team leader has a PCPU which is a portable version of the VCPU containing its own battery power supply. The CRU is clipped to the PCPU and the combined units can be carried on the leader's back, or slung by a shoulder strap fixed to 'D' rings on the equipment.

14 The normal antenna fitted to the CRU can be replaced by a mast mounted antenna to increase range up to a maximum of 800 m.

15 If necessary the team leader can operate remote from his equipment using a remote handset on the end of a length of D10 cable.

16 The items of equipment used in the GP role can be transported in the storage container provided. The 5.4 m mast and D10 cable are normally stowed in the vehicle.

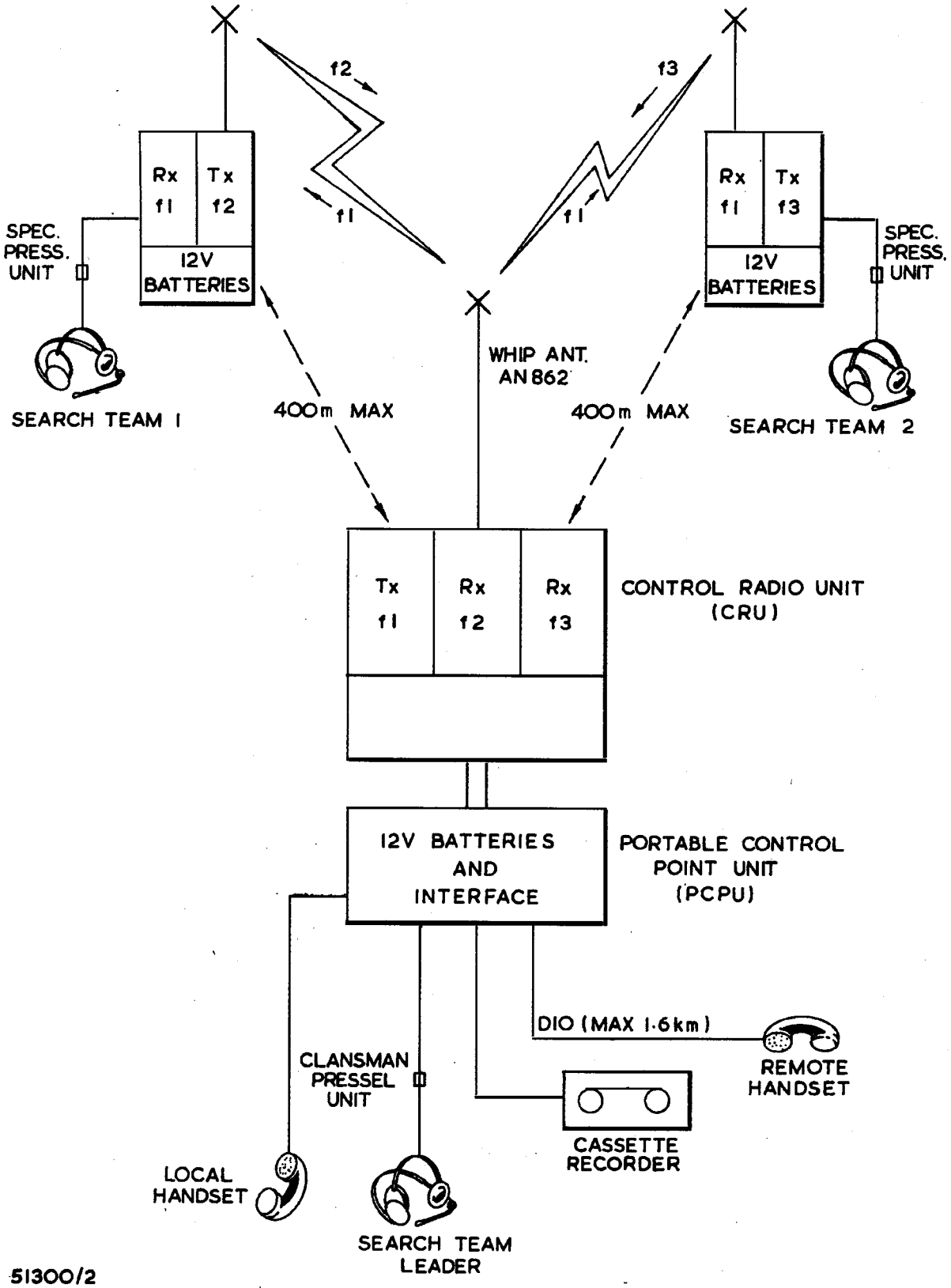


Fig 2 General purpose role: Schematic diagram

DETAILED DESCRIPTION

17 The equipment consists of the following units:

17.1	Control Radio Unit (CRU)	Used in both general purpose and vehicle installation.
17.2	Operator Radio Unit (ORU) (2 off)	
17.3	Loudspeaker Amplifier Unit (LSAU)	Used in vehicle installation role.
17.4	Cassette recorder	
17.5	Vehicle Control Point Unit (VCPU)	Used in vehicle installation role.
17.6	Portable Control Point Unit (PCPU)	Used in general purpose role.
17.7	Storage container	Used in general purpose role.

CONSTRUCTION

Control radio unit (Fig 3)

18 The CRU contains two receivers and one transmitter, each consisting of a mother board containing plug-in thick film modules mounted in a sheet-metal box. The transmitter, receivers and r.f. duplexer are mounted on a flat sheet metal chassis on the reverse side of which is mounted a box containing a voltage regulator p.e.c. and a transformer.

19 On the other end of the case is mounted a 7-way fixed plug for VCPU connection and a pair of terminals for two wire remote working.

20 A 34-way test socket is mounted internally which allows monitoring of d.c. and a.f. voltages and injection of test signals at Field level.

21 The CRU is contained in a glass reinforced polycarbonate case on which are mounted quick release catches for securing a PCPU. 'D' rings for attaching carrying straps are mounted either side of the case. Internal access is provided by unscrewing the end plate and withdrawing the unit from the case.

Operators radio unit (Fig 4)

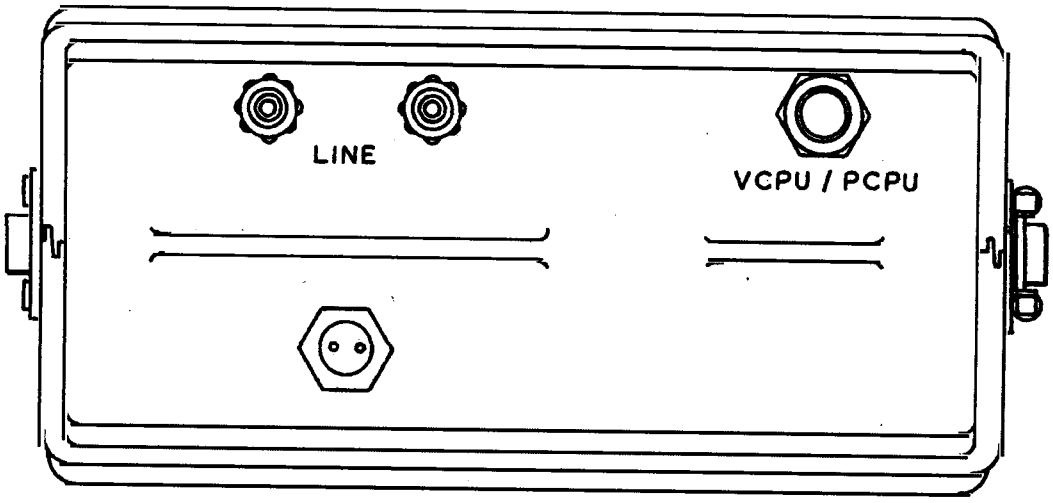
22 The ORU is contained in a polycarbonate case divided into two compartments. The upper section contains a transmitter and a receiver operating through a filter unit into a common antenna socket mounted on the top.

