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Colin Hinson

In the village of Blunham, Bedfordshire, UK.

Clansman

Vehicle H.F. Radios

MEL

CLANSMAN H.F. RADIO SYSTEMS
UK VRC 321 and UK VRC 322
1·5—30 MHz

The M.E.L. Equipment Company Limited,
Manor Royal,
Crawley, Sussex, England.
Tel. Crawley (0293) 28787
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MEL9078/2.72/1M GP

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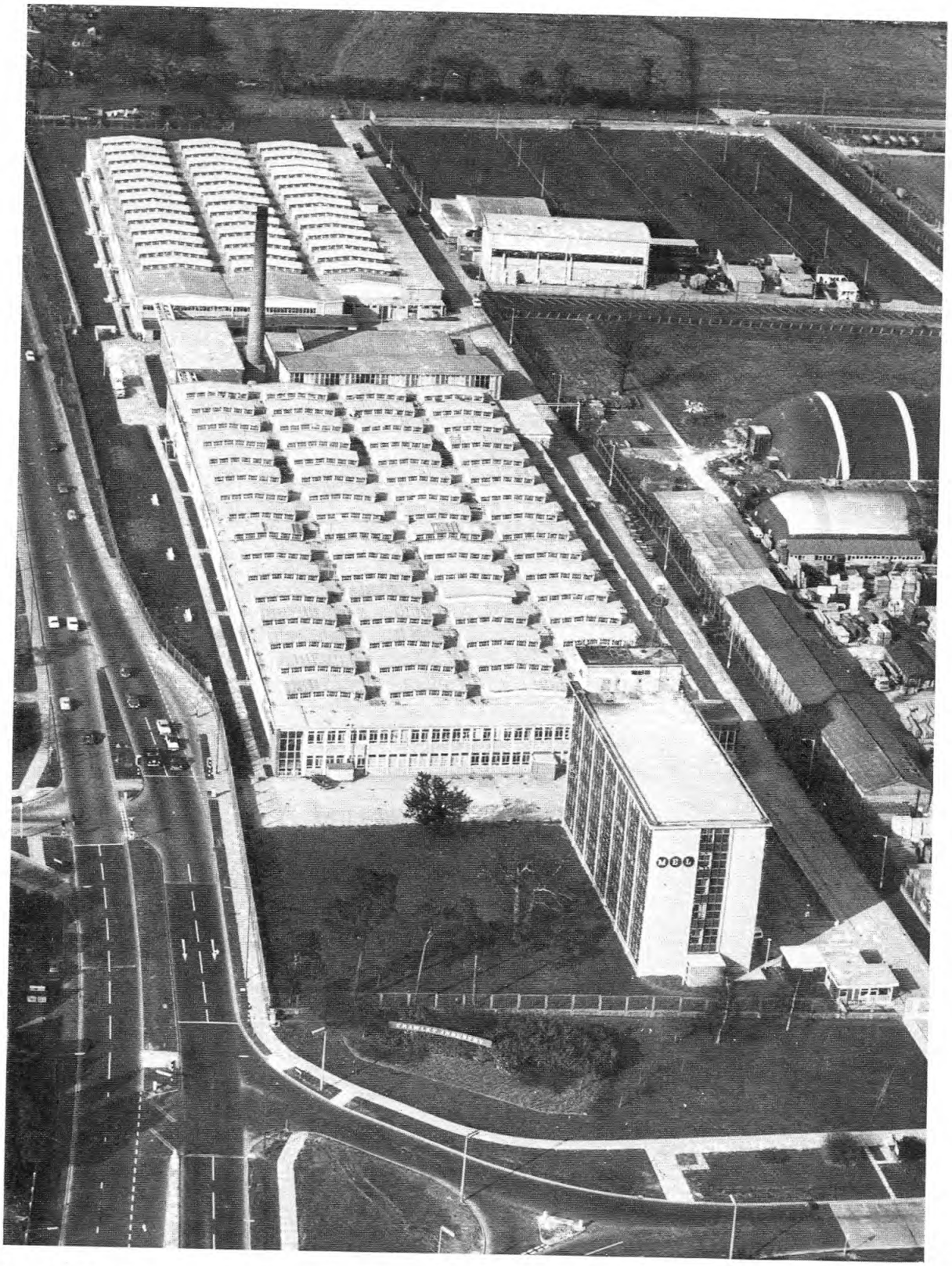


The M.E.L. Equipment Company Ltd. Factory at Crawley

INTRODUCTION

The type of radio for vehicle installation must be chosen very carefully and much depends upon the distances over which it will be required to communicate during military operations. If the desired range does not exceed 15Km then a V.H.F. station can be used. However, tactical considerations demand such a high degree of flexibility to link formations, extending from Divisional and Brigade Headquarters, it is more expedient to rely on H.F. radio communication.

The British Army Clansman UK VRC 321 and UK VRC 322 H.F. systems have been designed and developed specifically for mobile military usage in all types of vehicles, armoured, soft skinned or otherwise, and will form the basis for British Military H.F. combat communications from the early 1970's onwards. These equipments may also be used as ground stations for sky-wave operations over long distances. All equipments comply with current NATO specifications.

The UK VRC 321, 40 watt, H.F. vehicle station uses digital frequency selection in 100 Hz steps over the range 1.5 to 30 MHz, all frequencies being synthesised. Additional features include separate antenna tuning unit; operable from fluctuating power supplies within 20-32 volts d.c.; low power consumption. The ranges that can be achieved are in excess of the design requirements of 50 Km for ground-wave and 300 Km for sky-wave propagation.

The UK VRC 322 is a 300 watt, H.F. station incorporating the basic transmitter/receiver of the UK VRC 321 and has the same frequency range and operational simplicity. Ranges are in excess of the design requirements of 80 Km for ground-wave and 300 Km for sky-wave propagation.

A feature of Clansman equipments is their capability for use in both single and multi-set, HF/HF and HF/VHF, vehicle installations with a minimum of mutal interference. Advanced solid-state techniques and specially developed integrated circuits have been used in the equipments, resulting in low power consumption and units considerably reduced in size and weight.

CLANSMAN H.F. COMMUNICATIONS IN FIGHTING VEHICLES

From the commencement of the Clansman programme it was decided that specially designed radio stations were essential for operation in armoured vehicles, particularly tanks. Clansman H.F. equipments have been designed by The M.E.L. Equipment Company, on a Ministry of Defence contract, for use by the UK Services in vehicles of all types. Extensive studies of the environment in a fighting vehicle have set the following parameters for the radio equipments.

The station must withstand shocks of up to 40g, and operate in conditions of high vibration and for long periods in high ambient temperatures.

The station must operate from vehicle supplies that are nominally 28V d.c. but may vary from 20–32V d.c. may have surges up to 80V and spikes up to $\pm$600V, and may have ripple of up to 7V peak to peak. Neither pole of the input supply should be earthed in the equipment.

To facilitate the exchange of H.F. and V.H.F. stations they must have standardised mountings which also permits rapid removal of the equipments from the vehicle for use as a ground station. For the optimum utilisation of the available space the depth and height of the main units must be standardised.

All controls and connections must be on the front panels of the main units.

It must be possible to mount the main units in any part of the vehicle without having regard to the antenna position and, if necessary, there must be separate antenna tuning units that can be mounted near the antenna base.

The station must be easy to operate, even while the vehicle is on the move, under poor lighting conditions, and while the vehicle is engaging the enemy, therefore the controls and indicators must be unambiguous and easily operated.

It must be possible to operate the station with either a vehicle harness system or, particularly when the station is demounted, with audio gear connected directly to the main unit or with remote audio units.

The stations must be contained in as few units as possible to simplify demounting and setting up a ground or fixed station, and also to reduce the number of cables, connectors etc. required.

The stations must be capable of independent operation in either multiset installation or in close proximity to other vehicles. The stations mounted in one vehicle may consist of a mixture of V.H.F. and H.F. stations or 2 H.F. stations.

The station must not compromise the security of the vehicle during radio silence conditions by radiating a detectable signal while receiving, and must not permit easier detection of the vehicle by night or day.

The station must in no way impair the fighting efficiency of the vehicle.

The station must have the greatest possible reliability and not have a long warm-up time.

The station must have a first class radio performance and a high degree of protection against both deliberate and accidental interference.

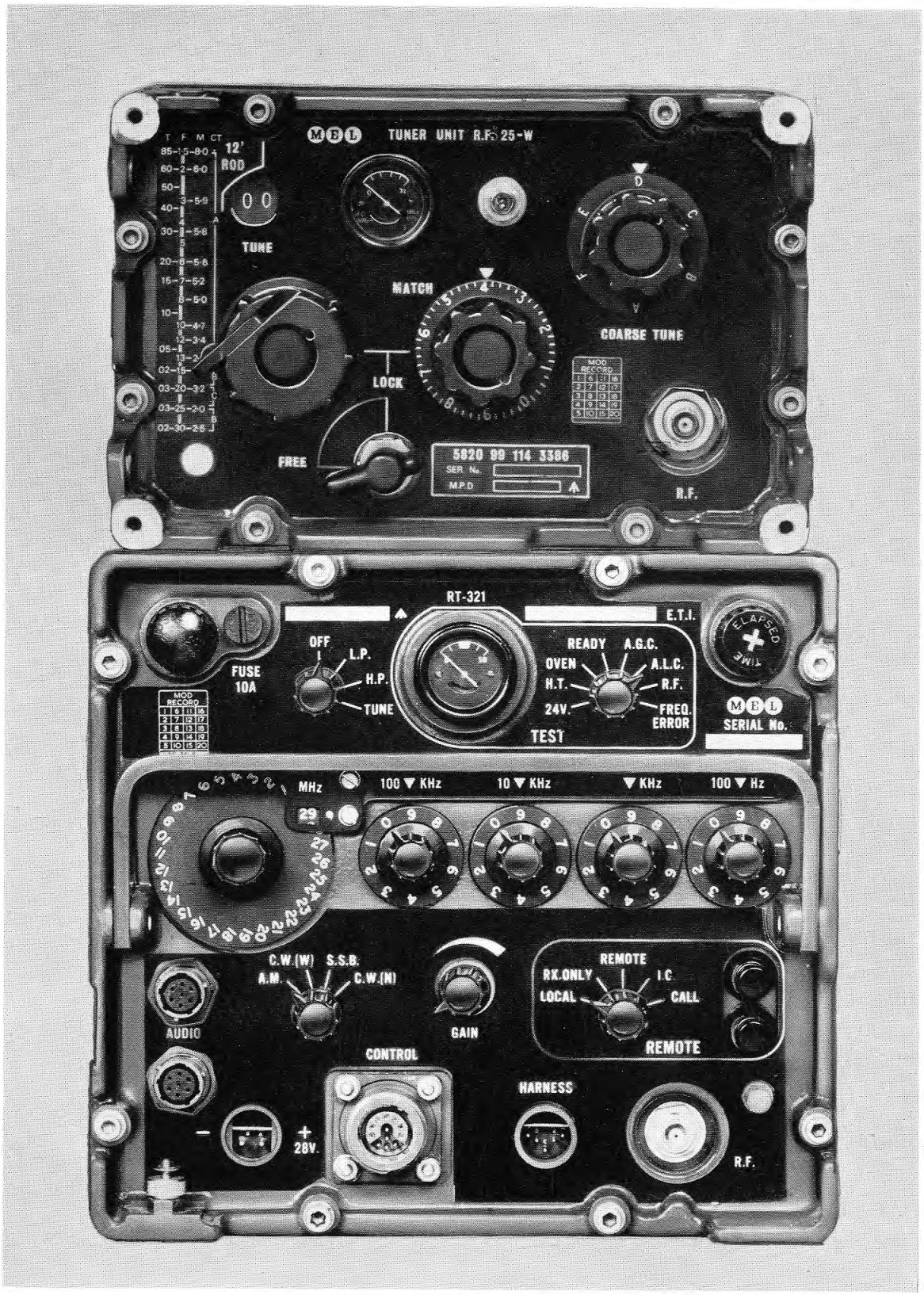
The UK VRC 321 and 322 stations having been designed with all these points in view, they are ideally suited to the fighting vehicle environment. They are smaller, more flexible and of higher performance than the sets which they replace. Particular mention must be made of their performance in multi-set and close proximity situations.

Contemporary solid state H.F. equipments emit broadband noise which severely limits the extent to which they can be co-sited with other radio equipments. In the RT.321 the broadband noise has been reduced to a minimum and, in addition, the receiver is protected against very large unwanted signals. In its basic form the UK VRC 321 can operate in the same vehicle as a VHF station, or in a vehicle only a few metres distant from another UK VRC 321, at very small frequency separation. If two UK VRC 321's must be fitted in the same vehicle a Radio Frequency Selector Unit is available to give similar performance when the antennas of the two stations are only 2 metres apart.

The UK VRC 321 can be operated by anyone after only a few minutes signals training. Frequency selection over the whole HF range from 1.5 to 30 MHz can be made to any 100 Hz point by the use of unambiguous, decade switches and once effected it is only necessary to tune the antenna tuning unit for optimum operation and to select the mode of operation and the power level. Fine tuning or precise adjustments are unnecessary.

Thus the UK VRC 321 provides a rugged reliable solution to all the problems of mobile HF SSB communications in a military environment. Although the foregoing has been written with specific reference to the UK VRC 321 it is equally applicable to the UK VRC 322.

UK VRC 322 In Armoured Command Vehicle *Crown Copyright*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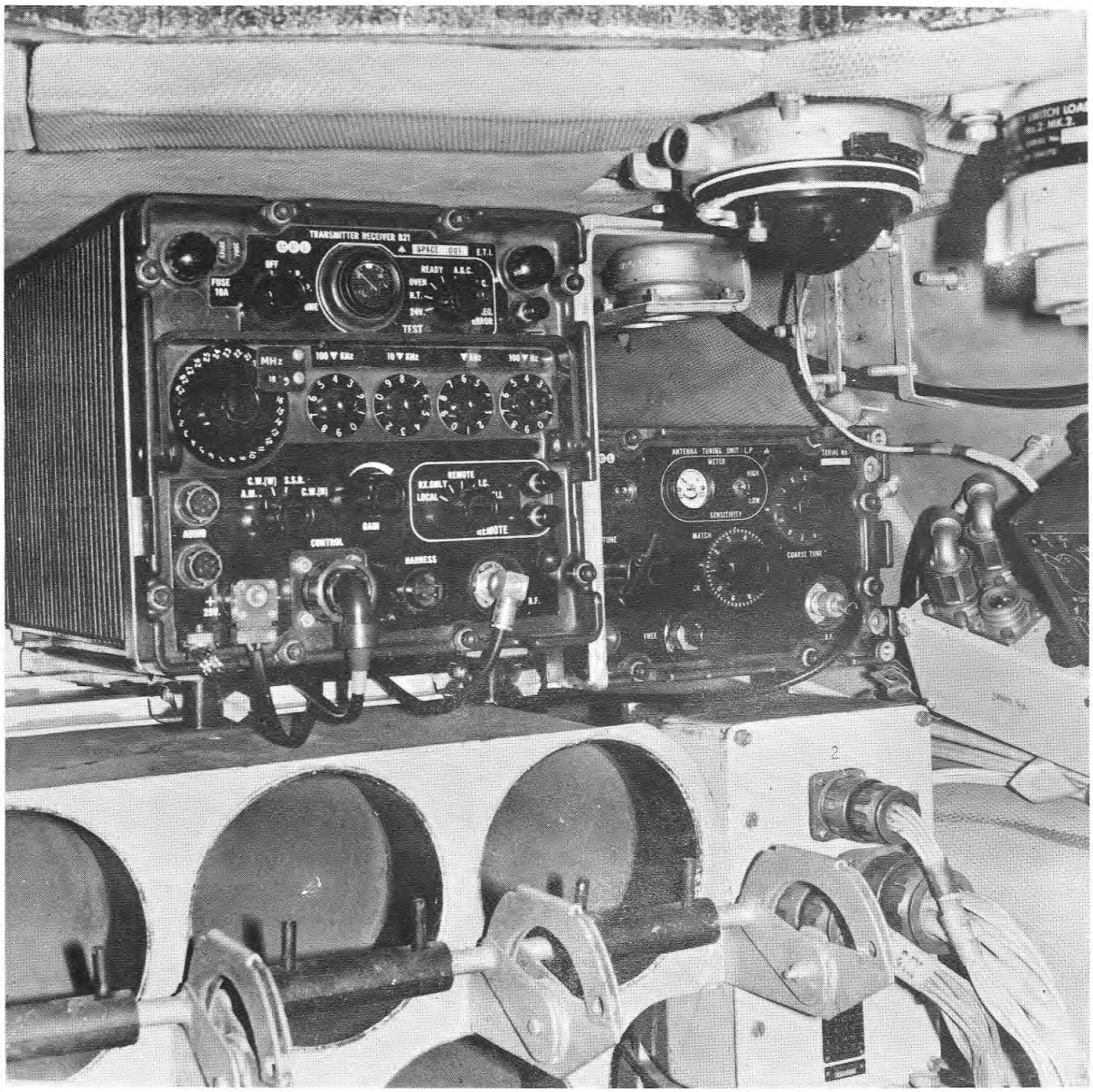
UK VRC 321



UK/VRC 321 Chieftain Tank Installation

UK VRC 321 AND UK VRC 322 SYSTEM DESCRIPTION

Introduction

The UK VRC 321 and 322 HF stations have been designed for both mobile and fixed station applications in the frequency range 1.5 to 30 MHz. A wide range of system configuration and operational modes are available.

The basic 40 Watt, UK VRC 321 station consists of two units; the Receiver/Transmitter RT.321 and the associated Tuner Unit R.F. 25. The 300 Watt, UK VRC 322 station also uses the Receiver/Transmitter RT.321 but includes a Power Amplifier and a Tuner Unit R.F. 250.

Ancillary units are available which extend the operational facilities—a radio teletype modem to permit FSK operation on teleprinter circuits, an R.F. Selector Unit to provide for the operation of two stations in the same vehicle and a Power Supply Unit for operation from 50 Hz A.C. supplies.

The stations include whip, dipole, and extended range ground-wave antennas, and a range of audio accessories and remote control facilities.

