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HF RECEIVING ANTENNA SYSTEM, AX8, 14, 19 (PLESSEY TYPES PVS 439, 880, 1120)

GENERAL AND TECHNICAL INFORMATION
REPAIR AND RECONDITIONING INSTRUCTIONS

BY COMMAND OF THE DEFENCE COUNCIL

L.T. Burnett

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C O N T E N T S

THE PLESSEY COMPANY LIMITED

PLESSEY RADIO

SERVICE MANUAL

for

PV439

FLEXIBLE HF RECEIVER AERIAL SYSTEM

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PLESSEY RADIO

MARTIN ROAD WEST LEIGH · HAVANT · HAMPSHIRE

TELEPHONE HAVANT (070 12) 6391 TELEX 86227

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1.1 GENERAL

This manual gives a technical description of the PV349 Aerial System and instructions for its maintenance after installation. The Installation Manual contains instructions for pre-installation testing and the installation of the aerial and associated equipment, also component information.

The aerial system operates over the frequency range 1.5 MHz to 10 MHz and yields simultaneously 24 independent beam outputs centred on bearings at successive 15° intervals in the azimuthal plane. Adjacent beams overlap sufficiently to ensure adequate coverage of all bearing angles. The total weight of the system is about 3 tons 16 cwt.

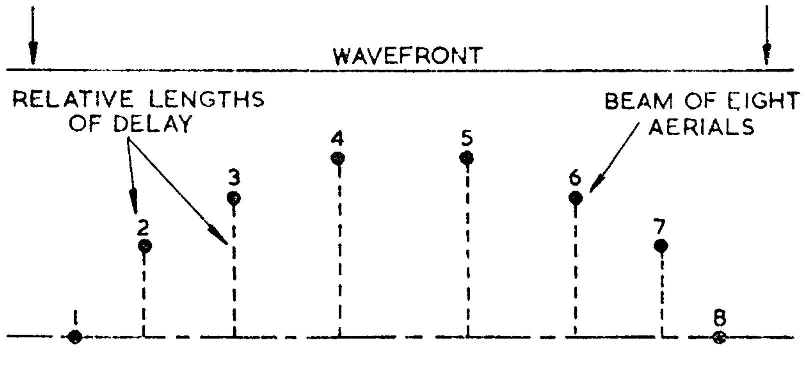
1.2 MECHANICAL DESCRIPTION

The aerial installation employs 24 aerials equally spaced on the circumference of a 500 feet diameter circle. The aerials, which are approximately 42 feet high, are in the form of elevated feed monopoles, the feed point being about 11 feet above gound level. Each mast consists of four 10 feet lengths of triangular section steel lattice (the side of each sectiob being bolted together during assembly) with a strong glass fibre insulating section at the feed point which incorporates a ferrite cored impedance matching transformer and a lightning protection spark gap. The mast rests on a steel base plate and is electrically earthed by means of six earth stakes driven into the ground. The aerial is guyed with six terylene ropes, three attached at a height of 22 feet and three at 42 feet, these being secured to three earth pickets. The assembled aerial weighs about 300 lbs. The ground area occupied by the circle of aerials is roughly 5 acres.

Twentyfour feed cables of equal electrical length, normally laid on the ground, convey the aerial signals to the beam forming cabinet located in a building at or near the centre of the aerial circle. The cabinet dimensions are 26" x 25" x 78" high and the assembly weighs approximately 5 cwt.

1.3 BRIEF CIRCUIT DESCRIPTION

Each aerial signal is split by means of hybrid transformer units into eight independent paths which include fixed time delays produced by various lengths of delay cable. Each of the 24 beams is formed by combining together the delayed signal in one particular path from each of eight adjacent aerials.



The accompanying diagram illustrates the relationship between any eight adjacent aerials of the system and the plane wave front of an incident signal. The signal direction of arrival is shown perpendicular to the line joining aerials 1 and 8 and the delays are chosen to give optimum beam reception in this direction. The wavefront arrives at aerials 4 and 5 before it arrives at 3 and 6 and at 3 and 6 before reaching 2 and 7, and so on. The lengths of the perpendicular lines from each aerial to the line joining aerials 1 and 8 represent the electrical delay lengths required to put all the signals for one beam into phase, assuming the incident signal arrives horizontally. The system has been optimised for signals arriving from an elevation of 15° and hence the above delay lenghts have been reduced by approximately 3½% to accommodate this.

The signals from each aerial are also made available at auxiliary sockets at the front of the cabinet. The beam and aerial output signals may be connected to suitable receivers, either directly or via active multi-couplers. Any output socket not in use should be terminated in one of the BNC 75Ω loads included with the equipment. Additional lightning protection is provided at the inputs to the cabinet.

1.4 SYSTEM APPLICATIONS

The 24 signals from the beam-forming cabinet can be applied directly to any HF receiver of nominal 75Ω input impedance such as the Plessey PR155 series of MF/HF Communication Receivers, or can be fed to a configuration of Antenna Multicoupler Switching and Amplifier Systems from the Plessey PV132-138 and PV920 series which have been designed by Plessey Radio to provide outputs for use with a large number of receivers.

The Beam Selector Set Plessey Type PVS560 has been designed as ancillary equipment to the Antenna System. Used in conjunction with a suitable HF Communication Receiver, for example the PR155, it provides a simultaneous visual display of the relative amplitudes of the beams (sum or difference) or alternatively, the antenna auxiliary outputs. Additional signals, such as those from other antennas or from a generator, can also be displayed for comparison.

1.5 TECHNICAL SUMMARY

AERIAL ARRAY

Diameter	500 ft.
Height of Aerials	42ft., consisting of 4 x 10 ft. sections and 1 x 2 ft. insulating section.
Weight	Total weight of array 3 tons 5 cwt.
Area of Array	Less than 5 acres.
Total Area Recommended	Square or circular area of 20 acres free from any large metal structure.
Type of aerial	Elevated Feed Monopole, the feed point being 11 ft. above the ground.
Frequency Coverage	2 to 8 MHz, but operable over the range 1.5 to 10MHz.
Directional Properties	Optimised for signal elevations of 15° but satisfactory up to 60°.

BEAM FORMING CABINET

Hut Dimensions	10 ft. x 10 ft., sufficient for equipment and one operator.
Cabinet Dimensions	26" x 25" x 78" high.
Weight	5 cwt (approx.).
Outputs	24 beam outputs and 24 aerial auxiliary outputs, suitable for 75 ohm input receiving equipment.

Note: All BSF threaded items in this equipment are now replaced by Unified threaded items.

Therefore in each case, in the manual, for "BSF" read "UNC" and substitute the nearest equivalent Unified diameter.

2. PRE-INSTALLATION ELECTRICAL TESTS

2.1 GENERAL

It is recommended that the following electrical tests be performed before installing the Flexible HF Receiving Aerial System.

The apparatus required for the tests detailed below consists of an Avometer Model 8 and a 6BA screwdriver. On no account should a Megger or other high voltage insulation tester be used in testing, as this may cause damage to the secondary lightning diverter diodes and the input circuit of the hybrid splitting units.

2.2 INSULATING SECTION (Fig. 1)

These tests concern only the brace plate assembly of the insulating section (Fig. 1), at this stage separate from the upper braids and insulated rods. Set the Avometer to read ohms and connect its leads to the spark gap terminals, one of which is at the centre of the top of the white Delrin block and the other is on the underside of the brace plate. Rotate the centre top screw clockwise until it just makes contact with the lower screw, as indicated by a continuity reading on the meter. Finally rotate the top screw in an anti-clockwise direction for one quarter turn (i.e. 90°) to give the correct gap. Remove the meter.

Using the Avometer, verify that continuity exists between the transformer earthing braids (soldered to the outer conductor of the coaxial socket) and (i) the inner conductor of the coaxial socket and (ii) the aerial terminal of the transformer.

Repeat these tests for each brace plate assembly.

2.3 FEEDER CABLES (TYPE CODED 'D')

Test the continuity of the inner and outer conductors. The order of resistance to be expected is 1.5 ohms for the inner wire and 0.5 ohm for the outer braid.

Using the Avometer on its ohmX100 resistance range, verify that a resistance greater than 10Mohms exists between the inner and outer conductors of each feeder cable.

2.4 CABINET CABLES (Figs. 2 & 2A)

It will be observed that the cabinet contains a large number of coaxial cables, of different lengths and types, which are identified by coding letters A,B,C,E,F and G (5.4). The circuit diagram of the system (Fig.2) gives complete information about the routeing of the cables.

Test the inner and outer conductors of all cables for continuity using the Avometer and also make sure that isolation exists between the inner and outer conductor of each cable. These tests should be undertaken with reference to Fig.2, to establish not only that the cables are in good order but also that they are fitted in the correct positions. See 4.4.3 for the method of extracting the miniature coaxial sockets from their plastic shells.

Note that each of the cables E, F and G can be tested in conjunction with two cables type B. It will only be necessary to disconnect these cables to isolate a fault. Verify that cables E, F and G are plugged into the correct sockets. Cables A, B and C should have a continuity resistance of 0.1ohm or less. The approximate values of resistance to be expected in continuity tests on cables E. F and G are as follows:-

Cable	Inner	Outer
E	1.5 ohms	0.25 ohms
F	1.2 ohms	0.2 ohms
G	0.6 ohms	0.1 ohms

In the isolation test, the meter should indicate a resistance greater that 10Mohms.

2.5 BNC 75 ohms DUMMY LOADS

Measure the resistance between the inner and outer connection of each of the 48 BNC 75 ohms dummy loads using the Avometer on ohm ÷ 100 resistance range. It should be 75 ohms ±1%.

3. INSTALLATION

3.1 GENERAL

The sections below describe the complete installation of the Flexible HF Receiving Aerial System, aided by drawings and photographs.

All the assemblies and sub-assemblies necessary are listed in Chapter 5 of this manual.

3.2 MARKING OUT THE AERIAL SITE

3.2.1 General (Fig. 3)

It is assumed that a suitable site has been selected. Large variations in ground level, for instance tens of feet, would make a site unsuitable, but variations in level of several feet would not unduly impair the performance of the system. As noted in Chap.1, the circle of aerials occupies about 5 acres. The site should be free of sizeable metallic structures, such as iron barns and pylons, for a concentric circular area of at least 20 acres, i.e., twice the diameter of the aerial circle.

Two methods are here suggested for marking out the aerial positions. It should be borne in mind that the radial directions of the aerials from the centre of the circle do not correspond with the directions at which the beams have optimum response. The optimum beam directions lie midway between the radials to adjacent aerials. Unless it is especially desired to align a beam in a particular direction, it is suggested that one of the 24 beams be aimed towards true north.

Fig. 3 indicates schematically the disposition of the 24 aerials with relation to the centre of the circle, at which point the building housing the beam forming cabinet is to be positioned after marking out the site.

3.2.2 Method 1

The equipment required for this method comprises:-

(a) One steel measuring tape, 300 ft. long.

(b) One theodolite, accuracy of setting not worse than 5 minutes of arc, together with a suitable tripod and plumb bob.

(c) One 8 ft. ranging pole.

(d) Twenty-five stakes, approximately 3 ft. long.

(e) One hammer, 2 lb.

(f) One magnetic compass, calibrated at intervals not greater than 0.5 degree and fitted with sights.

Two operators are required.

Note: The ground at the centre point should be the most level available because the control building for the beam forming cabinet is to be placed here.

A stake should be driven into the ground at the centre point. It is assumed that one beam is to be aimed towards true north. The radial direction of the first aerial east of true north is therefore $7\frac{1}{2}^{o}$ E of N. The magnetic compass provided should be used to obtain an initial sighting of this direction from the centre point, making due allowance for the difference between true north and magnetic north. For example, if magnetic north for the particular place is 9^{o}W of true north, then the compass sighting is $16\frac{1}{2}^{o}$ E of N (magnetic). Having noted the approximate direction, the steel measuring tape is laid out from the centre along that line, being held by one person whilst a second person, also carrying a hammer, the stakes and ranging pole, walks out 250 ft. The tape should now be straightened and pulled taut, with its zero mark aligned with the centre stake. The final positioning consists of re-sighting the radial direction from the centre-point and guiding the operator on the circumference of the circle to the correct position by use of the ranging pole. One stake should be lightly driven in on the radial and then the steel tape should be straightened and tautened while just touching the stake. Holding the tape in tension, the stake should be positioned at the 250 ft. point (within a radius of 6 in. about this point); finally, drive the stake well into the ground, leaving about 2 ft. above the surface.

The theodolite should now be erected with its centre vertically above the centre stake and the telescope aligned on the newly positioned stake at the circumference. The theodolite azimuth reading is to be noted (or set to zero). In order to determine the position of the adjacent aerial, the theodolite telescope must be rotated eastward or westward by exactly 15^{o}. The operator at the circumference should now position the ranging pole on the radial as indicated by the observer at the theodolite. The measuring tape should next be pulled across to the new position and straightened along the line from the centre stake to the pole. Then, as before, by making the tape taut, the second aerial position at a 250 ft. radius ($\pm$6 in.) can be marked by driving in a stake alongside the tape measure.

The positions of the remaining 22 aerials can be similarly determined in turn by stepping round the theodolite telescope exactly 15^{o} at a time. Note that it may prove necessary to remove bushes or even small outcrops of rock. It is assumed, however, that as far as possible the area will have been vetted for its freedom from such obstacles.

As a final check, the distance between neighbouring stakes should be measured. The distance should be 65 ft. 5 in. $\pm$ 1ft. 0in.

3.2.3 Method 2 (Fig. 4)

The equipment required for this method is as for method 1 plus one extra theodolite; a third operator is also required.

This method is the same as method 1 up to the point of determining the position of the first aerial. The second aerial to be sited is the diametrically opposite one. It is suggested that this be positioned by making use of one of the theodolites at the centre of the circle as in method 1. The theodolite is trained on the stake for aerial No.1 and the azimuth reading noted or set to zero. The theodolite is then rotated through exactly 180° to give the alignment for the diametrically opposite aerial, the position of which is found in the manner described for the second and subsequent aerials in method 1.

The purpose in now describing an alternative scheme for positioning the marker stakes for the remaining 22 aerials is that, in general, the site for the aerial array will not be devoid of bushes, causing difficulty in the alignment of the measuring tape.

The method suggested is as follows. The two theodolites are erected vertically above the two diametrically opposed aerial stakes. The instruments are trained on each other and set to zero in azimuth. The theodolites are then rotated to the angles specified in the table in Fig. 4 while the third operator moves his ranging pole to the instructions of the two theodolite operators who direct him in turn until the pole is correctly positioned in the sights of both instruments. A stake is then driven in to mark the spot for the centre of the aerial. It should be noted that the directions from each theodolite to the aerial position are mutually perpendicular so that provided each theodolite is accurately positioned and aligned the aerial location is precisely determined.

Fig. 4 illustrates the method described above, and lists the angles to which the theodolites, designated A and B, should be set for each of the 22 aerial positions, the numbers of the aerials corresponding with the figures on the diagram.

As a final check, the distance between neighbouring stakes should be measured. This distance should be 65 ft. 5 in. ± 1 ft. 0 in.

3.3 AERIAL ERECTION

3.3.1 General

The following description of the recommended method of assembling and erecting the aerials is supported by drawings and photographs (Fig 1 and Figs. 5 to 21).

A minimum team of six riggers (including a foreman) is necessary for the erection.

3.3.2 Aerial Assembly (Figs. 1, 5 to 10 & 15)

As mentioned in 1.2, each of the aerials has a length of about 42 ft. The aerial is made up of four 10 ft. lengths of triangular section steel lattice plus a 2 ft. long glass fibre insulating section. The bottom of the aerial is bolted to a triangular base plate and through this to a 2 ft. x 2 ft. steel plate. The top of the aerial is also capped with a plate.

Note: It is essential that the aerial assembly operations be carried out exactly in the order given below.

Assemble, first, each of the 10 ft. lengths of lattice section. These consist of three sides, different from each other, which can be bolted together in a specific way only. The sides should first be arranged so that the spigots in the tubes are at one end of the section and should be presented to one another with the lugs on the inside and the bracing members on the outside. A total of sixteen $\frac{3}{8}$in. BSF x 1 in. long screws and nuts are needed for the assembly. It is important at this stage just to thread the screws through the nuts because this leaves the structure quite flexible for fitting to its neighbour.

The second stage in the assembly is to fit the various parts of the aerial together (Figs. 1 & 5). These components, including the base plates, the top plate and the three insulated rods, should be brought as nearly as possible to the position from which the completed aerial will be erected, that is, with the aerial lying along the radial of the circle to the aerial marker stake. The aerial top must be nearest to the centre of the circle and the base of the aerial should be positioned about 1 ft. from the marker stake and within the circumference.

The four steel sections of the aerial should be arranged so that the climbing rungs will lie on the same face of the aerial tower. Some levering of the sections may be necessary to fit them together (Appendix, item 10), but by keeping all fixings slack until the whole structure is put together, force fitting is kept to a minimum. If needed, a wooden mallet rather than a hammer is recommended in order to avoid damaging the plating.

The spigots of the triangular plate should be inserted into the tubes of the bottom 10 ft. section (Figs. 5 & 6). The base plate should be held vertical, standing on edge A (Fig. 1), whilst the section and triangular plate are brought up to it, and the fixing holes aligned. Insert three $\frac{3}{8}$in. BSF x $1\frac{1}{4}$in. screws from the underside of the plate and place the connector earthing assemblies (Figs. 1 & 7) and plain washers on the screws before threading on the nuts, which should be left loose. Slide the insulated rods on to the spigots at the other end of the section (Fig. 8) aligning the fixing lugs. Do not bolt these together at this stage. Slide the next section on to the spigots of the insulated rods, insert the $\frac{3}{8}$in. BSF x 1 in. screws and thread on the nuts, leaving them slack. The remaining two sections should be added in similar fashion, and the top plate fixed to the aerial (Fig. 9). Finally, attach the brace plate to the insulated rods (Figs. 1 & 10) using $\frac{3}{8}$in. BSF x 1 in. screws, plain washers (adjacent to the board) and nuts, these also being left slack. Loosely bolt the insulated rods to the bottom section, using $\frac{3}{8}$in. BSF x 1 in. screws and nuts, first placing the free termination of the three braids (soldered to the shell of the coaxial socket) on the screws.

Having loosely assembled the aerial the fixings should be tightened gradually along the whole length of the aerial, starting from the base, so that no unnecessary distortion occurs at any point. Note that operators, if astride the aerial whilst securing the fixings, must not sit on the structure. Also tighten the three fixings of the brace plate assembly to the insulating rods. Finally, connect the upper braid assembly, first slipping the metal insert in the rain shield over the transformer lead (Figs. 1 & 10). Orientate the assembly so that the large braids are aligned with the three fixing lugs on the insulating rods and so that the thin braid lies nearest to the lightning protection unit. Secure the assembly to the transformer by tightening the 4BA fixing screw. Fix the three braid terminations to the special lugs using $\frac{3}{8}$in. BSF x $\frac{3}{4}$in. long screws and nuts, keeping the braids just taut but without straining the transformer lead. Affix the thin braid to the lightning protection unit using the screw marked thus * , ensuring that contact is also made with the short braid on the unit. Verify, using the Avometer on ohms range, that continuity now exists between the upper and lower sets of braids.

The remaining aerials for the complete circle should be prepared in a similar way round the perimeter before starting the erection of the array.

3.3.3 Preparation for Aerial Erection (Figs. 1, 11 & 14)

Before erecting the aerials, it is recommended that all the ground anchors, 3 per aerial, be secured in position and the aerial guy rope assemblies, 6 per aerial, be fixed to the aerial anchor points found at 22 ft. from the base and at the top. It is also considered worthwhile to grease the threads of all the shackles and bottle screws in order to facilitate future dismantling of the aerials.

The ground anchors, which resemble single-turn corkscrews, are to be placed on a pitch circle of 32 ft. ±6 in. radius. The 3 anchors for each aerial are to be as nearly as possible equispaced. One anchor is to be positioned 32ft. from the aerial marker stake in a radial direction and away from the centre and the other two on the intercepts of 32 ft. radius arcs centred at the marker stake and 55 ft. 5 in. radius arcs centred on the position of the first anchor (Fig.14). The anchors are to be screwed into the ground at an angle of about 45° (See Fig.1) so that the shaft of the anchor will lie roughly in the same direction as the guy ropes to the aerial. It is suggested that the best technique for starting the screwing of the anchors into the ground is to dig out a spit of earth at the anchor entry point at about 45° to the vertical. This enables the operators to present the anchor at the correct angle to the ground while providing a surface normal to the anchor shaft to ease the starting of the insertion. A tommy bar, not less than 6 ft. long, is passed through the eye of the anchor at the top of the shaft and is used to apply pressure to start the insertion as well as to screw the anchor in until only the eye remains above the surface.

It should be noted that it may not always be possible to use the ground anchors where the terrain is rocky. For this reason, reference is made to the T-section earth pickets (not supplied) in the Recommended Spares List (Chap.6). These should be driven in with a 14 lb sledge hammer in the same vertical plane as the ground anchors which they replace, but at right angles to them.

The details of the guy rope assembly can be seen in Fig. 1. For each aerial, 6 guy ropes are needed, three of length 48 ft. to be attached to the top of the aerial and three of length 36½ ft. to be connected to the middle. One end of each rope is attached to an anchor point of the aerial with a ⅜in. D x ¾in. wide shackle, the screw of which should then be locked by wiring with 16 SWG copper wire.

Fig. 11 illustrates the typical method of connection of one of the ground anchors to a bottle screw via a ⅜in. D. x 1 in. wide shackle. The bottle screw shown has a shackle termination at its other end, at which point one end of the 4 ft. chain is attached. In general, only about a 3 ft. length of the chain is required but the amount used is determined as undulations in the ground demand.

The figure shows a further $\frac{3}{8}$in. D. x $\frac{3}{4}$in. wide shackle attached for eventually joining to the guy rope. This is merely for convenience of storage because at this stage it is not known to which link the shackle should be connected. The figure also indicates that another similar assembly is attached to the ground anchor, which is used to secure the two guy ropes from one corner of the aerial triangular structure.

3.3.4 Aerial Erection (Fig. 1 & Figs. 11 to 21)

The preparations for aerial erection are now complete and each aerial should be erected in turn with the assistance of the special tackle shown in Fig. 14. This consists of the following items :-

(a) One derrick pole (Fig. 12) about 18 ft. long and diameter of about 4in. with a wooden block fixed to the base of the pole; the block has a semi-circular cut out to fit over the aerial tubing. The other end of the derrick pole is shown in Fig. 13; the top of the pole is capped with a metal tube having a plate welded to its top end. The plate has four holes suitable for accepting $\frac{3}{8}$in. shackles disposed at 90° intervals round the tube. Also two $\frac{3}{8}$in. shackles and two bottle screws.

(b) One long block and tackle, e.g. 4:1 advantage.

(c) Two earth pickets, not less than 3 ft. 6 in. long.

(d) Two ropes 36 ft. long, spliced, with shackles for each end and two bottle screws.

(e) Two short blocks and tackle (3 ft. long minimum) with shackles.

(f) Tensiometer, as illustrated in Fig. 21. (This is optional).

The following items are also supplied and may be used at the discretion of the foreman rigger:-

(g) One pivot angle with three fixing nuts and bolts ($\frac{3}{8}$in. BSF x 1 in. long).

(h) Two pivot stakes.

The use of items (g) and (h) is shown in Fig. 14. Item (g) is bolted to the base plate of the aerial and helps to prevent any axial rotation of the aerial during erection. Items (h) ensure that the base of the aerial remains correctly positioned during erection.

Figs. 16 to 20 show three braces across the insulated section of the aerial. These braces are not supplied because the strength of the glass fibre tubes of the insulated section gives an ample factor of safety during erection. However, at the discretion of the foreman rigger, devices similar to those illustrated may be used.

The bottom of the derrick pole (item (a)) is lashed to the uppermost tube of the aerial near the baseplate as shown in Fig. 12 and the two guy ropes from the same corner of the aerial are secured tightly to the top of the pole as in Fig. 13. Note that the use of the bottle screws here shown enables the two guys to be tautened uniformly. The fixing end of the hauling block and tackle (item (b)) is attached also to the top of the derrick pole by means of a shackle. The point of attachment is diametrically opposite that of the guy ropes (Fig. 13). The hauling end of the block and tackle is shackled to the ground anchor positioned on the radial line along the aerial. Finally, complete the connections to the top of the derrick pole by attaching the two 36 ft. ropes (item (d)), with shackles, one to each of the two remaining holes in the top plate.

The two earth pickets, item (c) above, should now be driven into the ground at distances of 32 ft. on either side of the base of the aerial on a line tangential to the circle (Fig. 14). One short block and tackle, (item (e)above), should be attached at its fixed end to each of these pickets.

The derrick is now hauled into a vertical position (Fig. 16), with one rigger ensuring that the pole base rides smoothly round on the aerial. The two 36 ft. ropes are now attached to the earth pickets (item (c)) via bottle screws, the derrick is accurately set up in the vertical plane and the bottle screws adjusted to make the rig secure.

The two other guy ropes from the 22 ft. high point on the aerial are now secured, one to each of the earth pickets, item (c), via the short blocks and tackle, item (e). The two remaining guy ropes attached to the top of the aerial are used as steadying ropes as the aerial reaches its vertical position.