23 The method of manufacture of the radio assemblies is similar to that of the CRU. A 34-way test and monitor socket is mounted internally for use at Field level.

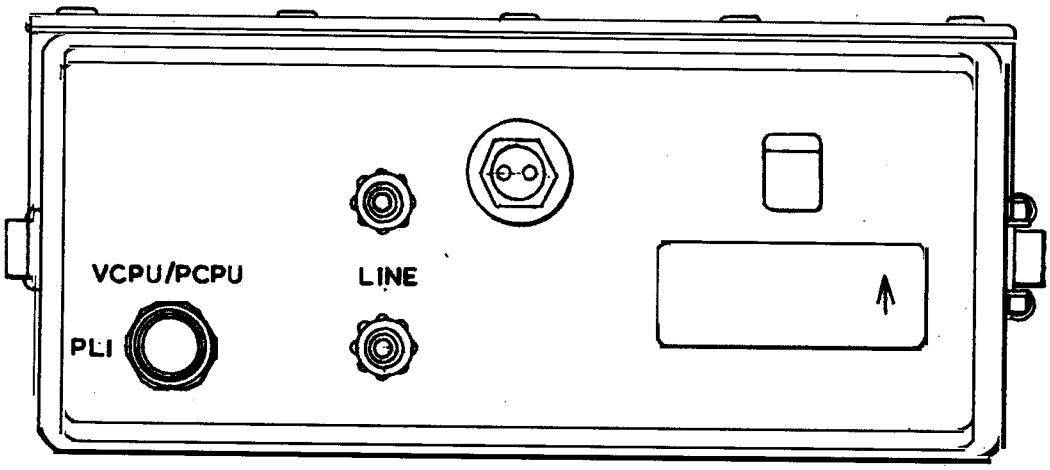
24 A 7-way Thorn headgear socket and two switches, ON/OFF and DUP/PTT (duplex/press-to-talk) are mounted adjacent to the antenna socket. The upper section is sealed, access being provided by unscrewing the end plate and withdrawing the unit from the case.

25 A vent to facilitate seal testing is mounted in the lower wall, access being via the unsealed lower section.

26 The lower section contains two battery holders mounted on the inside of a hinged metal lid which is secured by two Dzus fasteners.



SUBSEQUENT PRODUCTION MODELS AFTER INITIAL 12



FIRST 12 PRODUCTION MODELS (YELLOW BAND)

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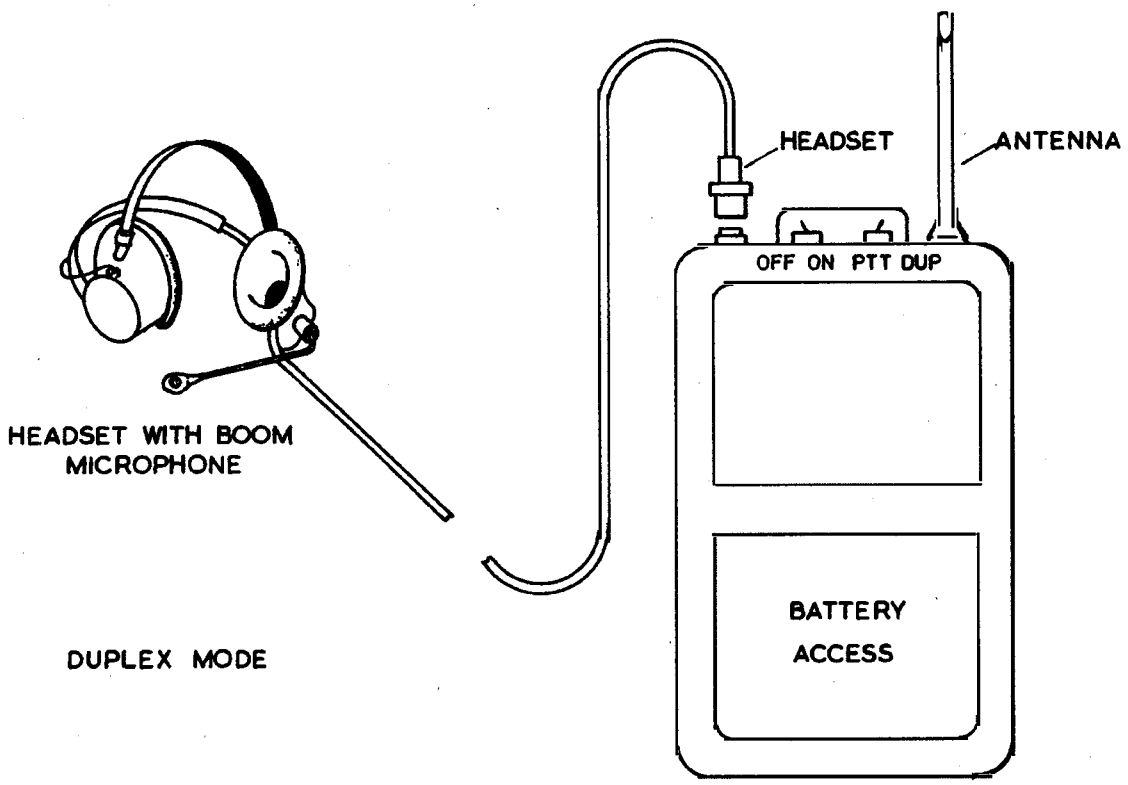
Fig 3 Control radio unit