System Capabilities

The stations have been designed to satisfy to the greatest possible extent the wide variety of systems that may be required of a H.F. station. They can operate on either Upper Sideband, Full Double Sideband, C.W. or, with the appropriate adaptor, FSK for teleprinter. Thus they can be used to communicate with any older H.F. stations using voice or modern long distance teleprinter circuits. In each mode the station uses an optimised bandwidth and the stability of the station is adequate to permit both narrowband CW and FSK operation with narrow shift and frequency diversity at any frequency in the band.

The Receiver/Transmitter is a self contained unit designed to operate directly from vehicular 24V supplies. The station can be operated for long periods in forward tactical areas close to the enemy when generator or blower noise would be unacceptable. The Receiver/Transmitter is completely solid state and has the long term reliability associated with those techniques.

Both stations have been designed to take full advantage of not only the vehicular whip antenna for mobile operation, but also of a single mast and broadband H.F. antenna combination for static operation. This antenna gives at least 12 dB advantage at the L.F. end of the H.F. band and, between 20 and 30 MHz, not only improves the angle of radiation of the ground-wave propagation but also provides antenna elevation and consequently increased range in hilly and wooded terrain. It enables concealment and protection to be given to the vehicle and personnel, since only the antenna need break the skyline.

One very important advantage of the stations is their ability to operate in close proximity to other similar stations. Either station can operate in a vehicle with a similar station in an adjacent vehicle with a frequency separation of about 10% over most of the H.F. band, a performance considerably in excess of that of previous generation equipment. This performance will cater for all normal radio village situations but when a still higher degree of protection is required the R.F. Selector Unit can fulfil this need. It adds selectivity to the receiver and reduces the out-of-band transmitter noise output, making it possible to operate at a similar frequency separation with two stations in the same vehicle. The UK VRC 321 station can operate in the same vehicle as a VHF station without interference and without the use of the R.F. Selector Unit. All the units meet in full, the Electro Magnetic Radiation requirements of the UK S.R.D.E. Technical Specification TS/1400 Class A.

The stations can be operated either with audio accessories connected directly to the Receiver/Transmitter, or via a complete range of vehicular harness items to provide control of multiset installations and intercommunications. There are also facilities to permit the remote operation of the station from a distance of up to 3 Km, and separate receiving and transmitting station operation controlled by a single operator.

The following diagrams, Figures 1 to 12, show the wide range of systems provided by the various units from the single, d.c. operated, UK VRC 321 station to the duplex UK VRC 322 teleprinter station. The selection is by no means complete as it shows only two of the many possible telegraph stations.

Operational Facilities

The units have been designed to permit operation by relatively unskilled personnel with the minimum of signals training. For example the Receiver/Transmitter is tuned by setting the five frequency selector switches to the required frequency. Finally the Antenna Tuning Unit controls are set to the positions shown by the relevant tuning chart and, after operating the Pressel, the tune and match controls are re-adjusted for maximum meter readings. Each of the continuously variable controls has a calibrated scale to permit a log to be prepared of the settings for each channel.

To change the operational mode the operator need only alter the mode on the Receiver/Transmitter. This automatically sets the amplifier bias and also introduces a frequency offset to keep the frequency indicated at the centre of the emitted passband. This means that a station will hear a call whether or not the calling station is switched to the same mode. Since the station can be switched in 100 Hz steps it can receive any SSB transmission, whatever its frequency accuracy, with an error of not more than 50 Hz.

Not only has the operator's task been simplified, but care has also been taken to ensure that he cannot cause permanent damage as a result of misconnection; damaged connectors; short circuit or open circuit antennas, or supply transients. The R.F. Amplifier and Tuner Unit R.F. are protected against damage during the tuning sequence, or as a result of mistuning, and an indication is given to the operator by suppression of his sidetone if the units are incorrectly tuned, or giving no output. Another important feature is that the high voltage antenna connector is at the rear of the Tuner Unit R.F., where there is less risk of the operator making accidental contact.

Physical Flexibility

All the units mount on mounting bars and since the units are of the same depth and height they are suitable for side-by-side mounting. Where rigid mounting is acceptable such as in soft skinned vehicles, the units may be mounted on top of each other. The R.F. Selector Unit can be mounted on top of any of the other units.

Whilst it is not necessary to mount all the units in close proximity it is desirable to keep the lead between the antenna base and the tuning unit reasonably short, therefore in some vehicles it may be desirable to mount the Tuner Unit R.F. in one position and the other units elsewhere. In smaller vehicles it may be necessary to mount each unit in a different position. Figures 13 to 18 show some of the configurations.

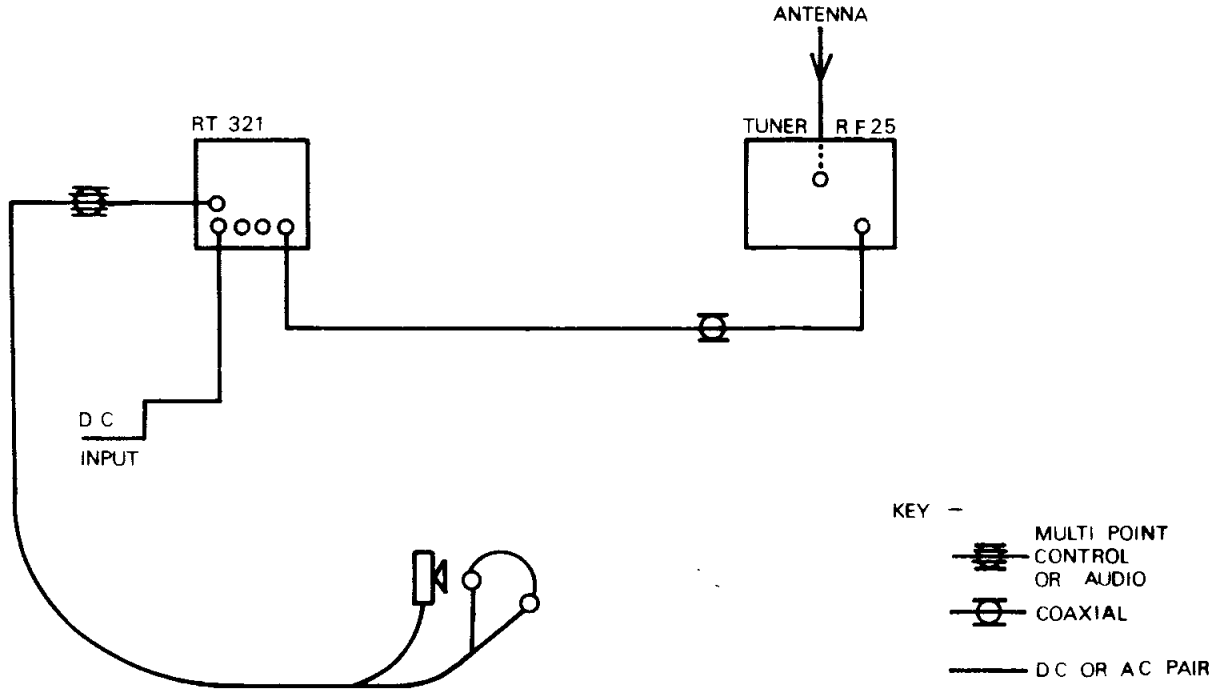
Repairs and Maintenance

Any faulty unit or cable can be identified by front panel meter indications, the sub-assembly modules having test points and coaxial connectors for connection of test equipment in order to identify the faulty module, which can be removed by unsoldering the d.c. connections on a special connector block, unplugging the coaxial leads and unscrewing the fixing screws.

In all cases the faulty module can be replaced without realignment. The special connector block can be used as a plug and socket to check that the replacement unit cures the fault before the individual connections are soldered.

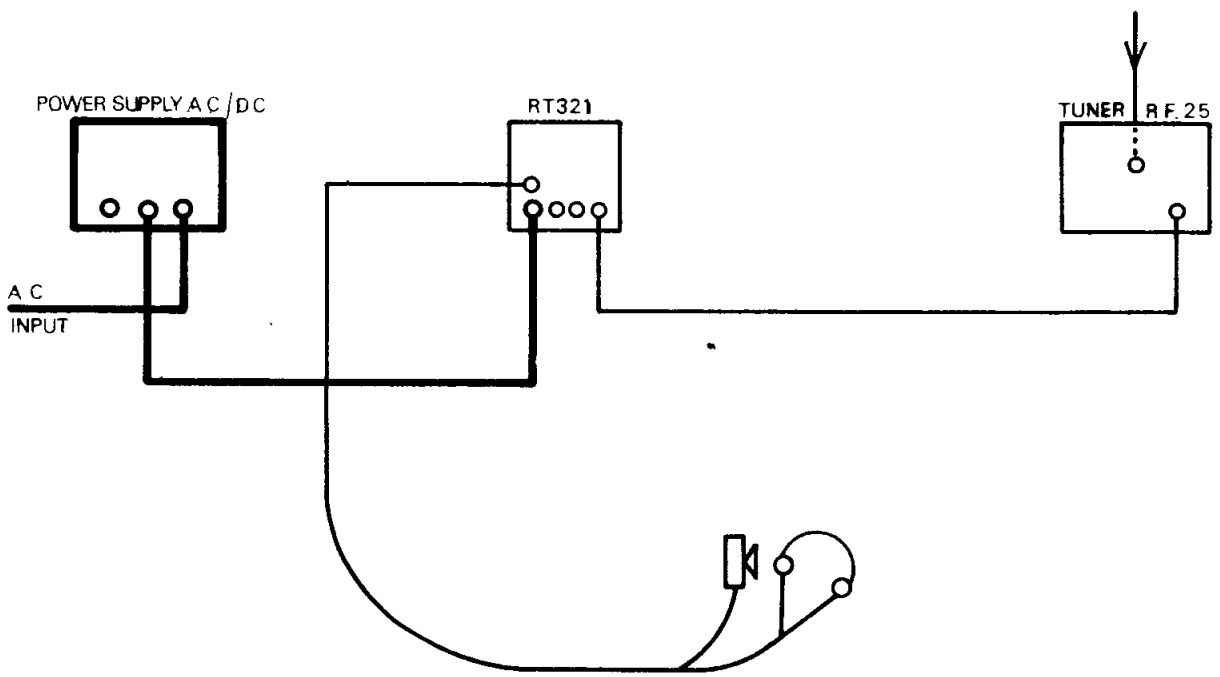
Most of the components are mounted on printed wiring boards and can be unsoldered, removed and replaced without damaging the board. The R.F. Amplifier valve in the UK VRC 322 can be changed without breaking the equipment seal.

The high reliability of the stations is achieved by using modern high quality components and inter-connection techniques throughout. This includes, in particular, the wide use of integrated circuits, printed wiring boards and flow soldering. To reduce the number of early life failures each unit is given some mechanical conditioning (bump and vibration) and a burn-in test before delivery.



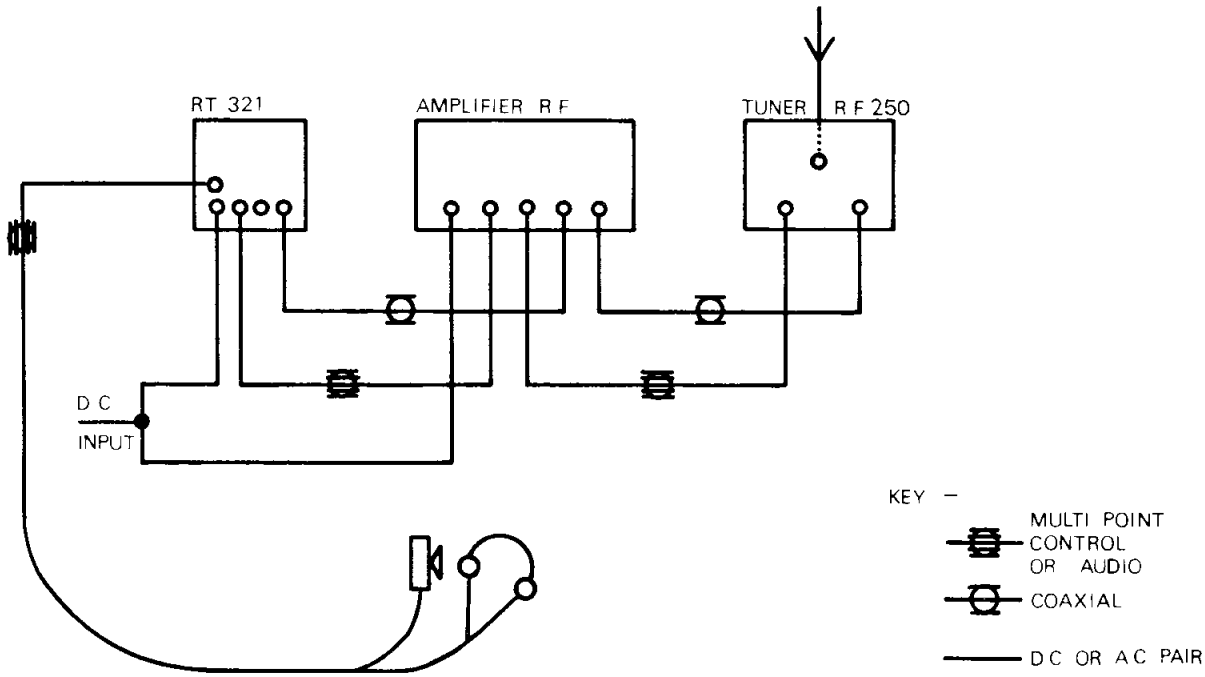
D. C. Operated UK VRC 321 Station

Fig. 1



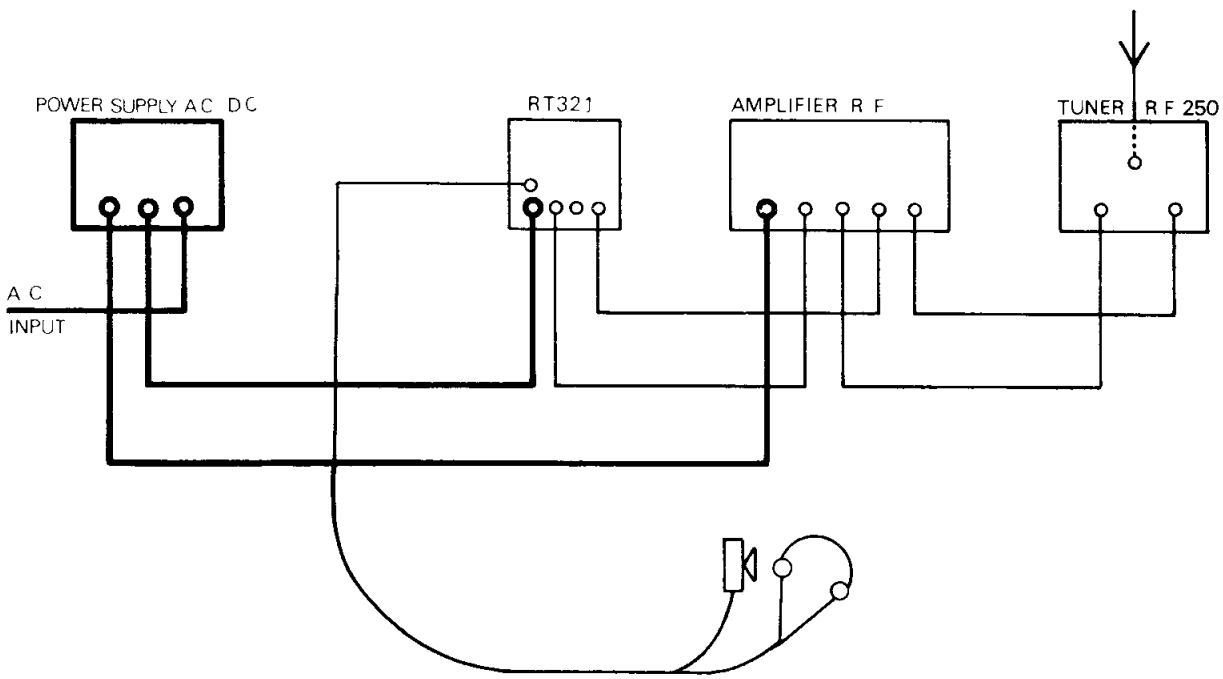
A.C. Operated UK VRC 321 Station

Fig. 2



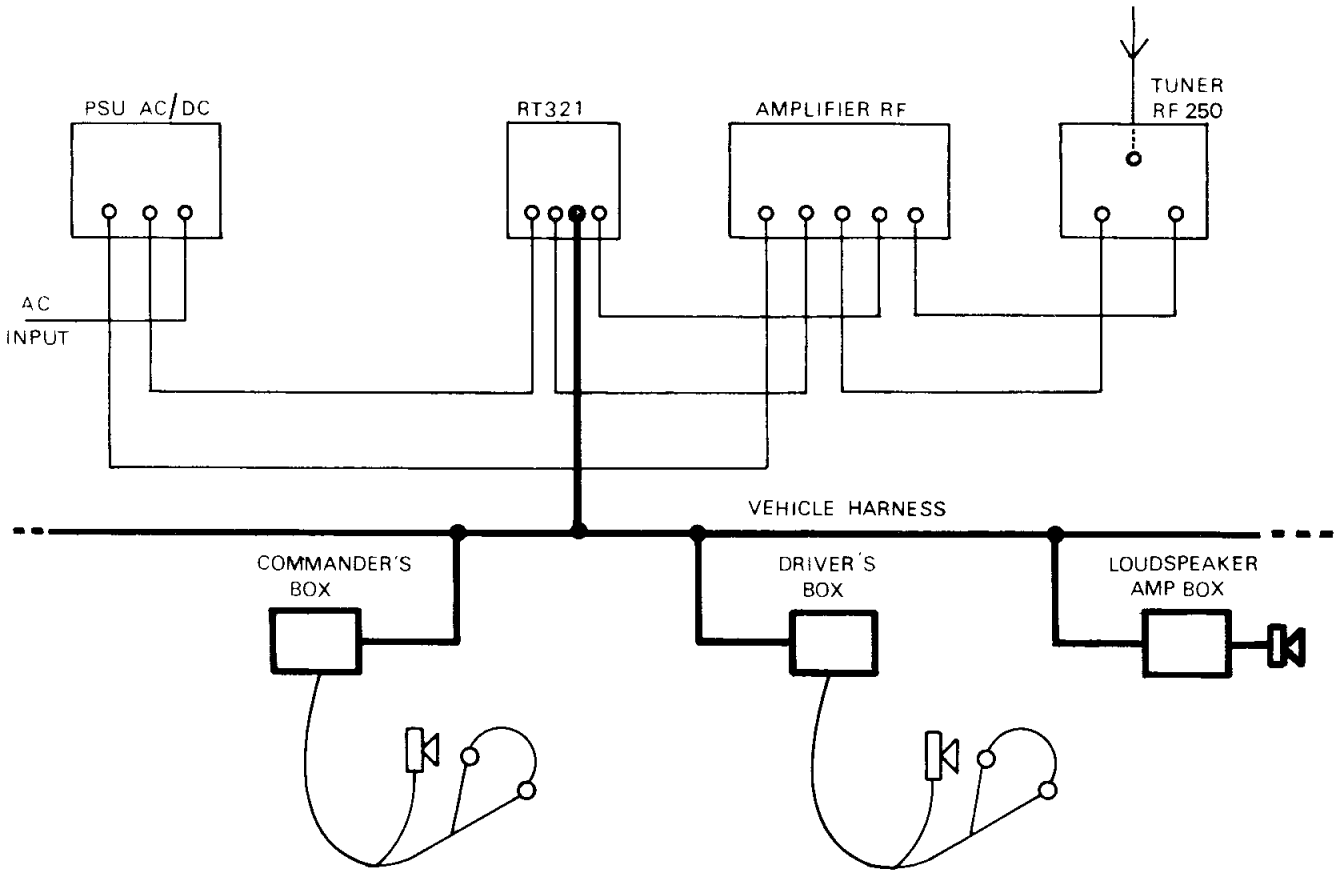
Simple D. C. Operated UK VRC 322 Station