Preparations are now complete to erect the aerial. A team of five riggers is considered the minimum number sufficient for the task and their disposition is illustrated in Figs. 17 and 18. Two persons are required to haul up the aerial by means of the block and tackle; two further assistants have to man the two aerial guy ropes which are used during erection as side stays, pulling on them or slackening via the blocks and tackle as required. These figures show the aerials in the course of erection.

When the aerial has been elevated to an angle of about 70°, the hauling ropes of the two blocks and tackle should be securely tied to the earth pickets adjacent to them. Two riggers should now control the two free guys as back steadies while the two hauling riggers carefully lower the derrick pole to the ground. This procedure is shown in Fig. 19.

Having erected the aerial, the two free top guys are connected to the ground anchors via the chains (see the last paragraph of section 3.3.3 and also Fig. 11) and lightly tensioned with the bottle screws. The two lower guys to be attached to the same anchor are freed from the auxiliary earth pickets and similarly fixed and tensioned as depicted in Fig. 20. Finally, the hauling block and tackle is unshackled from the third ground anchor and the two guys are released one at a time from the top of the derrick pole and attached to the chains on the anchor, again with some nominal tensioning.

The final details to be attended to are the general tidying up of the aerial, adjustment of the guys to make the aerial truly vertical, adequate tensioning of the guys and making the earth connections of the aerial.

The derrick pole should be unlashed from the aerial. It is probably convenient to leave the two 36 ft. ropes connected to the top of the pole ready for the erection of the next aerial. These ropes are disconnected from the two auxiliary earth pickets as are the short blocks and tackle, after which the pickets should be extracted from the ground.

If the pivot angle and pivot stakes (items (g) and (h) above) have been employed, they should now be removed. Similarly, the three braces across the insulated section of the aerial may now be unclamped.

The aerial may be most simply checked for verticality by two riggers observing the aerial from two mutually perpendicular directions. This method is satisfactory if the surrounding land is reasonably flat but in a sloping environment a plumb line hung on the aerial is probably more reliable. Coarse adjustments of the aerial angle can be made by slipping or taking up links on the chains attached to the guy ropes; finer adjustments can be made by means of the bottle screws.

When the aerial has been aligned vertically, each of the six guys should be adequately tensioned, using the tensiometer illustrated in Fig. 21, by adjustment of the bottle screws (a suitable tension is 300 lbs). After all six adjustments have been completed, all the shackles at the lower end of the guy ropes and the bottle screws should have their screws locked by wiring them with 16 SWG copper wire. Alternatively, if no tensiometer is available, the ropes can be tensioned adequately using the pull of two men simultaneously on each of the three guys attached to the middle of the aerial, repeating the procedure with the ropes attached to the top. Any further adjustment necessary can then be made for verticality of the aerial as outlined above.

Fig. 1 indicates the disposition of the six earth stakes round the aerial base plate. After driving the stakes in until about 6 in. protrudes above the ground, fix one braid to each stake with a $\frac{3}{8}$in. BSF x $\frac{3}{4}$in. bolt and nut, making sure that they are screwed tightly together. When all six connections have been made, drive the stakes in until only about one inch protrudes above the ground.

This completes the erection and it is recommended that all the aerials be erected before the feeders are connected.

3.4 AERIAL FEEDERS AND CABINET

3.4.1 Aerial Feeders (Fig. 3)

The feeders are each about 275 ft. long. Of this length, 10 ft. is taken up by connecting them to the elevated feed point of the aerials and after allowing 250 ft. for the distance to the centre of the circle, 15 ft. remain to effect the connection to the cabinet. Note that each feeder is coded with the letter 'D' and a serial number which ranges from 001 - 024. Feeder cable D001 is to be connected to aerial 1 (Fig. 3), D002 to aerial 2 and so on to attach cable D024 to aerial 24.

After connecting the feeder (each end of which is fitted with a Type C plug) to the aerial, the two clamps should be fitted as indicated in the left hand and top right hand sketches of Fig. 3 so as to support the cable near its aerial connection and also near the ground. The cable should then be laid out as nearly as possible in a straight line towards the centre of the circle. This procedure should be followed for the feeders of all the other aerials.

3.4.2 The Cabinet (Fig. 3 & Figs. 22 to 24)

The cabinet is housed in a building at or near the centre of the circle of aerials. The departure from centre may not be very great because the length of feeder available for connection to the cabinet is 15 ft. only; it should also be noted that it may not be possible to introduce all of the cables into the building at the optimum point.

The exterior of the cabinet is shown in Fig. 22 and the interior, exposed by removing the upper and lower front panels and one side panel, is illustrated in Fig. 23. It is recommended that the cabinet be raised on wooden plinths above the floor of the building to a height of about 3 in., as shown in Fig. 23.

Fig. 24 has a view mainly of the splitting and recombining hybrid units. As delivered on site, it is likely that the hybrid units will not have been fitted in place. These should be plugged in at this stage, the splitting units (having Type C sockets and two Cannon multiway coaxial plugs) being located in the lowest three rows (in any order since they are identical units) and the recombining units (having Type BNC sockets and one Cannon multiway coaxial plug) in the top three rows. Fig.24 shows the hybrid units retained in position by bars which pass in front of each row of eight. The bars are marked with the reference number of the splitting or recombining unit immediately behind them (respectively S1 to S24 and R1 to R24). Not illustrated are the 24 small secondary lightning diverter units fitted with a Type C plug and socket. One of these units is to be plugged on to each of the splitter hybrid units in such a way that its Type C socket faces downwards.

Raising the cabinet above the floor on plinths enables the aerial feeder cables to be passed underneath the cabinet and introduced through its base. The lower sketch on the right-hand side of Fig. 3 indicates the manner in which the 24 feeder cables are to be arranged in groups of 6, each group comprising those feeders whose serial number is shown in the diagram. The cables are to be plugged into the small boxes (secondary lightning diverter units), which in turn are connected to the hybrid splitting units (marked S1 to S24). Feeder cable D001 is fitted to the box on S1, D002 to the box on S2 and so on. The feeder cables should now be pulled out a little near their ends, in such a way that when the upper clamps are tightened there is no downward strain on the cables. The lower clamps are then to be tightened,having ensured that the lengths of feeder between the two sets of clamps are not taut. The method is illustrated in Fig. 23, where some of the feeders may be seen clamped in position.

The array outputs are available at the BNC sockets on the recombining hybrid units. The user has the choice of routeing the cable connections to these outputs (Fig. 3), either (a) through the base of the cabinet, in which case the cables are retained by the upper and lower clamps between the input feeder cables or (b) through the top of the cabinet by removing the plate covering the grommeted hole.

It should be noted that one of the 75 ohms BNC plug terminations should be fitted to each recombining module output socket which is not being used. The aerial auxiliary outputs should also be similarly terminated when not in use.

4.1 INTRODUCTION

This chapter describes the operation of the system together with a description of the sub-assemblies contained in the Beam Forming Cabinet.

The beam-forming circuit diagram Fig. 2 shows the formation of the sum beam associated with adjacent antennas 1 to 8. This beam has been designated No.1. The remaining 23 beams are formed in similar fashion in a clockwise direction using antennas 2 to 9, 3 to 10 and so on up to 24, 1 to 7.

The plane wavefront of an incident signal is taken to be approaching parallel to a line joining antennas 1 and 8. The wavefront arrives at antennas 4 and 5 before it arrives at 3 and 6 and at 3 and 6 before reaching 2 and 7, finally reaching 1 and 8.

The signals, transmitted along the feeder cables matched in electrical lenght to preserve antenna phases (relative to one another), are input to the Lightning Protection Modules in the upper half of the Beam-Froming Cabinet. The Lightning Protection Modules, which provide additional protection against Lightning surges down the feeder cables, route the signals to the respective Hybrid Boxes Type A (splitting modules S1-S8) where each signal is divided into eight independent time delayed paths plus an additional patch providing an auxiliary output.

Note: The time delays are provided by delay cables situated in the lower half of the Beam-Forming Cabinet (see Fig.23). There are a total of 24 of each of 3 different delay lengths, a set of 3 delay cables connecting to each of the Hybrid Boxes type A via a connector panel and miniature coaxial cable.

One path from each of the eight Hybrid Boxes Type A associated with eight adjacent antennas (e.g. 1 to 8) is fed into the Hybrid Box Type B(1) which produces the 'sum' beam output. The paths are chosen such that the longest delay is associated with antennas 4 and 5, the intermediate delay with antennas 3 and 6, the shortest delay with antennas 2 and 7 and no delay with antennas 1 and 8. Thus at the Hybrid Box Type B(1) (Recombining Module) signals are correctly phased for the indicated direction of arrival. The delays are such that the system is optimised for signals arriving at an elevation of 15°. The system beamwidth for ground waves and for signals received from elevation angles of up to 20° differs only slightly from this optimum condition and the equipment is usable with signals from up to 60° of elevation. The adjacent beams overlap to ensure that, even at the upper end of the frequency range, signals from all directions are received adequately. The beams are independent and can, if required, be used simultaneously with separate receivers. The use of one beam for one specific purpose does not however preclude the use of other beams being employed in other applications.

The 'sum' beam outputs are available at the front of the cabinet at the socket on the Recombining Modules, and can be fed to filters which give additional protection to receivers or line amplifiers against large amplitude m.f. and low h.f. signals.

The auxiliary outputs, which are available at the front of the cabinet (see Fig. 24), may be used to drive the H.F. Direction Finding Equipment Plessey Type PVS860 or may be used for monitoring or test purposes.

4.3 BEAM FORMING CABINET (1.5-10MHz)

4.3.1 Introduction

The Beam Forming Cabinet houses all the assemblies associated with the beam-forming networks and is located in a building at or near the centre of the antenna array.

4.3.2 Recombining Module (Hybrid Box Type B)

There are 24 recombining modules, R1-R24, only one of which (R1) is shown, in Fig.2, for clarity. The recombining module is a plug-in die-cast box which contains seven hybrid transformers (identical to those used in the splitting module) which produce the summation of eight input signals (Sum or Array output signal).

Note: R1 produces the 'sum' output from antennas 1 to 8, R2 produces the 'sum' output from antennas 2 to 9 etc.

With reference to Fig. 2 recombining module R1 receives eight inputs, suitably phased, from splitting modules S1 to S8.
Thus inputs from S1 and S8 have zero delay,
inputs from S2 and S7 have small delay,
inputs from S3 and S6 have medium delay,
and inputs from S4 and S5 have large delay.

These eight input signals are successively recombined in the hybrid transformers and finally produce a 'sum' output signal which is available at a BNC socket on the front of the module. The r.f. system impedance is nominally 75Ω throughout the recombining module.

4.3.3 Lightning Protection Module

This is a small box which contains 2 diodes and 2 zener diodes and affords extra protection against voltage surges down the feeder cables from an induced lightning strike on the aerial. The box has a type C socket, which connects with the plug of the feeder cable, and a type C plug which mates with the socket on the Splitting Module.

4.3.4 Splitting Module (Hybrid Box Type A)

The Splitting Module is a plug-in die cast box which contains the necessary circuitry to divide an antenna signal into eight paths. By means of coaxial delay cables, mounted in the lower half of the beam-forming cabinet (see Interior view of Fig. 23), which connects into the splitting module as shown in Fig. 22 the antenna signal is divided into 4 pairs of independent time delayed paths. The r.f. system impedance is nominally 75Ω throughout the splitting module.

With reference to Fig. 2 the splitting module consists of eight hybrid transformers (H), seven of which are shown in block form and one which shows the circuit form. There are a total of 24 splitting modules (S1 to S24), the example in Fig. 2 showing S1.

The antenna signal is input to the splitting module via the lightning protection module. The first hybrid transformer splits the signal into two signals of equal amplitude, which are applied to the inputs of two further hybrid transformers. These latter transformers together yield four equal outputs, three of which are connected to socket S1/B at pins 5, 6 and 7. These three outputs are then routed to three delay lines; pin 5 to a small delay (G), pin 6 to a medium delay (F) and pin 7 to a large delay line (E). The other ends of these delay lines are connected back to the splitting module via pins 3, 2 and 1 respectively on socket S1/B where they are input to three more hybrid transformers.

The fourth outpur from the first pair of hybrid transformers connects to another hybrid transformer, one output of which provides an Antenna Auxiliary Output No. 1 via pin 4 of socket S1/B. The other output provides the input to another hybrid transformer.

At this stage there are four inputs available to four output hybrid transformers thus providing eight outputs at socket S1/A. Due to the inclusion of three delay lines, one in each of three paths, the eight outputs are delayed with respect to the antenna input signal as follows:

Socket S1/A Pin	Delay
1 and 2	Zero
3 and 4	Small
5 and 6	Medium
7 and 8	Large

Note: These delays are equal to the delay lengths discussed in Chap.1., Para. 5. The splitting modules (designated S) are located in three rows of eight just above the antenna auxiliary panel.

CHAPTER 5 - MAINTENANCE

5.1 GENERAL

This chapter describes the maintenance work which should be periodically carried out on the Flexible HF Receiving Aerial System. It is suggested that the routine checks should be made once a month when the system is being used regularly; also, the maintenance should be undertaken before use when the system has not been in use for a considerable time.

Note: On no account should a Megger or other high voltage insulation tester be used for the resistance tests detailed below, as this will result in damage to the secondary lightning diverter diodes and the input circuit of the hybrid splitting unit.

5.2 AERIALS

5.2.1 Aerial Structure

No maintenance should be required for the aerial structure, but it is advisable to check visually that the galvanising is still substantially intact and that no appreciable areas of rust are developing. Extreme rusting should be examined and, if necessary the aerial lowered, partially dismantled to remove the faulty side and reassembled using a similar side from the kit of spares.

Note: It is essential that the aerial be dismantled in exactly the opposite order to that described for its assembly, namely, that (a) the upper braid assembly and (b) the brace plate assembly should first be removed before unfixing the steel lattice sections.

5.2.2 Aerial Guys

A visual inspection of the terylene guy ropes should be made to ensure that they have not frayed and that the splices have remained intact. Check that the tensions in the ropes are adequate and evenly matched. If available, a tensiometer may be used. The suggested tension is 300 lbs. Note that a falling off in tension could occur if one of the ground anchors moves. It is therefore advisable to inspect each anchor for obvious signs of pulling out or of damage to the exposed eye of the anchor. Make sure that the screws of the shackles (18 per aerial) and the bottle screws are securely wired. Note that it is necessary to climb the aerial to check the shackles attached to the aerial anchor points.

5.2.3 Aerial Earth

Each aerial is earthed by six braids attached to its base. Check that the braids are in good order and securely attached both to the aerial and to the six earthing stakes. Replacement of a pair of braids may be effected by unscrewing the appropriate nut at the foot of the aerial and raising the corresponding earth stakes to enable the braids to be detached. Substitute the new braids, bolt them securely to the aerial and stakes and drive in the stakes to protrude about 1 in. above the ground.

5.2.4 Aerial Lightning Protection Spark Gap and Transformer

The lightning protection spark gap, which shunts the primary winding of the aerial transformer, should be disconnected from the transformer, correctly adjusted and reconnected as follows. To disconnect; slaken off the screw marked thus * and slip aside the short braid. Adjust the gap to the instructions in Chapter 2, Para. 2.2. After adjustment, replace the short braid in position and tighten the screw marked thus *.

The aerial transformer should be tested for continuity in accordance with Chapter 2, Para. 2.2.

Note: It is essential to disconnect the aerial feeder cable from the transformer for this test. Replace the cable after the test.

Should the aerial transformer windings fail to indicate continuity or if it is suspected that the windings may have a shorted turn, the transformer should be replaced in the following manner.

Unscrew one nut and bolt at the lower (earthy) junction of the insulating section with the steel aerial lattice and remove the braid terminating tag. Replace the nut and bolt. Repeat this operation for the two lower braids. The tags may be bent with pliers to pass through the holes in the brace plate assembly. Disconnect the thin braid joining the transformer to the underside of the lightning protection spark gap by unscrewing the fixing at the gap unit. Disconnect the upper braids from the transformer by slackening the 4BA screw immediately above the rain shield. Finally, unscrew the fixing nut of the Type C socket on the transformer assembly to release the unit.

Fit the new transformer to the insulating section with the triangular earth tage in the same orientation as before (this aligns the earth braid runs with the holes), secure the coaxial socket with its nut, refix the thin braid to the spark gap unit and attach the three large braids to the aerial fixings one at a time, ensuring that they are all tightly secured. Note that the aerial fixing nuts and bolts may have been damaged; if so, they should be renewed.

Finally, reconnect the upper braid assembly to the transformer by slipping the metal insert in the rain shield over the transformer top lead. Tighten the 4BA screw on to this lead. It is recommended that a continuity test be made between upper and lower braids after reassembly.

5.2.5 Aerial Feeder Cable

11. With the aerial end of the feeder cables disconnected, test, from the aerial end, the inner and outer conductors of each one for continuity, using the Avometer on Ω ÷ 100 resistance range. (The continuity is provided via the secondary lightning diverter unit by the input transformer winding of the associated hybrid splitting unit). The resistance measured should be about 2Ω. Disconnect the feeder cables from the secondary lightning diverter units and test for isolation between inner and outer conductors, using the Avometer on Ω x 100 resistance range. The reading should be not less than 10 Megohms.

12. Any feeder not conforming to the tests should be visually inspected for damage, and particular attention should be given to the coaxial plugs when looking for the causes of incorrect open or short circuits. The whole length of the feeder should be examined for damage to the outer PVS cover, preferably by walking along its length and running it through the hand. Any damage to the cover which exposes the copper braid should be repaired by first drying the exposed area and then brushing it with a coat of varnish. This should be allowed to dry, after which two layers (at least) of insulating tape should be tightly wound over the defective area. Finally, a second coat of varnish should be applied, covering the tape and the adjacent area of the PVC cover.

Reconnect the cable ends to the aerial.

5.3 CABINET

BNC 75Ω Dummy Loads

Each load should be tested as described in the Installation Manual Para. 2.5.

5.4 MISCELLANEOUS MAINTENANCE (see Fig.2)

5.4.1 Thunderstorms

An aerial system of this nature may sustain damage during a severe local thunderstorm. It is recommended that the maintenance checks and work described should be carried out as soon afterwards as possible.

If it is suspected that the aerial system us not functioning properly, it may also be advisable to measure the forward and reverse resistances (measured respectively on the Ω ÷ 100 and the Ω X 100 resistance ranges of the Avometer) of the individual diodes in the Secondary Lightning Diverter Unit. Refer to Fig. 2 for fuidance. The forward resistance should be typically 50Ω or less and the reverse greater than 1 Megohm.

The input winding (at Type C socket) of each hybrid splitting unit should also be tested for continuity using the Avometer. The wiring of the hybrid unit is very complicated and no attempt should be made to repair it. If a hybrid unit appears to be defective, a new unit should be fitted in its place. The following table indicates the resistance between earth (chassis) and the points specified on the splitting hybrid unit.

Coaxial outlet	Resistance
A1 to A8 inclusive, B6 and B7	37.5Ω
B1 to B5 inclusive	Continuity

5.4.2 Recombining Hybrid Units

A resistance of 37.5Ω should exist between each of the eight miniature coaxial inputs and earth (chassis). Continuity should be measured between the inner conductor of the BNC plug and earth. The recombining hybrid units, like the splitting units, should be renewed if defective.

5.4.3 Cabinet Cables A, B and C

The miniature cables coded A, B and C are fitted with sub-miniature coaxial sockets each of which is retained in position in the multiway plastic shell by a spring clip on the body of the socket. A special tool is provided to release these. Inser the outer tube of the tool into the plastic shell round the socket to be relcased (from the socket outlet side) and push the tube as far as it will go after a slight resistance is felt. This indicates that the retaining clip is now closed. Pushing on the knob of the tool will now eject the socket.

5.4.4 **Aerial Fixings**

It may be necessary to dismantle the aerial system from time to time and re-erect it elsewhere. It is most probable that the threads of the nuts and bolts used for fixing the aerials in their previous situation have been damaged in assembly and dismantling the steel lattice sections. It is therefore advised that a new set of 3/8in. BSF nuts and bolts be used for the reassembly.

Note: It is essential that the aerial be dismantled in exactly the opposite order to that described for its assembly, namely that (a) the upper braid assembly and (b) the brace plate assembly should first be removed before unfixing the steel lattice sections.

5.5 RF TESTS

5.5.1 General

Two methods of r.f. testing are described. Methods 1 or 2 may be used at the post-installation stage or for fault finding, see paras. 24 and 26.

Each beam 'sum' output is derived from eight adjacent signals; beam 1 from antennas 1-8, beam 2 from antennas 2-9 and so on up to beam 24 from antennas 24, 1-7. In a group of antennas forming a beam, for example 22, 23, 24, 1, 2, 3, 4 and 5, antenna 22 is taken to be the lowest number and antenna 5 the highest.

The antenna input cables are connected to the Splitting Modules via Lightning Protection Modules. The feeder cable associated with Antenna No. 1 connects to Splitting Module S1, antenna no. 2 to S2 etc.

The beam 'sum' outputs are made available on a BNC socket on the Recombining Modules, beam 'sum' output No. 1 (Summation of signals from Antennas 1 to 8) being derived from R1 etc.

5.5.2 Method 1

The following test equipment is required:-

(1) RF Signal Generator, 50 or 75Ω output impedance, e.g. Hewlett Packard Type 606A.

(2) Output cable for (1) terminated at one end with a BNC plug and at the other end with a BNC socket - C plug adaptor e.g. Greenpar GE703708.

(3) Valve Voltmeter with 75Ω input socket to measure 100mV r.m.s. e.g. Airmec Type 301.

Carry out the following:-

(1) Connect the valve voltmeter input socket to the signal generator. Set the frequency of the signal generator to 8MHz and adjust the output voltage control until the valve voltmeter indicates 100mV r.m.s.

(2) Disconnect the valve voltmeter and connect the signal generator output to the lightning protection module associated with splitting module S1 using the BNC-C adaptor. Using the valve voltmeter monitor the output at ANTENN AUXILIARY OUTPUT 1. Check that the indicated signal level is 10dB ± 0.6dB lower than the input signal.

(3) Repeat (2) with the signal generator connected to the lightning protection modules associated with splitting modules S2 to S24 in turn, the valve voltmeter monitoring the corresponding ANTENNA AUXILIARY OUTPUT socket. The indicated signal level, in each case, should be 10dB ± 0.6dB lower than the input signal.

(4) Connect the signal generator to the lightning protection module associated with splitting module S1, frequency and output level remaining as stated in (1).

(5) Monitor the beam sum outputs numbers R18-R24 and R1 in turn by connecting the appropriate output socket to the 75Ω input socket on the valve voltmeter.

(6) The correct signal level for each beam sum output is 20dB ± 1dB less than the input signal.

Note: In the case of R1 and R18 the level will be 3 to 3.5dB lower due to an extra hybrid transformer in the Splitting Module.

(7) Repeat (5) with the signal generator connected to the lightning protection modules associated with splitting modules S2 to S24. When measuring each beam sum output start at the cable whose number corresponds with the splitting module being tested then check the seven preceding numbered cables e.g. If the signal generator is connected to splitting module S5, the output is monitored at the beam sum output socket at R5, R4, R3, R2, R1, R24, R23 and R22.

Note: The signal level at the outer recombining modules e.g. R24 and R17 for input to S24, will be 3 to 3.5dB lower.

5.5.3 <u>Method 2</u>

The following test equipment is required:-

(1) Test Unit Plessey PV865 (This includes BNC socket - C plug adaptors).

(2) RF Signal Generator 50 or 75Ω output impedance, e.g. Hewlett Packard Type 606A.

(3) Valve voltmeter 75Ω input impedance, e.g. Airmec Type 301.

(4) Set of eight equal length 75Ω coaxial cables, each approximately 2½m (8ft.) long, fitted at each end with a 75Ω BNC plug.

Carry out the following:-

(1) At the Beam Forming Cabinet disconnect the antenna feeder cables from the 24 lightning protection modules.

(2) At the test unit PV865, using the cables provided, cross-patch eight of the switch outputs to the top row of the LOW BAND delay line sockets D3, D2, D1, D0, D0, D1, D2 and D3. Set the eight selected switches ON. Connect the signal generator to the INPUT socket.

(3) Set the signal generator frequency to 8MHz. Adjust the output level until the r.f. output, measured at delay line DO on the test unit using the valve voltmeter, is approximately 30mV. Note this level.

(4) Connect the delay line outputs in the order D3, D2, D1, DO, DO, D1, D3 and D3 to the splitting module inputs S1-8 respectively (via the lightning protection modules), using the co-axial cables (item (4)) and the adaptors included in item (1).

(5) Using the valve voltmeter measure the outputs at the ANTENNA AUXILIARY OUTPUTS 1-8 and the BEAM SUM OUTPUT 1 on the recombining module R1. The correct signal levels are as follows:-

ANTENNA AUXILIARY OUTPUT:	10dB ±0.6dB less than each input signal
BEAM SUM OUTPUT:	2.5dB ±1.2dB less than each input signal

(6) Disconnect each of the input cables to the splitting modules S1 to S8 in turn and check that the beam sum output is reduced by approximately 1.0dB. Check that each cable is correctly plugged back in position before removing the next one.