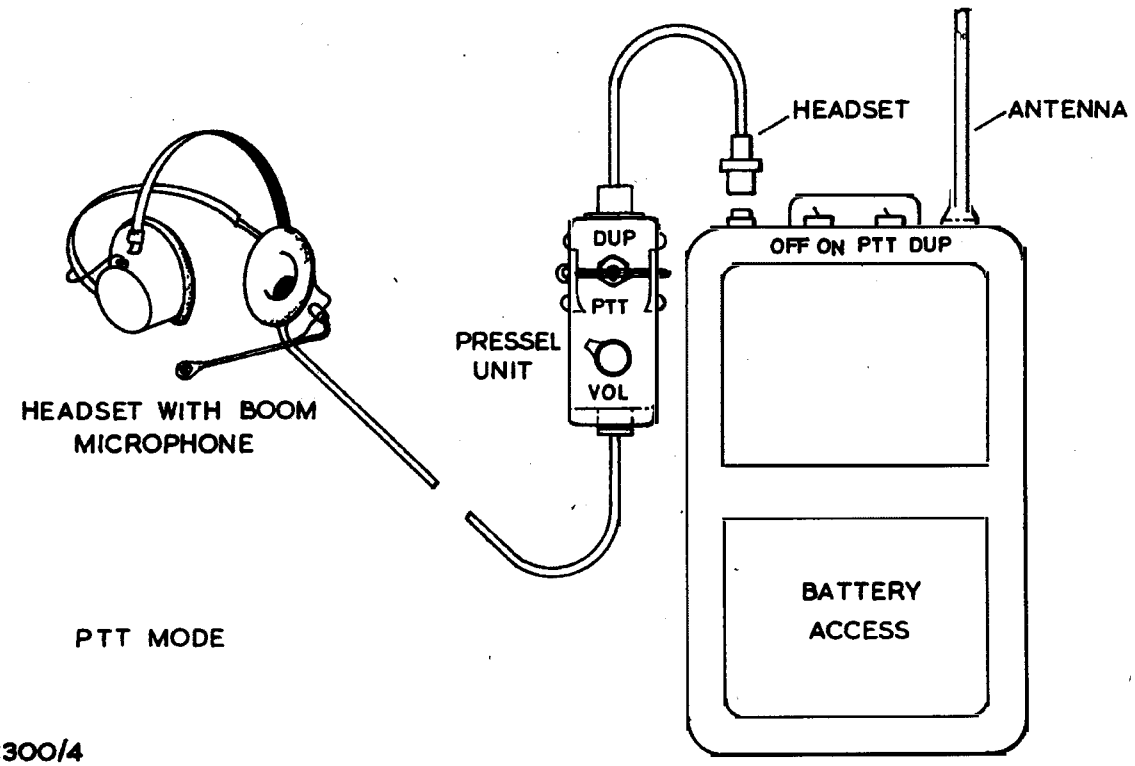
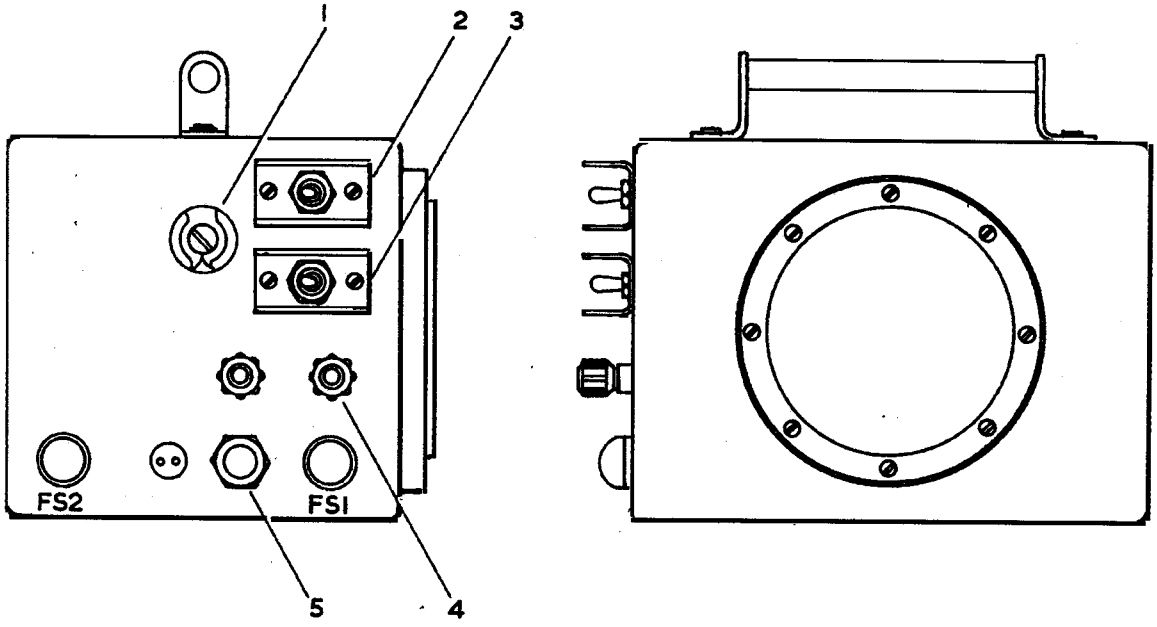


Fig 4 Operators radio unit

Loudspeaker amplifier unit (Fig 5)



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1 Volume control
2 On-Off switch
3 VEH/INT BATT switch
4 Terminals VCPU/PCPU handset or VCPU D10
5 PL1 to PCPU/VCPU

Fig 5 Loudspeaker amplifier unit

27 This unit is normally clamped to a frame in the EOD vehicle, but can be used remote via D10 line as required. It receives its audio input requirements from the VCPU in the installation role and has a power output of 1 W.

28 The case is of welded aluminium construction. Access to the printed circuit board within is gained by removing the loudspeaker.

29 The batteries are housed in a non-sealed extension of the main box. The battery flap is made of aluminium and has a polypropylene hinge.

30 A special plug connects a plug on the LSAU to the PCPU or the VCPU. In the latter case the VCPU may supply power to the LSAU by operation of a switch on the LSAU. There are two terminals to provide connections to the VCPU/PCPU handset terminals or the VCPU line terminals using D10 lines. An ON/OFF switch and a variable volume control knob are also fitted.

Cassette recorder (Fig 6)

31 The cassette recorder is a modified commercial unit (Phillips N2213) which derives its power and audio inputs from the VCPU in the vehicle installation role.

32 In the general purpose role, the recorder uses its own batteries (six 1.5 V SP11 type in series), and receives its audio input from the PCPU.

33 The recorder is contained in a non-sealed plastic case. It may be carried in the recorder satchel when used in the portable GP role. The satchel provides some weather protection, but no safeguard against physical shock is provided in this role and further protection should be provided where necessary. When used in the vehicle role, it is clamped to a frame which is shock mounted to the vehicle frame.

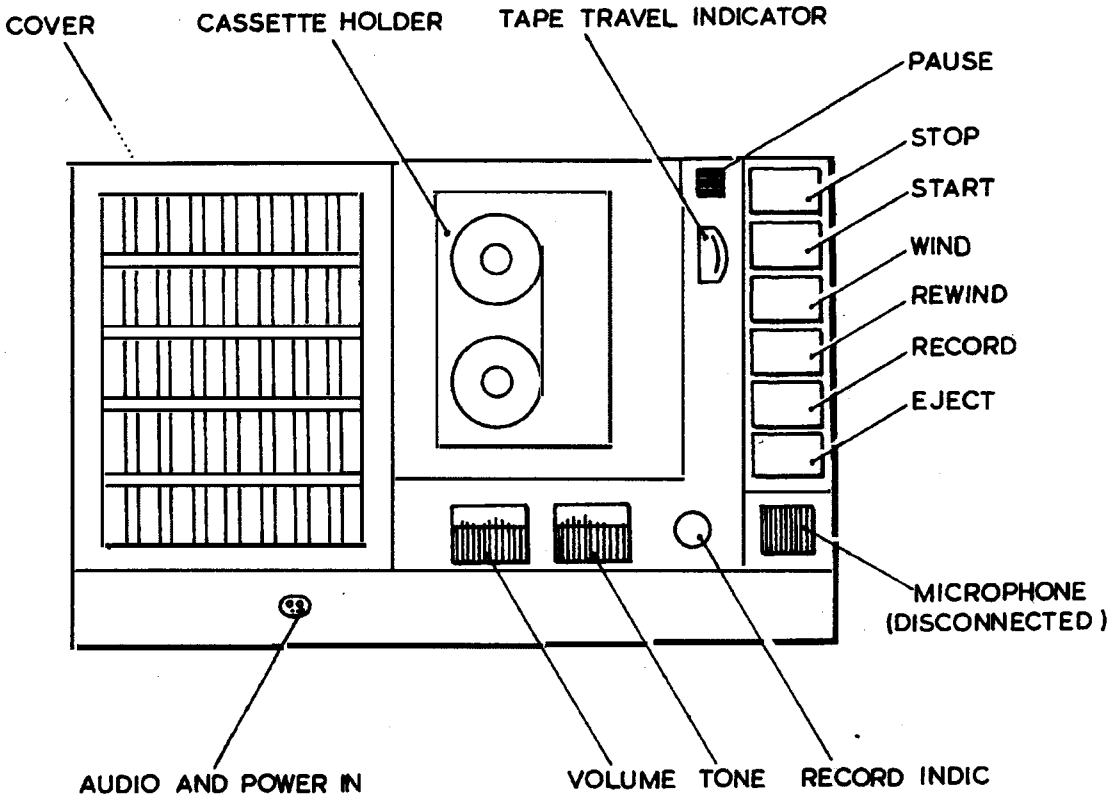

Fig 6 Cassette recorder

Vehicle control point unit (Fig 7)

34 The VCPU is contained in an unsealed metal box containing two p.e.c.s. It is intended to be permanently mounted in the protective conditions of a vehicle.