Fig. 3



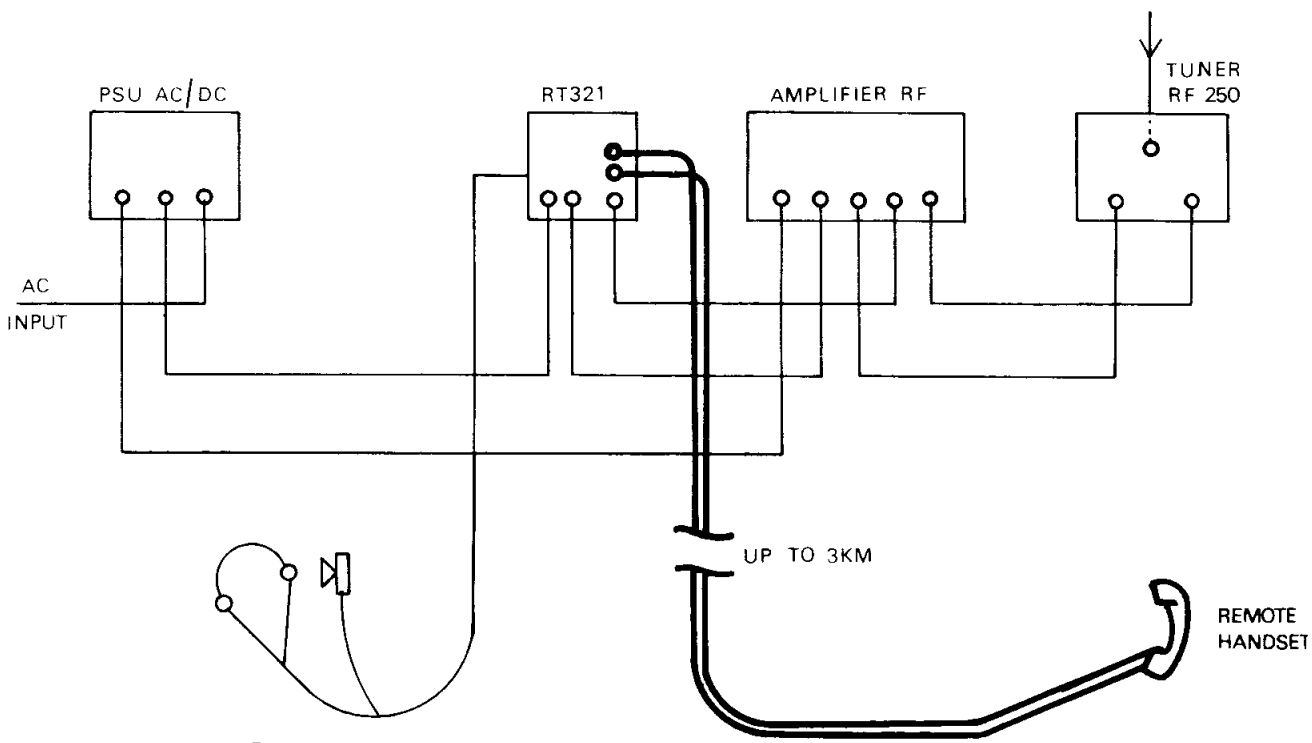
Simple A. C. Operated UK VRC 322 Station