(7) Repeat the above tests with the test unit delay line outputs connected to splitting modules S2-9, then S3-10 and so on up to S24, 1-7 testing each of the twenty four auxiliary and beam sum outputs in turn.

Note: The cables must be advanced one number at a time to maintain the correct beam-forming sequence, e.g. the delay lines D3, D2, D1, DO, DO, D1, D2 and D3 must be connected to splitting modules S2-9 respectively when testing beam 2.

(8) On completion of testing, reconnect all cables as for normal operation.

5.6 FAULT FINDING

The following tables lists the probable causes of specific fault symptoms:

(1)	One ANTENNA AUXILIARY OUTPUT faulty.	Fault on associated splitting module or its associated wiring.
(2)	One BEAM SUM OUTPUT reading much lower than the remainder.	Fault on associated re-combining module or the associated wiring.
(3)	Group of 8 consecutive BEAM SUM OUTPUTS slightly lower than the remainder (- 1.0dB).	Fault on the splitting module associated with the highest antenna number of the group, e.g. Fault on beam outputs 1-8 indicates fault on splitting module No.8.

5.7 THUNDERSTORMS

An antenna system of this type may sustain damage during a severe local thunderstorm. It is recommended that the checks on the Antenna Earth, the Antenna Transformer Assembly and Spark Gap, and the Antenna Feeder Cables are carried out as soon as possible following one of these thunderstorms.

5.8 FINAL INSPECTION

After working through the above maintenance schedule, ensure that all units have been replaced and connected in accordance with the numerical coding on the circuit diagram, Fig. 2.

6. AERIAL SYSTEM PARTS LIST

6.1 GENERAL

The list of parts given below is not a complete breakdown of the entire installation. It does, however, provide a catalogue of all items and sub-assemblies which are to be fitted together on site. It may also be used as a check list before installation to ensure that sufficient parts have been supplied for one complete aerial system.

6.2 AERIAL AND ASSOCIATED PARTS

Item	Number for each aerial	Total number.	Plessey Drawing No.
1 'Unimast' Tower 40 ft. high consisting of:	1	24	753/4/98001
(a) 10 ft. section	4	96	
Note: Each 10 ft. section is triangular and is supplied as 3 separate sides to be bolted together			
(b) Bottom plate	1	24	
(c) Top plate	1	24	
(d) 4 ft. chain	6	144	
(e) $\frac{3}{8}$in. UNC screw x $\frac{3}{4}$in. long	6	144	991/4/01428/008
(f) $\frac{3}{8}$in. UNC screw x 1 in.long	79	1896	991/4/01428/010
(g) $\frac{3}{8}$in. UNC screw x $1\frac{1}{4}$in.long	3	72	991/4/01428/012
(h) $\frac{3}{8}$in. UNC nut	88	2112	991/4/01429/003
(j) $\frac{3}{8}$in. plain washer	3	72	991/4/01430/003
2 Insulating Section consisting of:			
(a) Insulating rod assembly	3	72	665/1/90099
(b) Brace plate assembly comprising:-	1	24	665/1/90059

	Brace plate, transformer and socket assembly (also with three braids) and lightning protection unit and necessary fixings			
	(c) Upper braid assembly	1	24	665/1/90098
	(d) $\frac{3}{8}$in. UNC bolt x $\frac{3}{4}$in.long	3	72	991/4/01428/008
	(e) $\frac{3}{8}$in. UNC bolt x 1 in.long	3	72	991/4/01428/010
	(f) $\frac{3}{8}$in. UNC nut	6	144	991/4/01429/003
	(g) $\frac{3}{8}$in. plain washer	3	72	991/4/01430/003
3	4 ft. ground anchor	3	72	753/4/98002
4	Guy ropes			
	(a) 36$\frac{1}{2}$ ft. long	3	72	665/1/90066
	(b) 48 ft. long	3	72	665/1/90067
5	2 ft. x 2 ft. base plate	1	24	665/2/90076
6	Earth stake	6	144	665/2/90081
7	Earthing connector	3	72	665/1/90074
8	Shackle			
	(a) $\frac{3}{8}$in.D. x 1-1/16in.(nominal)throat	6	144	753/4/98006
	(b) $\frac{3}{8}$in.D. x $\frac{3}{4}$in. (nominal) throat	12	288	753/4/98005
9	Bottle screw	6	144	753/4/98007
10	Feeder cable clamp	3	72	665/2/90050 (mast)
11	Aerial Feeder Cable	1	24	665/4/90051/001 to /024
12	Pivot angle (supplied with 3 off items 1(g) and (h))	-	1	665/2/90082
13	Pivot stake	-	2	665/2/90078

6.3 BEAM FORMING CABINET & ASSOCIATED PARTS

	Item	Total Number	Plessey Drawing No.
1	Beamforming cabinet including previously connected delay cables and the blue coaxial cables (coded A, B, C) (5.4)	1	665/1/90003 less items 2 to 5 below
2	Hybrid splitting unit	24	665/4/90043
3	Hybrid recombining unit	24	665/4/90044
4	BNC 75 ohms Load	48	665/1/90045
5	Secondary Lightning Diverter Unit	24	665/1/90013

6.4 ITEMS PREVIOUSLY ASSEMBLED IN CABINET

	Item	Total Number	Plessey Drawing No.
1	Delay cable (with BNC plug terminations)		
	(a) E	24	665/4/90040/001 to 024
	(b) F	24	665/4/90041/001 to 024
	(c) G	24	665/4/90042/001 to 024
2	Coaxial cable ($\frac{1}{8}$in. D)		
	(a) A (Cannon receptacle & BNC bulkhead jack)	24	665/1/90018/001 to 024
	(b) B (Cannon receptacle & BNC bulkhead jack)	144	665/1/90019/001 to 144
	(c) C (with Cannon receptacles)	192	665/1/90020/001 to 192
3	Former (supporting items (5.4).1.)	12	665/1/90008

7. RECOMMENDED SPARES LIST (SUPPLIED ONLY TO SPECIAL ORDER)

	Item	Plessey Drawing No.
1	Aerial, 1 off (less items 3, 5 to 12, and 27 to 32).	665/1/90006 2 sheets
2	Transformer & Socket Assembly, 3 off	665/1/90071
3	Upper Braid Assembly, 3 off	665/1/90098
4	Lightning Protection Unit, 3 off	665/1/90083
5	Connector Earthing Assembly, 3 off	665/1/90074
6	Earthing Stake, 18 off	665/2/90081
7	Guy, 3 off	665/1/90066
8	Guy, 3 off	665/1/90067
9	Ground Anchor, 3 off	753/4/98002
10	Shackle, ⅜in.D.x 1-1/16in.throat 6 off	753/4/98006
11	Shackle, ⅜in.D.x ¾in. throat 12 off	753/4/98005
12	Bottle Screw, 6 off	753/4/98007
13	'Unimast' Earth Picket, 6 off	753/4/98004
14	Feeder Cable, 3 off	665/4/90051/001
15	Delay Cable, E, 3 off	665/4/90040/001
16	Delay Cable, F, 3 off	665/4/90041/001
17	Delay Cable, G, 3 off	665/4/90042/001
18	Cable, A, 3 off	665/1/90018/001
19	Cable, B, 6 off	665/1/90019/001
20	Cable, C, 6 off	665/1/90020/001
21	Hybrid Splitting Unit, 3 off	418/8/29512
22	Hybrid Recombining Unit, 3 off	418/8/29513
23	Diode, 6 off	415/4/98082
24	Zener Diode, 6 off	415/4/98083/017

25	75 ohms load (BNC connector), 4 off	665/1/90045
26	Cannon Extractor Tool CET-C6B, 1 off (supplied)	558/4/98025
27	$\frac{3}{8}$in. UNC screw x $\frac{3}{4}$in.long, 216 off	991/4/01428/008
28	$\frac{3}{8}$in. UNC screw x 1 in.long, 1968 off	991/4/01428/010
29	$\frac{3}{8}$in. UNC screw x 1$\frac{1}{4}$in.long, 72 off	991/4/01428/012
30	$\frac{3}{8}$in. UNC nut, 2256 off	991/4/01429/003
31	$\frac{3}{8}$in. UNC washer, 144 off	991/4/01430/003
32	Brace plate, 1 off	665/2/90069
33	Screw, special, 3 off	665/2/90085

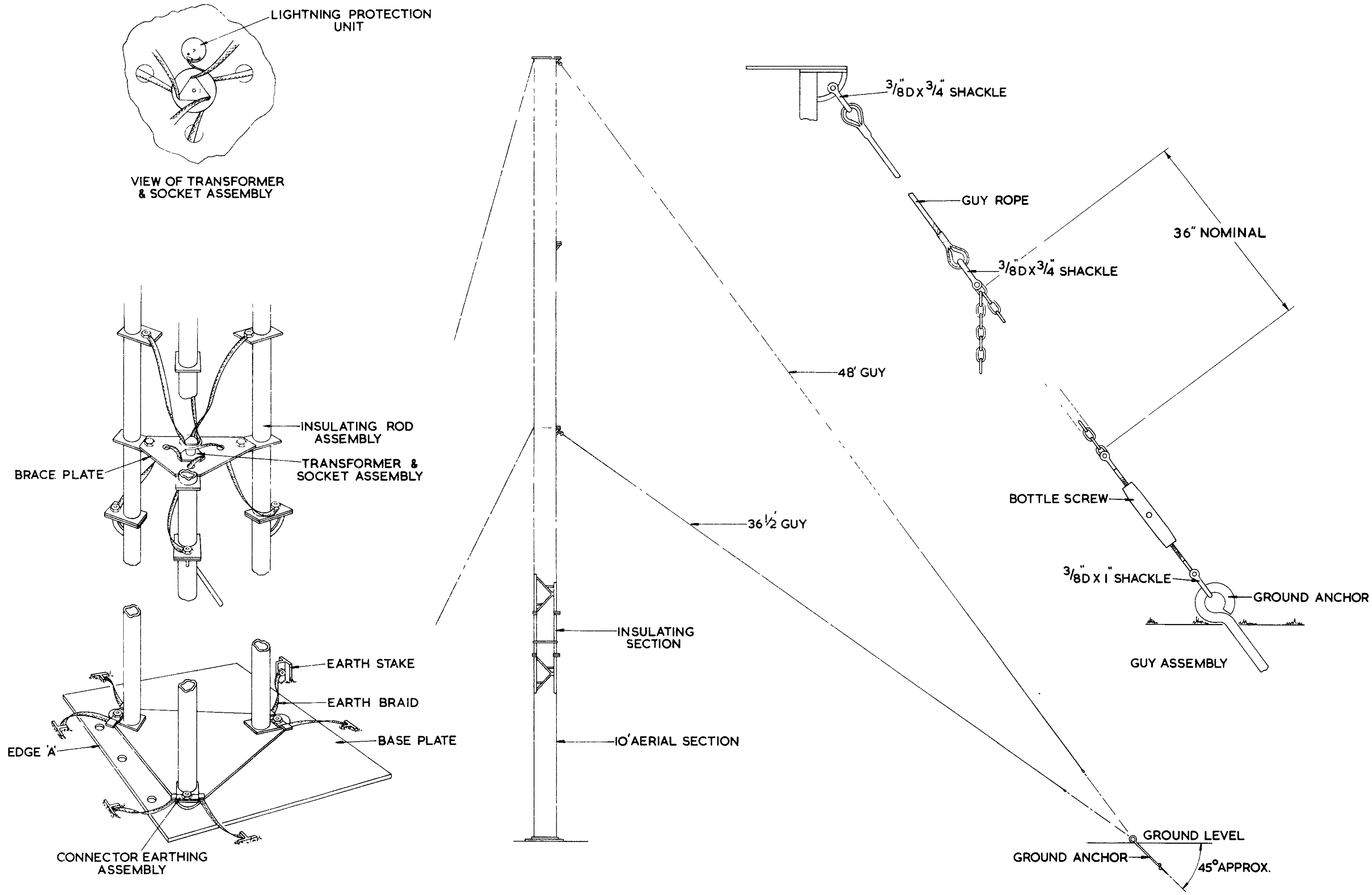
8. LIST OF ANCILLARY EQUIPMENT

The following is a list of items which are not normally supplied with the Flexible HF Receiving Aerial System but which are required for the installation and maintenance of the equipment.

	Item	Chapter & Para. No.
1	One Avometer Model 8 or Model 9	Chapters 2 and 4
2	One 6BA screwdriver	Chapters 2 and 4
3	One steel measuring tape, 300 ft. long	3.2
4	One theodolite (or two), (see text), with tripod(s) and plumb line(s)	3.2.2 & 3.3.3
5	One 8 ft. ranging pole	
6	Twenty-five 3 ft. long wooden stakes	
7	One Hammer, 2 lb	3.2.2 & 3.2.3
8	One magnetic compass (see text)	
9	Two (or more) $\frac{3}{8}$in. B.S.F. spanners	
10	One mild steel levering rod, say 4 ft. long	3.3.2
11	One large wooden mallet, 2 - 3 lbs.	
12	Thick grease for lubricating shackle and bottle screw threads	
13	One spade	
14	One (or more) tommy bar(s), 6 ft. long	3.3.3
15	One sledge hammer, 14 lbs	
16	Quantity of 16 SWG copper wire	

17	One derrick pole, 18 ft. long (see text)	
18	One long 4:1 block and tackle	
19	Two earth pickets, not less than 3ft.6in. long	
20	Two ropes, spliced, 36 ft. long	
21	Six shackles for items 17 and 20 above	
22	Four bottle screws for items 17 and 20 above	
23	Two short 4:1 blocks and tackle	3.3.4
24	Four shackles for item 23 above	
25	One tensiometer, reading up to 500 lbs. (Fig. 21) (not essential)	
26	Three wooden braces fitted with U-bolts and nut (Figs. 16 to 20) (optional)	
27	Length of rope for lashing item 17 to aerial	
28	Plumb line	
29	One 2BA screwdriver	3.4.1 & 3.4.2
30	One 2BA spanner	3.4.1
31	Two wooden plinths, 2ft.6in. x 3in. x 3in.	3.4.2
32	One Cannon extraction tool, CET-C6B (See Chapter 6, Item 26)	4.4.3
33	One spanner (1in. between flats) (preferably thin walled box type) for aerial transformer socket	4.2.4
34	One pair of taper nose pliers	
35	One 4BA screwdriver	

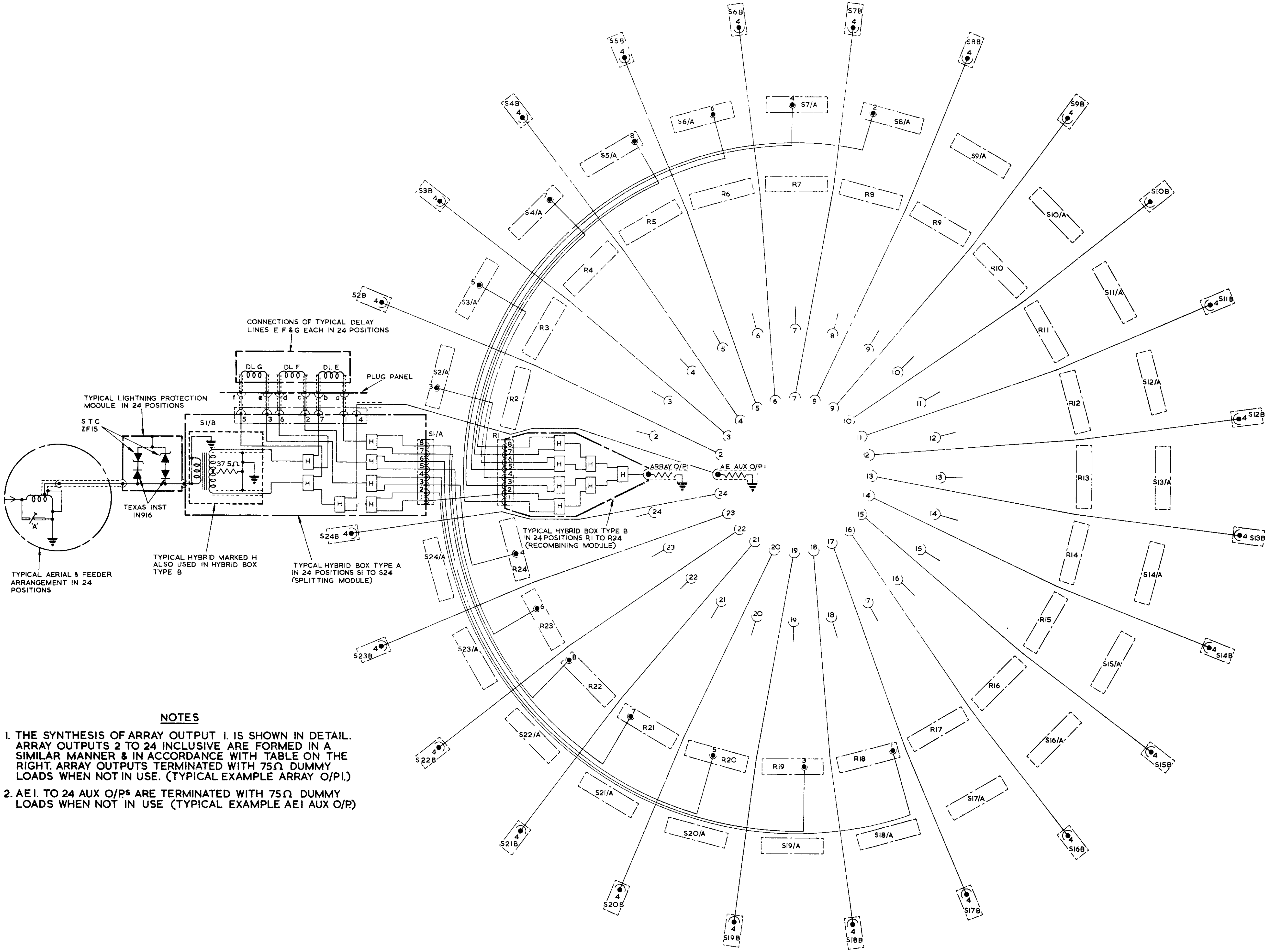
9. ILLUSTRATIONS



DWG. No. 665/6/90006 SH.1

FIG.1 AERIAL ASSEMBLY

FIG. 1.



NOTES

1. THE SYNTHESIS OF ARRAY OUTPUT 1. IS SHOWN IN DETAIL. ARRAY OUTPUTS 2 TO 24 INCLUSIVE ARE FORMED IN A SIMILAR MANNER & IN ACCORDANCE WITH TABLE ON THE RIGHT. ARRAY OUTPUTS TERMINATED WITH 75Ω DUMMY LOADS WHEN NOT IN USE. (TYPICAL EXAMPLE ARRAY O/P1.)
2. AE1. TO 24 AUX O/Ps ARE TERMINATED WITH 75Ω DUMMY LOADS WHEN NOT IN USE (TYPICAL EXAMPLE AE1 AUX O/P.)

DWG. No. 665/6/90001

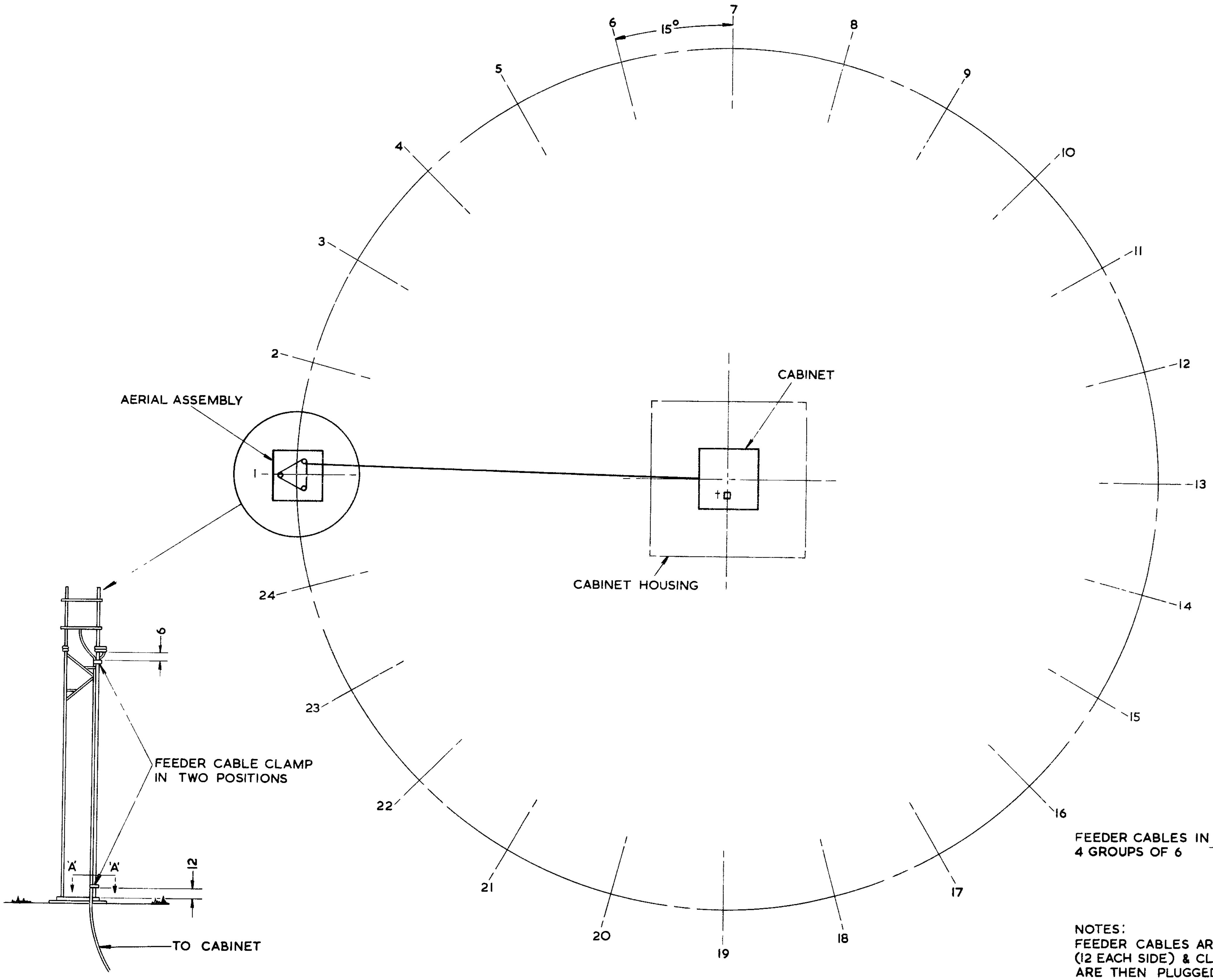
FIG. 2 CIRCUIT DIAGRAM BEAMFORMING CABINET