35 Power is supplied to the VCPU from the 12 V vehicle electrical system. The VCPU itself supplies stabilized power for two remote handsets and the control radio unit. The VCPU also supplies unstabilized d.c. to the cassette recorder and the loudspeaker amplifier unit.

36 There are two 7-pin sockets for connection to the headgear or GP handsets, and a 4-pin socket for connection to the cassette recorder. A further 4-pin socket for the loudspeaker has a different orientation to prevent misconnection.

37 Internal access is provided via the front cover which is secured by four slotted screws into the casing.

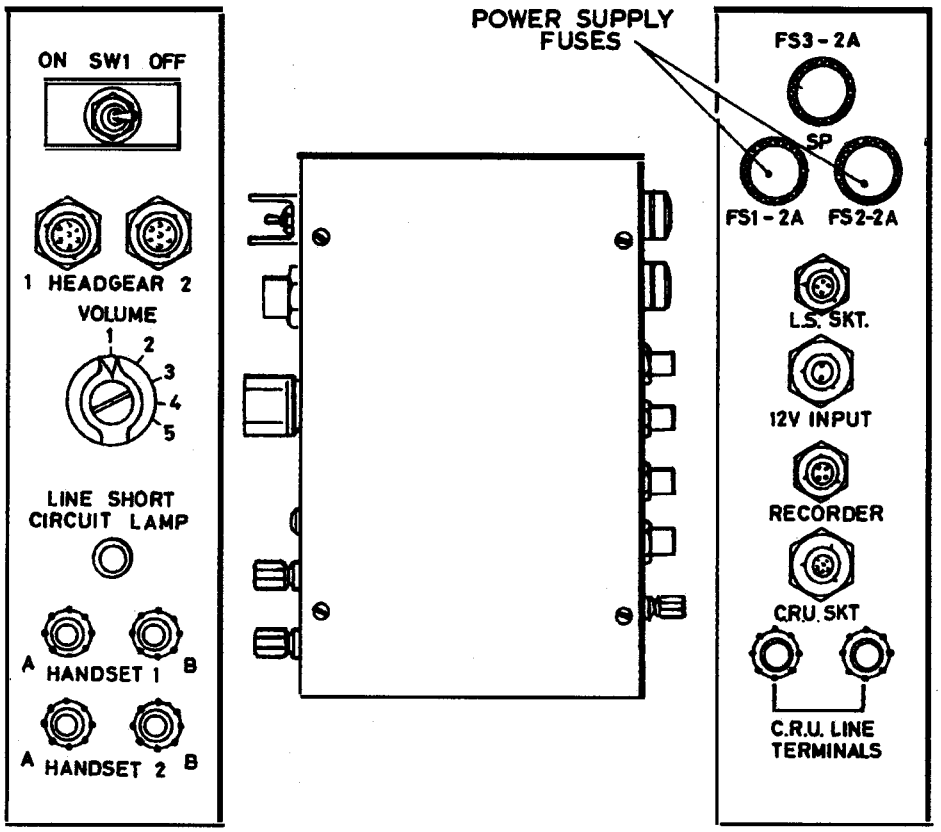

Fig 7 Vehicle control point unit

Portable control point unit (Fig 8)

38 The PCPU is contained in an unsealed glass reinforced polycarbonate case. Internal access is provided by a hinged lid on which is mounted two battery holders and a single Dzus fastener. A sealed metal box inside the PCPU case contains a p.e.c. and mounts an ON/OFF Volume control switch and a fuse holder, both accessible to the operator through a hole in the right hand side of the outer case.

39 Mounted on the left hand side of the outer case are two 7-way sockets (headset) and one 4-way socket (recorder). Two remote terminals are also mounted on the right hand side below the fuse. A differently orientated 4-pin socket is for connection to the loudspeaker unit when required. The externally mounted sockets and terminals are connected to the boxed p.e.c. by means of a 19-way plug socket mounted at one end of the sealed box and connected via a cable form. The PCPU is designed to clip to the base of the CRU by quick release catches and this forms one complete unit which can be carried on the operators back or stood on the ground. Connection between units is made by a flying lead terminating in a 7-way socket.