Fig. 4



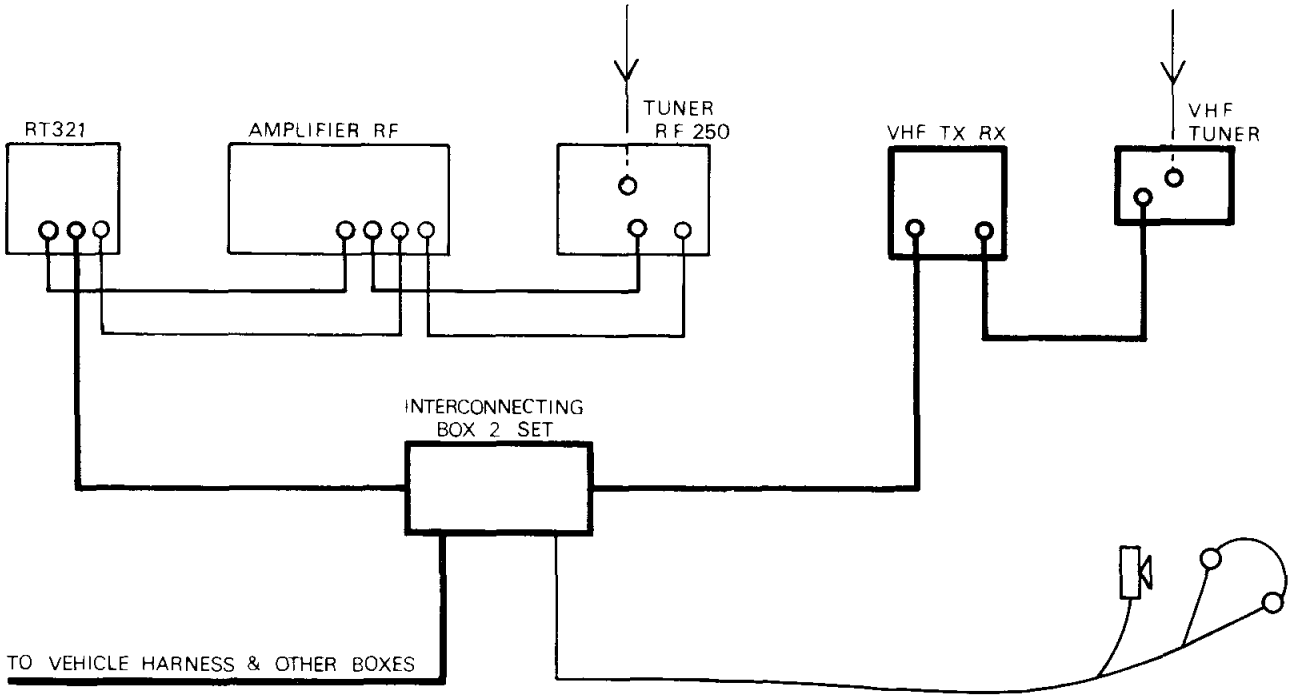
Harness Controlled UK VRC 322 Station

Fig. 5

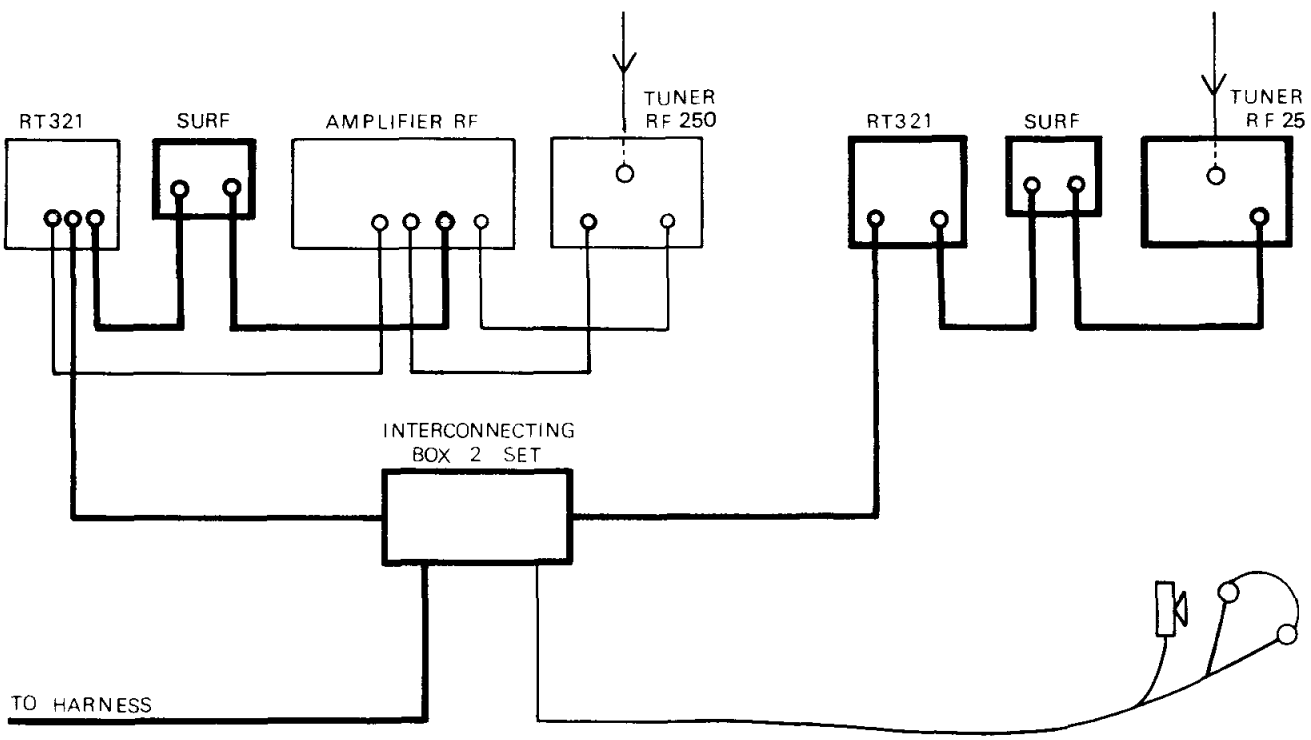


Remote Controlled UK VRC 322 Station

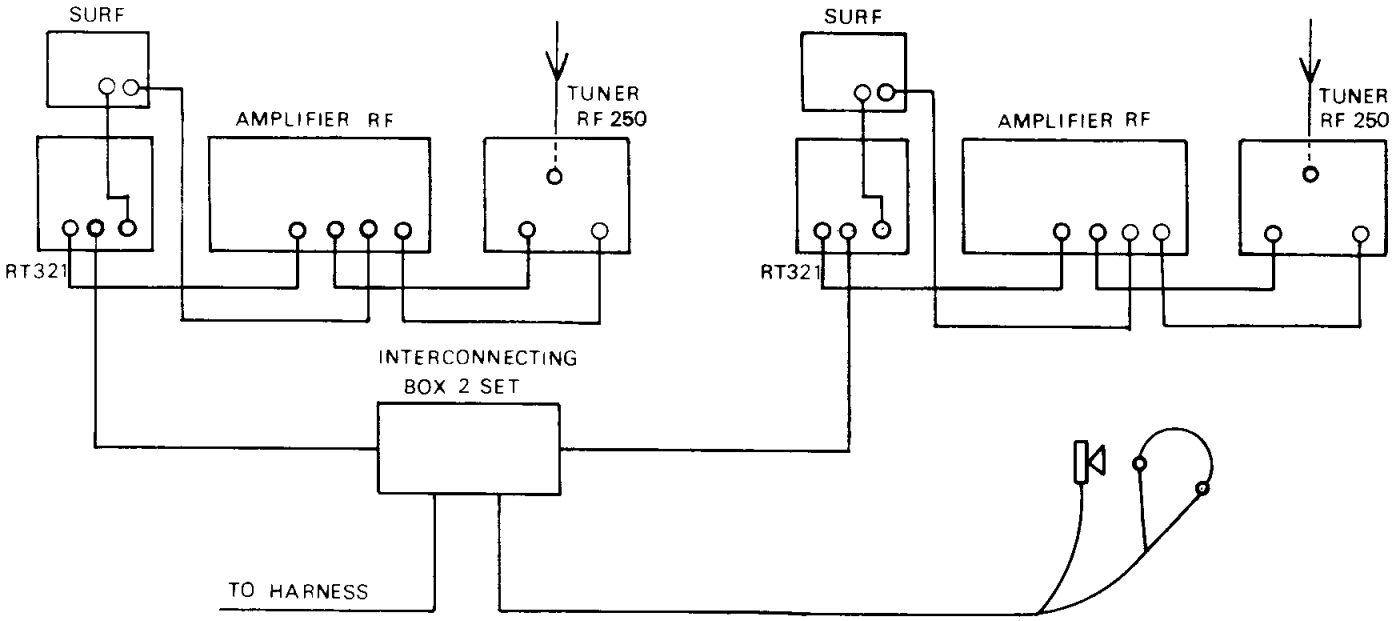
Fig. 6



HF/VHF Two Set Station Fig. 7

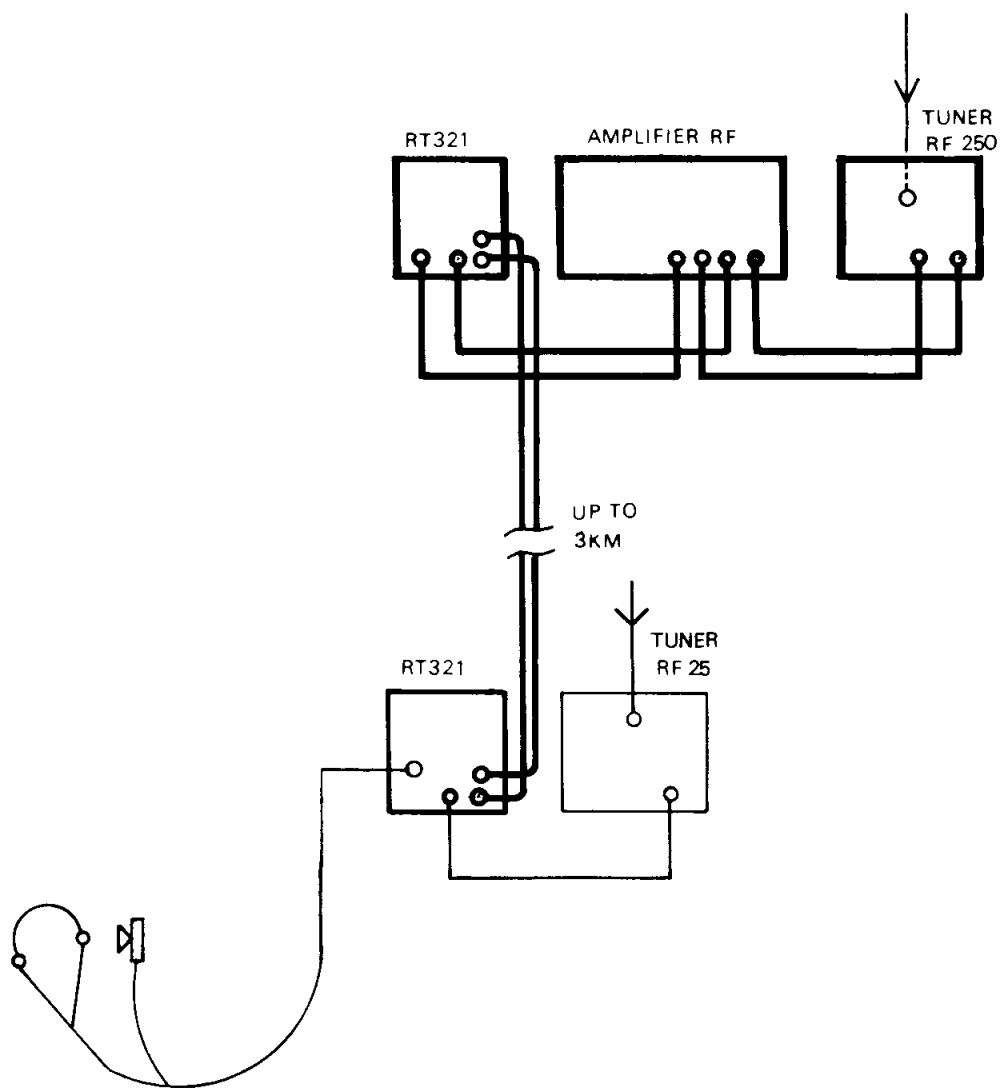


Duplex HF Station in one vehicle (One UK VRC 322 & One UK VRC 321) Fig. 8



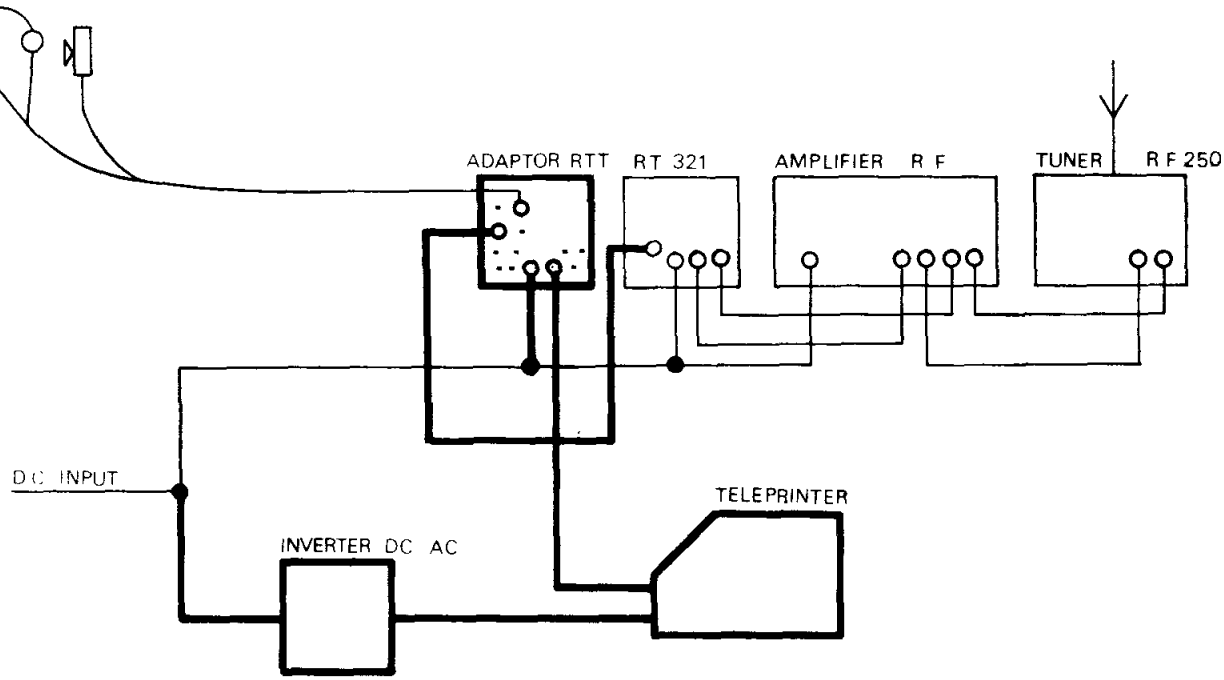
Dual UK VRC 322 Station in one vehicle

Fig. 9

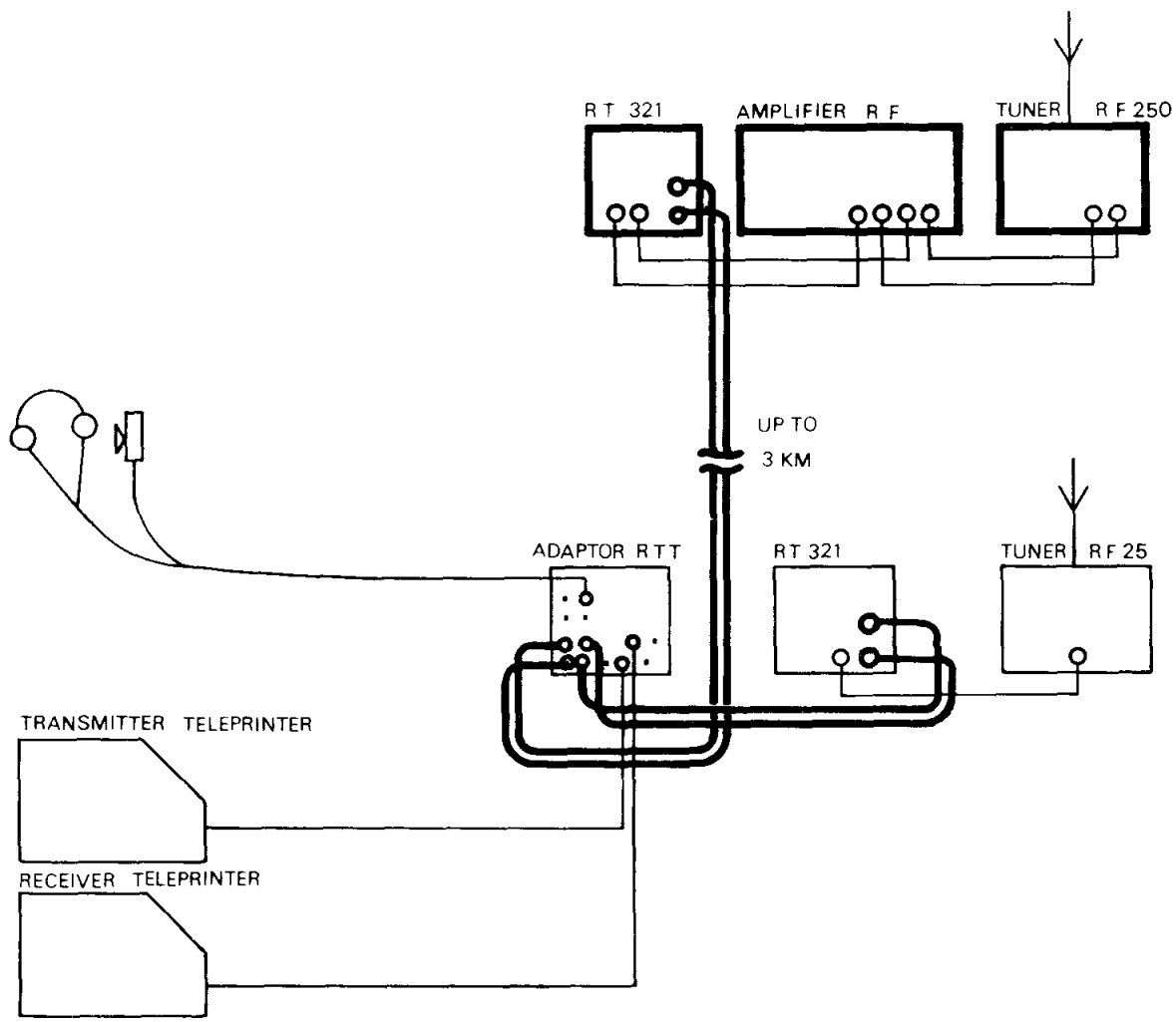


UK VRC 322 Station with separated transmitter

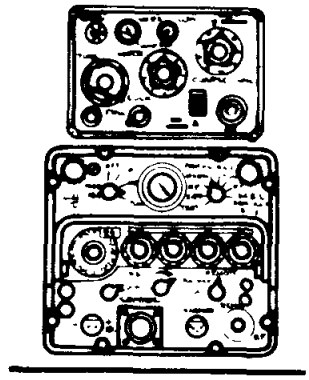
Fig. 10



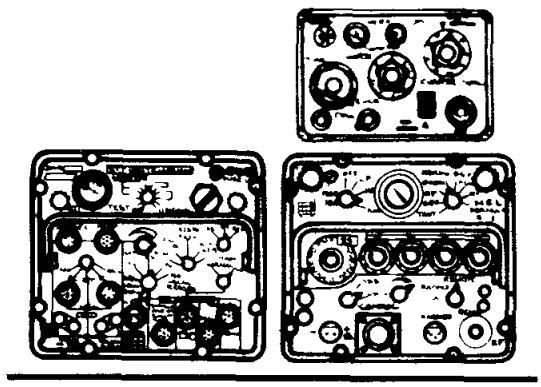
Simplex UK VRC 322 Teleprinter Station Fig. 11



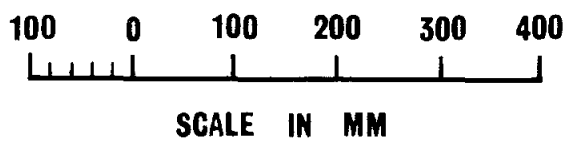
Duplex UK VRC 322 Teleprinter Station with Remote Transmitter Fig. 12

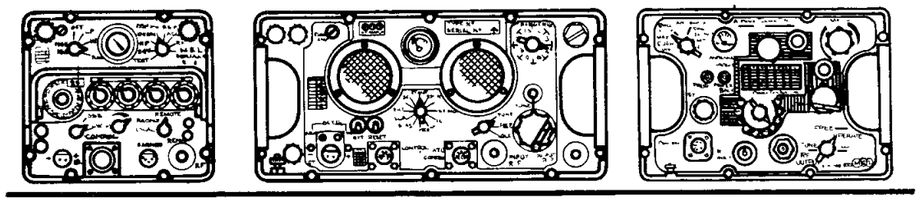


UK VRC 321 — D. C. Operated Station Fig. 13

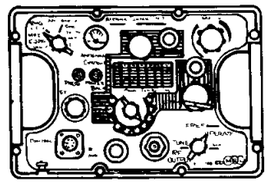


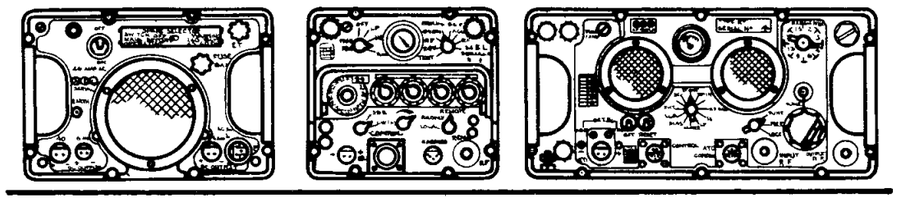
UK VRC 321 — D. C. Operated Station with R.T.T. Facility Fig. 14



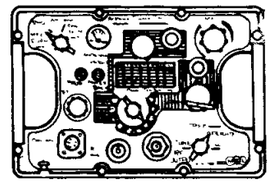


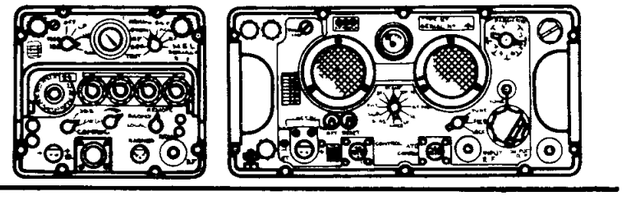
UK VRC 322 – D. C. Operated Station Fig. 15

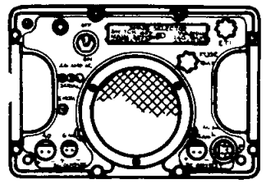




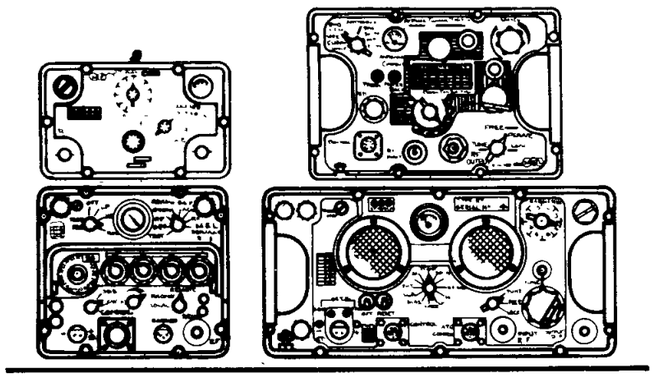
UK VRC 322 – A. C. Operated Station with Separated Tuning Unit Fig. 16







UK VRC 322 – A. C. Operated Station with Separated A. C. P.S.U. and Tuning Unit Fig. 17



UK VRC 322 – Compact D. C. Operated Station with R.F.S.U. Fig. 18

TECHNICAL DESCRIPTION

TRANSMITTER/RECEIVER RT.321 BA. 1001.

Introduction

The RT.321 (BA. 1001) is a transmitter/receiver covering the frequency range 1.5 to 30 MHz in 100 Hz steps. In order to avoid spurious receiver responses two intermediate frequencies are used, the first being either 37 or 43 MHz, dependent on the signal frequency, and the second is 1.75 MHz.

The I.F. filters, common to both transmit and receive paths, are selected according to the mode of operation.

The local oscillators used in the frequency conversions are derived from a digital synthesiser which is phase locked to sub-multiples of a 14 MHz high stability, crystal controlled, reference oscillator.

A wide dynamic range radio frequency amplifier and first mixer, together with a step automatic gain control characteristic, gives a signal handling capability for the receiver of levels from below 1 microvolt to 1 volt.

The audio input to the transmitter is processed by a VOGAD (Voice Operated Gain Adjustment Device) and clipping circuits to reduce the peak/mean ratio and increase the transmitter effective power and range. The transmitter power amplifier is wideband and employs automatic level control to regulate the output power to 40W p.e.p. Selectivity is included at the receiver input and transmitter driver stage to allow close proximity duplex working: tuning is effected automatically on selection of the signal frequency.

Receiver

The received signal is passed through a 30 MHz low pass filter to eliminate out of band signals and then to a double tuned selective circuit to reduce the interference from adjacent high level signals. This circuit employs band switched fixed capacitors and a 2-gang variable permeability inductor. Tuning is initiated by a change in the setting of the frequency selection controls and effected automatically using the transmit signal; interlocks inhibit set operation until tuning is complete. The R.F. amplifier design combines a low noise figure with a high signal handling capability; it also has a very good intermodulation performance permitting reception of a 1 μV wanted signal in the presence of unwanted signals up to 100 mV. The signal is then up-converted to the first I.F. of 37 or 43 MHz in a balanced FET mixer having a dynamic range exceeding 100 dB with good intermodulation performance. The first I.F. crystal filter has a bandwidth of 18 KHz to allow 1 KHz and 100 Hz frequency steps to be applied to the 2nd local oscillator. After amplification in the first I.F. amplifier the signal is converted to the second I.F. of 1.75 MHz in a balanced ring mixer using hot carrier diodes. The appropriate crystal filter is selected according to the mode of operation and after amplification in the second I.F. amplifier the signal is demodulated in a balanced diode mixer. The automatic gain control voltage is applied to both I.F. amplifiers. Separate audio amplifiers using integrated circuits amplify the audio signal to the harness output and local headset sockets; the local headset amplifier includes a manually operated gain control.

Transmitter

Driver

The audio input signal is amplified by the VOGAD circuit which controls the peak of the audio waveform; the signal is then clipped to reduce the peak/mean power ratio. This process increases the mean power of the transmitted signal whilst limiting the p.e.p. level. The signal then modulates the carrier at the second I.F. of 1.75 MHz in a diode modulator and, after amplification, is filtered in the second I.F. crystal filter which is selected according to the mode of operation. The signal is then converted to the first intermediate frequency of 37 or 43 MHz in the second mixer and, after amplification is filtered in the first I.F. crystal filter. The signal is converted to the wanted R.F. in a balanced diode mixer and amplified in a wide-band gain controlled R.F. amplifier. Out of band transmitter noise is reduced by passing the signal through a double tuned selective circuit as used in the receiver. The output of the second I.F. is monitored as a sidetone.

Power Amplifier

The power amplifier is a wideband class AB solid state linear amplifier having an output power of 40W p.e.p. A detector in the output provides a control voltage which is used to vary the gain of the pre-amplifier and maintain the output power at the correct level. Finally, the signal is filtered in a 30 MHz low pass filter to reduce out-of-band (VHF) spurious radiation.

Synthesiser

The first local oscillator is varactor diode tuned covering the frequency range 44.5 to 67 MHz. It is controlled by a phase locked loop incorporating variable dividers and locked to a 12.5 KHz reference signal derived from a 14 MHz crystal reference oscillator. The frequency is adjustable in 1 MHz, 100 KHz and 10 KHz steps by means of a 29 way switch and 2 decade controls on the front panel. The second local oscillator frequency is derived by direct multiplication of the frequency given by a second set of variable dividers which are locked to a 6.25 KHz reference generated by the first local oscillator loop. It is adjustable over a 10 KHz range in 1 KHz and 100 Hz steps by means of two decade controls on the front panel.

Power Supply

The power supply comprises input filtering, followed by a series chopper regulator, capable of withstanding the voltage spikes and surges that occur in armoured vehicles, and feeding a square wave inverter and regulator circuits. The acceptable input voltage range is from 20-32 volts d.c. with the input floating with respect to chassis earth.

Remote Control and Intercommunication

The RT. 321 incorporates facilities for the remote control of one set, and the remote operation of two sets, at distances of up to 3Km separation using a normal 'pair' of field cable.

Remote control is defined as the ability to transmit or receive traffic from the remote position. The mode may be CW or Voice, but selection of the mode from the distant point is not possible. It is possible for an operator at one end of the remote line to call and to intercommunicate with an operator at the other end of the line. In this situation the transmitter is inhibited, but incoming received signals will be heard.

Construction

The printed wiring boards are mounted in modular sub-assemblies grouped around a main chassis framework. In general there are two boards per module, with ample test points accessible through screening covers. Signal path circuits are interconnected by means of miniature coaxial plugs and sockets. Supplies and switching connections are made through individual retractable connectors employing 'Varicon' board mounted sockets. Throughout the assembly/test phase of manufacture these interconnections are simply 'push fits' but when initial testing is complete these connections are soldered up. Thus the flexibility of a push fit connection is retained for as long as possible and the reliability of a soldered joint is obtained in use. Subsequently, upon unsoldering, the joints are push fit connectors which can be used during replacement testing.

The power output stages of the transmitter are mounted on heat sinks which are integral with the front panel for optimum dissipation. The power supply inverter transistors have heat sinks which are connected mechanically with flexible conducting straps to the case.

TUNER UNIT, RADIO FREQUENCY 25.

The T.U.R.F. 25 consists of an 'L match' network with both the input capacitor and the series inductor continuously variable which matches all impedances in which the resistive component is less than 50 ohms. When the resistive component exceeds 50 ohms, one of three shunt capacitors is added to the output of the 'L' network to form a pi configuration, thus the network will tune and match a wide range of antenna impedance.

The T.U.R.F. 25 meter displays the reverse power, into the RT.321, when 'Tune' is selected and the forward power, into the T.U.R.F. when in the operating mode. The detector circuit being mounted in the RT. 321, current to the T.U.R.F. meter is conducted along the inner of the coaxial cable.

The three controls—Coarse Tune, Tune and Match—are operated to give maximum current indication on the meter corresponding to minimum reverse power.

The R.F. input to the T.U.R.F. 25 is via a coaxial connector and the output termination is a screw terminal mounted on an insulator.

AMPLIFIER, RADIO FREQUENCY BA. 1005.

Introduction

The single stage amplifier employs a high gain beam tetrode valve operating in a linear mode from a self contained power supply unit.

The R.F. input circuit is a wideband transformer, frequency compensated for valve input capacity. The output circuit comprises a 'pi-L' network whose input and output capacitors and output inductor are switched in eight bands giving a frequency coverage of approximately 1.5:1 on each band with a variable coil providing fine tuning within each. This arrangement gives an optimum impedance match with only one variable component and maintains a constant loading on the valve with a 50 ohm matched output load.

An internal, 50 ohm, dummy load is fitted to facilitate rapid tuning whilst maintaining radio silence for as long as possible. A standing wave ratio indicator is fitted to facilitate tuning of the amplifier, (forward power) and to give an indication of match on the 50 ohm output feeder (reflected power).