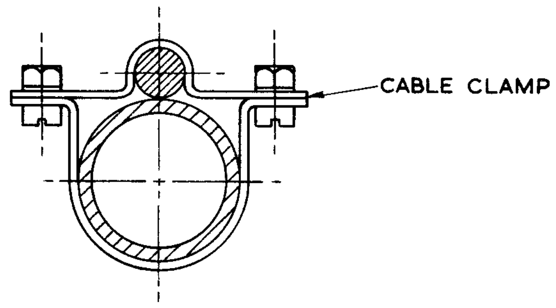
FIG. 2

FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO
S 1/A1	R 1/2	S 5/A8	R 1/7	S10/A7	R 7/8	S15/A6	R10/5	S20/A5	R18/6
S 1/A2	R18/1	S 6/A1	R 6/2	S10/A8	R 6/7	S15/A7	R12/8	S20/A6	R15/5
S 1/A3	R24/4	S 6/A2	R23/1	S11/A1	R11/2	S15/A8	R11/7	S21/A7	R18/8
S 1/A4	R19/3	S 6/A3	R 5/4	S11/A2	R 4/1	S16/A1	R16/2	S21/A8	R17/7
S 1/A5	R23/6	S 6/A4	R24/3	S11/A3	R10/4	S16/A2	R 9/1	S22/A1	R22/2
S 1/A6	R20/5	S 6/A5	R 4/6	S11/A4	R 5/3	S16/A3	R15/4	S22/A2	R15/1
S 1/A7	R22/8	S 6/A6	R 1/5	S11/A5	R 9/6	S16/A4	R10/3	S22/A3	R21/4
S 1/A8	R21/7	S 6/A7	R 3/8	S11/A6	R 6/5	S16/A5	R14/6	S22/A4	R16/3
S 2/A1	R 2/2	S 6/A8	R 2/7	S11/A7	R 8/8	S16/A6	R11/5	S22/A5	R20/6
S 2/A2	R19/1	S 7/A1	R 7/2	S11/AB	R 7/7	S16/A7	R13/8	S22/A6	R17/5
S 2/A3	R 1/4	S 7/A2	R24/1	S12/A1	R12/2	S16/A8	R12/7	S22/A7	R19/8
S 2/A4	R20/4	S 7/A3	R 6/4	S12/A2	R 5/1	S17/A1	R17/2	S22/A8	R18/7
S 2/A5	R24/6	S 7/A4	R 1/3	S12/A3	R11/4	S17/A2	R10/1	S23/A1	R23/2
S 2/A6	R21/5	S 7/A5	R 5/6	S12/A4	R 6/3	S17/A3	R16/4	S23/A2	R16/1
S 2/A7	R23/8	S 7/A6	R 2/5	S12/A5	R10/6	S17/A4	R11/3	S23/A3	R22/4
S 2/A8	R22/7	S 7/A7	R 4/8	S12/A6	R 7/5	S17/A5	R15/6	S23/A4	R16/3
S 3/A1	R 3/2	S 7/A8	R 3/7	S12/A7	R 9/8	S17/A6	R12/5	S23/A5	R21/6
S 3/A2	R20/1	S 8/A1	R 8/2	S12/A8	R 8/7	S17/A7	R14/8	S23/A6	R18/5
S 3/A3	R 2/4	S 8/A2	R 1/1	S13/A1	R13/2	S17/A8	R13/7	S23/A7	R20/8
S 3/A4	R21/3	S 8/A3	R 7/4	S13/A2	R 6/1	S18/A1	R18/2	S23/A8	R19/7
S 3/A5	R 1/6	S 8/A4	R 2/3	S13/A3	R12/4	S18/A2	R11/1	S24/A1	R24/2
S 3/A6	R22/5	S 8/A5	R 6/6	S13/A4	R 7/3	S18/A3	R17/4	S24/A2	R17/1
S 3/A7	R24/8	S 8/A6	R 3/5	S13/A5	R11/6	S18/A4	R12/3	S24/A3	R23/4
S 3/A8	R23/7	S 8/A7	R 5/8	S13/A6	R 8/5	S18/A5	R16/6	S24/A4	R18/3
S 4/A1	R 4/2	S 8/A8	R 4/7	S13/A7	R10/8	S18/A6	R15/8	S24/A5	R22/6
S 4/A2	R21/1	S 9/A1	R 9/2	S13/A8	R 9/7	S18/A7	R15/8	S24/A6	R19/5
S 4/A3	R 3/4	S 9/A2	R 2/1	S14/A1	R14/2	S18/A8	R14/7	S24/A7	R21/8
S 4/A4	R22/3	S 9/A3	R 8/4	S14/A2	R 7/1	S19/A1	R13/2	S24/A8	R20/7
S 4/A5	R 2/6	S 9/A4	R 3/3	S14/A3	R13/4	S19/A2	R12/1		
S 4/A6	R23/5	S 9/A5	R 7/6	S14/A4	R 8/3	S19/A3	R18/4		
S 4/A7	R 1/8	S 9/A6	R 4/5	S14/A5	R12/6	S19/A4	R13/3		
S 4/A8	R24/7	S 9/A7	R 6/8	S14/A6	R 9/5	S19/A5	R17/6		
S 5/A1	R 5/2	S 9/A8	R 5/7	S14/A7	R11/8	S19/A6	R14/5		
S 5/A2	R22/1	S10/A1	R10/2	S14/A8	R10/7	S19/A7	R16/8		
S 5/A3	R 4/4	S10/A2	R 3/1	S15/A1	R15/2	S19/A8	R15/7		
S 5/A4	R23/3	S10/A3	R 9/4	S15/A2	R 8/1	S20/A1	R20/2		
S 5/A5	R 3/6	S10/A4	R 4/3	S15/A3	R14/4	S20/A2	R13/1		
S 5/A6	R24/5	S10/A5	R 8/6	S15/A4	R 9/3	S20/A3	R19/4		
S 5/A7	R 2/8	S10/A6	R 5/5	S15/A5	R13/6	S20/A4	R14/3		

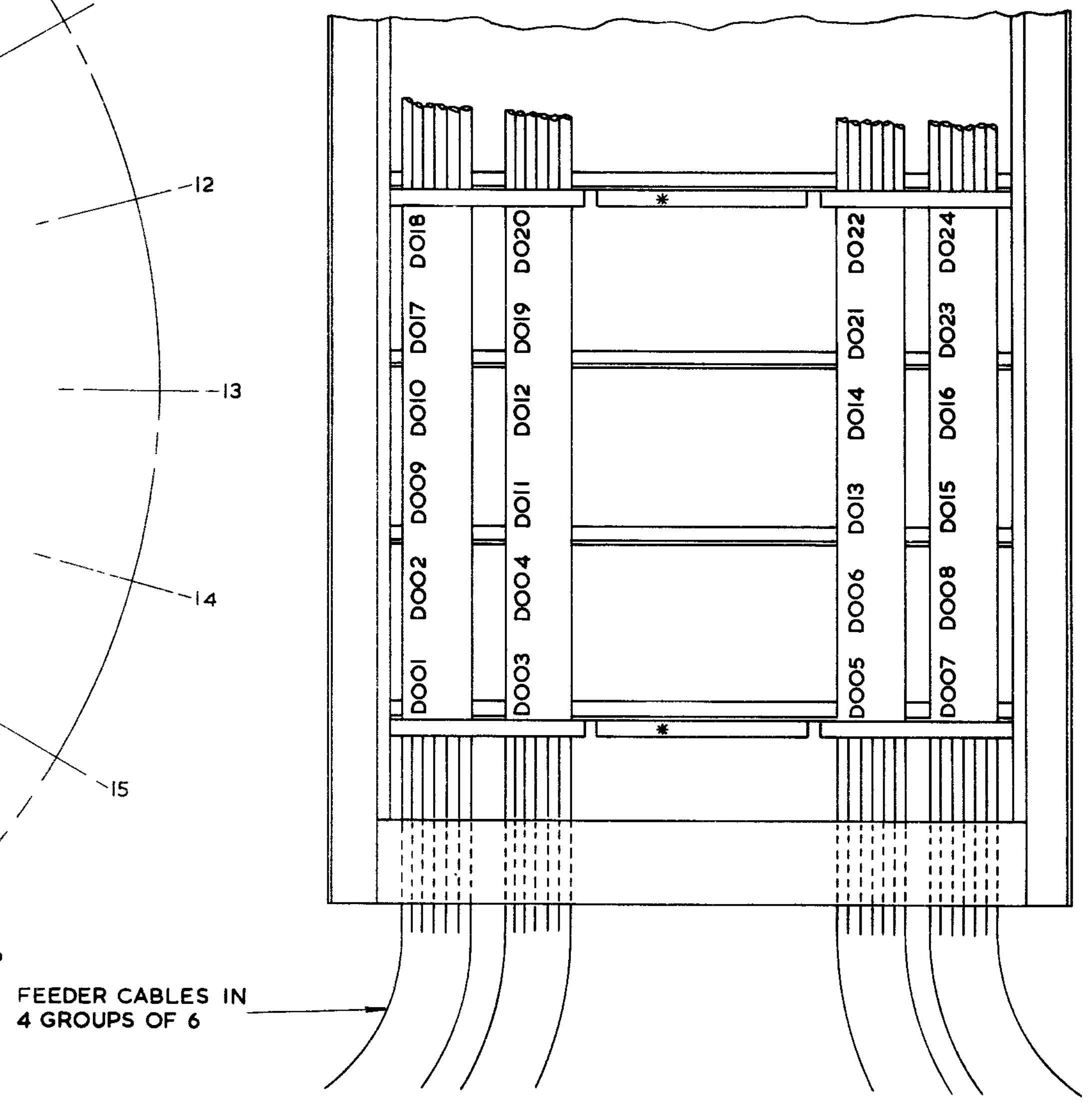
FIG. 2A WIRING TABLE FOR BEAM FORMING CABINET

Fig. 2A





SECTION 'A-A'



PART FRONT VIEW OF CABINET

NOTES:
FEEDER CABLES ARE FED INTO UNDERSIDE OF CABINET BROUGHT TO THE FRONT (12 EACH SIDE) & CLAMPED IN 4 POSITIONS AS SHOWN ABOVE. FEEDER CABLES ARE THEN PLUGGED INTO BOXES ON SPLITTING MODULES MARKED S1 TO S24. CABLES ARE CODED DO01 TO DO24. THESE PLUG INTO BOXES S1 TO S24 RESPECTIVELY.

† THE SOLID PLATE ON TOP OF THE CABINET IS REMOVED IF IT IS REQUIRED TO TAKE THE CABLES FROM THE RECOMBINING UNITS OUT THROUGH THE TOP.

* IF CABLE OUTLET IS REQUIRED AT BASE. CABLES ARE TO BE CLEATED IN TWO POSITIONS WITH CLAMPS.

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FIG. 3 LAYOUT OF FLEXIBLE HF RECEIVING AERIAL SYSTEM

FIG. 3

AERIAL No.	THEODOLITE A ANGLE α, DEGREES	THEODOLITE B ANGLE β, DEGREES	AERIAL No.	THEODOLITE A ANGLE α, DEGREES	THEODOLITE B ANGLE β, DEGREES
1	277 1/2	7 1/2	13	7 1/2	277 1/2
2	285	15	14	15	285
3	292 1/2	22 1/2	15	22 1/2	292 1/2
4	300	30	16	30	300
5	307 1/2	37 1/2	17	37 1/2	307 1/2
6	315	45	18	45	315
7	322 1/2	52 1/2	19	52 1/2	322 1/2
8	330	60	20	60	330
9	337 1/2	67 1/2	21	67 1/2	337 1/2
10	345	75	22	75	345
11	352 1/2	82 1/2	23	82 1/2	352 1/2