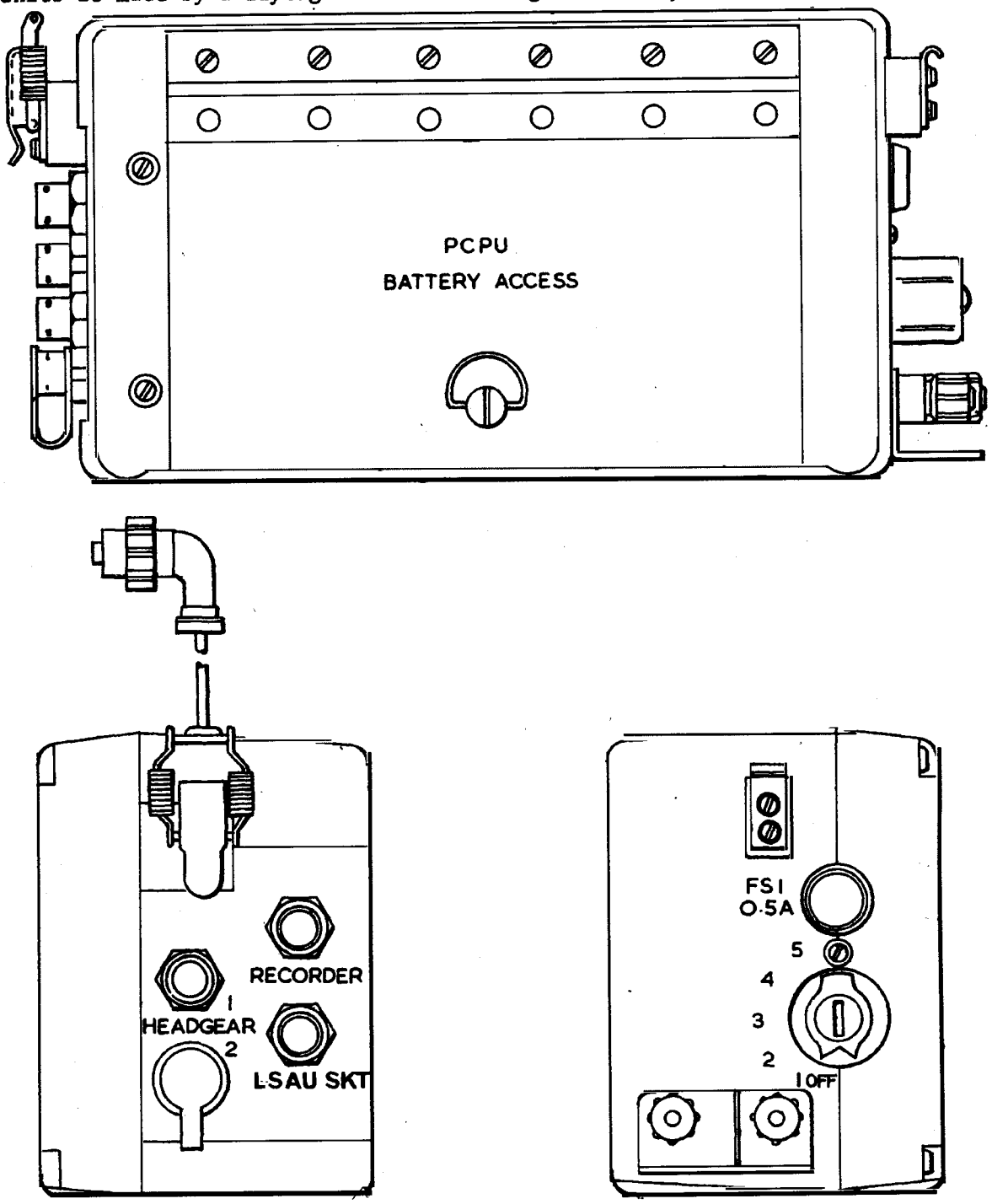

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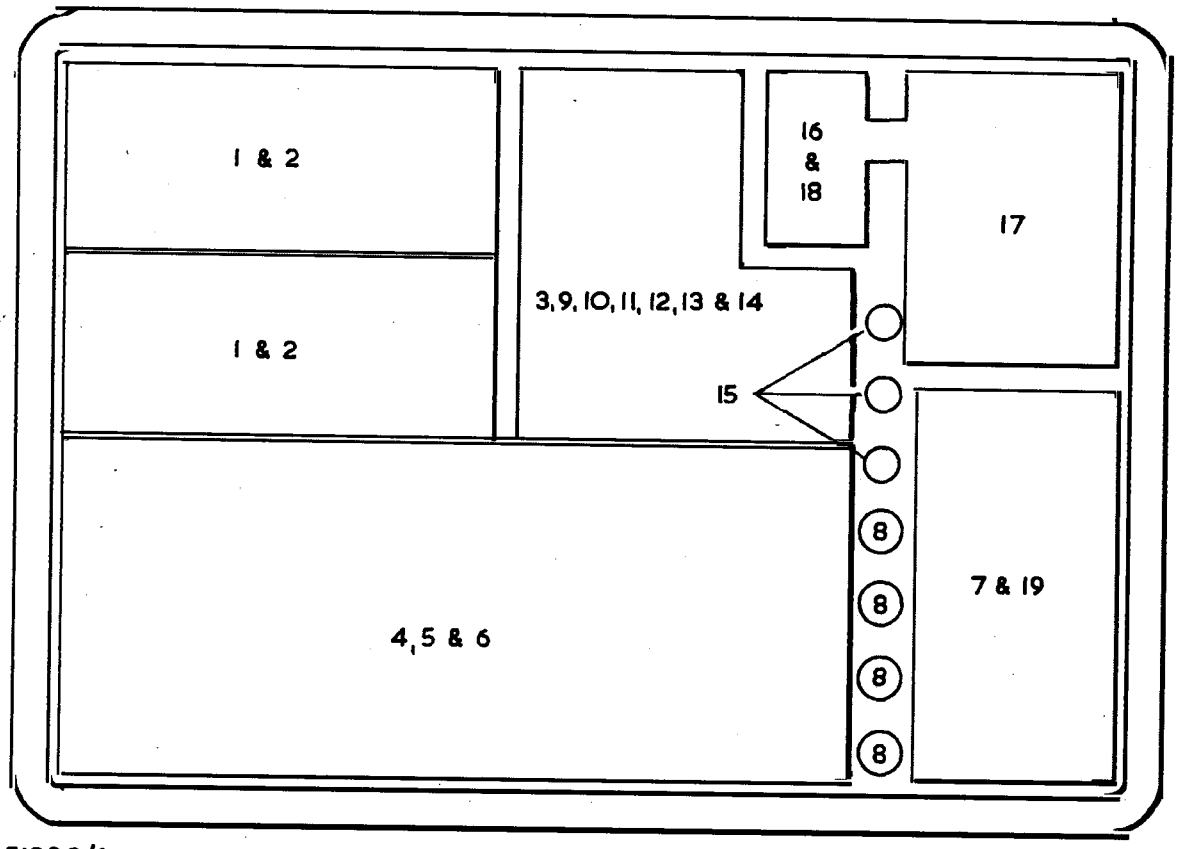
Fig 8 Portable control point unit

Storage container (Fig 9)

40 This is a SKYPAK unit, providing protection for the storage of two ORUs, CRU, PCPU, cassette recorder, cassettes, antennas, interconnecting cables, batteries, pressel units and audio ancillaries required for use in the general purpose role. Inside, the units are prevented from moving by means of shaped neoprene rubber dividers.



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Item		Qty	Item		Qty
1	Operators Radio Unit (ORU)	2	11	Pressel unit Clansman	1
2	Satchel (ORU)	2	12	Handset general	1
3	Pressel unit	2	13	Cable interconnecting cassette rec/PCPU/VCPU	1
4	Control Radio Unit (CRU)	1	14	Antenna feeder	1
5	Portable Control Point Unit (PCPU)	1	15	Remote antenna (in lid)	1
6	Satchel (CRU/PCPU)	1	16	Battery SP11	12
7	Cassette recorder	1	17	Battery Storno	16
8	Antenna AN 862	4	18	Cassettes C90	3
9	Remote handsets Clansman	1	19	Satchel (cassette)	1
10	Headset Clansman	1			

Fig 9 Storage container

REPAIR POLICY

41 The repair policy for the system is as follows:

41.1	Unit repairs	Repairs by replacement of loose CES items and replacement of knobs and fuses.
41.2	Field repairs	By replacement of plug in modules, sub-assemblies and components not mounted on sub-assemblies.
41.3	CENTREM repairs	Nil.
41.4	Base repairs	Nil.

MAIN PARAMETERS

42 The main parameters for the system are:

42.1 Range. The Shoracre system has a maximum range of 400 m to 800 m between transmitters and receivers, depending on the type of antenna mounting in use with the control radio unit.

42.2 Physical data. Physical dimensions and weights are given in Table 1.

TABLE 1 PHYSICAL DATA

Description (1)	Height in. (2)	Height mm	Width in. (3)	Width mm	Depth in. (4)	Depth mm	Weight lb (5)	Weight kg
Vehicle control point unit	14.8	375	9.4	240	3.1	80	7.9	3.6
Portable control point unit	6.1	155	12.2	310	4.3	110	6.4	2.9
Cassette recorder	9.6	245	7.5	190	2.6	68	3.6	1.65
Battery (BU803)	3.7	94	2.5	64	1.2	31	0.6	0.26
Case transit (empty)	26.4	670	16.2	414	15.7	400	34.1	15.5
Control radio unit	12.6	320	12.4	315	5.7	145	13.2	6.0
Operators radio unit	13.0	330	8.8	223.5	2.1	53.5	6.7	3.03
Loudspeaker amplifier unit	8.1	206	10.0	255	7.2	185	6.25	2.84

42.3 Frequency range. The Shoracre equipment works within the u.h.f. band of 430 MHz to 450 MHz. Nominal radio frequencies may only be divulged in accordance with current security regulations. Frequencies of the CRU and ORUs must be compatible. This is denoted by colour coding compatible items of a system with an identical colour. Three frequency plans denoted by the colours red, yellow and blue have been allocated for Shoracre systems. In addition to having the same colour identification, one ORU of a system must be numbered 1, and the other must be numbered 2 to ensure system compatibility. The identifying colours are to be found in the battery compartment of the ORUs, and in the connector 'well' of the CRU. The numbers 1 and 2 are on the coloured discs of the ORUs.