Power Supplies

All valve and ancillary supplies are generated internally from the 20-32 volt d.c. input. The E.H.T. supply is obtained from twelve low power inverters whose d.c. outputs are added in series and have 'mark-space' controlled regulation to maintain a constant output voltage. All other supplies are obtained via a 'chopper regulator' type stabiliser.

Cooling System

The power supply section of the amplifier employs forced air cooling over an external heat exchanger the cooling fins of which are radial extrusions in an aluminium cylinder in which the blower is mounted. The amplifier valve has a coaxial base arrangement and a radial 'honeycomb' anode structure and is mounted in an insulated tube through which air is blown. The cooling systems are mounted centrally in their respective section of the unit and afford general conduction cooling. All internal circuitry is sealed and the air inlets to the blower ducts are filtered.

Protective Circuits

Control and protection circuits are extensive to prevent damage due to mis-operation of the amplifier and to give early warning of poor feeder matching.

Automatic Level Control (A.L.C.) is derived from the peak output via the 'forward' circuit of the standing wave indicator. On S.S.B. the peak envelope power output is in excess of 300 watts over the entire frequency range. On C.W., a degree of auto bias is introduced into the amplifier input circuit and A.L.C. starts to operate at a predetermined valve anode current. A.L.C. also operates in the event of high screen grid current and also in the event of the instantaneous control grid voltage going positive. In addition the A.L.C. signal is utilised to control the output level of the RT.321.

There is an input/output level comparator which inhibits the amplifier if the gain is below a pre-determined level, indicating incorrect anode tuning. The amplifier is also inhibited if the reverse power at the output exceeds a predetermined level due to an antenna unit mismatch. A 'reset' is provided on the front panel. Protection against blower failure is provided by an electronic sensing system which detects the air flow.

TUNER UNIT, RADIO FREQUENCY 250. BA. 1006.

The tuner unit tunes and matches a wide variety of antenna types to the amplifier load impedance. It is manually operated and comprises two R.F. networks which are used for different parts of the R.F. spectrum and parts of which have a common control.

The circuit for lower frequencies is, for most of the frequency range, a simple 'L match' arrangement with a continuously variable input capacitor, a fixed, and a variable inductor. These components, in combination, permit tuning of the very high series reactance presented by the antenna on the lowest frequencies (1.5 to 2 MHz). Above these frequencies the fixed component is switched out and only the variable inductor is used. To cater for antennas longer than a quarter wavelength, up to 16 MHz, a variety of fixed capacitors may be switched into circuit modifying the 'L match' to a pi configuration with or without capacitance in series with the main tuning inductance.

To avoid the selection of inefficient inductance values of the main variable inductor above 16 MHz, a completely separate high frequency network is included. This comprises a parallel network with variable tuning by capacitance and adjustable loading by variable tapped transformer action.

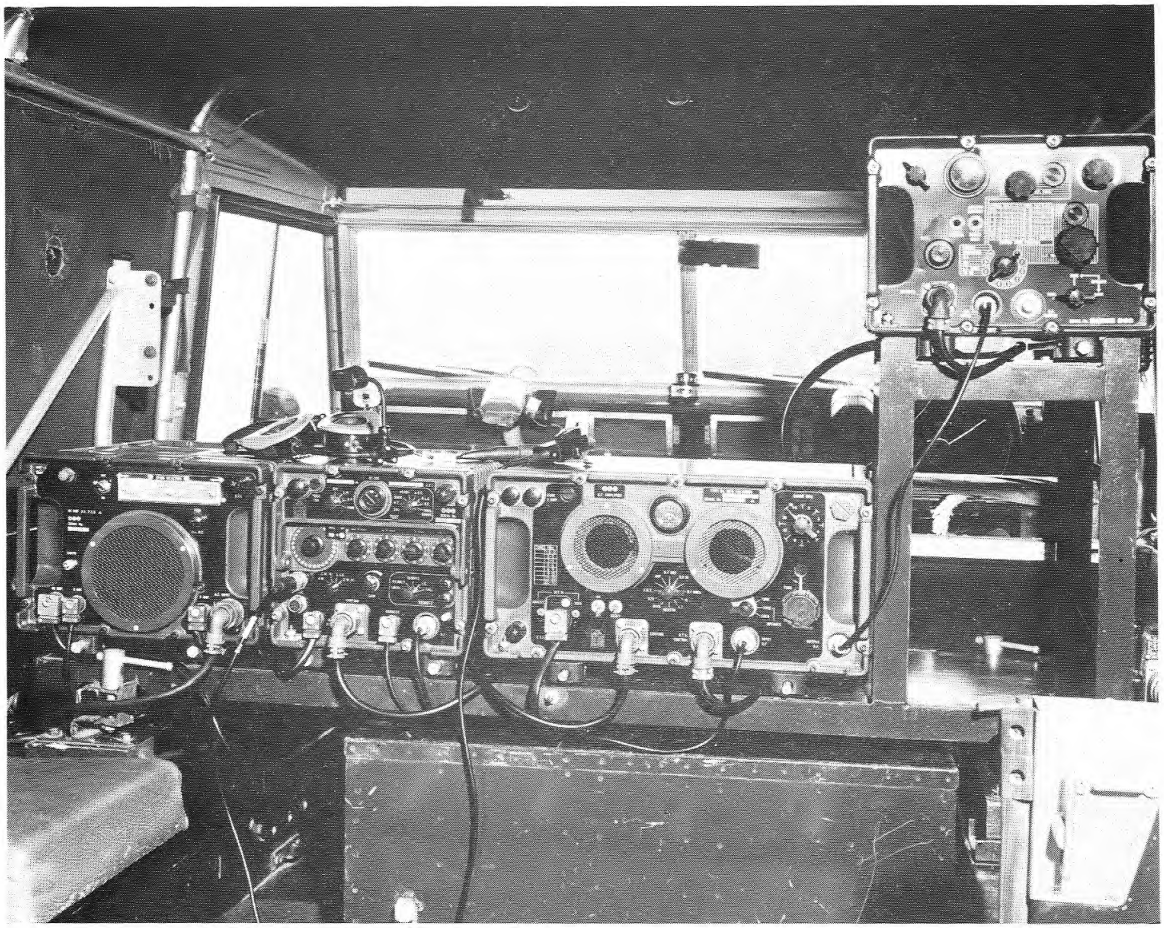
By ganging the variable capacitor of both networks simplified tuning is obtained, the changeover from one network to the other being effected by the main circuit switch.

The tuner maintains the highest working efficiency consistent with the unit size, but at the lowest frequency with short whip antennas considerable R.F. energy is dissipated in the series coils. In continuous operation at high ambient temperatures the coils would overheat and to eliminate this risk a small blower is included which is switched on automatically when required.

To select the various networks, high quality switches are incorporated which employ glass filled NORYL as the insulating material. They provide generous spacing for high voltage points. In order to achieve an acceptable case size, particularly at the lowest frequencies with short antennas, the voltage on the antenna terminal is limited to 10 K Volts by an Automatic Level Control voltage which controls the output power of the RT.321. In practice this limitation only occurs over a small fraction of the operating frequency range and has little effect on the operational distance range.

The standing wave meter indicates reverse power when 'Tune' is selected and forward power when in the operating mode.

In addition there is a continuous monitor of current through the variable coil so that in the event of incorrect selection of tuning network, or open circuit antenna, the high coil current will inhibit the transmitter automatically.



UK VRC 322 A.C. Station in Landrover

SELECTOR UNIT, RADIO FREQUENCY, BA 1069.

Introduction

In order that transmitter/receivers, such as the RT.321, may work in close proximity one to another, or high level interfering signals, it is essential to introduce selectivity into both the transmit and receive paths. In the transmitter the selectivity affords rejection of wideband noise which would otherwise interfere with an adjacent receiver, and in the receiver the selectivity rejects the adjacent transmitter emission which might block the receiver or intermodulate with other signals in the receiver early stages.

To permit two set working (duplex), in one vehicle, additional selectivity is required to counteract the effect of closer antenna spacing. This selectivity is provided by the Radio Frequency Selector Unit. It is connected between the RT.321 and the R.F. Amplifier.

The unit consists of a capacitively coupled double tuned circuit having a low insertion loss and high selectivity. This circuit consists of fixed inductors and coupling components switched in 8 bands together with a 2-gang variable capacitor. Tuning is effected manually by means of controls on the front panel. All inductors are air-cored in order to give the high degree of linearity required.

The circuits are mounted in a chassis framework which has been designed to retain the high 'Q' factors of the switched inductors. The complete unit may be installed in any position.

Performance without R.F.S.U.

In the UK VRC 321 and 322 stations selectivity is included in the RT.321 as standard. This permits the operation of two stations in reasonably close proximity and gives the receiver an exceptional out of band rejection and overall performance. The performance of two basic stations may be summarised as follows:

a) Two UK VRC 321 stations can operate with antennas 3.6 metres long and at a separation of 20 metres with a frequency separation of 15% so that the interfering transmitter noise is no more than 1 μV at the receiver input terminal. The transmitter signal degrades a 20 dB signal-to-noise ratio to no worse than 6 dB signal-to-noise by blocking. Above and below 17 MHz performance is improved either by a reduction in the percentage frequency separation or by an improvement in the interference performance.

b) For two UK VRC 322 stations and the same interference criteria the required antenna separation is 40 metres and frequency separation 20%. Since in the UK VRC 322, some selectivity is included in the amplifier itself, the overall performance is limited by the receiver rejection.

Performance with R.F.S.U.

a) Two UK VRC 321 stations using antennas 3.6 m in length and a separation of 2m can operate with a frequency separation of 15% whereby the interfering transmitter noise is no more than 1 μV at the receiver input terminal. The transmitter signal degrades a 20 dB signal-to-noise ratio to no worse than 6 dB signal-to-noise by blocking. Above and below 17 MHz, performance is improved either by a reduction in the percentage frequency separation or by an improvement in the interference performance.

b) For two UK VRC 322 stations with the same antenna separation and interference criteria, the frequency separation is 25%.

A.C. POWER SUPPLY UNIT, 46 AMP.

Introduction

The power supply unit provides three outputs, each from 25-30 V d.c. from full to zero load. One of these supplies the RF Amplifier unit (40 amps) and the other two are limited to 6 amps. The ripple voltage is approximately 0.7 pk-pk at 46 amps.

The a.c. input voltage is adjustable at the front panel to any one of the nominal voltages: 115, 200, 220 and 240 V. $\pm 5\%$. 45-60 Hz.

Fuses or cut-outs associated with the mains input of d.c. outputs are replaceable or can be reset at the front panel.

General Description

The power supply is a thyristor phase controlled system where the thyristors are in the primary circuit of a transformer. The transformer is followed by the conventional full wave rectification and smoothing circuits. The output voltage is sampled and compared with a zenered reference voltage. The difference voltage is amplified using a differential amplifier and is used to control the firing angle of the thyristors.

Current limiting is provided by a magnetic amplifier type of transformer, the output of which is rectified and the voltage used to reduce the conduction angle of the thyristors.

The on off switch is a three pole circuit breaker which limits the input current to a maximum of 12 amps for 200-240 V input and 20 amps for 115 V input. This protects the mains source from faults within the power supply unit.

Voltage selection is by tapered contact screws which connect the contact plates on the front surface of the selector with individual rear contacts. A micro switch inhibits mains voltages from the voltage selector when the cover plate is removed.

Cooling air is drawn in at the front of the unit and blown out at the rear.

RADIO CONTROL HARNESS

The Clansman Radio Control Harness is a system incorporating operating, junction, and adaptor boxes which, together with the audio gear, permits the operation of up to three Clansman radio from various positions in the vehicle. The harness also provides for intercommunication between the various operator positions independently of the radio system. Facilities are available for remote operation via a two wire line of up to 3 Km (two miles).

The harness provides facilities for radio rebroadcast, which may be automatic or manually controlled, between two of the installed radios. This facility can be extended for use between any installed radio and a remote radio connected into the harness system by a two wire line.

The basic control harness is intended for use with a one or two radio installation. It is a single system suitable for all vehicle installations, the varying requirements of each being met by variations in the arrangement of standard units.

All the boxes in a system are connected in series, with the free ends joined by a cable forming a closed loop, this gives a measure of protection against cable failures.

A three radio installation can be built up from the basic two radio harness by adding special boxes which provide the extra channel and control functions required.

When working with one radio station or one intercommunication source only, the transmit sidetone is heard in both ears. However, where it is required to monitor an additional radio or intercommunication source the working signal is heard in the left ear and the monitor signal in the right.

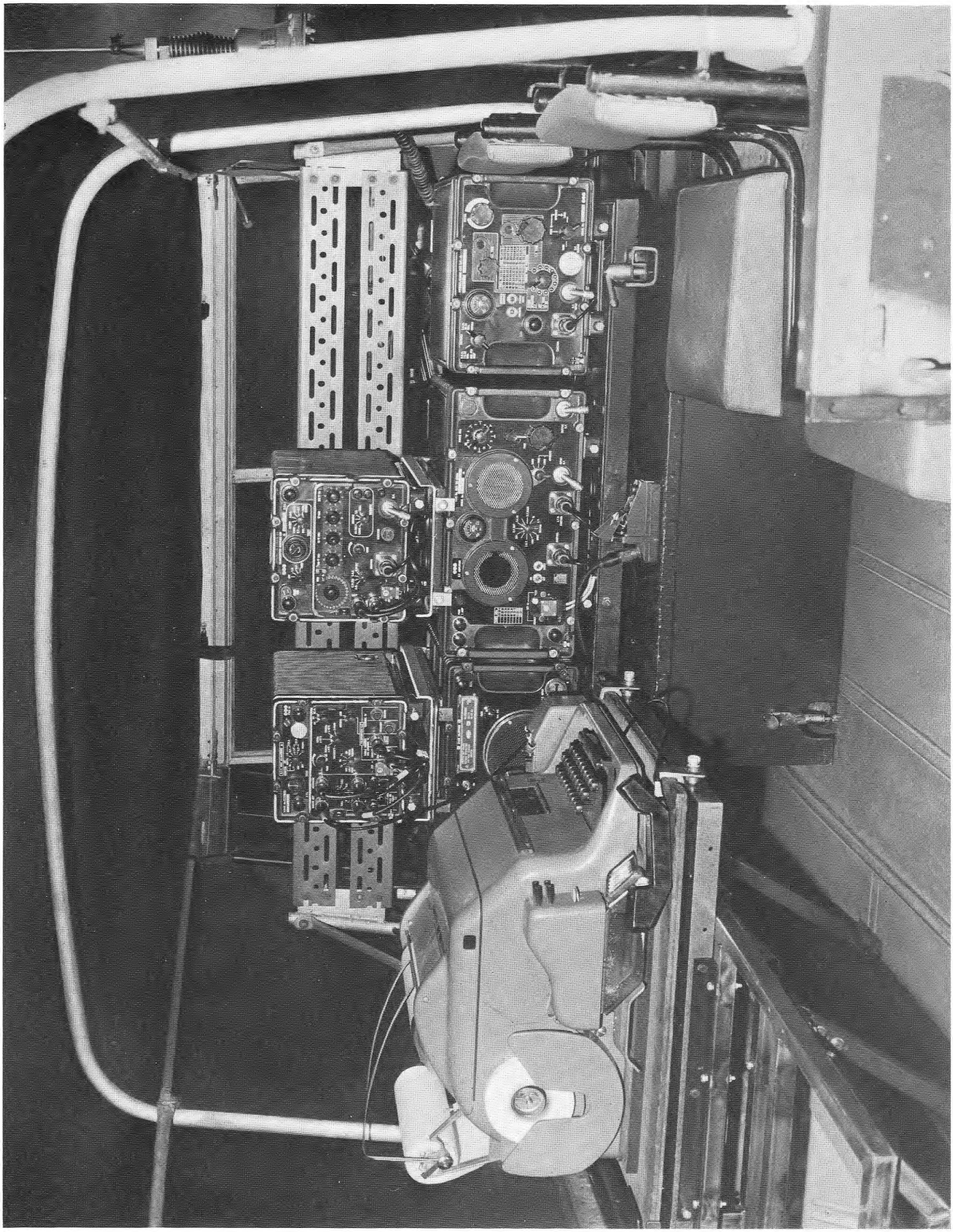
The harness system operates from a 20–32 volt d.c. supply, which can be derived either from the vehicle electrical system or a separate radio battery.

The harness boxes are made in a cast light alloy. Plug and Socket connections are made at the sides, top, or bottom of the boxes. The controls are situated on the front face and are protected by flanges on the boxes.

Attachment of the boxes to the vehicle is made by flexible belting which fits on to the studs fitted in the vehicle.

In addition to the standard range of boxes which comprise the harness system a Clansman Radio Adaptor Box (CRAB) can be supplied which provides an interface between the Clansman radios and the precedent types A and B harness.

Adaptor Boxes can be made available which will adapt the Clansman radios to any other harness system.



ADAPTOR TELEGRAPH RADIO BA. 1012.

Introduction

The A.T.R. Unit enables the binary signals from telegraph or computer peripheral apparatus to be transmitted by the various radio sets in the Clansman family. This is achieved by converting the d.c. impulses into V.F. two-tone signals. Conversely the V.F. signals received via a radio are translated into a form suitable to drive the teleprinter or computer peripheral apparatus.

The unit is powered by a 20–32 volt d.c. supply and the unit provides all supplies necessary for the operation of the teleprinters. The 'Normal' telegraph interface has been designed specifically to be compatible with the NATO standard Siemens and Halske T100R single current teleprinter. However, other single current machines using the International Telegraph (5 Unit) Code No. 2 at speeds of 50 or 75 Bauds, equivalent to 66 or 100 words per minute respectively are suitable.

The low level interface is in accordance with CCITT recommendation V24, i.e. nominally $\pm$ 6 Volt, the "A", or space signal being the positive potential and the "Z", or mark signal being negative. Operation with this interface permits the use of telegraph apparatus using the International Telegraph Code No. 5 (ISO 7-Bit Code), at a speed of 110 Bauds, also equivalent to 100 words per minute. Alternatively operation at speeds up to 750 Bits/sec are within the range of the Unit. Speeds up to 1200 Bits/sec can be transmitted and received adequately, but with a reduced specification e.g. a lower dynamic range.

Provision is made for both Simplex and Duplex modes of operation and the telegraph site can be separated from the radio site. In the case of Duplex operation the radio transmitter may be at a different site from the receiver.