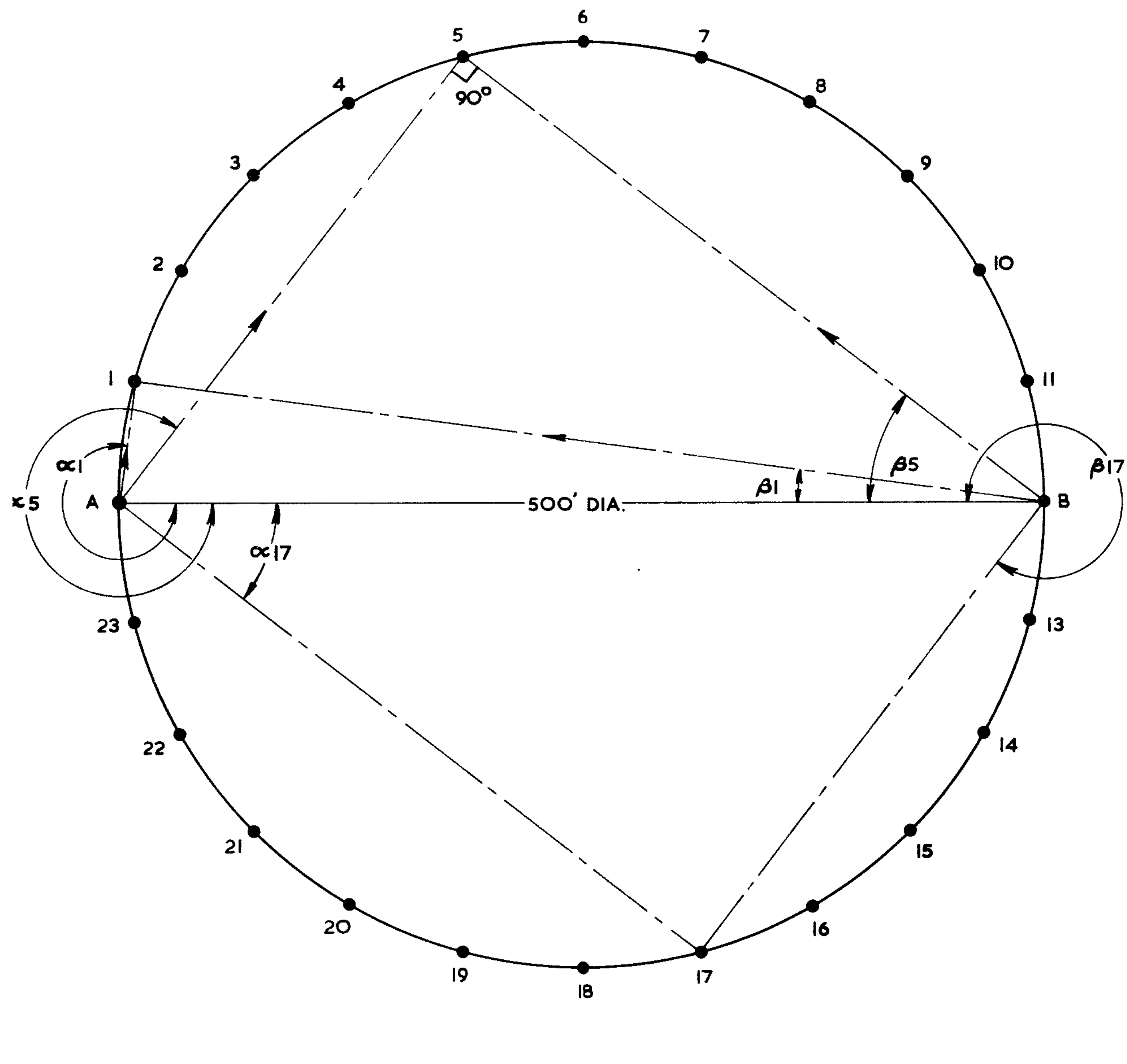


FIG. 4 MARKING OUT THE AERIAL SITE (METHOD 2) FIG. 4

FIG. 5. POSITIONING THE AERIAL ELEMENTS

FIG. 7. FITTED BASEPLATE & EARTHING BRAIDS

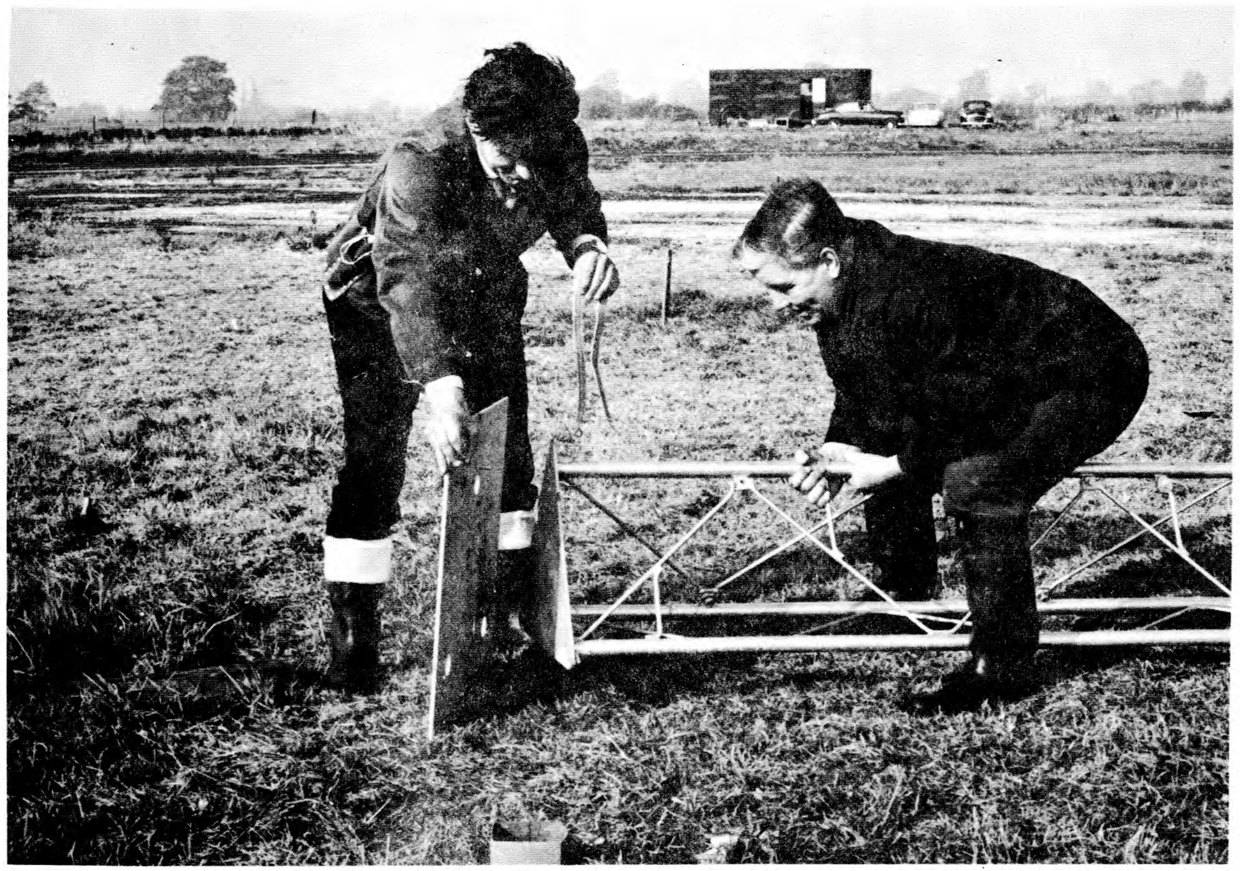


FIG. 6. FITTING THE AERIAL BASE PLATE

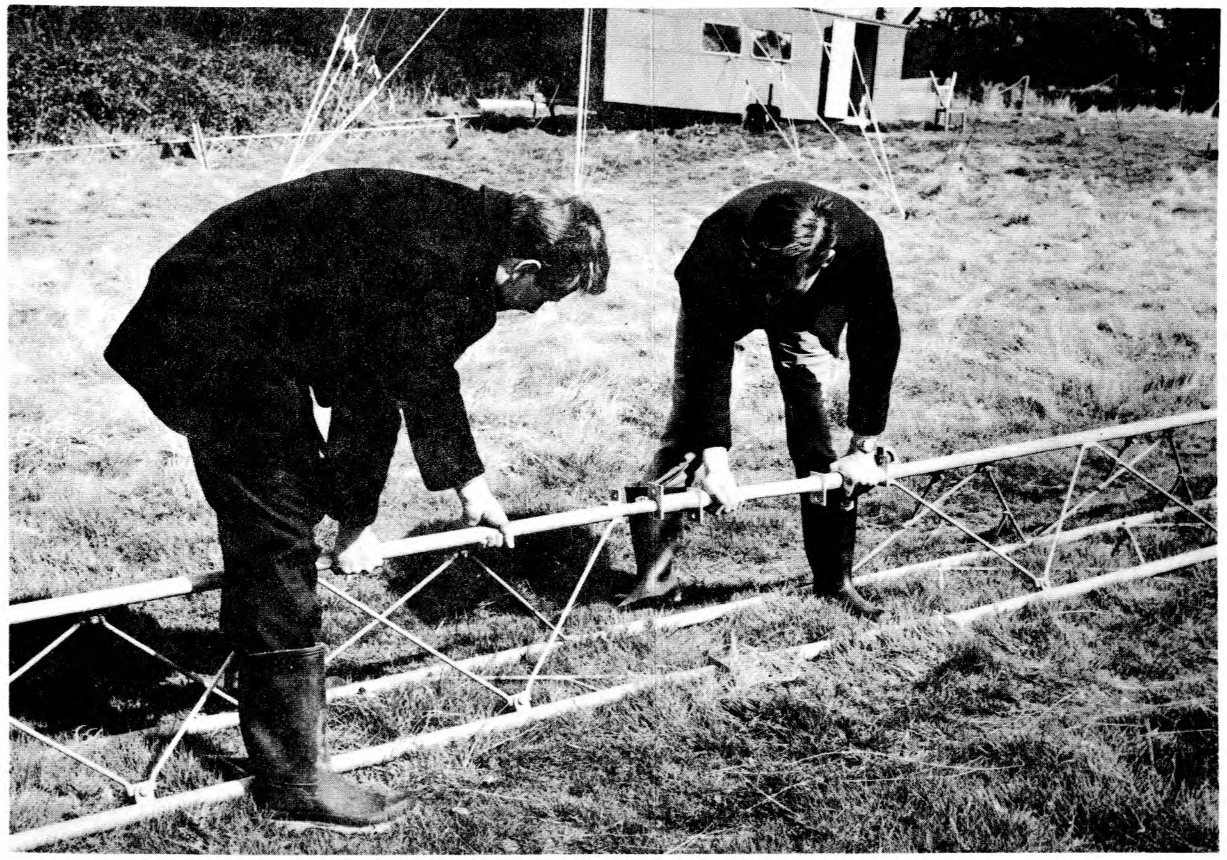


FIG. 8. CONNECTION OF AERIAL INSULATOR TO BOTTOM SECTION

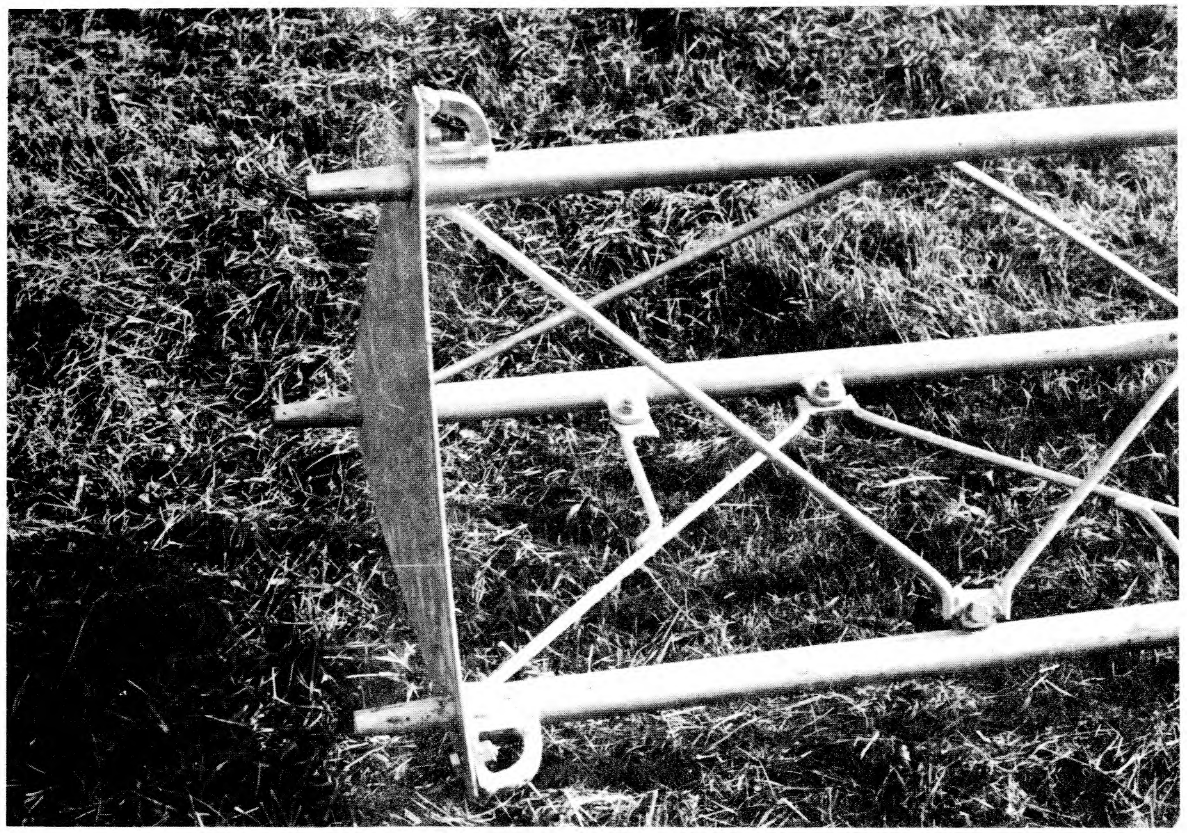


FIG. 9. TOP PLATE FITTED TO AERIAL TOP SECTION

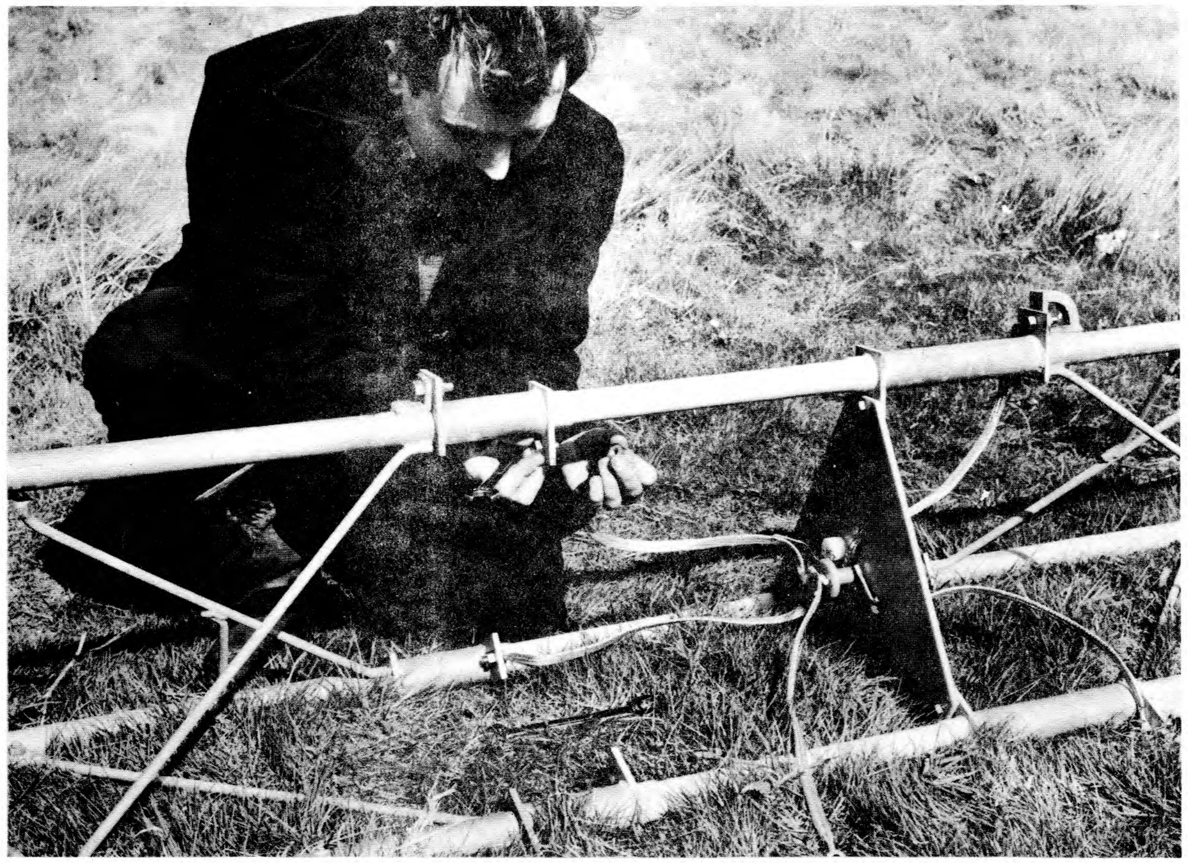


FIG. 10. FINAL ASSEMBLY OF AERIAL INSULATED SECTION

FIG. 11. CONNECTIONS TO GROUND ANCHOR

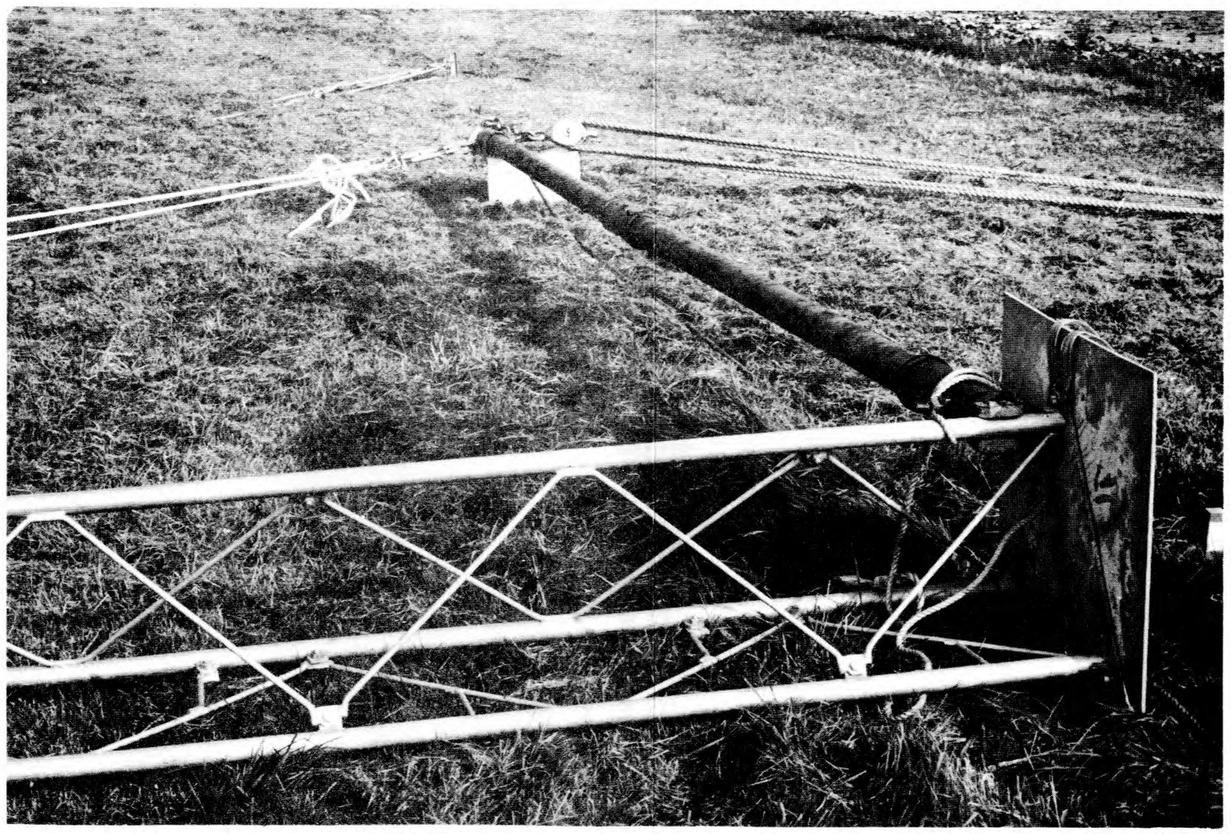
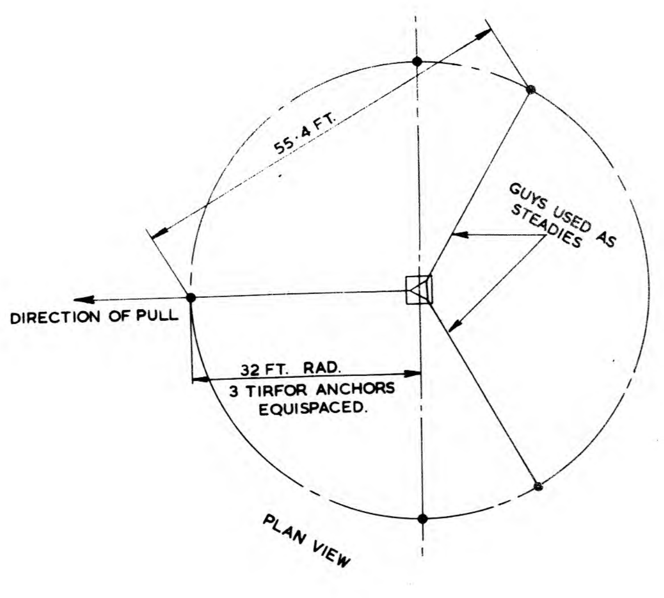
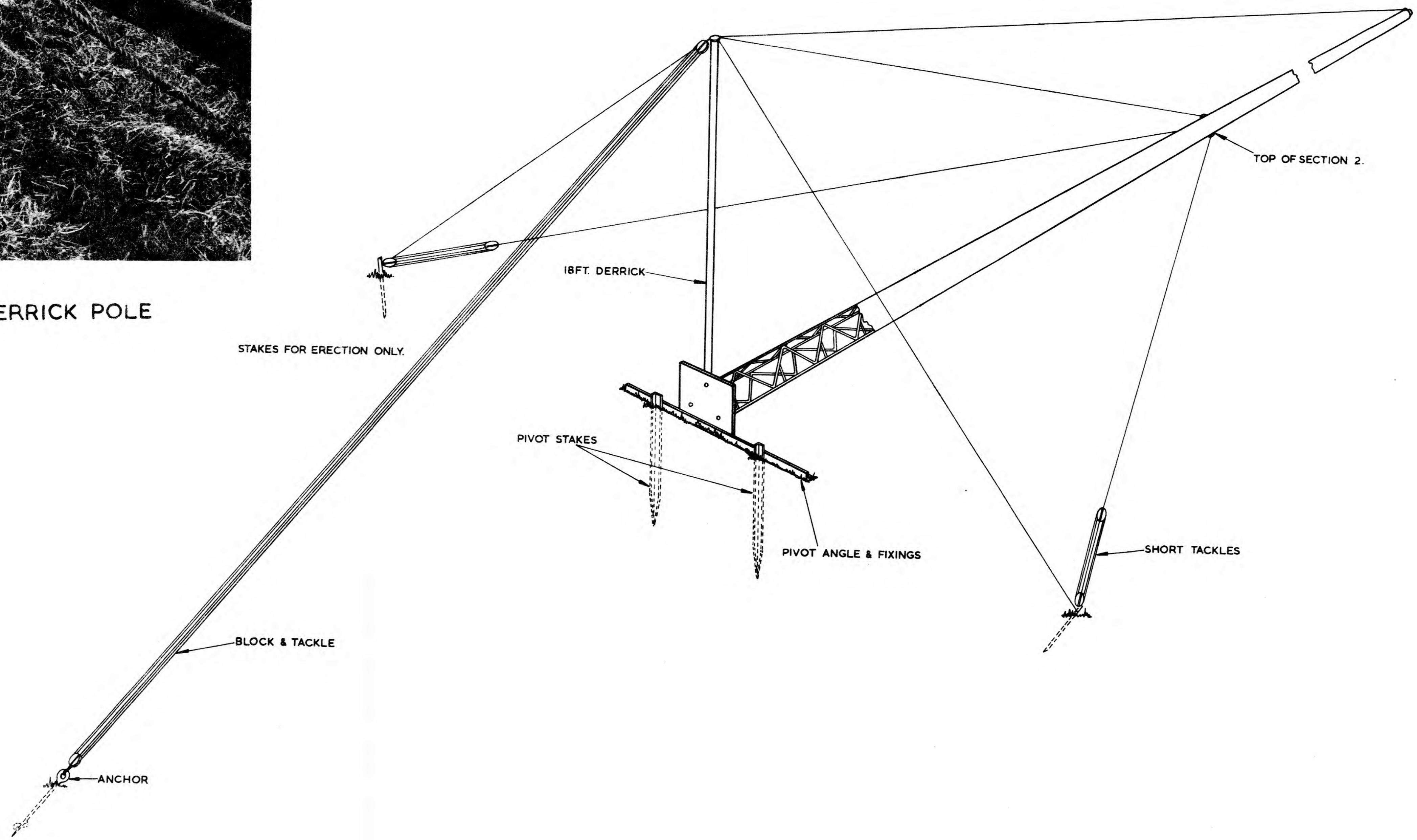


FIG. 12. ATTACHMENT OF DERRICK POLE TO AERIAL BASE

FIG . 13 . CLOSE UP VIEW TOP OF DERRICK POLE





DRG. No. 665/6/9006 SH.2

FIG. 14. ERECTION DETAILS

FIG. 14.

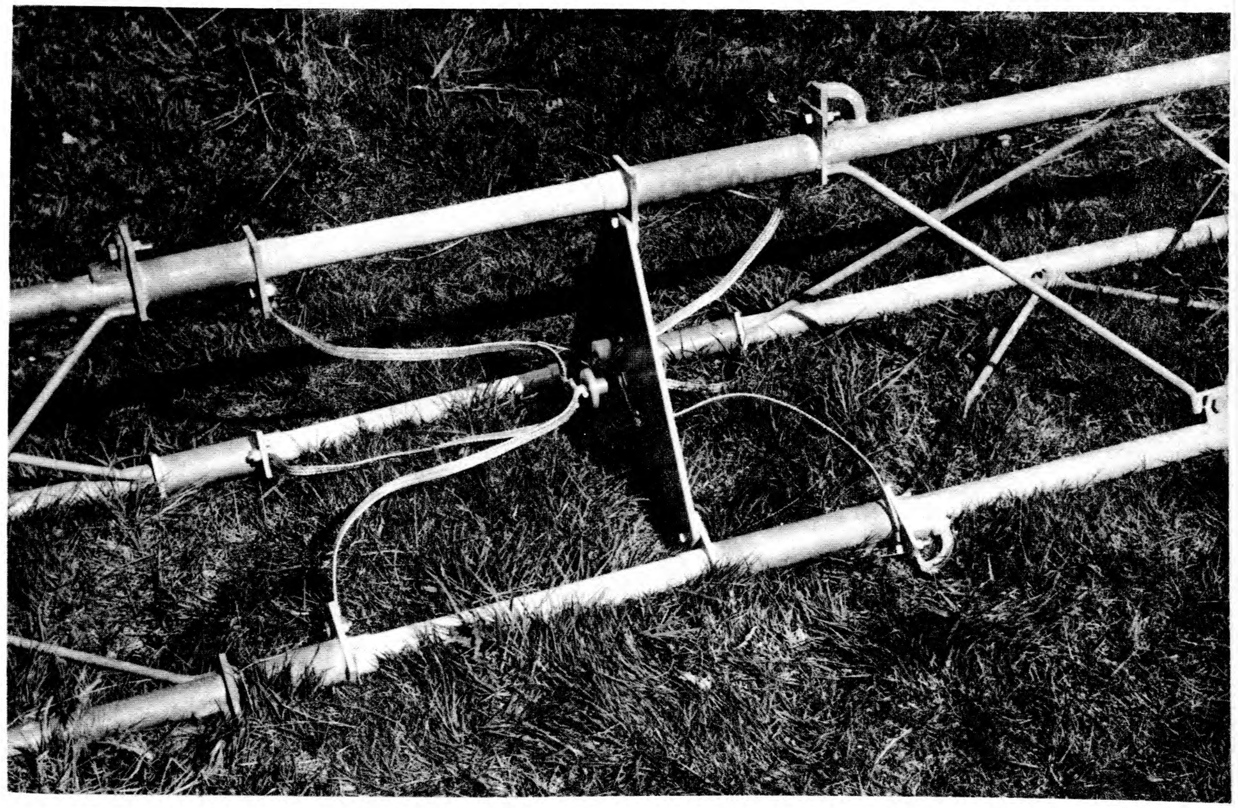


FIG. 15. CLOSE UP VIEW OF AERIAL INSULATING SECTION

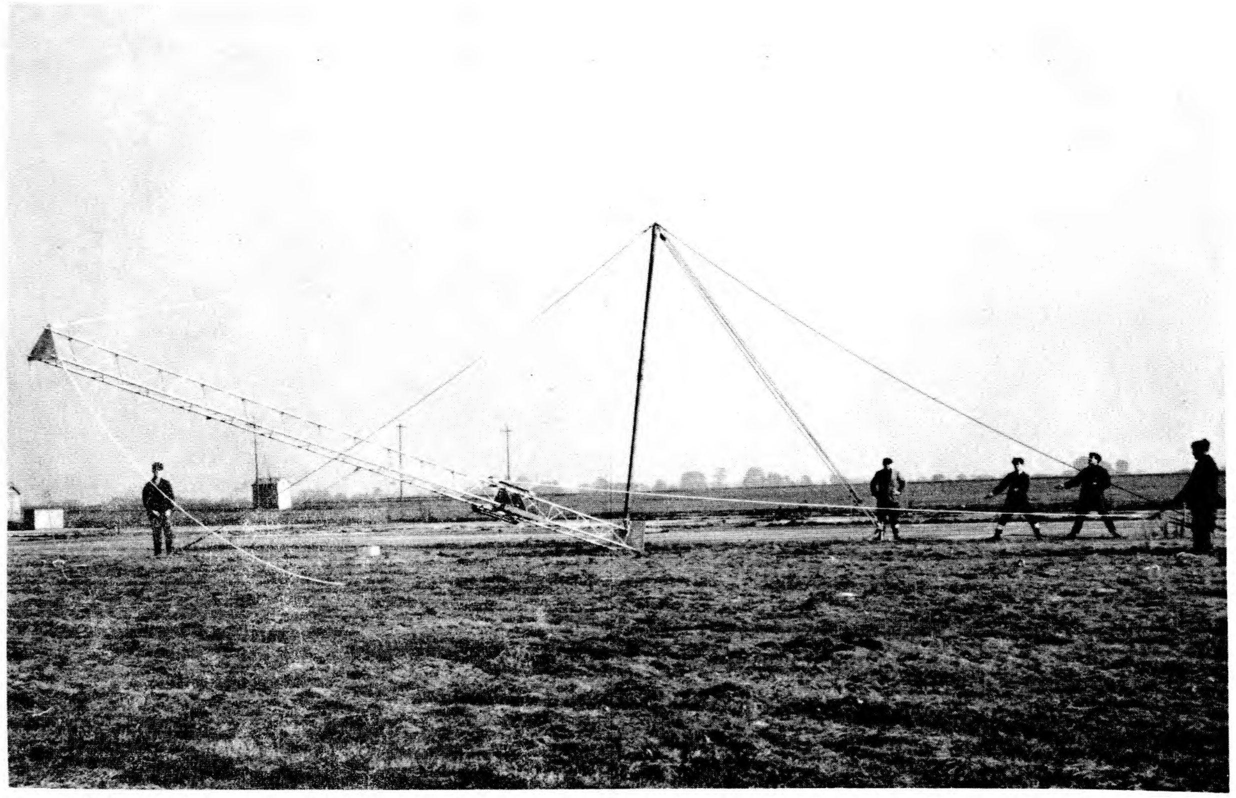


FIG. 17. ERECTION OF AERIAL, VIEW "A"

FIG. 16. ERECTION OF DERRICK POLE

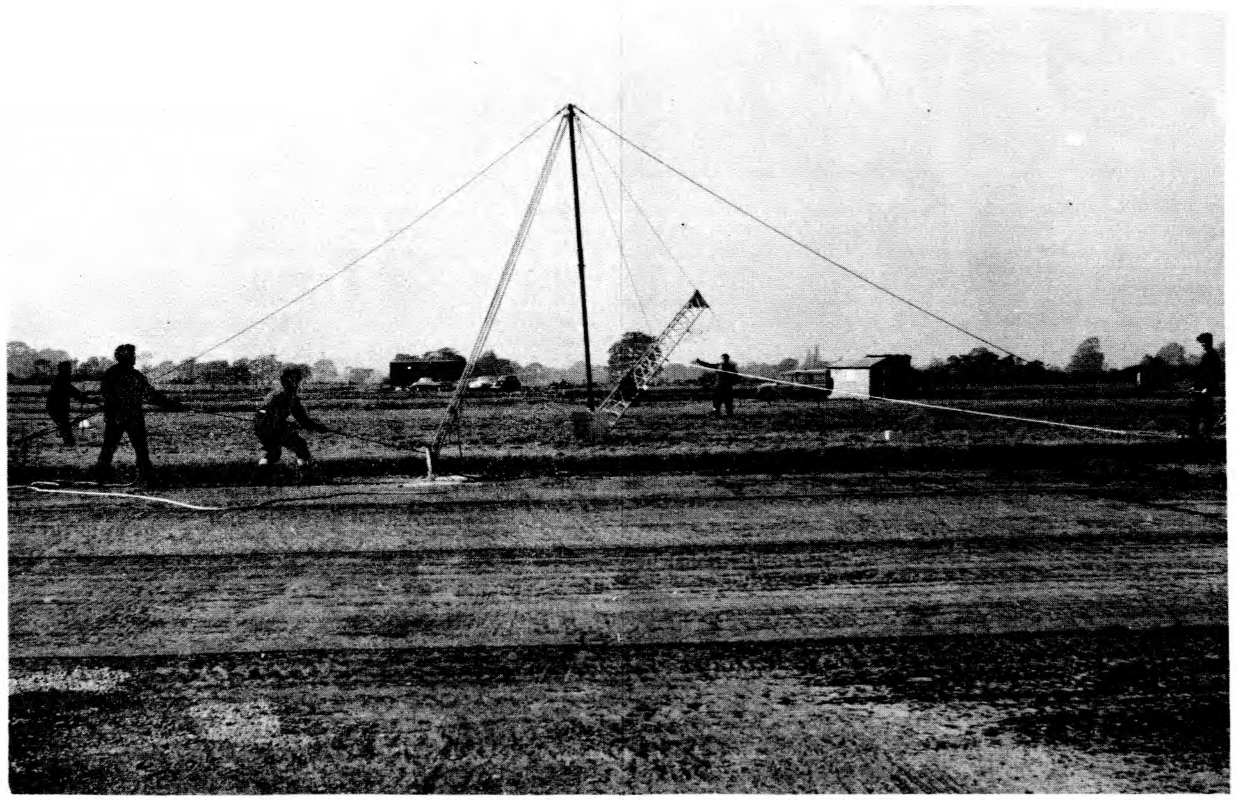


FIG. 18. ERECTION OF AERIAL, VIEW "B"