42.4 Power supplies. Power supplies are as given in Table 2.

TABLE 2 POWER SUPPLIES

Unit (1)	Power supplies (2)
Operator radio unit	Integral 12 V battery*
Control radio unit	From VCPU in vehicle role From PCPU in GP role
Portable control point unit	Contains two 12 V rechargeable batteries for CRU* and remote handsets.
Vehicle control point unit	Powered from vehicle 12 V battery.
Cassette recorder	From VCPU in vehicle role Uses own internal batteries (6 x 1.5 V SP11s) in GP role
Loudspeaker amp unit	From VCPU in vehicle role

*Piptone warning is provided when battery voltage falls to 10 V

PRINCIPLES OF OPERATION

Operators radio unit (Fig 4)

43 The ORU contains separate u.h.f. transmitters and receiver stages operating through a filter into a common quarter wave antenna with an r.f. output of 15 mW on transmit. Two switches are located on the top of the unit, both being guarded to prevent accidental operation. The switches are marked ON/OFF and DUP/PTT duplex/press-to-talk).

44 The ON/OFF switch provides power to the receiver and transmitter in the ON position and disconnects the internal batteries in the OFF position. When PTT is selected on the DUP/PTT switch, the transmitter is only active when the external pressel associated with the headgear is operated, the receiver being active all the time the unit is switched on, its output being controlled by means of the stepped volume control on the pressel unit. In the DUP position, the receiver and transmitter are both active.

45 The headgear connector, also on top of the unit, is of standard Clansman type, allowing any of that range of headgear to be connected as required. Should the normal Clansman type pressel unit be used instead of the special pressel, no volume control is available and the audio output will be at maximum.

46 In the vehicle installation role, all transmissions from either ORU are received by the appropriate receiver in the CRU and then passed by the connecting cable to the VCPU where they can be monitored and recorded. They are also radiated by the common transmitter in the CRU for reception by the ORU's, thus feeding both ORU operators with sidetone which confirms that their transmissions are reaching the VCPU and can thus be recorded.

47 In the general purpose role, all transmissions from the ORU's are received by the appropriate receiver in the CRU and passed to the PCPU where they can be monitored and recorded. They are also radiated by the common transmitter in the CRU back to the ORU's for reception and sidetone.

48 Should the ORU battery voltage fall below 10 V, a piptone warning is superimposed on the audio output from the receiver. The piptone warning is not re-radiated but has a distinctive mark to space ratio of 1:3 to ensure the ORU operator is aware that the failing battery is in his own set, and not an external fault in the PCPU (which is re-radiated at a longer mark to space ratio).

Control radio unit (Fig 3)

49 The CRU contains two u.h.f. receivers and one u.h.f. transmitter operating through a filter assembly to a common antenna socket. The r.f. output of the transmitter is 65 mW. The outputs from the receivers, one tuned to the frequency of the ORU 1 transmitter and the other to the ORU 2 transmitter, are fed in parallel to the line connection terminals. The same signals are used to modulate the common transmitter and provide sidetone back to the ORU's.

50 In the vehicle installation role the CRU can be mounted in the EOD vehicle where it is connected to a vehicle mounted antenna and to the VCPU by a short connecting link. This link carries the power supply to the CRU and the audio signals between the two units. To increase the distance between the operator and the EOD vehicle, the CRU can be removed from the vehicle and extended via D10 cable.

51 In the general purpose role the CRU functions in the same manner but obtains its power from the PCPU which is attached by quick release clips. Audio signals are also fed through the same connecting cable. There are no controls on the CRU, the two receivers and the transmitter being active all the time that power is applied. The line connecting terminals are not polarity conscious, so connection can be made to either terminal.

52 In both vehicle installation and GP roles, the line voltage, the level of which will depend on the length of connecting cable, is regulated to 12 V before being applied to the radio equipment.

Vehicle control point unit (Fig 7)

53 The VCPU is the central unit in the vehicle installation role. It is fed from the vehicle 12 V battery supply and in turn provides power to the CRU, the cassette tape recorder, the PA system and the remote handset.

54 The line connection to the CRU is a common point in the communications of all outstations. Any signal generated passes to this point, and thence to the incident controller and the cassette recorder. Conversely, any signal appearing at this point is heard by all the outstations, either by direct line connections or by radio connections via the CRU.

55 The 12 V supply voltage to the VCPU is first filtered and then fed to a d.c. converter which has two outputs, 15 V and 30 V d.c. The 15 V supply is available on pin C of the audio equipment via a resistor. The cassette recorder obtains its power from the 12 V supply via the VCPU. The 30 V supply is fed to the line connectors to provide power for the CRU. The 30 V is used at this point to allow for losses in the D10 interconnecting cable when the CRU is remoted from the EOD vehicle. Derived from the 30 V supply is a separate supply of approximately 20 V which supplies the CRU when connected via the short interconnecting cable.

56 The power input has a 2 A protection fuse fitted in each line, which, apart from normal overload protection, will also blow if the voltage exceeds 17 V. A spare fuse is provided.

57 Two outlet sockets are provided for connection to any of the Clansman range of headgear or local handsets.

58 Two pairs of cable piercing terminals are provided for connecting to remote handsets by D10 cable (1.6 km maximum length). The VCPU is fitted with a five position volume control and socket for output to a loudspeaker amplifier unit.

Portable control point unit (Fig 8)

59 All signals received by the CRU receiver are fed to the PCPU where they can be monitored by the search team leader. Likewise all speech by the team leader is fed to the common transmitter in the CRU and thus transmitted to the ORU's.

60 The PCPU contains two 12 V rechargeable batteries which provide power for the radio equipment in the CRU, and for the remote handsets. Should the battery voltage fall below 10 V,piptone warning is superimposed on the audio output and re-broadcast over the air so that all personnel involved are aware of an impending battery problem.

61 Two outlet sockets are provided for connection to any of the Clansman range of headgear or local handsets. One pair of cable piercing terminals is provided for connection of a remote handset by D10 cable (1.6 km maximum length).

62 The only control on the PCPU is a switch which switches the battery supply to the CRU on or off, combined with a stepped volume control adjusting the a.f. level to the handsets.

63 The PCPU is also fitted with sockets providing outputs to cassette recorder, and a single 0.5 A fuse.

Cassette recorder (Fig 6)

64 The recorder derives its power from the VCPU in the vehicle installation role. In the general purpose role, the recorder uses its own internal batteries (six 1.5 V SP11 in series). A lead is used to connect the recorder to either the VCPU in the vehicle installation role, or to the PCPU in the general purpose role.

65 The recorder is provided with automatic recording level control, so no audio level adjustment is required during the recording process. Output on playback is adjusted by the built in volume and tone controls.

66 It is essential that recorder and cassettes are kept away from sources of excessive heat or magnetic fields such as loudspeakers. Ingress of sand or grit must be avoided.

Loudspeaker amplifier unit (Fig 5)

67 The loudspeaker amplifier unit is used as part of the Shoracre vehicle installation system to provide PA facilities, and is used in conjunction with the VCPU. The unit is clamped to a frame which is shock mounted to the vehicle.