The Unit has been designed to be directly controlled by the teleprinter operator. It is assumed therefore, that the telegraph/data apparatus and the A.T.R. Unit will always be in close proximity. Suitable circuits are included for Tx/Rx switching of a remote radio transmitter.

Separation can be up to 3.2 Km (2 miles) by using field cable or 5.6 Km (3.5 miles) by using a pair from a multi-pair cable. The main criterion is that the loop resistance must not exceed 440 ohms, however, the frequency response of the cable and terminations must also be carefully considered.

Facilities are provided to enable the telegraphist to communicate with the radio operators over the remote-lines.

Transmit Section

The incoming signals from either the teleprinter or data apparatus are first converted into standard logic levels. Various logic functions are then performed, controlled by the setting of the switches.

The V.F. output is a frequency modulated signal produced by frequency exchange switching circuits. The centre frequencies and values of shift frequencies are in accordance with the U.S. MIL-STD-188B specification for FSK and two tone compatibility. These are as follows:

(a) 2000 Hz $\pm$ 425 Hz — For speeds up to 750 Bits/sec.

(b) 425 Hz $\pm$ 42.5 Hz
(c) 2805 Hz $\pm$ 42.5 Hz
— Primarily intended for 50/75 Bauds but can be operated at 110 Bauds.

The 'square wave' output from the modulator circuits is passed through low pass filters. Sinusoidal outputs from these filters are then amplified and sent out to the local radio or remote line via impedance matching transformers.

Receive Section

The V.F. signals from either a local radio or remote line are passed to a linear amplifier via impedance matching transformers. Following the amplifier is a bank of band pass filters which are part of the demodulator circuits.

Filter assessor demodulators have been used because of their superior performance when operating in selective fading conditions. This is due to the frequency diversity advantage obtained by the assessors over the more conventional limiter-discriminator demodulator.

Outputs from the assessors are converted into the standard logic levels and the various logic functions are performed. The local record, start element and reperforate paths are added and circuits are provided to give the correct outputs to drive either teleprinters or data equipment.

Remote Control

By connecting a standard headgear to the A.T.R. unit the tones can be monitored. Alternatively, by operating the TRAFFIC/RC switch the telegraphist can communicate with the remote radio operator or with either operator when transmitter and receiver sites are separated. The microphone and headphone are connected to the remote lines via the same amplifiers used when operating telegraphy.

The distant radio sets provide a d.c. potential on the remote lines. By controlling the amplitude of the current flowing in the lines the telegraphist can either operate the 'pressel' line of the transmitter or call the operator. The distant operator calls the A.T.R. unit by removing the d.c. potential from the line and sending a 2 KHz tone.

Monitoring

In addition to the audio monitoring referred to, a meter is included to aid the operator. The following functions can be monitored by checking that the meter is indicating in a specified segment.

a) Level of the d.c. supply.
b) Level of the d.c. potential on the remote lines.
c) Average of all internal supply lines.
d) Condition of the incoming and outgoing telegraph lines, e.g. "A" or "Z" condition at both Normal and Low Levels.

Modes of Operation

The A.T.R. Unit may be used in any of the following operational modes.
The terms quoted are used in the context defined by the International Telecommunication Union.

Teleprinter

The T100R teleprinter transmitter and receiver sections are not mechanically interlocked, but can be interconnected by electrical circuits when required. A tape transmitter and reperforator will normally be fitted and these attachments are mechanically interlocked to the main printer.

It is not always necessary to obtain a 'local record'; for example, when operating from a pre-prepared tape. Therefore the Transmit-Receive switch has two transmit positions permitting transmission either with or without local record. In the second method the teleprinter transmitter is kept active by feeding occasional 'Start' elements to the receive section.

Simplex

Only one teleprinter is required, the teleprinter receiver being used when a 'local record' is required.

Duplex

Two teleprinters are required, the first to transmit and produce the 'local record', the second being a receive only machine.

Reperforate

This position is provided to enable the teleprinter to be used during 'off-line' periods to prepare taoe for later transmission. All emissions from the A.T.R. unit, including the V.F. output and the 'pressel' line, are inhibited. Only the telegraph interface is active.

Diversity

When working with narrow shifts, the telegraph signals applied to Channel 'A' can be sent over both channels simultaneously.

2-Channel

Since there is only one Tx/Rx switch, it has been assumed that this mode will normally be used on a duplex basis. Simplex operation is possible if both telegraph channels are controlled by one operator; for example, when at least one teleprinter is transmitting from tape.

SPECIFICATION—ADAPTOR TELEGRAPH RADIO

Transmitter Section

INPUTS	Teleprinter	50/75 Baud Single Current 40 mA d.c.
	Teleprinter	110 Baud 'Electronic' ± 6 Volts.
	Data	750 Bits/Sec. ± 6 Volts.
OUTPUTS	Local	40 mV (Max.) R.M.S. into 300 ohm.
	Remote	4 mWatts (Max.) From 50 ohm source into a 1 Kilohm load.
FREQUENCIES		
	Wide Shift	Space or "A", 2.425 KHz.
		Mark or "Z", 1.575 KHz
	Narrow Shift	Space or "A", 2.8475 KHz or 467.5 Hz.
		Mark or "Z", 2.7625 KHz or 382.5 Hz.

Receive Section

OUTPUTS	Teleprinter	50/75 Baud Single Current 40 mA d.c.
	Teleprinter	110 Baud 'Electronic' ± 6 Volts.
	Data	750 Bits/Sec. ± 6 Volts.
INPUTS	Local	50 mW +0 to —50 dB 150 ohm load.
	Remote	2.5 mW (Max.) +0 to —50 dB 50 ohm load.

Transmit/Receive Switching

Local	Reed Relay Contact
Remote	10 mA d.c.

Environmental Conditions

The A.T.R. Unit has been designed to meet requirements similar to the Ministry of Defence specification DEF 133, L3. The temperature range over which the unit will meet its specification is from —40°C to +55°C plus direct solar radiation.

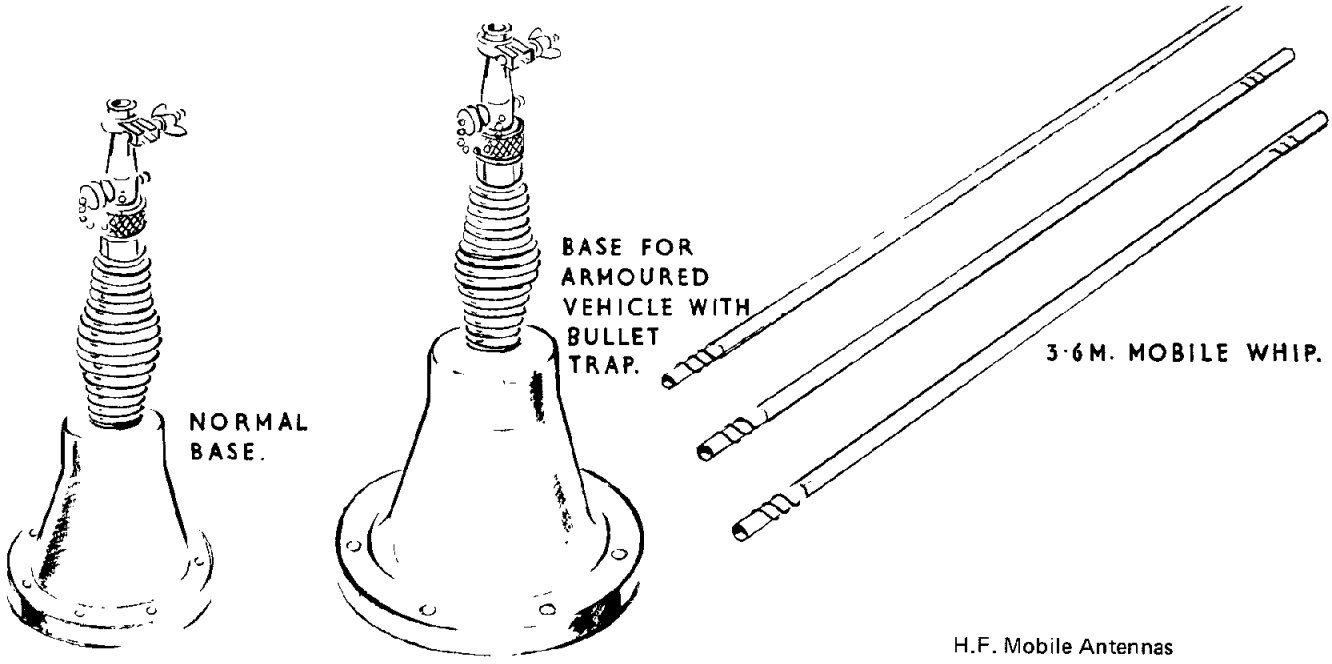
TYPES OF ANTENNA

Introduction

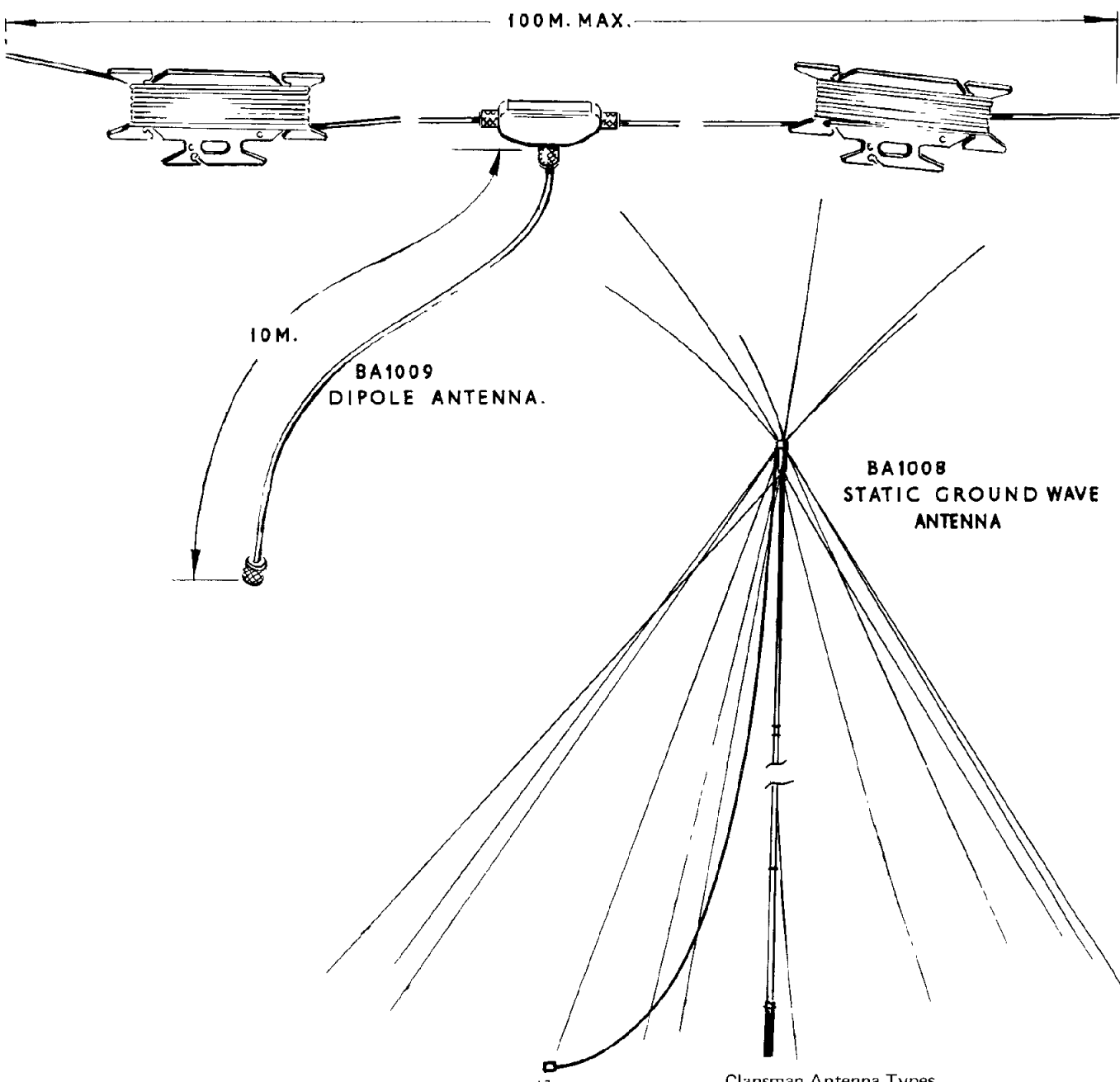
The antennas described have been developed as part of the Clansman range of H.F. equipment. There is an adjustable dipole for short to medium distance sky-wave propagation and a static ground-wave antenna for extended ground-wave propagation. The static ground-wave antenna acts as a top loaded vertical antenna from 1.5 to 20 MHz and a biconical antenna from 20 to 30 MHz.

Both types of antenna are in portable kit form for ease of stowage and to provide the mobility necessary in a military environment. Ease of erection and adjustment have been the keynote of the design philosophy.

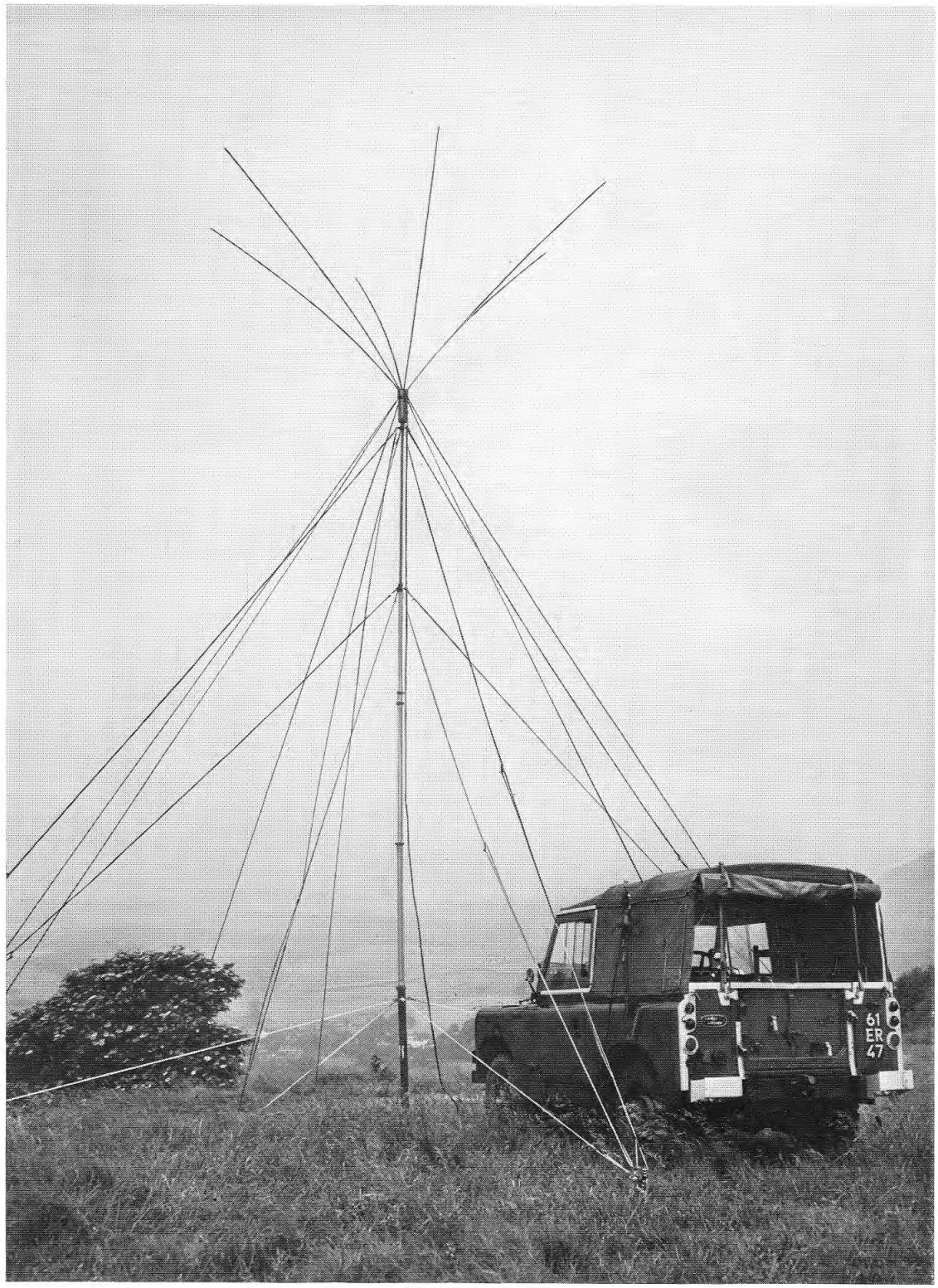
The antennas are intended for use when mobile units are performing a static function, or where an improved signal strength is required over that obtained from a whip antenna; for ground-wave signals; or when communication is required over distances where sky-wave propagation is essential.



H.F. Mobile Antennas



Clansman Antenna Types



Static Ground Wave Antenna

STATIC GROUND-WAVE ANTENNA BA. 1008.

Introduction

The antenna has been designed primarily to provide ground-wave coverage over the frequency range of 1.5 to 30 MHz, although as the vertical polar diagram shows, it has an angle of radiation suitable for short to medium distance sky-wave propagation over the frequency range 20–30 MHz.

The static ground-wave antenna consists of a frequency independent biconical section for the frequency range 20 to 30 MHz and a top loaded vertical radiator for frequencies between 1.5 and 20 MHz.

The biconical section consists of a polypropylene head which supports six upper and six lower elements. The upper elements are two section fibreglass rods, and the lower elements copper/terylene braid with a p.v.c. outer covering. Power is applied from a 50 ohm source with or without an A.T.U. by means of a coaxial cable 10 metres long.

The outer braid of the coaxial cable is used as a vertical radiator over the frequency range 1.5 to 20 MHz, with the biconical section acting as the top capacity loading. An A.T.U. is required for this frequency coverage.

Electrical Performance

The radiation efficiency of the top loaded vertical antenna shows the following improvements over a 3.6 metre whip antenna.