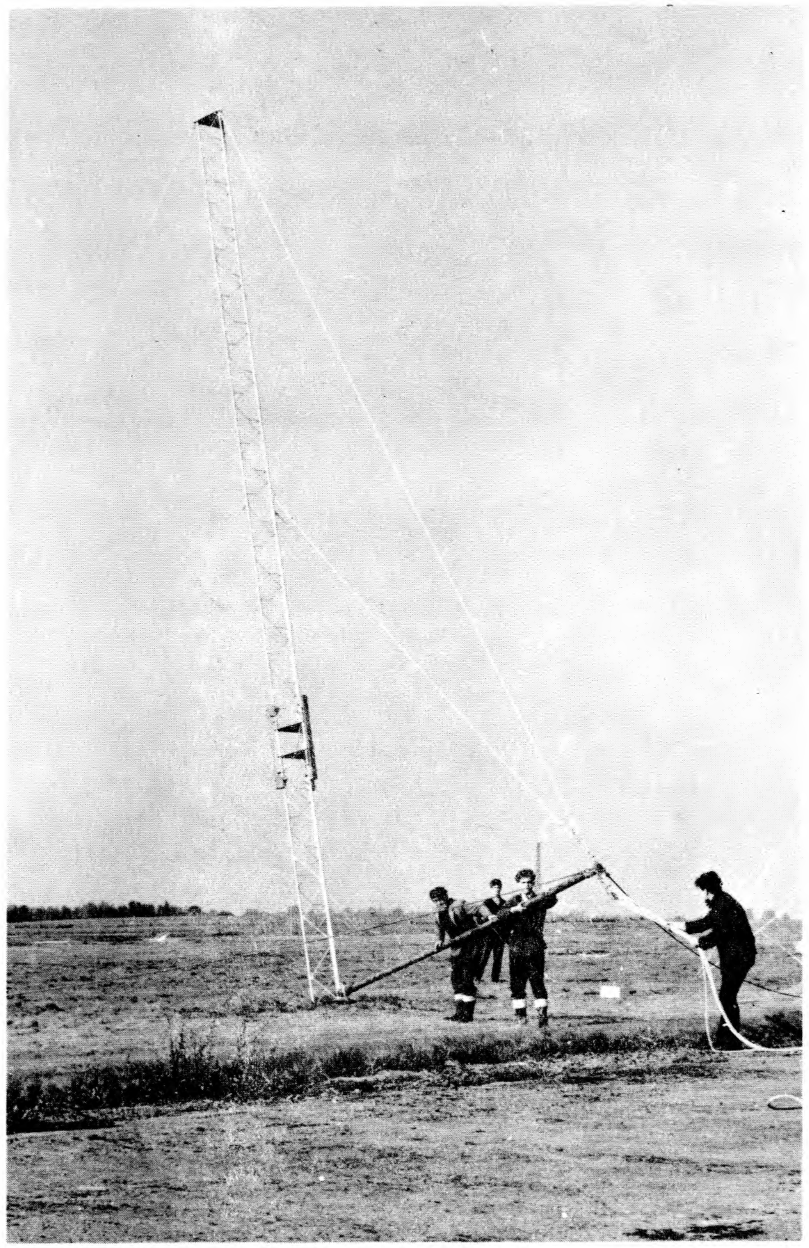


FIG. 19. FINAL DETAIL OF ERECTION OF AERIAL

FIG. 20. SECURING THE GUY ROPES

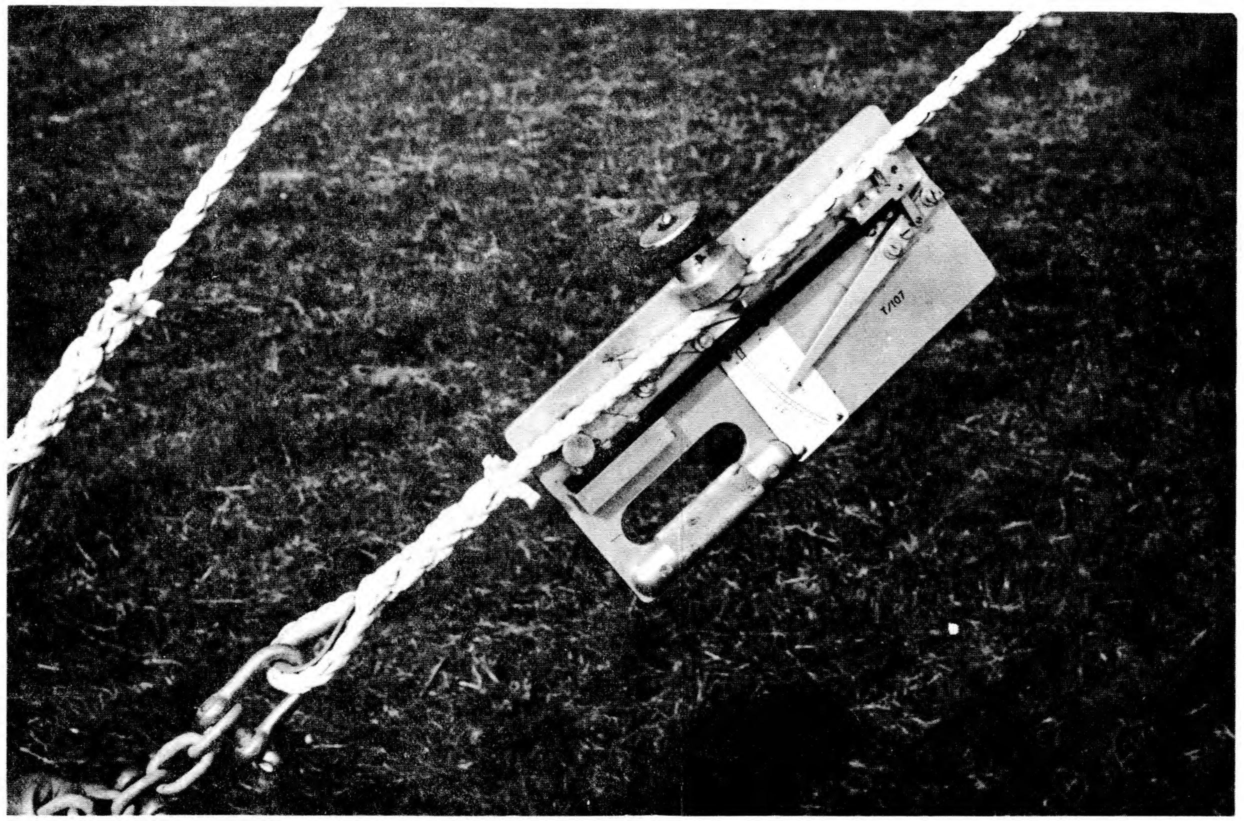
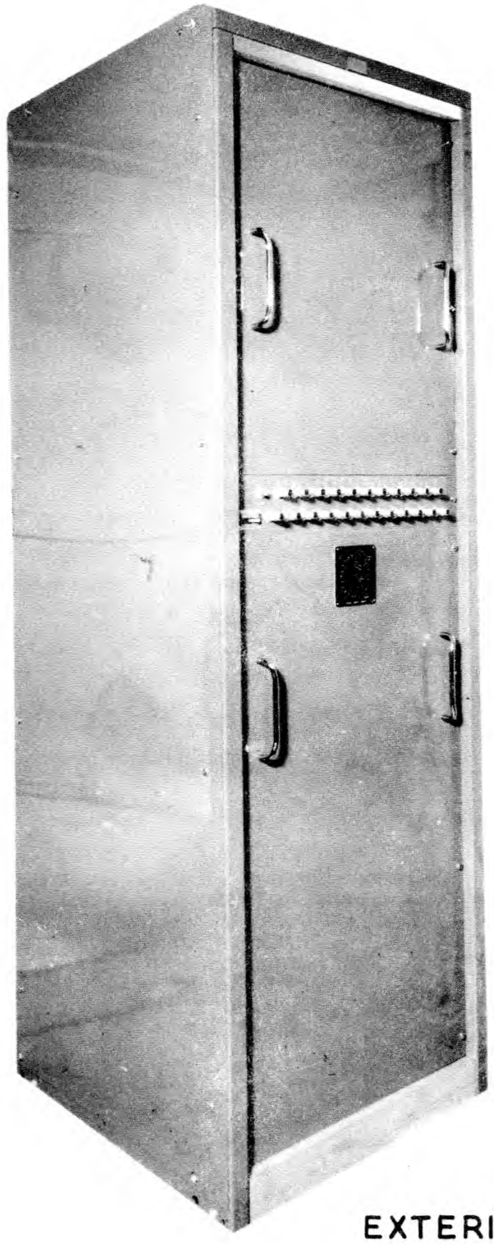
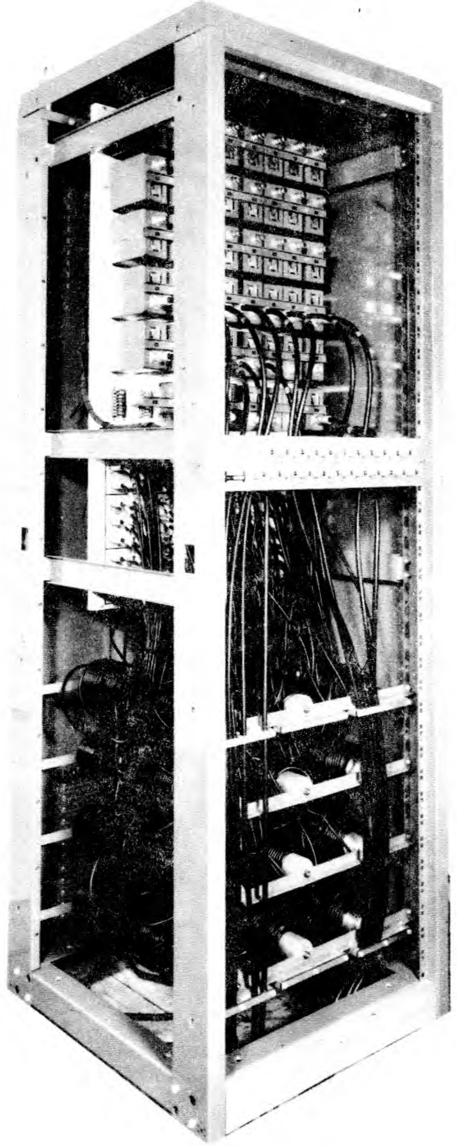


FIG. 21. USE OF TENSIOMETER



EXTERIOR



INTERIOR

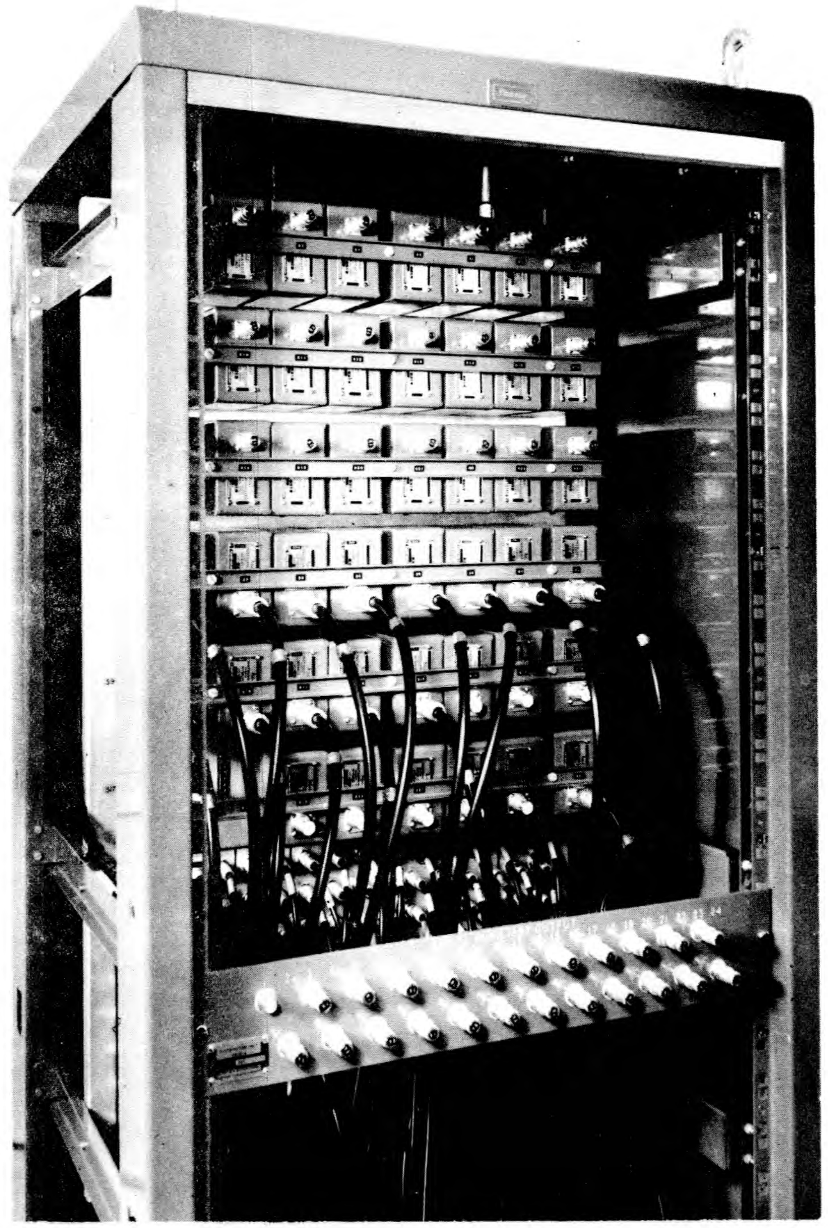


FIG. 24. CLOSE UP VIEW OF HYBRIDS

FIG. 22 & 23. BEAM FORMING CABINETS.

THE PLESSEY COMPANY LIMITED
PLESSEY AVIONICS & COMMUNICATIONS

SERVICE MANUAL
FOR
MULTIPLE BEAM
HIGH FREQUENCY RECEIVING
ANTENNA SYSTEM (1.5-30MHz)
PVS 1120 SERIES

Publication No 337
Issue 11

PLESSEY AVIONICS & COMMUNICATIONS
MARTIN ROAD · WEST LEIGH HAVANT HAMPSHIRE
TELEPHONE HAVANT (0705) 48 6391 TELEX 86227

MULTIPLE BEAM HIGH FREQUENCY RECEIVING

ANTENNA SYSTEM (1.5-30MHz) PVS 1120

WARNING

CERTAIN CRINKLE WASHERS AND TRANSISTOR HEAT SINKS USED IN THIS EQUIPMENT ARE MADE OF COPPER/BERYLLIUM MATERIAL. IN THE FORM SUPPLIED THIS MATERIAL IS PERFECTLY SAFE BUT, IF NOT PROPERLY HANDLED, CAN CONSTITUTE A SERIOUS HAZARD TO HEALTH.

ALLOYS CONTAINING BERYLLIUM IN TEMPERATURES BELOW 700^{o}C ARE CONSIDERED HARMLESS, BUT OXIDATION AND VOLATILISATION OCCURS WHEN THIS TEMPERATURE IS EXCEEDED, THE TOXIC HAZARD BEING RELATED DIRECTLY TO THE BERYLLIUM CONTENT OF THE ALLOY.

SHOULD THIS MATERIAL BE FRACTURED, ANY DUST PRODUCED REPRESENTS A SERIOUS TOXIC HAZARD.

DELIBERATE ABRASION OF THE MATERIAL MUST NOT BE ATTEMPTED UNDER ANY CIRCUMSTANCES.

PLESSEY AVIONICS & COMMUNICATIONS
MARTIN ROAD,
WEST LEIGH,
HAVANT, HANTS, ENGLAND.

MULTIPLE BEAM HIGH FREQUENCY RECEIVING ANTENNA SYSTEM

(1.5-30MHz) PVS1120

CONTENTS

TECHNICAL SUMMARY AND SYSTEM VARIANTS

MULTIPLE BEAM HIGH FREQUENCY RECEIVING ANTENNA SYSTEM (1.5-30MHz)
PVS1120 SERIES

TECHNICAL SUMMARY

General

Beams	Optimised in 24 directions at 15° intervals in azimuth with adjacent beams overlapping.
Elevational properties	Optimum reception at 12° (1.5-9.7MHz) and 15° (9.7-30MHz), usable from 0° up to 60°.
Frequency coverage	1.5MHz to 30MHz. Crossover point 9.7MHz.
Form of array	Two sets of 24 monopoles equally spaced on 150m and 50m diameter concentric circles respectively and lying on common radials.
Area of array	2 hectares (5 acres)
Total area required	Square or circular area of 8 hectares (20 acres) free from any large metallic structures.

Antenna Equipment

Type of antenna	Elevated feed monopoles
Number of antennas in system	48
Height of antennas	6.1m (2oft.) inner circle 12m (39ft.6in.) outer circle
Antenna feeder cables	Matched in electrical lengths appropriate to each set of monopoles.
Total weight, 48 antennas plus feeders	1755kg. (3870 lb.)
Total weight of antenna counterpoises (supplied with variant A)	360kg. (795 lb.)

Beam-forming Building and Equipment

Building size	3½m x 3½m (12ft x 12ft) minimum sufficient for equipment and one operator.
Beam Forming Cabinet size	1.98m x 660mm x 634mm (6ft.6in. x 2ft.2in. x 2ft.1in.)

Equipment weight	182kg. (400 lb.)
Outputs	(1) 48 "sum" beams combined in 12 dual filters to give 24 "sum" beam outputs from the antenna ring having the better directional properties at the particular chosen frequency. (2) 48 "difference" beams yielding a null output for signals arriving from the beam-pointing directions. The null levels are less than 10% (1.5-9.7MHz) and 16% (9.7-30MHz) of the corresponding "sum" beam levels. Used for certain d.f. applications. (3) 48 antenna "auxiliary" outputs at a minimum level of -5dB relative to antenna input level (amplifier off) or +5dB (amplifiers on). May be used for connection to Plessey Direction Finding Equipment PVS860 series (Part of DF1 system).
System impedance	75 ohms
Power requirement	150VA at 115V or 240V 48-450Hz.

EQUIVALENCE BETWEEN PLESSEY & MOD EQUIPMENTS

Equipment Title	Plessey Designation	MOD Designation
Multiple Beam Receiving Antenna System (1.5-30MHz)	PVS1120 PVS1120A	AX-19 AX-19 Plus PJ-12 (24 off) Plus PJ-13 (24 off)
Antenna Kit (1.5-10MHz)	-	PA-46
Antenna Kit (8-30MHz)	-	PA-43
Antenna Counterpoise Kit (1.5-10MHz)	-	PJ-13
Antenna Counterpoise Kit (8-30MHz)	-	PJ-12

EQUIVALENCE TABLE (Contd.)

Equipment Title	Plessey Designation	MOD Designation
Beam-forming Cabinet	PV1121	-
Cabinet	-	MV-42
Rack Mounting (1.5-10MHz)	PV892	-
Rack Mounting (8-30MHz)	PV882	-
Rack Mounting	-	ER-30
Antenna Distribution Unit (1.5-10MHz)	-	DX-7
Antenna Distribution Unit (8-30MHz)	-	DX-6
Combining Unit	-	CV-2
Power Unit	PV883	PP-88
Dual Bandpass Filter Unit	PV133K	-
Feed-through Panel	-	PC-44
Test Unit	PV884	TU-45
Multi-Beam Receiving Antenna System (8-30MHz)	PVS880	AX-14
Multi-Beam Receiving Antenna System (1.5-10MHz)	PVS890	-

SYSTEM VARIANTS

PVS1120

This system, covering the frequency range 1.5-30MHz, comprises:

(1) 24 Antenna Kits (1.5-10MHz), each consisting of an Antenna Assembly (1.5-10MHz) and a Cable Antenna Feeder (1.5-10MHz).

(2) 24 Antenna Kits (8-30MHz), each consisting of an Antenna Assembly (8-30MHz) and a Cable Antenna Feeder (8-30MHz).

(3) Beam Forming Cabinet (1.5-30MHz) PV1121, which includes a Rack Mounting (1.5-10MHz) PV882, a Rack Mounting (8-30MHz) PV892, a Power Unit PV883 and 12 Dual Band-Pass Filter Units PV133K.

The Rack Mounting (1.5-10MHz) PV892 contains 24 Antenna Distribution Units (1.5-10MHz) and 24 Combining Units, while the Rack Mounting (8-30MHz) PV882 contains 24 Antenna Distribution Units (8-30MHz) and 24 Combining Units.

PVS1120A

This system comprises the items detailed above for the PVS1120 system, plus the following:

(1) 24 Antenna Counterpoise Kits (1.5-10MHz).
(2) 24 Antenna Counterpoise Kits (8-30MHz).

PVS880

This system, covering the frequency range 8-30MHz, comprises:

(1) 24 Antenna Kits (8-30MHz), each consisting of an Antenna Assembly (8-30MHz) and a Cable Antenna Feeder (8-30MHz).

(2) Beam Forming Cabinet (8-30MHz) PV881, which includes a Rack Mounting (8-30MHz) PV882 and a Power Unit PV883.

The Rack Mounting (8-30MHz) PV882 contains 24 Antenna Distribution Units (8-30MHz) and 24 Combining Units.

PVS880A

This system comprises the items detailed above for the PVS880 system, plus 24 Antenna Counterpoise Kits (8-30MHz).

PVS880B

This system comprises the items detailed above for the PVS880 system, plus 12 Dual Band-Pass Filter Units PV133K.

PVS880C

This system comprises the items detailed above for the PVS880 system, plus the following:

(1) 24 Antenna Counterpoise Kits (8-30MHz).
(2) 12 Dual Band-Pass Filter Units PV133K.

PVS890

This system, covering the frequency range 1.5-10MHz, comprises:

(1) 24 Antenna Kits (1.5-10MHz), each consisting of an Antenna Assembly (1.5-10MHz) and a Cable Antenna Feeder (1.5-10MHz).

(2) Beam Forming Cabinet (1.5-10MHz) PV891, which includes a Rack Mounting (1.5-10MHz) PV892 and a Power Unit PV883.

The Rack Mounting (1.5-10MHz) PV892 contains 24 Antenna Distribution Units (1.5-10MHz) and 24 Combining Units.

PVS890A

This system comprises the items detailed above for the PVS890 system, plus 24 Antenna Counterpoise Kits (1.5-10MHz).

PVS890B

This system comprises the items detailed above for the PVS890 system, plus 12 Dual Band-Pass Filter Units PV133K.

PVS890C

This system comprises the items detailed above for the PVS890 system, plus the following:

(1) 24 Antenna Counterpoise Kits (1.5-10MHz).
(2) 12 Dual Band-Pass Filter Units PV133K.

Doublet Antenna System

Reference should be made to Appendix 1.

NOTE

This manual is applicable to all variants, it details the PVS1120 system and unless stipulated otherwise, can be related to a variant by ignoring those references which the foregoing indicates are not common to the PVS1120.

CHAPTER 1

INTRODUCTION

GENERAL

1. The Multiple Beam High Frequency Receiving Antenna System (1.5-30MHz) consists of two sets of 24 antennas on concentric circles of 150m and 50m diameter. The antennas drive a complex of beam forming networks housed in a building at the centre of the antenna circles. The system operates over the frequency range 1.5-30MHz, and produces simultaneously 24 independent beam outputs on azimuthal bearings at successive 15° intervals.

2. Where it is necessary to stabilise the impedance of the antennas against variation in ground conductivity across the site and with climatic change, counterpoises are used. The equipment is then designated PVS1120A.

3. The system may be supplied to cover two separate frequency bands; 1.5-10MHz and 8-30MHz. These variants are designated PVS890 and PVS880 respectively.

4. The antennas are in the form of monopoles constructed of 50mm (2in) diameter aluminium tubing, those of the outer ring being approximately 12m (40ft) high and covering the range 1.5-9.7MHz, whilst those of the inner ring are approximately 6m (20ft) high and cover the range 9.7-30MHz. Figs. 2 and 3 show the two types of monopoles erected.

5. The 24 antennas of each ring are connected by two sets of 24 electrically-matched feeder cables to beam-forming circuits contained in rack mountings. These are housed in a single cabinet located in a building at the centre of the circle.

6. The beam-forming circuits are preceded by 10dB gain amplifiers powered by a d.c. supply unit which is also fitted in the beam-forming cabinet. The use of these amplifiers is optional, but it may be desirable in low-noise regions, particularly in the upper HF band, where noise field strengths tend to be lower than elsewhere in the HF band. The beam-forming circuits produce sets of 24 beams from each of the two antenna rings, and, since the antennas lie on radials common to the two circles, 24 pairs of beams are produced.

7. These beams are independently and simultaneoulsy available for feeding receivers. They are designed for reception from 24 directions separated by 15° intervals in the azimuthal plane, and are optimised for signals arriving from elevation angles of 12° (in the 1.5-9.7MHz band) and of 15° (in the 9.7-30MHz band). The system beam widths for ground waves and for signals received from elevation angles of up to 20° differ only slightly from this optimum condition, and the equipment is usable with signals from up to 60° elevation. The beams also have a large enough beam-width in azimuth to ensure that the complete system provides satisfactory reception from any direction over the frequency band. In general, the outer antenna ring (low frequency) provides externally noise-limited conditions when using receivers having noise factors of 10dB and below.

8. The 48 (two sets of 24) beams are combined in twelve PV133K filter units. Each filter unit consists of a pair of dual band-pass filters covering the range 1.5-9.7MHz and 9.7-35MHz with a common output socket.

9. The 24 combined pairs of beams from the filters are fed via 24 coaxial cable feeders to the receiving station. If the feeder losses are unacceptably high, a Plessey MF/HF wideband amplifier Type PV922 can be interposed between each filter output and its associated feeder cable. These feeders are not supplied as part of the standard equipment, and are normally manufactured on site as required. Consult Fig. 5 note 5 and the last table in Chapter 5.

10. The 24 signals from the beam-forming cabinet can be applied directly to any HF receiver of nominal 75Ω input impedance.

11. The Beam Selector Set PVS560 has been designed as ancillary equipment to the antenna system. Used in conjunction with a suitable HF receiver (e.g. PR155) it provides a simultaneous visual display of the relative amplitudes of the beams (sum or difference) or, alternatively, the antenna auxiliary outputs. Additional signals, such as those from other antennas or from a generator, can also be displayed for comparison.

MECHANICAL DESCRIPTION

High-Band (8-30MHz) Antennas

12. The system uses 24 antennas equally spaced on the circumference of a 50m diameter circle. The antennas, which are 6.1m (20ft) high are elevated feed monopoles with their feed point 2.1m (7ft) above ground level.

13. Each antenna consists of two 50mm (2in) diameter aluminium tubes of HT30 grade material; the lower element is 2.1m (7ft) long and the upper element 3.95m (13ft) long. The two elements fit into a mast insulator at the feed point. The mast insulator is a glass fibre tube to which the antenna transformer assembly is attached. The assembly houses a ferrite-cored impedance matching transformer and a sealed surge voltage lightning protector.

14. The antenna foot assembly is a square aluminium plate of 30mm (1ft) side, and is electrically earthed by braid attached to two aluminium 'Tee' section earth stakes. The antenna is guyed with three pre-stretched Terylene stays attached to a houndsplate supported by a clamp to the upper antenna element.

15. Twenty four feeder cables of equal electrical length, normally laid on the ground or buried just beneath the surface, feed the antenna signals to the Beam Forming Cabinet located in a building at or near the centre of the antenna circle.

16. The Counterpoise Kit (8-30MHz) for each antenna (used in the PVS1120A variant) comprises a set of four 5.3m lengths of p.v.c. insulated 7/0.85mm copper wire, 8 aluminium 'Tee' section earth stakes, and sufficient ¼" - 28 UNF x 1" long screws, nuts and washers for fixing purposes. The wire is laid in the form of eight equally disposed radials about the antenna base to which they are connected. The stakes provide electrical connection at the other end of the wires and secure them in position.

Low-Band (1.5-10MHz) Antennas

17. The installation comprises 24 antennas equally spaced on the circumference of a 150m diameter circle. The antennas, which are approximately 12m (39ft.6in) high, are in the form of elevated feed monopoles with a feed point 4m (13ft.2in) above ground level.

18. Each antenna consists of three 50mm (2in) diameter aluminium tubes of HT30 grade material, each 3.95m (13ft) long. The two lower tubes fit into the antenna feed point insulator. This consists of a glass fibre tube to which is attached a smaller tube closed at its upper end housing the antenna transformer assembly, comprising a ferrite cored impedance matching transformer and a sealed surge voltage lightning protector.

19. The upper tube of the mast is joined to the centre tube by a special high tensile screw, with a lock nut to prevent the top tube slacking off.

20. The antenna foot assembly is a square aluminium plate of 300mm (1ft) side, and is electrically earthed by braid attached to two aluminium 'Tee' section earth stakes.

21. The antenna is guyed by three sets of three pre-stretched Terylene stays. Each set of stays is attached to a houndsplate supported on each antenna element by a clamp.

22. Twenty four feeder cables of equal electrical length, normally laid on the ground or buried just beneath the surface, feed the antenna signals to the Beam Forming Cabinet.

23. The Counterpoise Kit (1.5-10MHz) for each antenna (used in PVS1120A variant) comprises a set of four 15.9m lengths of p.v.c. insulated 7/0.85mm copper wire, 8 aluminium 'Tee' section earth stakes, and sufficient $\frac{1}{4}$" - 28 UNF x 1" long screws, nuts and washers for fixing purposes. The wire is laid in the form of eight equally disposed radials about the antenna base to which they are connected. The stakes provide electrical connection at the other end of the wires and secure them in position.

BRIEF CIRCUIT DESCRIPTION

24. Each antenna system produces two sets of 24 beam outputs. These are designated the "sum" beams and the "difference" beams. The "sum" beams are normally used for directional reception, whilst the "difference" beams are intended for use in certain d.f. applications.

25. Each antenna signal is connected to an Antenna Distribution Unit (ADU). The ADU contains sets of lumped constant delay lines, and produces eight independent fixed time-delayed RF outputs. Each of the 24 "sum" beams is formed in a Combining Unit by adding together one particular delayed signal from each of eight adjacent antennas. The 24 "difference" beams are formed in a similar manner in the same Combining Units, except that the sum of the signals on (for example) antennas 1 to 4 is subtracted from the sum of the signals on antennas 5 to 8.