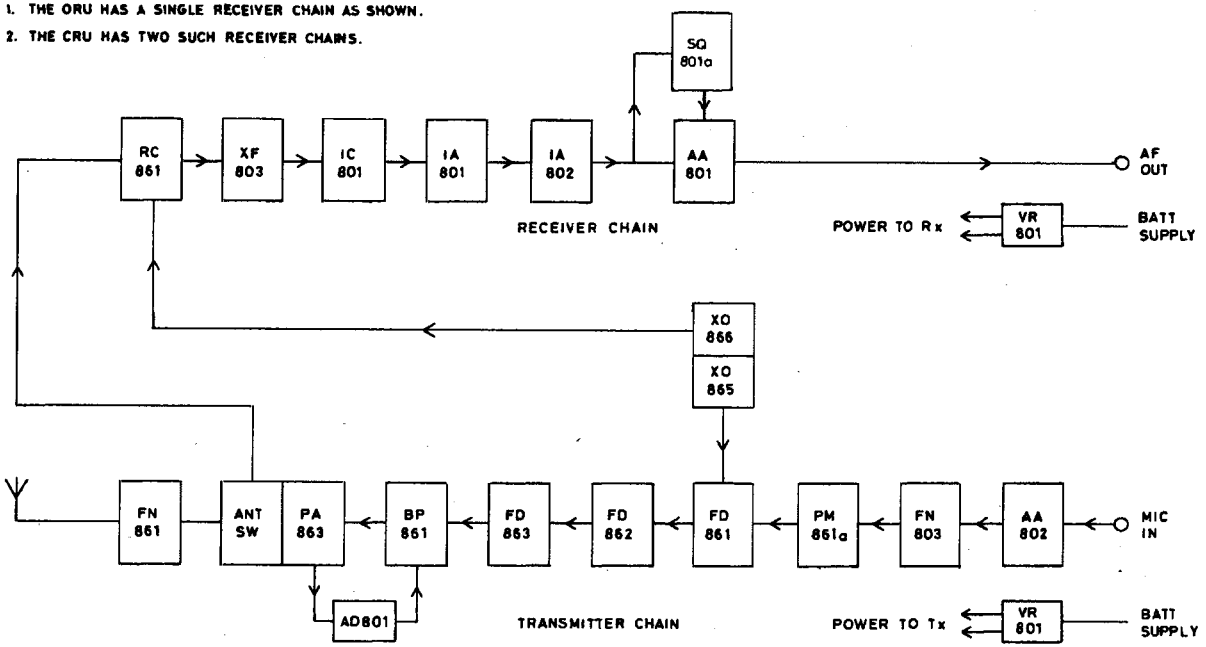
68 A special cable connects a plug on the unit to the VCPU, which supplies power to the unit by the operation of a switch on the LSAU.

69 Two terminals provide connection to the VCPU handset terminals or the VCPU line terminals using D10 lines. Two fuses are mounted below these terminals. The unit is fitted with a variable volume control for adjustment of its audio output. The maximum output is 1 W.

70/72 Deleted.

NOTES :-

1. THE ORU HAS A SINGLE RECEIVER CHAIN AS SHOWN.
2. THE CRU HAS TWO SUCH RECEIVER CHAINS.



3. THE CRU HAS A SINGLE TRANSMITTER CHAIN AS SHOWN.
4. THE ORU HAS A SINGLE TRANSMITTER CHAIN, WHICH IS SIMILAR TO THAT OF THE CRU, BUT OMITS THE PA863 AND AD801 STAGES. THE BP861 FEEDS THE FN861 DIRECT.

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ORU/CRU block diagram

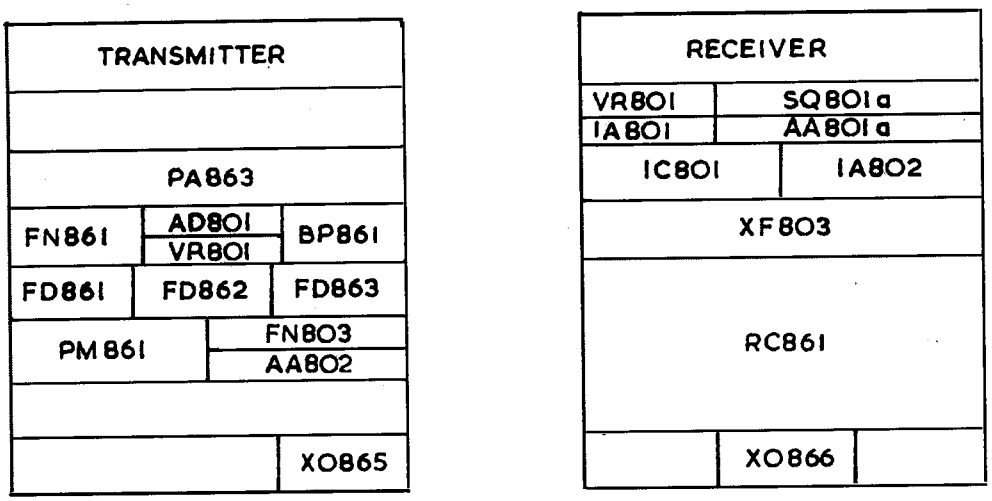

Fig 11 ORU/CRU position of sub-modules

Notes...

(1) The ORU has one receiver, sub-modules as shown
(2) The CRU has two such receivers, with two sets of sub-modules
(3) The CRU has one transmitter, sub-modules as shown
(4) The ORU has one transmitter similar to the CRU, but does not include the PA863 and AD801 sub-modules.

CONTROL RADIO UNIT - CIRCUIT DESCRIPTION (Figs 10 and 11)

Transmitter circuit

73 The CRU radio section contains a u.h.f. f.m. transmitter and two receivers operating through a filter assembly into a common antenna to provide duplex operation. The transmitter is built up of several modules, each of which is completely enclosed (screened) and has connector pins protruding from the bottom of the module. All the modules are mounted onto a mother board. The transmitter consists of the following modules:

AA802 Modulation amplifier
FN803 Modulation filter for 20 kHz or 25 kHz channel separation
XO865 Crystal oscillator
PM861a Phase modulator
FD861 1st frequency doubler
FD862 2nd frequency doubler
FD863 3rd frequency doubler
BP861 Band pass filter
PA863 Power amplifier
FN861 Antenna filter
AD801 A.D.C. circuit
VR801 Voltage regulator

Modulation amplifier (AA802 and FN803)

74 Modulation is derived from the amplifier, (AA802) in conjunction with a modulation filter (FN803). The input signal is applied to an operational amplifier, the gain of which can be adjusted to meet specification figures.

75 The amplified a.f. signal is applied to a limiter via a differentiating network. The limiter is also an operational amplifier with negative feedback. Following the limiter is an integration network and an active lowpass filter where the active element is another operational amplifier. The active filter removes any harmonics of the original input signal that arise during limiting action. An additional limiter is inserted between the integration network and the active lowpass filter to prevent strong input signals of low frequencies from overloading the filter.

Transmitter oscillator (XO865)

76 XO865 is a temperature compensated transmitter oscillator.

77 The transmitter exciter signal is generated by a Colpitts type crystal oscillator operating on the crystal's fundamental frequency, in the range of 52.50 MHz to 58.75 MHz. The output signal is capacitively coupled from the tank circuit.

Phase modulator (PM861a)

78 The phase modulator consists of an input and an output buffer plus a phase modulator stage. The exciter signal from the oscillator is fed to the input buffer stage. This amplifier, with following π network, ensures a constant sine wave signal to the phase modulator. The modulator is a transistor amplifier stage where the modulating audio signal is applied to the emitter, which is r.f. decoupled. The modulation signal varies the conductance (gm) of the amplifier and thus the phase angle of the r.f. signal at its output.

79 To function properly, the modulator must work into a constant load. It is therefore followed by a buffer stage whose output signal is of sufficient amplitude to drive the following frequency doubler stage.

Multiplier chain (FD862, FD863)

80 The multiplier chain consists of three very similar frequency doubler stages. Each stage operates as a grounded emitter transistor amplifier followed by two inductively coupled l.c. circuits tuned to the second harmonic of the input frequency.