Frequency MHz	Gain dB
1.5 to 8	8
8 to 12	3
12 to 20	0

The gain improvement over a 4 metre whip for the biconical antenna over the frequency range 20 to 30 MHz is as follows:

Frequency MHz	Gain dB
20	1
26	6
30	4

The V.S.W.R. is better than 2:1 over the frequency range.

Power Rating

The antenna will operate over a temperature range of —40° to +85°C with an input of 250 watts C.W. Between the temperatures +10° to +30°C the permissible input power level is increased to 400 watts C.W.

Portability

For ease of transportation the antenna is supplied in kit form in a carrying bag. The weights of the various component parts are as follows:

	Kg.	lbs.
Antenna Rods	2.84	6
Biconical Head	1.49	3
Pegs and Guys	2.84	6
Carrying Bag	0.5	1
Total Kit	7.67	16

Mast

The antenna is mounted on a 9 metre telescopic mast which is easily erected by one man.

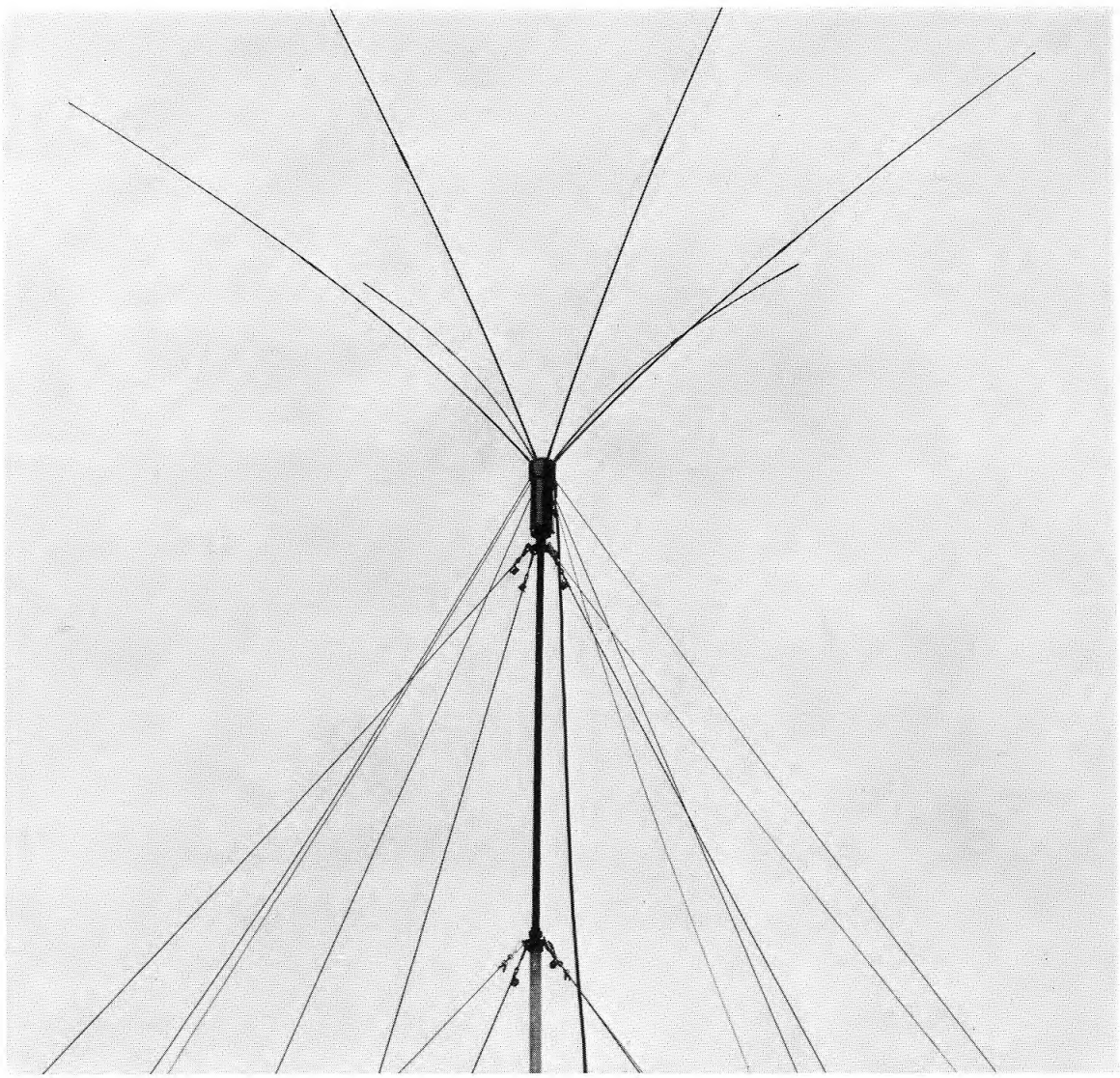
The mast consists of 7 telescopic sections, six of steel and the seventh or bottom section of fibreglass, to isolate the mast from ground.

A plate is fixed to the top of the bottom section to act as a fixing point for the lower guy ropes which are used to steady the mast during erection. Two other stay-plates are fitted to the mast, one on section 5 and the other on the top section.

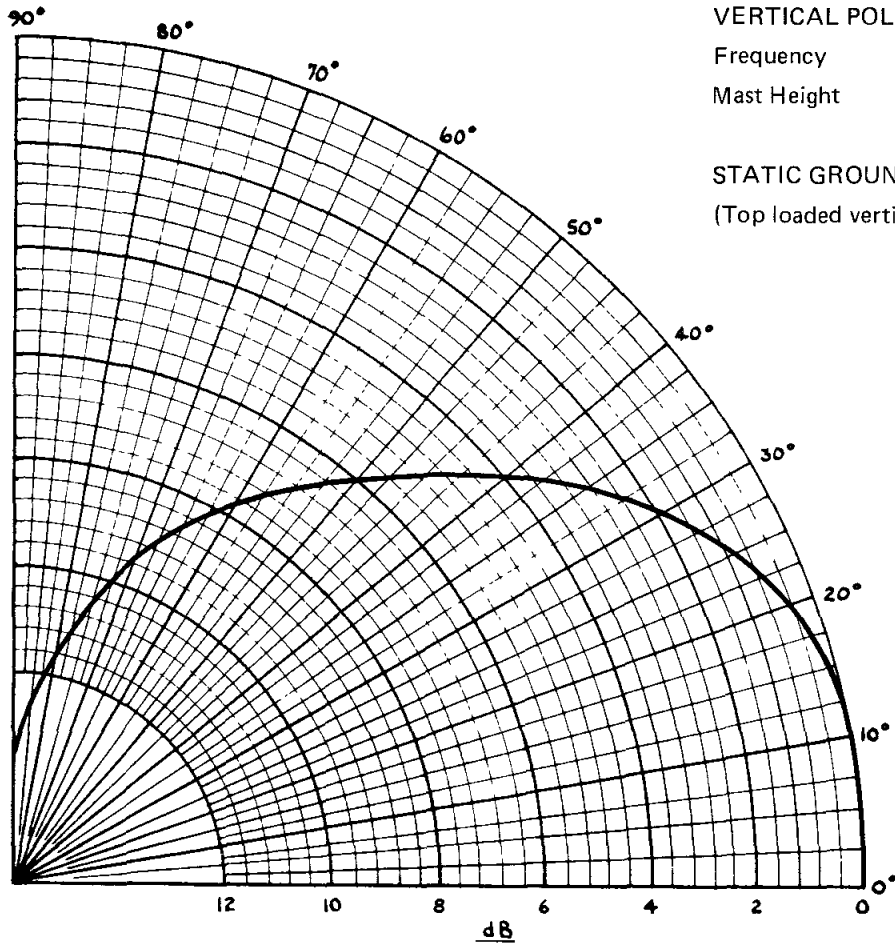
Each section of the mast has a locking ring which enables any section to be locked at any point up to its full extension.

The dimensions of the mast are as follows:

Closed length	:	1.55 metres (5 ′-0″)
Extended length	:	9 metres (29 ′-6″)
Diameter bottom section	:	66.8 mm ($2\frac{1}{2}$″)
Diameter top section	:	25.4 mm (1″)
Weight	:	9.1 kg. (20 lbs)
Finish	:	Olive Drab to DEF 1059



Static Ground Wave Antenna Bi-conical detail



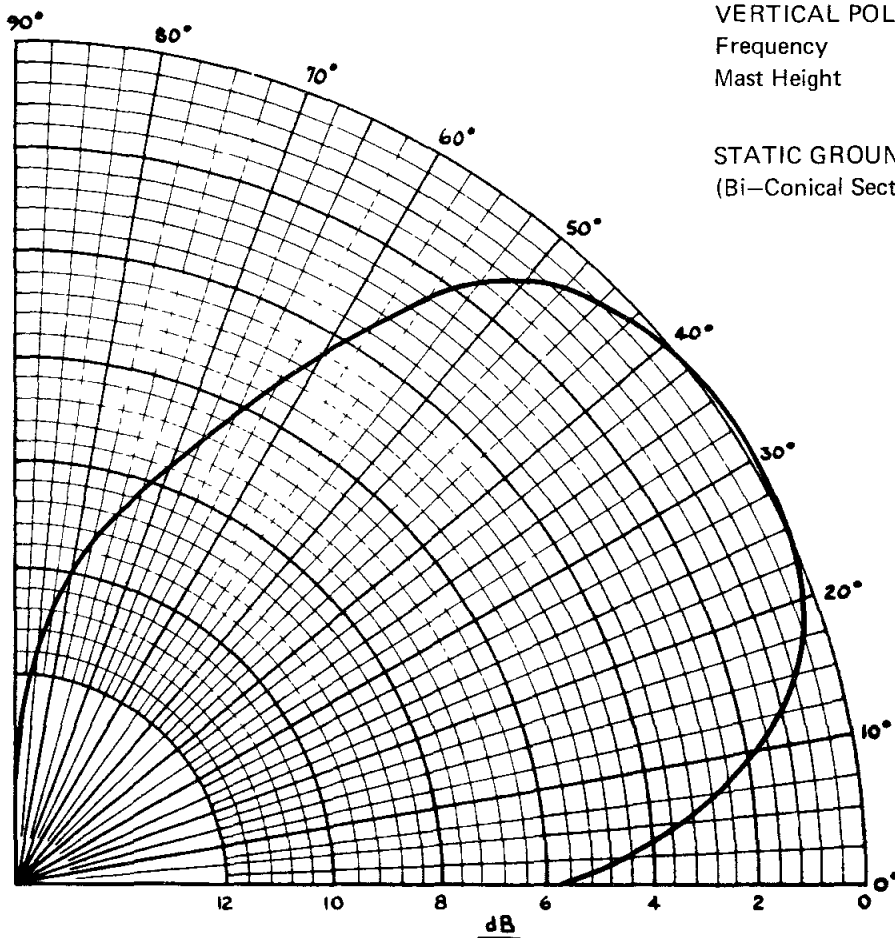
VERTICAL POLAR DIAGRAM "A"

Frequency 1.5 – 20 MHz

Mast Height 9 Metres

STATIC GROUND WAVE ANTENNA

(Top loaded vertical)



VERTICAL POLAR DIAGRAM B

Frequency 20–30 MHz

Mast Height 9 metres

STATIC GROUND WAVE ANTENNA

(Bi–Conical Section)

Mobile Whip Antenna

DIPOLE ANTENNA BA. 1009.

The dipole antenna is intended for short to medium range sky-wave propagation over the frequency range 1.5 to 30 MHz.

The dipole consists of a central insulated moulding to which each side of the dipole and the coaxial cable are terminated. The dipole itself is made from 2 x 50 metres of copper/terylene braid with p.v.c. outer insulation. The braid is wound onto a moulded flat plastic former which acts as stowage for the braid, and also as an end insulator when the dipole is in use.

The dipole is marked at 1 metre intervals throughout its length to enable it to be set for a specific frequency, the required length being obtained by reference to a length v. frequency calibration chart.

The two wires of the dipole are unwound from the stowage formers for the required distance and secured in the notches provided in the moulding. The dipole can then be erected on whatever supports are available. The dipole kit is complete with 10 metres of coaxial cable and the supporting halyards for the ends of the dipole.

One half of the dipole may be used as a long wire antenna in situations where it is impracticable to support both ends of the wire dipole. Such an arrangement affords considerable ground-wave advantage or as an alternative sky-wave antenna.

MOBILE ANTENNA BA. 1010.

Where H.F. communication is required to and from vehicles, and mobility is a prime consideration, the obvious choice of antenna is a short vertical whip. An antenna of this type has formed part of the Clansman development programme for use over the H.F. range of 1.5 to 30 MHz.

The BA. 1010 whip antenna comprises a base insulator and three standard whip 'F' sections, as currently used by the British Army, giving a total whip length of 3.6 metres.

The whip sections are copper coated steel, each 1.22 metres long, designed to withstand combat conditions in all environments likely to be encountered.

The base assembly comprises an insulator, a spring loaded section and an adaptor which attaches the whip to the spring loaded section. The spring section is designed to absorb the impact shock which occurs when a whip strikes trees or other obstacles when the vehicle is in motion.

The R.F. connection is made either via a flying lead which forms an integral part of the base assembly, or by a coaxial 'C' type connector on the adaptor. The flying lead is insulated to withstand the high voltages that may occur at the low frequency end of the range. The horizontal radiation pattern of the whip antenna is circular, although this may be modified slightly by the geometry of the vehicle and by the environment in which the vehicle is working; for example, proximity to buildings, dense forest or jungle.

Radiation in the vertical plane is low angle and ideally suited for ground-wave propagation.

SPECIFICATION FOR UK VRC 321

General

The UK VRC 321 is a medium power H.F. Radio Station designed primarily for use as a vehicle set but can be used as a ground station. It consists of the following items:

Receiver Transmitter RT.321		Nato No. 5820-99-114-3385
Tuner Unit R.F. 25 W.		Nato No. 5820-99-114-3386
Interconnecting and Supply Cables		According to the particular demands of the installation
Mountings.	Shock Mounts	B.A. 1064
	Rigid Mounted	B.A. 1065

Frequency Coverage

Operates at any frequency in the band 1.5000 to 29.9999 MHz selected in 100 Hz steps.

Operational Modes

Designed for the following modes of operation.

USB	(A3J)
DSB	(A3)
CW	(A1)

In addition facilities are available for A.T.R. (F1, when used in conjunction with an ancillary Modem).

Operational Facilities

Frequency selection is by means of decade switches.

It is possible to reduce the output power by approximately 10 dB.

It is possible to modulate, key and listen to the station either with audio gear connected directly to the receiver/transmitter, or with a vehicle harness system, or from a point up to 3 Km away by means of 2 wires connected to the receiver/transmitter.

Means are provided to reset the reference frequency without breaking the equipment seal.

Power Supply

The station operates without damage from a nominal 28 V d.c. supply having the following characteristics.

Steady State Voltage in the range 20–32 Volts d.c.

Ripple (0-100 KHz) 7 V Peak to Peak (Ripple troughs not to drop below 20 V).

Surges of up to 80V for 50 mSec.

Spikes of up to $\pm$ 600 V for 10 μSec.

Neither side of the input supply is earthed in the equipment.

Frequency Stability

The stability of the reference frequency is such that the frequency error at any supply voltage or ambient temperature in the range does not exceed 7 parts in 10^7 during a period of six months.

The error during a period of one month for the same causes does not exceed 1.5 parts in 10^7.

The peak deviation of the nominal carrier does not exceed 5 Hz.

Bandwidth

The overall bandwidth of the station is as follows:

DSB	6 dB bandwidth not less than 5.5 KHz
	60 dB bandwidth not greater than 13 KHz
USB and CW (Wide)	6 dB bandwidth not less than 2.7 KHz
	45 dB bandwidth not greater than 6 KHz
	60 dB bandwidth not greater than 10 KHz
CW (Narrow)	6 dB bandwidth not less than 200 Hz
	20 dB bandwidth not greater than 1 KHz
	45 dB bandwidth not greater than 2 KHz

Frequency of Emission

On DSB and CW the frequency of emission is the nominal frequency as indicated by the decade switches.

On USB the suppressed carrier frequency is –2 KHz relative to the nominal frequency.

AF Response

The AF response of the receiver and the transmitter is between $\pm$ 2 dB relative to 1 KHz over the band 300 to 3000 Hz.

Tuning Indication

Means are provided on the Tuner Unit R.F. to indicate that it has been tuned for minimum reverse current to the transmitter.

Duty Cycle

The station is capable of continuous transmission on all modes at any ambient temperature up to 55°C. After a long period of transmission at high ambient the output will be reduced automatically to protect the equipment.

Power Consumption

Full Power Transmit:	Not greater than 5 Amps average on S.S.B. at nominal 28 Volts d.c.
Receive:	Not greater than 1.2 Amps at nominal 28 Volts d.c.

Operational Delay Time

The station is ready for operation in not more than 10 seconds after switch on.

Protection

The station is protected against permanent damage due to misconnections, open and short circuit and mismatched antennas, misoperation of any control, incorrect polarity supply, and open or short circuit interconnecting cables.

Electromagnetic Interference

The station meets Category A and B1 performance to specification TS1400.

Interconnections

Interconnection between units is via cables and connectors mounted on the front panels.

Serviceability

The units are designed to facilitate rapid fault location and repair by the replacement of sub-units or sub-assemblies.

Mounting

Facilities are provided to mount the units in either soft skinned or armoured vehicles so that the equipment will withstand the mechanical stresses present. When mounted in an armoured vehicle the sway space requirement does not exceed 30 mm in each direction.

Reception

Sensitivity

With a 2 μV EMF signal from a 50 ohm source the USB output at 1 KHz is not less than 50 mW into 150 ohms.

Noise Factor

On all modes the noise factor is not greater than 16 dB (i.e. approximately 1.0 μV EMF on SSB for 10 dB Signal + Noise-to-Noise ratio).

AF Output

The audio output into a 150 ohm load is not less than 50 mW and into a 75 ohm load not less than 80 mW.

Automatic Gain Control

The audio output increases by not more than 6 dB when the RF input is increased from 2 μV to 1 Volt EMF.

Gain Control

Means are provided to reduce the audio output by not less than 40 dB.

CW Output

The frequency of the AF output when receiving a CW signal on the nominal frequency is at a fixed frequency of 2.0 KHz.

Image and I.F. Rejection

The rejection of the image frequencies and the two I.F.'s is not less than 90 dB.