26. Figure (a) illustrates the relationship between any eight adjacent antennas of the system and the plane wavefront of an incident signal. The signal direction of arrival is shown perpendicular to the line joining antennas 1 and 8 and the delays are chosen to give optimum beam reception in this direction. The wavefront arrives at antennas 4 and 5 before it arrives at 3 and 6, and at 3 and 6 before reaching 2 and 7, and so on. The lengths of the perpendicular lines from each antenna to the line joining antennas 1 and 8 represent the electrical delay lengths required to put all the signals for one "sum" beam into phase assuming the incident signal arrives horizontally.

27. The system is optimised for signals arriving from an elevation of 15° (high-band) and 12° (low-band), and the above delay lengths have been reduced by approximately 3½% and 2% respectively to achieve this. The system produces a satisfactorily uniform response for ground waves and for up to 20° elevation angle and is usable up to 60° elevation. As a result of the symmetry of the array, the "difference" beams produce a null response to signals arriving from directions for which the corresponding "sum" beams give a maximum response.

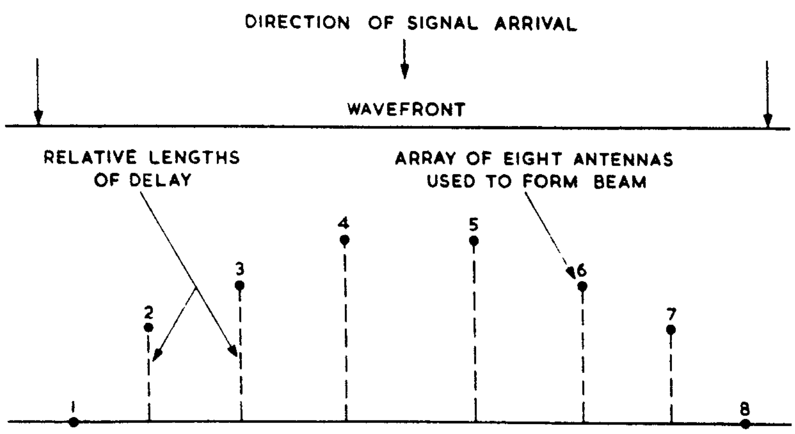


Fig. (a)

28. In addition to the hybrid units and the delay lines, the beam-forming networks also include lightning protection networks, signal amplifiers and high pass filters. The signal amplifiers, whose use is optional, can be operationally controlled either at the Power Unit PV883, or from a remote position. The high pass filters limit the amplitude of MF and low HF signals to the input of the signal amplifiers.

29. The signals from each antenna are available at auxiliary sockets mounted at the lower front of the Rack Mounting. These outputs, whose level is nominally 3 dB below the input level with the signal amplifiers off or 7dB above the input level with the signal amplifiers on, can be used to drive the HF Direction Finding Equipment Plessey Type PVS860 or, alternatively, can be used for test or monitoring purposes. Note that the DF techniques here are different from those mentioned in para. 27.

30. The sum beam outputs derived from each of the two antenna rings are combined in the PV133K filters. Each filter unit consists of a pair of dual band-pass filters covering the range 1.5 to 9.7MHz and 9.7 to 35MHz with a common output socket.

31. The PV133K filters also give additional protection of receivers and feeder line amplifier against large amplitude MF and low HF signals.

32. The PV133K filter outputs may be connected to suitable receivers, either directly or via active multi-couplers.

DOUBLET ANTENNA SYSTEM

33. Reference should be made to Appendix 1.

CHAPTER 2

INSTALLATION

INTRODUCTION

1. This chapter describes the tests and procedures necessary to install the Multiple Beam HF Receiving Antenna System PVS1120.

2. The assemblies and sub-assemblies required for the system are listed in Chap.5. The necessary illustrations are contained in Chap.6.

PRE-INSTALLATION TESTS

3. It is recommended that the following electrical tests are carried out before installing the system. These tests should be carried out using a multimeter (an Avometer Model 8 is suitable). Do not use a Megger or other high voltage tester as these instruments may cause damage to the system.

Antenna Transformer Assembly

4. Check, at each assembly, that continuity exists between the metal tab support and (a) the flying sleeved lead, and (b) the inner conductor of the co-axial socket.

Feeder Cables (Code No.1 and No.2)

5. Test the continuity of the inner and outer conductors with the multimeter set to the low ohms range. The measured resistance for cables coded No.1 should be approximately 2.25 ohms for the inner core and 0.75 ohm for the outer braid. For the cables coded No.2, the measured resistance should be approximately 0.75 ohm for the inner core and 0.25 ohm for the outer braid. Cables are of exact electrical length. Extreme care should be exercised to ensure that these are not subjected to strain during installation.

6. Set the multimeter to the OHMS x 100 range and check that the resistance, measured between the inner and outer conductors, is greater than 10 megohms.

MARKING OUT THE ANTENNA SITE

General (Fig. 1)

7. It is assumed that a suitable site, with no large variations in ground level, has been selected. If the system is to be employed for beam reception only, the bases of the outer antennas should be coplanar to within ±3m, and the bases of the inner antennas coplanar to within ±1m. Alternatively, a steady slope across the site of up to 4° would be acceptable. If the system is also to be used for direction finding purposes, it is recommended that the bases of the outer antennas be coplanar to within ±0.5m. Alternatively, the site may have a steady slope of not greater than 2°.

8. The outer circle of antennas occupies about 2 hectares (5 acres). The site should be free of sizeable metallic structures, such as iron barns and pylons, for a concentric area of at least 8 hectares (20 acres), i.e. twice the diameter of the outer circle of antennas.

9. The radial directions of the antennas from the centre of the circle do not correspond with the directions at which the beams have optimum response. The optimum beam directions lie midway between the radials of adjacent antennas. Unless it is especially required to align a beam in a particular direction, it is suggested that one of the 24 beams of each antenna array be aimed towards true north.

10. Fig. 1 indicates the disposition of the two sets of 24 antennas with relation to the centre of the circle. The centre of the circle should be substantially level as the building housing the beam forming cabinet is positioned here after marking out the site.

11. Two methods are given for marking out the antenna positions. Method 1 can be used if the array area is clear of all obstructions, such as trees, shrubs, etc., which allows the use of a measuring tape to mark out the antenna positions. Method 2 is used where, because of obstructions, it is impracticable to use a measuring tape, and antenna positions are determined by the use of two theodolites.

Method 1

12. Two operators and the following equipment are required for this method:

(1) One steel measuring tape 100m (300ft) long.

(2) One theodolite, accuracy of setting not worse than 5 minutes of arc, with tripod and plumb bob.

(3) One ranging pole 2.5m (8ft).

(4) Fortynine stakes approximately 1m (3ft) long.

(5) One hammer, 1kg. (2 lb.).

(6) One magnetic compass calibrated at intervals not greater than 0.5° and fitted with optical sights.

13. Drive a stake into the ground at the centre point. It is assumed that beam No. 1 is to be aimed towards true north. The radial direction of antenna No. 1 is therefore $52\frac{1}{2}^{\circ}$ W of N. The magnetic compass is used to obtain an initial sighting of this direction from the centre point, making allowance for the difference between true north and magnetic north. For example, if magnetic north for the particular place is 9°E of true north, then the compass sighting is $61\frac{1}{2}^{\circ}$ W of N (magnetic). Note the approximate direction, and lay the steel measuring tape out from the centre in that direction. The tape is held at the centre by one operator, whilst the second operator, also carrying the hammer, stakes and ranging pole, walks out 75m. The tape should be straightened and pulled taut, with its zero mark aligned with the centre stake. The final positioning is determined by re-sighting the radial direction from the centre-point and guiding the operator on the circumference of the circle to the correct position by use of the ranging pole. One stake is lightly driven in on the radial and the steel tape straightened and tautened while just touching the stake. Holding the tape in tension, the stake is positioned at the 75m point (within a radius of 150mm (6in) about this point); finally, drive the stake well into the ground, leaving about 600mm (2ft) above the surface.

14. A second stake is positioned at the 25m point (within a radius of 150mm (6in) about this point) and then driven into the ground, leaving about 600mm (2ft) above the surface.

15. The theodolite is now erected with its centre vertically above the centre stake and the telescope aligned on the newly positioned stake at the circumference. The theodolite azimuth reading is noted (or set to zero), and the theodolite telescope is rotated eastward or westward by exactly 15° to determine the position of the adjacent antenna. The operator at the circumference positions the ranging pole on the radial as indicated by the observer at the theodolite. The measuring tape is pulled across to the new position and straightened along the line from the centre stake to the pole. Then, as before, with the tape taut, the second antenna positions at 75m and 25m radius ± 150mm (±6in) are marked by driving in stakes alongside the tape measure.

16. The positions of the remaining 22 antennas in the outer and inner circles are similarly determined, in turn, by stepping round the theodolite telescope exactly 15° at a time. As a final check, the distance between neighbouring stakes is measured; this should be 19.58m ± 300mm (64ft.3in ± 1ft.0in) for the outer circle, and 6.53m ± 300mm (21ft.5in ± 1ft.0in) for the inner circle.

Method 2 (FIG. 4)

17. The equipment required for this method is as for method 1 plus one extra theodolite and a third operator.

18. This method is the same as method 1 up to the point of determining the position of the first pair of antennas. It is suggested that these are positioned by making use of one of the theodolites at the centre of the circle as in method 1. The theodolite is trained on the stake for antenna No. 1 and the azimuth reading noted or set to zero. The theodolite is then rotated through exactly 180° to give the alignment for the diametrically opposite antenna, the position of which is determined as described for the second and subsequent antennas in method 1.

19. The two theodolites are now erected vertically above the two diametrically opposed antenna stakes on the outer circle. The instruments are trained on each other and set to zero in azimuth. The theodolites are then rotated to the angles specified in the table in Fig. 4, while the third operator moves his ranging pole to the instructions of the two theodolite operators who direct him in turn until the pole is correctly positioned in the sights of both instruments. A stake is driven in to mark the spot for the centre of the antenna. Note that the directions from each theodolite to the antenna position are mutually perpendicular so that, provided each theodolite is correctly positioned and aligned, the antenna location is precisely determined.

20. Fig. 4 illustrates the method described above, and lists the angles to which the theodolites, disignated A and B, are set for each of the 22 antenna positions in each circle, the numbers of the antennas corresponding with the figures on the diagram.

21. As a final check, the distance between neighbouring stakes is measured. This should be 19.5m ± 300mm (64ft.3in ± 1ft.0in) for the outer circle.

22. Repeat paragraphs 19, 20 and 21 for the inner circle, using the same table in Fig. 4. In the final check, the distance between neighbouring stakes should be 6.53m ± 300mm (64ft.3in ± 1ft.0in) for the outer circle.

HIGH-BAND (INNER) ANTENNA ARRAY

General

23. A team of two men is required to erect the inner antenna array, together with the following equipment:

(a) Tool kit Plessey No. 686/1/02198.

(b) A tommy bar not less than 2m long suitable for the ground anchors.

(c) Tensiometer for measuring stay tensions between 50 and 75 lb.

Antenna Assembly (Fig.2)

24. Each antenna comprises two elements (2.1m and 3.95m), a houndsplate and clamp, a mast insulator, an antenna transformer assembly, and a foot.

25. Before assembly, coat all threaded sections with anti-scuffing paste to specification DTD5530. Coat the inside of the mast insulator and the mating sections of the upper and lower elements with silicone grease, e.g. Midland Silicone Ltd., silicone compound Type MS4.

26. Assemble the antennas as follows:-

(1) Fit the clamp assembly over the blue coloured band on the 3.95m (13ft) element. Fit the houndsplate over the bunged end of the element, with the bent corners facing towards the clamp.

(2) Screw the stainless steel ¼" - 28UNF x 1" screws 991/4/01449/028 into two diagonally opposite holes in the antenna foot and lock each screw with a stainless steel nut 991/4/01996/002. For PVS1120A systems fit a ¼" - 28UNF x 1" screw and nut in each of the four holes in the antenna foot.

(3) Fit the antenna foot to the lower 2.1m (7ft) element by screwing the ⅜" - 16UNF x 1¼" screw 991/4/01485/018 fitted with the ⅜" crinkle washer 999/4/01130/012 into the tapped boss at the closed end of the element. Ensure that the projecting end of the bolts fitted at (2) face upwards towards to lower element.

(4) Fit the open ends of the two elements into the mast insulator, such that the open end of the antenna transformer assembly housing faces down, i.e. towards the lower element. Align the tapped holes in the elements with the holes in the mast insulator.

(5) Insert the antenna transformer assembly into the housing so that the metal tongue lies against the mast insulator and push home until it seats on the stepped section in the housing.

The flying lead exits from the housing at the corner of the metal support of the assembly and is bent upward outside the antenna transformer housing. The metal tongue and flying lead are then connected to the lower element and upper element respectively through holes in the mast insulator with the 10-32UNF 19mm ($\frac{3}{4}$") long slotted screws through metal spacers. See Fig. (b).

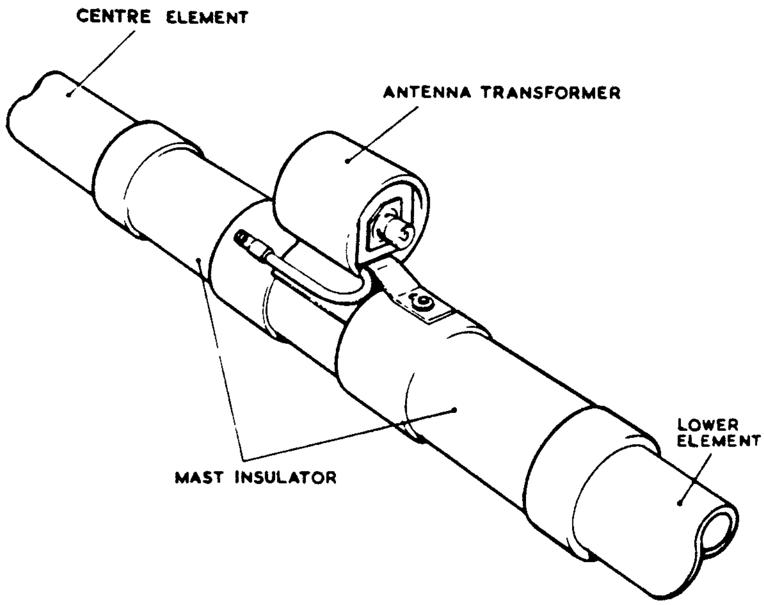


Fig. (b)

(6) Attach the three Terylene stays to the houndsplate using the stainless steel shackles 753/4/98008. Pass the 'D' of the shackle through the eye of the stay, and the pin through the hole in the houndsplate with the threaded end pointing down.

(7) Attach a rigging screw 686/4/02270 to the remote end of each stay. To the other end of each rigging screw attach a length of chain 686/4/02271.

(8) Fit an undamaged protection cap over the top of the upper antenna element.

(9) Assemble the remaining antennas and position them around the perimeter of the array circle before starting the erection of the array.

Preparation for Antenna Erection

27. Before erecting the antennas, it is recommended that all the ground anchors are secured in position.

28. The ground anchors, which resemble single-turn corkscrews, are positioned on a pitch circle of 4.1m (13ft.6in) radius from the centre of

each antenna foot. One ground anchor is positioned 4.1m (13ft.6in) from the antenna marker stake in a radial direction and towards the centre. The other two ground anchors for the antenna guy ropes are common to adjacent antennas, and are sited on the intercepts of the pitch circles of the antennas. The positions and dimensions are shown on Fig. 1.

29. The anchors are screwed vertically into the ground. It is suggested that the best technique for starting the anchor is to dig out a spit of earth at the anchor entry point. A tommy bar, not less than 2m (6ft) long, is passed through the eye of the anchor at the top, and is used to apply pressure to start the insertion as well as to screw the ground anchor in until only the eye remains above the surface.

30. It may not always be possible to use ground anchors where the terrain is rocky or sandy. In these conditions, the use of concrete piles is usually satisfactory.

Antenna Erection

31. When the preparations for antenna erection are complete, the antenna may be erected.

32. One man lifts the antenna into a vertical attitude in the required position, with the Antenna Transformer housing facing in towards the centre of the circle, whilst the second man secures the stays to the ground anchors, using galvanised steel shackles 686/4/02272.

33. The rigging screws are extended and the stays tensioned to 50-75 lbs. on the tensiometer by taking up a link at a time of the chain on the ground anchor shackle. Final adjustment is made by closing the rigging screws.

NOTE: The antenna must remain vertical and straight at all times.

34. The rigging screw threads are to be coated with Aeroshell Grease 14 DTD900/4609, and the surplus chain links dressed neatly round the ground anchors.

Earthing Stakes (PVS1120)

35. Fig. 2 indicates the position of the two earth stakes 686/2/02141 at the antenna foot. Drive the earth stakes vertically into ground, adjacent to the projecting screws on the antenna foot, until about 150mm (6in) protrudes above the ground. Connect the earth braids 686/1/02142 to the screws on the foot, and secure with the crinkle washer 999/4/01130/010 and the ¼" - 28UNF stainless steel nut 991/4/01996/002, and likewise to the earth stakes. Finally, drive the earth stakes in until about 25mm (1in) protrudes above the ground.

Counterpoise Kit (PVS1120A)

36. The positions and dimensions of the eight earth stakes are given in Fig. 1.

NOTE: It can be seen that, because of the configuration of the antenna stays, any access road will run close by an antenna mast. In these circumstances, when a counterpoise is fitted, it will encroach on this access, and provision must be made to sink some of the radial wires below the surface level. If the access is made of solid material, e.g. concrete or granite chips, it is advisable, at the time of construction, to insert 50mm x 50mm (2in x 2in) wooden shuttering, as necessary, so that the radial wires can be laid in the troughs when the counterpoise is fitted.

37. The positions of the eight stakes are marked out and a spit of earth removed at each position. Troughs 50mm (2in) deep are cut to accommodate the radial wires. The earth stakes are driven into the ground, with the leg of the Tee pointing inwards towards the antenna, leaving sufficient of the earth stake proud to enable the connections to be made.

38. Fit a $\frac{1}{4}$" - 28UNF x 1" screw 991/4/01449/028 to each earth stake and secure with a nut 991/4/01996/002 and a $\frac{1}{4}$" crinckle washer 999/4/01130/010. Fit a counterpoise wire to each of the corner screws in the antenna foot by wrapping and twisting the bared centre section around the screw, and secure it between two washers with a nut. The two ends of each counterpoise wire are secured to the adjacent earth stakes in a similar manner. Finally, drive the earth stakes 50mm (2in) below the surface level and refill the troughs.

Antenna Feeders

39. The co-axial antenna feeders are each about 35m (115ft) long. Of this length, 2.5m (8ft) is required to connect up to the elevated feed point, plus 25m (82ft) from the antenna to the centre of the array, leaving about 7.5m (24ft) for the connection to the beam-forming equipment.

40. All feeder cables are received on site coded No. 2. Cable marker clips are supplied with the equipment, and are fitted in addition to the coding No. 2 as described below. The feeder cable associated with the antenna No. 1 is to be coded 2019 by adding cable marker clips (see Components List, Chap.5) 019 at the antenna end, the digit '9' denoting the frequency band 8-30MHz. The feeder cable associated with antenna No. 2 is to be marked 2029 and so on, the feeder cable associated with antenna No. 24 being marked 2249.

41. Each feeder cable is fitted with Type C plugs at each end. The straight connector is fitted to the Antenna Transformer assembly, and the elbow connector is fitted to the beam-forming cabinet.

42. Connect a feeder cable to each antenna in turn, and secure it in three positions (indicated on Fig. 2) with a cable binder 915/4/98727 and clip 915/4/98774/003 using the tool provided (see Appendix to Chap. 4). Disconnect the feeder cable, fit the tube (686/2/02275) over the feeder cable, reconnect cable, slide the tube over the transformer assembly housing, and snap on the cap (686/2/02276). Each feeder cable is then laid in as straight a line as possible to the centre of the array and passed into the hut. This end of the cable is also to be labelled in accordance with the method given in para. 40 using the marker clips supplied.

LOW-BAND (OUTER) ANTENNA ARRAY (Fig. 3)

General

43. A minimum team of three men is required to erect the outer antenna array together with the following equipment:

(a) Tool Kit, Plessey No. 686/1/02198.

(b) A tommy bar, not less than 2m long, suitable for the ground anchors.

(c) Tensiometer for measuring stay tensions between 50 and 75 lb.

(d) Earth stakes, Plessey No. 686/2/02141 - 2 off.

(e) Length of rope, Plessey No. 686/2/02191.

Antenna Assembly

44. Each antenna comprises three 3.95m (13ft) elements, three houndsplates and clamps, a mast insulator, an antenna transformer assembly and a foot.

45. Before assembly, coat all threaded sections with anti-scuffing paste to specification DTD5530. Coat the inside of the mast insulator and the mating sections of the centre and lower elements with silicone grease, e.g. Midland Silicone Ltd., Silicone Compound Type MS4.

46. Assemble the antennas as follows:

(1) Fit a clamp assembly over the red band on one element, another clamp over the yellow band on the second element, and a third clamp over the green band on the third element. Fit a houndsplate over (i) the open end of the red and green band clamped elements and (ii) the bunged end of the yellow band clamped element, with the bent corners facing towards the clamp.

(2) Join the top element (red band) to the centre element (yellow band) using the set screw (hexagonal socket) 991/4/00300/157. The set screw should be inserted into the top of the centre element to half its length and locked in position using the stainless steel locknut 991/4/01996/005. Tools are provided in the tool kit 686/1/02198.

NOTE: When screwing the set screw in, a slight resistance will be felt after about 19mm ($\frac{3}{4}$"). This is caused by the action of the locking helicoils in the boss at the element end.

The top element should now be screwed on to the set screw.

(3) Screw the stainless steel $\frac{1}{4}$" - 38UNF x 1" screws 991/4/01449/028 into two diagonally opposite holes in the antenna foot and lock each screw with a stainless steel nut 991/4/01996/002 (PVS1120). For PVS1120A, fit a $\frac{1}{4}$" - 38UNF x 1" screw and nut in each of the four holes in the antenna foot.

(4) Fit the antenna foot to the lower element (green band) by screwing the $\frac{3}{8}$" - 16UNF x $1\frac{1}{4}$" screw 991/4/01485/018 fitted with the $\frac{3}{8}$" crinkle washer 999/4/01130/012 into the tapped boss at the closed end of the element. Ensure that the

projecting ends of the screws fitted at (3) face upwards towards the lower element.

(5) Insert the open ends of the lower and centre elements into the mast insulator, such that the open end of the transformer assembly housing faces down, i.e. towards the lower element. Align the tapped holes in the elements with the holes in the mast insulator.

(6) Insert the antenna transformer assembly into the housing so that the metal tongue lies against the mast insulator and push home until it seats on the stepped section in the housing. The flying lead exits from the housing at the corner of the metal support of the assembly and is bent upward outside the antenna transformer housing. The metal tongue and flying lead are then connected to the lower element and centre element respectively through holes in the mast insulator with 10-32UNF 19mm ($\frac{3}{4}$") long slotted screws through metal spacers. See Fig. (b).

(7) Attach the three Terylene stays with red markers to the top houndsplate, the three stays with yellow markers to the centre houndsplate, and the three stays with green markers to the bottom houndsplate, using stainless steel shackles 753/4/98008. Pass the 'D' of the shackle through the eye of the stay, and the pin through the hole in the houndsplate with the threaded end pointing down.

(8) Attach a rigging screw 686/4/02270 to the remote end of each stay. To the other end of each rigging screw attach a length of chain 686/4/02271.

(9) Fit an undamaged protection cap over the top of the upper antenna element.

(10) Assemble the remaining antenna elements and position them around the perimeter of the array circle before starting the erection of the array.

Preparation for Antenna Erection

47. Before erecting the antennas it is recommended that all the ground anchors are secured in position.

48. The ground anchors, which resemble single-turn corkscrews, are positioned on a pitch circle of 10.6m (34ft.9in) radius from the centre of each antenna foot. One ground anchor is positioned 10.6m (34ft.9in) from the antenna marker stake in a radial direction and away from the centre. The other two ground anchors for the antenna guy ropes are common to adjacent antennas, and are sited on the intercepts of the pitch circles of the antennas. The positions and dimensions are shown on Fig. 1.

49. The anchors are screwed vertically into the ground. It is suggested that the best technique for starting the anchor is to dig out a spit of earth at the anchor entry point. A tommy bar, not less than 2m (6ft) long, is passed through the eye of the anchor at the top and is used to apply

pressure to start the insertion as well as to screw the ground anchor in until only the eye remains above the surface.

50. It may not always be possible to use ground anchors where the terrain is rocky or sandy. In these conditions, the use of concrete piles is usually satisfactory.

Antenna Erection

51. Two earth stakes 686/2/02141 should now be driven into the ground on either side of the antenna marker stake at a distance of not more than 380mm (15in) from the mast centre until about 300mm (12in) protrudes above the ground. The antenna is laid on the ground with the antenna foot between the two stakes and along the radial line away from one of the ground anchors. A length of rope (supplied with the kit) is attached to the earth stakes and secured to the mast using a clove hitch. The three stays on either side of the mast should be temporarily secured to the ground anchors out of line with the mast, using galvanised steel shackles 656/4/02272. See Fig. (c).