Band pass filter (BP861)

81 The multiplier chain is terminated by the BP861, a double tuned band pass filter, which suppresses undesired harmonics produced in the frequency multiplying process.

Power amplifier (PA863)

82 PA863 comprises two amplifier stages. The collector voltage to the first transistor is supplied via the a.d.c. circuit, and is variable. If more gain is required, the collector supply a.d.c. voltage will rise. On the other hand, if the drive signal is excessive, the a.d.c. voltage will fail.

A.D.C. circuit (AD801)

83 The transmitter output current is kept very nearly constant by means of the a.d.c. circuit. The voltage drop across a small 6.8 ohm resistor in the output transistor's collector return is monitored by the a.d.c. stage, which then controls the collector voltage to the first transistor amplifier so as to maintain the r.f. output at a constant value.

Antenna filter (FN861)

84 A nine-pole lowpass filter having a cutoff frequency of 470 MHz is inserted between the transmitter output and the duplex filter. The filter suppresses any harmonics created in PA863.

Receiver circuits

85 The receiver is a double superheterodyne using intermediate frequencies of 21.4 MHz and 103.5 kHz. Channel selectivity is achieved by means of a crystal filter in the first i.f. circuit. The receiver employs an electronic squelch circuit whose threshold can be set with a resistor on the mother board.

86 The receiver consists of the following modules:

RC861	Receiver converter
XO866	Crystal oscillator
XF803	Crystal filter for 20 kHz or 25 kHz channel separation
IC801	I.F. converter
IA801	1st i.f. amplifier
IA802	2nd i.f. amplifier and discriminator
SQ801a	Squelch circuit
AA801	A.F. amplifier
VR801	Voltage regulator

Receiver converter (RC861)

87 The RC861 converts the frequency of the antenna signal to the 1st i.f. frequency of 21.4 MHz. The incoming signal path from the antenna is through the duplex filter to the input of the RC861. The signal then passes through a two-element band-pass filter to a transistor operating as a grounded base amplifier. After amplification, the signal passes through a three-element u.h.f. filter. This filter largely determines the selectivity of the converter. The signal is fed to the mixer via a matching transformer L7, providing optimum sensitivity/gain. The local oscillator signal from the XO866 module, after passing through a lowpass filter, proceeds to a frequency tripler. The filter allows only the oscillator signal to reach the tripler. The output from the tripler is then applied to the gate of the mixer, which is a field effect transistor operating in grounded source configuration.

88 The i.f. signal is taken off via a combination auto-transformer/L network to match the impedance of the following crystal filter.

89 X0866 is a temperature compensated receiver oscillator.

90 The local oscillator signal of 124 MHz to 153 MHz is generated in the Hartley type crystal oscillator where the transistor operates as a grounded base amplifier. The output signal is capacitively coupled from the tank circuit.

91 The local oscillator signal frequency is 21.4 MHz below the antenna frequency and the formula for calculating the crystal frequency is therefore:

$$f_x = f_a - \frac{21.4 \text{ MHz}}{3}$$

(where f_x = crystal frequency and f_a = antenna frequency)

Crystal filter (XF803)

92 The crystal filter unit comprises an eight-pole monolithic crystal filter and an impedance matching transformer for matching the output to the impedance of the following i.f. converter. Practically all of the receiver selectivity is achieved in the crystal filter.

I.F. converter (IC801)

93 The first i.f. frequency (21.4 MHz) is converted to the second i.f. frequency (103.5 kHz) in this module, which contains an amplifier, a mixer and an oscillator. The output signal is taken off from a centre tap on the coil in the mixer transistor's collector circuit and fed to an intermediate frequency amplifier (1A801).

I.F. amplifier and discriminator (1A801 and 1A802)

94 The first intermediate frequency amplifier (IA801) consists of two differential amplifiers in series. The output signal is applied to the second intermediate frequency amplifier (IA802) which contains a 103.5 kHz band pass filter, a quadrature detector, a lowpass filter and an audio frequency amplifier. The i.f. amplifier, detector and a.f. amplifier are all included in one integrated circuit.

95 The balanced quadrature detector provides a.m. suppression. Inserted between the detector and the a.f. amplifier is an active lowpass filter which removes any superimposed i.f. signal. The detector bandwidth and the audio amplifier output voltage can be regulated by means of two external resistors on the mother board.

A.F. amplifier (AA801)

96 The audio frequency signal from IA802 is fed to the AA801 a.f. amplifier.

97 The signal passes through an active high pass filter that rejects any low frequency noise, and is then fed to an integration network which provides the required de-emphasis. An integrated circuit containing two separate amplifiers makes up the amplifier and output stages. The volume control is inserted between these two amplifiers.

98 In no signal conditions, the squelch circuit blocks the a.f. signal path by grounding the squelch terminal. On receipt of signal, the squelch output goes positive again, allowing the audio amplifiers to operate normally.

Squelch circuit (SQ801a)

99 The receiver squelch circuit operates automatically, according to the noise content of the antenna signal. Weak signals contain greater noise than acceptable signal levels. The output a.f. signal from 1A802 is also present at the input to SQ801a, where it must first pass through an active highpass filter which suppresses frequencies below 7 kHz. Higher frequencies are amplified, then detected and whenever the signal-to-noise ratio is unsatisfactory, the detected noise signal will be sufficient to turn off the audio amplifiers by depriving them of their collector voltage. With an acceptable signal strength at the antenna, the noise content will be too low to trigger the squelch, and the audio amplifiers will operate normally. An external resistor sets the squelch to open the path for a signal-to-noise ratio of 12 dB SINAD.

100 The modulating a.f. input signal is made by superimposing the line input signal and the a.f. signals from the two receivers. The a.f. signals from the two receivers are taken off at the top of the volume controls and are thus squelch controlled.

Power supply and voltage regulator (VR801)

101 Because of variations in voltage as the battery discharges, two VR801 type voltage regulators are used to supply many of the transmitter and receiver circuits in the RF864 with a constant 7.5 V potential. The regulators are short circuit protected.

Duplex filter (BF861)

102 The duplex filter contains a series of tuned circuits which prevent blocking of the receivers by the transmitter carrier, and which attenuate side band noise from the transmitter at the receiver frequencies. The filter does not form part of the radio compartment assembly, but is mounted to the left of the 34 - way test socket on the CRU chassis.

OPERATORS RADIO UNIT CIRCUIT DESCRIPTION

103 The ORU radio section contains a u.h.f. f.m. transmitter and receiver operating through a filter assembly into a common antenna.

Transmitter circuit

104 The transmitter is built up of several modules, each of which is completely enclosed (screened) with connector pins protruding from the bottom of each module. All the modules are then mounted on to a mother board. The transmitter section consists of the following modules.

AA802	Modulation amplifier
FN803	Modulation filter
XO865	Crystal oscillator
PM861	Phase modulator
FD861	1st frequency doubler
FD862	2nd frequency doubler
FD863	3rd frequency doubler
BP861	Bandpass filter
FN861	Antenna filter
VR801	Voltage regulator

105 The above modules are the same as those used in the CRU, but omit the latters PA863 power amplifier and AD801 stages. Details of the individual modules may therefore be found in the CRU section, Paras 73 to 80 and Para 84.

106 The duplex filter BF862 in the ORU has a similar function to the BF 861 in the CRU, see Para 102.

Receiver circuit

107 The single receiver used in the ORU is the same as each of the pairs described in the CRU Paras 85 to 102, the individual modules being identical.

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