The rejection of the in-band sub-harmonics of the first I.F. is not less than 80 dB.

Intermodulation

The output produced by two 6.3 mV EMF unwanted signals at ± 75 KHz and ± 150 KHz relative to the nominal frequency is not greater than that produced by a 0.63 μV EMF wanted signal.

Blocking

The Signal-to-Noise ratio of a 1 μV SSB signal is reduced by not more than 10 dB by unwanted signals as follows:

Nominal Frequency	±10% Frequency Separation
1.5—10 MHz	200 mV. EMF
10 —15 MHz	600 mV. EMF
15 —30 MHz	2.0 V. EMF

Antenna Tuner Unit R.F. 25 W.

The Tuner Unit tunes and matches to a VSWR of not greater than 1.2 to 1 over the whole band.

Antenna Connection

The Tuner Unit provides a single screw terminal for the mobile, end fed, and static ground-wave antenna below 20 MHz.

Ancillaries

The station is fully compatible with the following ancillary items.
Clansman Audio Gear to Specification No. TS. 1231
Clansman Harness to Specification No. TS. 1192A
Clansman Adaptor Telegraph Radio to permit F1 operation.
Clansman Radio Frequency Selector Unit to Specification BA. 1069.
A.C. Power Supply Unit 46 Amp to Specification No. BA. 1007.

Transmission

Output Power

The minimum output power of the station is as follows:

	Medium Power	Low Power
USB Single Tone	25 W	2 W
USB Multi-Tone	40 W PEP	2 W PEP
DSB Carrier Unmodulated	25 W	2 W
CW	25 W	2 W

AF Input

The station is fully modulated by a single tome input of between 2mV and 40mV into 300 ohms at at 1 KHz. On D.S.B. full modulation is at a modulation depth of not less than 85%. Means are provided to increase the mean modulation depth by limiting the peaks of the audio input.

Output Control

Automatic Level Control is provided to control the output of the transmitter to prevent over dissipation or excessive distortion.

Harmonics

The harmonics at the output of the RT. 321 plus T.U.R.F. 25 are not less than 40 dB below the fundamental.

Distortion

With two equal modulation tones the third intermodulation products are not less than 25 dB below either tone.

Unwanted Emissions

All other unwanted emissions at a frequency separation greater than 10% from the required frequency are not less than 100 dB below PEP.

The noise output in a 3 KHz bandwidth at ± 10% frequency separation is not less than 110 dB below PEP.

Sidetone

Transmitter sidetone is available on all modes and provides an indication of correct operation.

Size and Weight

The individual unit sizes and weights of the station are:

	Height	Depth	Width	Weight
R.T. 321	215 mm.	355 mm.	230 mm.	18 Kg.
T.U.R.F. 25 W.	140 mm.	280 mm.	215 mm.	10 Kg.

Environment

The station operates in the following environmental conditions:

Temperature	—37°C to + 52°C. (Storage —40°C to + 65°C).
Humidity	100% at up to 30°C
Altitude	Up to 2,500 metre.
Solar Radiation	Incident radiation up to 1.35KW/m^2 for 6 hours per day.

The units meet the tests taken from DEF 133 table L3 listed in Appendix 1.

Interchangeability

All units and sub-units of the equipment are mechanically interchangeable without any modification or radio frequency realignment of such items.

SPECIFICATION FOR UK VRC 322.

General

The UK VRC 322 is a medium power H.F. Radio Station designed primarily for use as a vehicle set but can be used as a ground station. It consists of the following items:

Receiver Transmitter RT.321		Nato No. 5820-99-114-3385
Amplifier RF 300W		Nato No. 5820-99-114-3387
Tuner Unit RF 250 W.		Nato No. 5820-99-114-3388
Interconnecting and Supply Cables		According to the particular demands of the installation.
Mountings.	Shock Mounts	BA1064
	Rigid Mounted	BA1065

Frequency Coverage

The station operates at any frequency in the band 1.5000 to 29.9999 MHz selected in 100 Hz steps.

Operational Modes

The station operates in the following modes.

USB	(A3J)
DSB	(A3)
CW	(A1)

In addition facilities are available for A.T.R. (F1), when used in conjunction with an ancillary modem.

Operational Facilities

Frequency selection on the RT.321 is by means of decade switches.

Tuning of the Amplifier RF and Tuner Unit RF is by means of the minimum number of controls consistent with a rapid and straightforward tuning sequence.

It is possible to reduce the output power by approximately 10 dB and 20 dB.

It is possible to modulate, key and listen to the station either with audio gear connected directly to the receiver transmitter, or with a vehicle harness system, or from a point up to 3Km away by means of 2 wires connected to the receiver transmitter.

Means are provided to reset the reference frequency without breaking the equipment seal.

Power Supply

The station operates without damage from a nominal 28 V. d.c. supply having the following characteristics.

Steady State Voltage in the range 20-32 Volts d.c.

Ripple (0-100 KHz) 7V Peak to Peak (Ripple troughs not to drop below 20 V).

Surges of up to 80 V for 50 mSec.

Spikes of up to $\pm$ 600 V for 10 μSec.

Neither side of the input supply is earthed in the equipment.

Frequency Stability

The stability of the reference frequency is such that the frequency error at any supply voltage or ambient temperature in the range does not exceed 7 parts in 10^7 during a period of six months.

The error during a period of one month for the same causes does not exceed 1.5 parts in 10^7.

The peak deviation of the nominal carrier does not exceed 5 Hz.

Bandwidth

The overall bandwidth of the station is as follows:

DSB	6 dB bandwidth not less than	5.5 KHz.
	60 dB bandwidth not greater than	13 KHz.
USB and CW (Wide)	6 dB bandwidth not less than	2.7 KHz.
	45 dB bandwidth not greater than	6 KHz.
	60 dB bandwidth not greater than	10 KHz.
CW (NARROW)	6 dB bandwidth not less than	200 Hz.
	20 dB bandwidth not greater than	1 KHz.
	45 dB bandwidth not greater than	2 KHz.

Frequency of Emission

On DSB and CW the frequency of emission is the nominal frequency as indicated by the decade switches.

On USB the suppressed carrier frequency is –2 KHz relative to the nominal frequency.

AF Response

The AF response of the receiver and the transmitter is between ± 2 dB relative to 1 KHz over the band 300 to 3000Hz.

Tuning Indication

Means are provided on both the Amplifier RF and the Tuner Unit RF to indicate that they have been tuned correctly.

Duty Cycle

The station is capable of continuous full power transmission on all modes at any ambient temperature up to 55°C. If this requirement presents severe additional problems over a small part of the band when using a mobile antenna some relaxation after a period of 20 minutes may be required.

Power Consumption

Full Power Transmit:	Not greater than 46 Amp at 25V. input.
Receiver with Amplifier at Stand By:	Not greater than 12 Amp.
Receiver with Amplifier Off:	Not greater than 1.5 Amp.

Warm-up Time

The station is ready for operation in not more than two minutes after switch on.

Protection

The station is protected against permanent damage due to misconnections, open and short circuit and mismatched antennas, misoperation of any control, incorrect polarity supply, failure or blockage of the cooling system, and open or short circuit interconnecting cables. The operator is protected against danger from High DC or RF voltage.

Electromagnetic Interference

The station meets Category A and B1 performance to specification TS1400.

Interconnections

Interconnections between units is via cables and connectors mounted on the front panels. The control cables between the Amplifier RF and both the Receiver/Transmitter and the Tuner Unit RF use similar connectors.

Serviceability

The station includes simple inbuilt monitoring facilities to indicate which unit is faulty in the event of a station failure. The units are designed to facilitate rapid fault location and repair by the replacement of sub-units or sub-assemblies.

Mountings

Facilities are provided to mount the units in either soft skinned or armoured vehicles so that the equipment will withstand the mechanical stresses present. When mounted in an armoured vehicle the sway space requirement does not exceed 30mm in each direction.

Transmission

Output Power

The minimum output power of the station is as follows:

	High Power	Medium Power	Low Power
USB Single Tone	175 W	25 W	2 W
USB Multi-Tone	300 W PEP	40 W PEP	2 W PEP
DSB Carrier Unmodulated	175 W	25 W	2 W
CW	200 W	25 W	2 W

AF Input

The station is fully modulated by a single tone input of between 2 mV and 40 mV into 300 ohms, at 1 KHz. On DSB full modulation is at a modulation depth of not less than 85%.

Means are provided to increase the mean modulation depth by limiting the peaks of the audio input.

Output Control

A.L.C. is provided to control the output of the station to prevent over dissipation or excessive distortion.

Harmonics

On high power the harmonics at the output of the amplifier are not less than 50 dB below the fundamental.

Distortion

With two equal modulation tones the third order intermodulation products are not less than 30 dB below either tone on high power.

Unwanted Emissions

All other unwanted emissions at a frequency separation greater than 10% from the required frequency are not less than 100 dB below PEP.

The noise output in a 3 KHz bandwidth at $\pm$ 10% frequency separation is not less than 110 dB below PEP.

Sidetone

Transmitter sidetone is available on all modes and provides an indication of correct operation.

Reception

Sensitivity

With a 2 μV EMF signal from a 50 ohm source the USB output at 1 KHz is not less than 50 mW into 150 ohms.

Noise Factor

On all modes the noise factor is not greater than 16 dB (i.e. approximately 1 μV EMF on SSB for 10 dB Signal -- Noise-to-Noise ratio.)

AF Output

The audio output into a 150 ohm load is not less than 50 mW and into a 75 ohm load not less than 80 mW.

Automatic Gain Control

The audio output increases by not more than 6 dB when the RF input is increased from 2 μV to 1 Volt EMF.

Gain Control

Means are provided to reduce the audio output by not less than 40 dB.

CW Output

The frequency of the AF output when receiving a CW signal on the nominal frequency is at a fixed frequency of 2 KHz.

Image and I.F. Rejection

The rejection of the image frequencies and the two I.F.'s is not less than 90 dB.

The rejection of the in-band sub-harmonics of the first I.F. is not less than 80 dB.

Intermodulation

The output produced by two 6.3 mV EMF unwanted signals at ± 75 KHz and ± 150 KHz relative to the nominal frequency is not greater than that produced by a 0.63 μV EMF wanted signal.

Blocking

The Signal-to-Noise ratio of a 1 μV SSB signal is reduced by not more than 3 dB by unwanted signals as follows:

Nominal Frequency	±10% Frequency Separation
1.5—10 MHz	250 mV. EMF
10—15 MHz	600 mV. EMF
15—30 MHz	2.5 V. EMF

Tuner Unit R.F. 250 W.

The Tuner Unit tunes and matches to a VSWR of not greater than 1.2 to 1 over the whole band.

Antenna Connection

The Tuner Unit provides a single screw terminal for the mobile, end-fed; and static ground-wave antenna below 20 MHz. It also provides a coaxial output for the dipole or static ground-wave antenna above 20 MHz.

Protection

Means are provided to protect the output of the Tuner Unit RF from excessive terminal voltages due to unsuitable antennas.

Size and Weight

The dimensions and weights of the individual units are:

	Height	Depth	Width	Weight
RT.321	215 mm.	355 mm.	230 mm.	18 Kg.
R.F. Amplifier	215 mm.	355 mm.	435 mm.	24 Kg.
T.U.R.F. 250 W.	215 mm.	355 mm.	310 mm.	19 Kg.

Environment

The station operates in the following environmental conditions.

Temperature	—37°C to + 52°C. (Storage—40°C to + 65°C).
Humidity	100% at up to 30°C
Altitude	Up to 2,500 metre.
Solar Radiation	Incident radiation up to 1.35 KW/m² for 6 hours per day.

The units meet the tests taken from DEF 133 table L3 listed in Appendix 1.

Interchangeability

All units and sub-units of the equipment are mechanically interchangeable without any modification or mechanical or radio frequency realignment of such items.

Ancillaries

The station is fully compatible with the following ancillary items.

Clansman Audio Gear to Specification No. TS1231.

Clansman Harness to Specification No. TS1192A.

Clansman Adaptor Telegraph Radio to permit F1 operation.

Clansman Radio Frequency Selector Unit to Specification BA. 1069.

A.C. Power Supply Unit 46 Amp to Specification No. BA. 1007.

SPECIFICATION FOR RADIO FREQUENCY SELECTOR UNIT BA. 1069.

Frequency Range

The unit operates over the frequency range 1.5 to 30 MHz switched in 8 bands at frequencies of 2.0, 3.0, 4.0, 6.0, 9.0, 13.0 and 20.0 MHz.

Selectivity

The selectivity is better than 13 dB at 5% off resonant frequency.

The selectivity is better than 24 dB at 10% off resonant frequency.

Impedances

The unit is designed to operate between source and load impedance of 50 ohm.

R.F. Power

The unit accepts a power of 40 watts in either receive or transmit direction. In the receive mode protection circuits operate at such a power level and normal receive operation is inhibited.

Insertion Loss

The insertion loss is not greater than 2 dB.

Size and Weight

The dimensions and weight of the unit are ;

Height	Depth	Width	Weight
150 mm	355 mm	215 mm	Not greater than 8 Kgm.

Mounting

The preferred position is on top of the RT.321 by means of a top mounting tray identical to that used for the Tuner Unit R.F. 25 W.

Environment

The unit operates in the following environmental conditions:

Temperature	—37°C to — 52°C. (Storage —40°C to 65°C).
Humidity	100% at up to 30°C
Altitude	Up to 2,500 metre
Solar Radiation	Incident radiation up to 1.135 KW m^2 for 6 hours per day.

The unit meets the tests taken from DEF 133 table L3 listed in Appendix 1.

SPECIFICATION FOR POWER SUPPLY UNIT 46 AMP. BA. 1007.

Input Voltage

The unit operates from mains supplies of 120 V. ± 10% and 220 V. ± 10%, 45 to 60 Hz.

Output Voltage

The output is in the range 24 to 32 V d.c. at all load currents from zero to full load.

Input Power

The mains input required for an output of 46 Amps does not exceed 2 KVA.

Output Ripple

The peak ripple on the output does not exceed 2 V.

Protection

The mains supply is protected against failures within the unit. The unit is protected against excessive load currents.

Electromagnetic Interference

The unit meets Category A, and B1 performance to Specification TS. 1400.

Size and Weight

The dimensions and weight of the unit are:

Height	Depth	Width	Weight
215 mm.	355 mm.	310 mm.	38 Kg.

Mounting

Facilities are provided to mount the unit in either soft skinned or armoured vehicles so that the unit will withstand the mechanical stresses present.

Environment

The unit operates in the following environmental conditions.

Temperature	—37°C to + 52°C. (Storage —40°C to + 65°C).
Humidity	100% at up to 30°C.
Altitude	Up to 2,500 metre.

The units meets the tests taken from DEF 133 table L2 listed in Appendix II.

REPAIRS AND MAINTENANCE

The design of the UK VRC 321 and UK VRC 322 systems has been directed towards rapid and unambiguous fault-finding at all maintenance levels. A faulty equipment unit can be identified from the readings on the front panel meter and, upon opening the equipment, any faulty module can be identified by simple voltmeter checks on the test points before any modules are removed. The R.F. performance of individual modules can be checked by connecting a signal generator and R.F. voltmeter to the R.F. connections on each module.

When a faulty module has been isolated the printed wiring boards can be checked by signal level and voltage measurements and subsequent faulty components can be identified by the same means.

The documentation that is available with the equipment will enable these tests to be made by a radio technician without difficulty.

Repairs can range from the replacement of modules to the replacement of individual components within a module. The level at which these repairs are carried out, whether at Divisional, Brigade, or Base Workshops will depend upon the maintenance philosophy of the user as will the spares support required for the maintenance of the equipment.

The calculated Mean Time Between Failures for the Receiver/Transmitter RT321 and the High Power Amplifier is approximately 750 hours. The Mean Time Between Failures for the T.U.R.F.s and A.T.R. Unit is 1500 hours. These figures however are considered to be minimum expectation but in practice the M.T.B.F. is far greater. As a guide to calculating the requirement for technicians the figures quoted can be trebled.

The average time for a technician to identify a fault, repair the unit, and re-test, is 4 hours. The maintenance and repair procedures being carried out with the standard professional test equipment used in Military workshops. Special to type test sets and test jigs are available if required.

VEHICLE INSTALLATION

The many types of armoured, light armoured and soft skinned vehicles in use by various Armed Forces have differing radio equipment requirements, dependent upon the overall communications network in use. This being so there can be no overall plan for installing Clansman radio that will cover all configurations and types of vehicle. Therefore a system harness has been produced that will permit combinations of equipments to be installed in a wide variety of vehicles.

Typical examples of possible combinations are as follows:

Single set H.F. Installation

Two set H.F. Installation

Two set HF/VHF Installation

Three set HF/HF/VHF Installation

Two set HF Low Power/HF High Power

This range of combinations is by no means exhaustive but serves to show the flexibility of the system.

The M.E.L. Equipment Company Ltd. will be pleased to advise in the planning of specific installations.

APPENDIX I

The UK VRC 321, UK VRC 322 and Radio Frequency Selector Unit will meet the following sections of DEF 133 L3 without shock mounting.

DEF 133 TABLE L3

GROUND EQUIPMENT EXPOSED AND IMMERSIBLE

	TESTS	DEF 133 CLAUSE
1.	Visual examination	6.1
2.	Resonance search	8.1
3.	Vibration functional	8.2
4.	Dry heat test 'A'	11.0
5.	Damp heat	11.1
6.	Low temperature exposure test 'B'	12.0
7.	Driving rain	15.1
8.	Immersion test 'C'	15.3
9.	Dust	10.0
10.	Tropical life	11.2
11.	Corrosion, salt	14.0
12.	Toppling	7.4
13.	Bump	7.0
14.	Sealing test 'A' or 'B'	15.5

APPENDIX II

The AC PSU BA. 1007 will meet the following sections of DEF 133 L2 without shock mounting.

DEF 133 TABLE L2

GROUND EQUIPMENT EXPOSED

	TESTS	DEF 133 CLAUSE
1.	Visual examination	6.1
2.	Resonance search	8.1
3.	Vibration functional	8.2
4.	Dry heat test 'A'	11.0
5.	Damp heat	11.1
6.	Low temperature exposure test 'B'	12.0
7.	Driving rain	15.1
8.	Dust	10.0
9.	Tropical life	11.2
10.	Corrosion, salt	14.0
11.	Toppling	7.4
12.	Bump	7.0