52. The preparations for the antenna erection are now complete, and lifting into the vertical position may now commence.

53. One man should raise the mast by walking from the mast head with the second man assisting by pulling on the upper two free stays. The third man should control the antenna by standing near the antenna foot. See Fig. (d). When the antenna is vertical, it should be turned so that the Antenna Transformer housing faces inwards towards the centre of the circle. The stays with green markers are then finally secured to the ground anchors, using galvanised steel shackles 686/4/02272. The rigging screws are extended, and the stays with green markers tensioned to about 60-75 lbs. by taking up a link at a time of the chain on the ground anchor shackles.

54. The stays with yellow and red markers are similarly attached to the ground anchors and then tensioned to about 60-75 lbs.

NOTE: The antenna must remain vertical and straight at all times.

55. Final adjustments to the tensioning of the stays are made by closing the rigging screws, so that the tensions obtained are 50-75 lbs. and the antenna is straight and vertical.

56. The anchoring rope may now be removed, and the anchoring stakes may be pulled out of the ground.

57. The rigging screw threads are to be coated with Aeroshell Grease 14 DTD900/4609, and the surplus chain links dressed neatly round the ground anchors.

Earth Stakes (PVS1120)

58. Drive the earth stakes further into the ground until about 150mm (6in) protrudes above the ground. Connect the earth braids 686/1/02142 to the screws on the antenna foot, and secure with the crinkle washer 999/4/01130/010 and the $\frac{1}{4}$" - 28UNF stainless steel nut 991/4/01996/002, and likewise to the earth stakes. Finally, drive the earth stakes in until about 25mm (1in) protrudes above the ground.

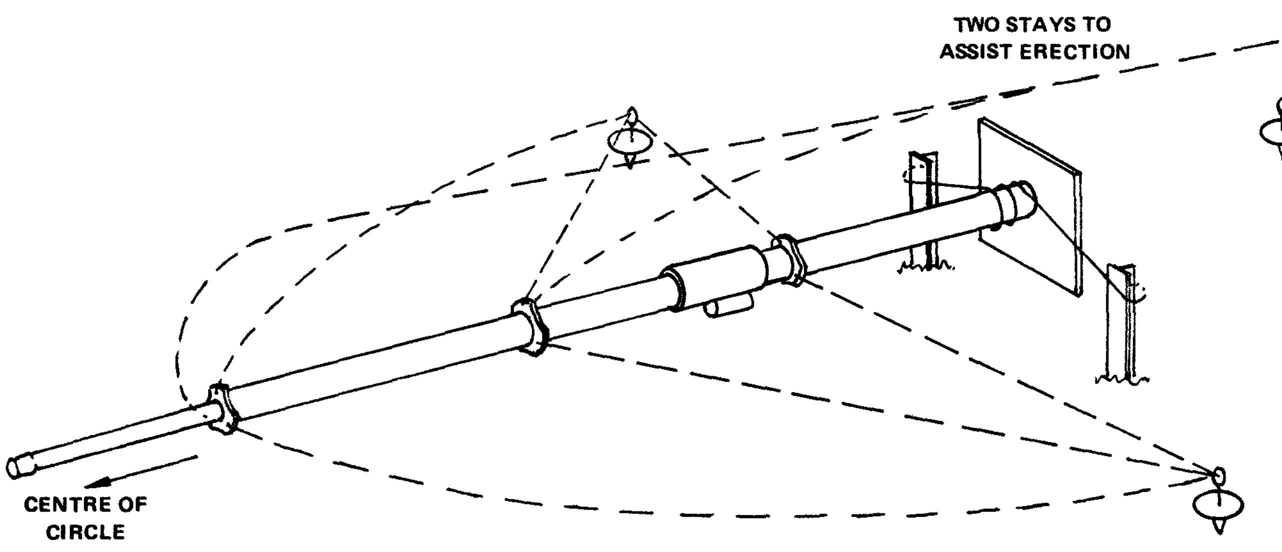

TWO STAYS TO
ASSIST ERECTION
CENTRE OF
CIRCLE

Fig. (c)

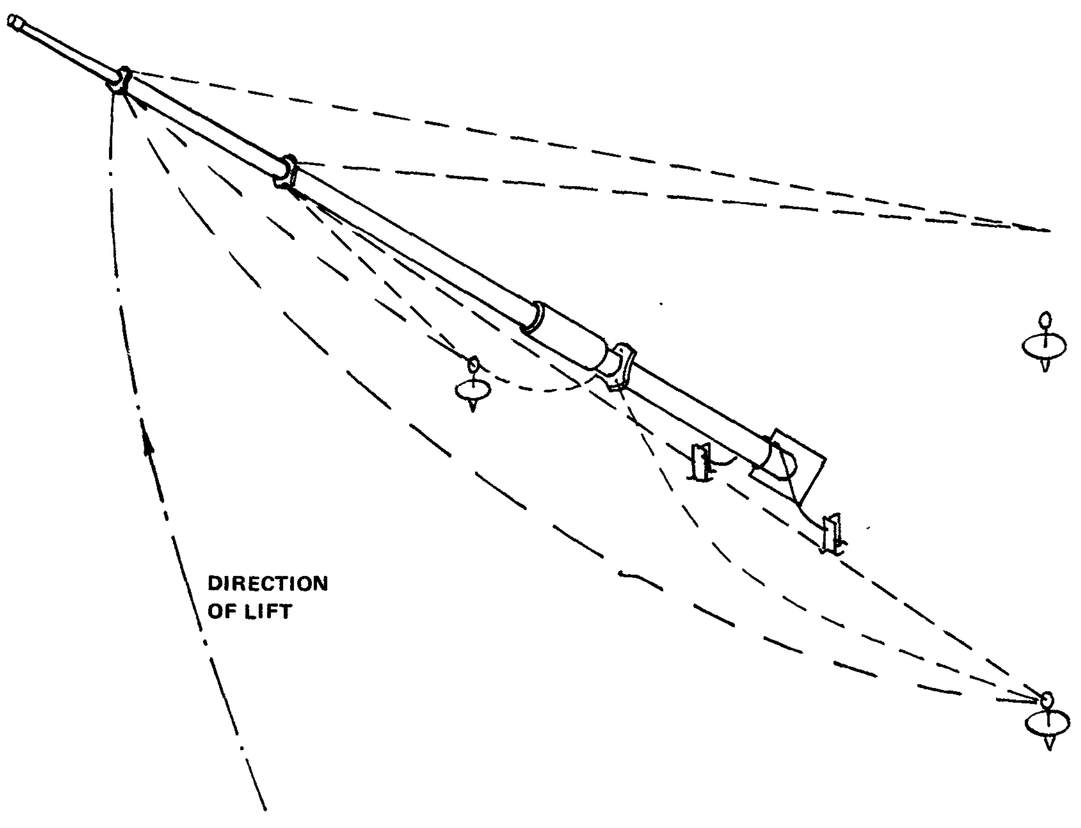

DIRECTION
OF LIFT

Fig. (d)

Counterpoise Kit (PVS1120A)

59. The positions and dimensions of the eight stakes are given in Fig. 1.

NOTE: It can be seen that, because of the configuration of the antenna stays, any access road will run close by an antenna mast. In these circumstances when a counterpoise is fitted it will encroach on this access and provision must be made to sink some of the radial wires below the surface level. If the access is made of solid material, e.g. concrete or granite chips, it is advisable, at the time of construction, to insert 50mm x 50mm (2in x 2in) wooden shuttering as necessary so that the radial wires can be laid in the troughs when the counterpoise is fitted.

60. The positions of the eight stakes are marked out and a spit of earth removed at each position. Troughs 50mm (2in) deep are cut to accommodate the radial wires. The earth stakes are driven into the ground, with the leg of the Tee pointing inwards towards the antenna, leaving sufficient of the earth stake proud to enable the connections to be made.

61. Fit a $\frac{1}{4}$" - 28UNF x 1" screw 991/4/01449/028 to each earth stake and secure with a nut 991/4/01996/002 and a $\frac{1}{4}$" crinkle washer 999/4/01130/010. Fit a counterpoise wire to each of the corner screws in the antenna foot by wrapping and twisting the bared centre section around the screw and secure it between two washers with a nut. The two ends of each counterpoise wire are secured to the adjacent earth stakes in a similar manner. Finally, drive the earth stakes 50mm (2in) below the surface level, and refill the troughs.

Antenna Feeders

62. The co-axial antenna feeders are each about 99.5m (326.4ft) long. Of this length, about 4m (13ft) is required to connect up to the elevated feed point, plus 75m (246ft) from the antenna to the centre of the array, leaving about 15m (49ft) for the connection to the beam-forming equipment.

63. All feeder cables are received on site coded No. 1. Cable marker clips are supplied with the equipment and are fitted in addition to the coding No. 1 as described below. The feeder cable associated with antenna No. 1 is to be coded 1010 by adding cable marker clips (see Components List, Chap. 5) 010 at the antenna end, the final digit '0' denoting the frequency band 1.5-10MHz. The feeder cable associated with the antenna No. 2 is to be marked 1020, and so on, the feeder cable associated with the antenna No. 24 being marked 1240.

64. Each feeder cable is fitted with Type C plugs at each end. The straight connector is fitted to the Antenna Transformer assembly, and the elbow connector is fitted to the beam-forming cabinet.

65. Connect a feeder cable to each antenna in turn, and secure it in four positions (indicated on Fig. 3) with a cable binder 915/4/98727 and clip 915/4/98774/003 using the tool provided (see Appendix to Chap. 4). Disconnect the feeder cable, fit the tube (686/2/02275) over the feeder cable, reconnect the cable, slide the tube over the transformer assembly housing, and snap on the cap (686/2/02276). Each feeder cable is then laid in as straight a line as possible to the centre of the array and passed into the hut. This end of the cable is also to be labelled in accordance with the method given in para. 63 using the marker clips supplied. Surplus cable is <u>not</u> to be removed, but should be coiled in vicinity of hut.

BEAM-FORMING CABINET

66. The beam-forming cabinet is housed in a building at or near the centre of the array. Views of the interior of the cabinet are given in Fig. 5.

67. It is recommended that the cabinet is raised on a wooden plinth above the floor to a height of about 76mm (3in). This will enable the antenna feeder cables to pass under, and be fed up the rear of, the cabinet.

68. Feeder cables are first connected to Rack, Mounting PV892 as follows. Feeder cable 1010 should rise at the right-hand side (viewed from the rear), and be secured at the top and bottom using the tool and cable clips provided. The elbow connector should then be connected to ANTENNA FEEDER INPUT socket 1 at the top of the Rack, Mounting, after ensuring that no sharp bends or undue strain is introduced into the feeder cable. Feeder cable 1020 should rise immediately to the left of feeder cable 1010, be secured with the cable clips, and then be connected to ANTENNA FEEDER INPUT socket 2. Feeder cables 1030 to 1240 should be progressively positioned, secured and connected to complete the installation of cables to Rack, Mounting PV892.

69. Feeder cables are now connected to rack, Mounting PV882 in a similar manner. Feeder cable 2019 should rise at the right-hand side and connect to ANTENNA FEEDER INPUT socket No. ', with feeder cables 2029 to 2249 progressively positioned and secured to its left.

70. The 24 BEAM SUM OUTPUT Cable Assemblies (3) are connected to the filters as detailed on a label fitted to the inside of the cabinet, right-hand side viewed from the rear. A feed-through panel is provided to allow the cables from the filter outputs to be routed inside and under the cabinet, and thence to connect to line amplifiers, or to the beam feeder cables, as appropriate. The cables from the filter output sockets to the receiving station are not supplied as part of the standard equipment, and are normally manufactured on site. Recommended coding is 9015 to 9245. See igs. 5 and 18 and the last table in Chapter 5. Connections of the cables to the filter outputs are made in accordance with the label on the inside of the cabinet door.

POST INSTALLATION TESTING

71. (1) The equipment as supplied is set for a 240V a.c. supply. If the local mains supply to be used differs from this setting, withdraw the Power Unit and remove the protective plate marked DANGER 240V AC, to gain access to the primary winding tappings. Consult the power supply manufacturer's booklet and set the tappings to suit the local mains supply. Replace the protective plate and resecure the Power Unit in position. (See Figs. 5 and 16).

(2) Connect a suitable mains cable to the Mains supply socket (supplied with accessory kit). Connect the socket to the Power Unit MAINS plug (3PL1).

(3) Switch ON the mains supply. Set the MAINS switch (3S1) on the Power Unit to ON and check that the MAINS indicating lamp at the top of the cabinet is illuminated.

(4) Using the multimeter, set to a suitable (e.g. 25V) d.c. range, measure the voltage between the two test points coloured red (+ve) and black (-ve) at the top of the relay chassis on the Power Unit. The indicated voltage should be 17V ± 0.5V.

(5) Set the 8-30MHz and 1.5-10MHz switches (3S3 and 3S4) ON, and check that the 8-30MHz and 1.5-10MHz indicating lamps are illuminated. Check that the voltage measured at (4) remains unaltered.

(6) Set the 8-30MHz and 1.5-10MHz switch (3S3 and 3S4) OFF, and check that the indicating lamps are extinguished.

(7) Set the MAINS switch (3S1) OFF and check that the MAINS indicating lamp is extinguished.

CHAPTER 3

CIRCUIT DESCRIPTION

BEAM FORMING

1. The following description applies to both the low and the high-band (outer and inner-ring) antenna array systems.

2. The beam-forming block diagram, Fig. 6 shows the formation of the sum and difference beams associated with adjacent antennas 1 to 8. These beams have been designated No. 1. The remaining 23 beams are formed in similar fashion, in a clockwise direction, using antennas 2 to 9, 3 to 10, and so on up to 24, 1 to 7.

3. The plane wavefront of an incident signal is taken to be approaching parallel to a line joining antennas 1 and 8. The wavefront arrives at antennas 4 and 5 before it arrives at 3 and 6, and at 3 and 6 before reaching 2 and 7, finally reaching 1 and 8.

4. The signals, transmitted along the feeder cables matched in electrical length to preserve antenna phases (relative to each other), are input to the appropriate Rack Mounting in the Beam Forming Cabinet. Co-axial cables in the Rack Mounting route the signals to the respective Antenna Distribution Units (1 to 8), where each signal is divided into eight independent time delayed paths plus an additional path providing an auxiliary output. One path from each of the eight Antenna Distribution Units associated with eight adjacent antennas (e.g. 1 to 8) is fed into the Combining Unit (1), which produces the "sum" beam and "difference" beam outputs. The paths are chosen such that the longest delay is associated with antennas 4 and 5, the intermediate delay with antennas 3 and 6, the shortest delay with antennas 2 and 7, and no delay with antennas 1 and 8. Thus, at the Combining Unit (1) all the signals are correctly phased for the indicated direction of arrival. The delays are such that the system is optimised for signals arriving at an elevation of 15° (high-band) and 12° (low-hand). The system beam width for ground waves and signals received from elevation angles of up to 20° differs only slightly from the optimum condition, and the equipment is usable with signals up from 60° of elevation. The adjacent beams overlap to ensure that, even at the upper end of the frequency range, signals from all directions are received adequately. The symmetry of the array produces a null response at the "difference" beam output when the direction of signals arriving give the corresponding "sum" output maximum response. The beams are independent, and can, if required, be used simultaneously with separate receivers. The use of one beam for one specific purpose does not, however, preclude the use of other beams in other applications.

5. The "sum" beam outputs are terminated with co-axial sockets at the end of a length of co axial cable, and fed to filters which give additional protection to receivers or line amplifiers against large amplitude m.f. and low h.f. signals. The co-axial cables are fed down from the Rack Mounting and connected to the filters.

6. The "difference" beam outputs are terminated with co-axial sockets mounted on the lower front panel of the Rack Mounting, and may be used for certain d.f. applications, or for other monitoring or test purposes.

7. The auxiliary outputs, taken directly from the Antenna Distribution Units, are also terminated with co-axial sockets mounted on the lower front of the Rack Mounting, and may be used to drive the H.F. Direction Finding Equipment Plessey Type PVS860, or may be used for monitoring or test purposes.

8. Signal amplifiers in the Antenna Distribution Units are collectively controlled, and can be switched into circuit at the Power Unit, giving a 10dB gain. The prupose of this facility is to give flexibility in operation for variations in external noise conditions. Use of the amplifiers is thus determined by the beam level which gives the better reception conditions at the required frequency. Where many different frequencies are in use, employment, or otherwise, of the amplifiers will be decided by local factors and requirements. Use of the amplifiers may be controlled remotely, e.g. at the main receiving station.

BEAM FORMING CABINET

Introduction

9. The Beam Forming Cabinet houses all the assemblies associated with the beam forming networks, and is located in a building at or near to the centre of the antenna arrays.

Mechanical Description (Fig. 5)

10. The Beam Forming Cabinet is free-standing and fitted with a door. It houses the following assemblies:-

(1) Rack, Mounting (8-30MHz) PV882.

(2) Rack, Mounting (1.5-10MHz) PV892.

(3) Power Unit PV883.

(4) Feedthrough Panel.

(5) Dual Band Pass Filters PV133K (12).

11. The cabinet dimensions and weight are:-

Height	1.98m (6ft 2in)
Width	660mm (2ft 2in)
Depth	635mm (2ft 1in)
Weight	182kg (400 lb)

12. A label detailing the filter outputs is fitted to the inside of the cabinet door. Another label, on the inside of the cabinet (right-hand side as viewed from the rear), details the filter inputs.

13. A MAINS indicating lamp is fitted at the top of the cabinet, and is connected by flying leads to the Power Unit at 3SKT3.

Racks, Mounting (8-30MHz) PV882 (686/1/02103/001) and (1.5-10MHz) PV892 (686/1/02103/002)

14. The Racks, Mounting PV882 and PV892 each consist of a Rack, Mounting 686/1/02134, 24 Antenna Distribution Units (8-30MHz) 419/1/10437 (DX-6) or (1.5-10MHz) 419/1/10441 (DX-7) and 24 Combining Units 419/1/10334 (CV-2).

Rack, Mounting 686/1/02124 (Fig. 7)

15. The Rack, Mounting 686/1/02124 comprises two side members that support and separate the lower and upper front faces. The antenna feeder input sockets 1-24 are mounted, in two staggered rows of twelve, on the upper front face, and the antenna auxiliary and beam difference output sockets on the lower front face.

16. The centre section is divided by a cross-member into an upper and lower section. Twenty four edge connectors are mounted vertically and parallel to each other at the rear of each section. Card guides, associated with each edge connector, are fitted to the upper and lower faces of each section. These guides locate the printed circuit cards which plug into the edge connectors. The upper centre section houses the 24 Antenna Distribution Units, and the lower section the 24 Combining Units.

17. All interconnecting wiring between the antenna feeder inputs, the Antenna Distribution Units, Combining Units and auxiliary, sum and difference beam outputs is made at the rear of the Rack, Mounting. Fig. 8 gives the wiring for one beam output; the remaining wiring is shown in tabular form.

18. Two carrying handles span the upper and lower front faces, and the Rack, Mounting is secured to the cabinet framework with four screws.

Antenna Distribution Unit (8-30MHz) 419/1/10437 (Figs. 9 and 10)

19. The Antenna Distribution Unit is a printed circuit card containing all the necessary circuitry to divide an antenna signal into four pairs of independent time delayed paths, i.e. a total of eight paths. An amplifier is also mounted on the card. The user has the option of turning off this amplifier by setting the 8-30MHz switch to OFF at the Power Unit PV883. This removes the d.c. supply from the amplifier, and de-energises a relay which breaks the r.f. input and output connections of the amplifier to the rest of the card and provides an alternative straight-through signal path in place of the amplifier. The r.f. system impedance is nominally 75Ω throughout the Antenna Distribution Unit.

20. The various stages of the unit are shown in block form on Fig. 6, and by dashed lines on the circuit diagram Fig. 9. The component layout is given in Fig. 10. Note that the co-axial cables have their inner identified by a number and their screen by a letter, e.g. 1(A) indicates that the inner is connected to pin 1 and its associated screen to pin A.

21. The antenna signal is input between pins 1(A), through a two-part surge voltage limiting network. The first part is a gas discharge tube which limits any surge to about 200V. This is followed by a diode network which limits the remaining surge to about 6V with the energy being absorbed in the coupling capacitor. This network is connected to a high-

pass filter which has a cut-off frequency of 6MHz. With relay RL1 de-energized (power Unit 8-30MHz switch OFF), the output at the filter is fed via the n.c. contacts of RL1 to the difference port of the hybrid transformer T3. One side port of T3 is connected to the associated ANTENNA AUXILIARY OUTPUT co-axial socket on the lower face of the Rack, Mounting, via pins 5(D). The other side port output is fed to the difference port of T4. The side ports of T4 feed T5 and T6. One side port output of T6 is fed to T10, whose side port outputs (undelayed) are connected between pins 9(K) and 7(H). The other side port output of T6 is fed through the delay network (I_3) to T9, whose side port outputs (minimum delay) are connected between pins 11(M) and 13(P). One side port output of T5 is fed via delay network (I_2) to T7, whose side port outputs (intermediate delay) are connected between pins 18(V) and 16(T). The other side port of T5 is fed via delay network (I_1) to T8, whose side port outputs (maximum delay) are fed between pins 20(X).

22. With the 8-30MHz switch on the Power Unit made, relay RL1 is energized, and a d.c. supply is applied to an amplifier, comprising transistor VT1 and its associated components and circuitry. The amplifier is thus switched into circuit and increases the amplitude of all the time delayed outputs by approximately 10dB.

23. The twenty four Antenna Distribution Units are mounted in the upper centre section of the Rack, Mounting. The units are not numbered, but assume a numbered identity corresponding with the front panel coding at the position in which the unit is located.

CAUTION: When handling these cards, exercise extreme care as the printed inductors L3 and L16, if scratched, can be destroyed.

Antenna Distribution Unit (1.5-10MHz) 419/1/10441 (Figs. 11 and 12)

24. The Antenna Distribution Unit (1.5-10MHz) differs from the Antenna Distribution Unit (8-30MHz) in only the following respects:

(1) The amplifier is turned off by setting the 1.5-10MHz switch to OFF at the Power Unit PV883 (cf. para. 19).

(2) The cut-off frequency of the high pass filter is 1.1MHz (cf. para. 21).

Combining Unit 419/1/10334 (Figs. 13 and 14)

25. The Combining Unit is a printed circuit card which receives as inputs one output from each of eight consecutively numbered Antenna Distribution Units (ADU's). The r.f. impedance of the Combining Unit is nominally 75Ω throughout. The outputs of ADU's numbered 1 to 8 are used for this description. The inputs are arranged such that, for example, the undelayed output of ADU1, input between pins 6(F), together with the minimum delayed output of ADU2, input between pins 8(J), are fed to the side ports of T3. Similarly, the undelayed output of ADU8, input between pins 14(R), and the minimum delayed output at ADU7, input between pins 12(N), are fed to T2. The maximum and intermediate delayed outputs from ADU4 and ADU3 are input between pins 3(C) and 1(A), respectively, and fed to T4. Similarly, the maximum and intermediate delayed outputs from ADU5 and ADU6 are input between pins 17(U) and 19(W), respectively, and fed to T1.

26. The difference ports, carrying the combined signals of T1 and T2, are connected to the side ports of T5, whilst the difference ports of T3 and T4 are connected to T6. The difference ports of T5 and T6 are connected to the side ports of T7, whose difference port is connected between pins 10(L), which, in this example, becomes SUM BEAM OUTPUT No.1. In order to maintain a 75 ohm output impedance for the sum port signal from T7, the centre tap on T7 primary is connected to a 2:1 impedance step-up autotransformer T8. The output from the full winding of T8 is connected to the DIFFERENCE BEAM OUTPUT No.1 co-axial socket on the lower front face of the Rack, Mounting via pins 22(Z).

27. A received signal arriving from the direction producing maximum response of the "sum" beam will produce a null (or minimum) response in the corresponding "difference" beam output.

28. The Combining Units, designated 1 to 24, are mounted in the lower centre section of the Rack, Mounting.

Power Unit (PV883) 686/1/02104 (Figs.15 and 16)

29. The Power Unit PV883 is mounted immediately below the centre front panel in the Beam Forming Cabinet, and supplies, via switching, 17V d.c. to the relays and the signal amplifiers in the Antenna Distribution Units. The circuit diagram is shown in Fig.15 and the component layout in Fig.16.

30. The front panel is a standard 483 mm x 133 mm (10" x 5¼") panel, and carries all the Power Unit components on its rear face. Viewed from the front, the power supply unit (Advance PM51 model) is mounted at the left, the relay chassis carrying the relays, plugs and sockets is mounted in the centre, and the four control switches and indicating lamps are at the right.

31. The unit requires, for local operation, only a suitable mains input to be connected to the MAINS socket 3PL1. For operation from a remote station, a cable carrying two leads is also required, and is connected to the REMOTE socket 3SKT4. A free socket 508/8/07001/225, a free plug 508/8/07023/220 and two outlet accessory kits 508/8/02719/301 are supplied for these purposes. Two further sockets, 3SKT1 and 3SKT2, are fitted for connecting to the Racks, Mounting PV882 and PV892 respectively. The cables connected to 3SKT1 and SKT2 pins B and C are internally connected at the Rack, Mounting to +17V and earth respectively. Thus, when the 8-30 MHz lamp 2ILP1 and the 1.5-10 MHz lamp 3ILP2 are illuminated, this indicates that power is available at Racks, Mounting PV882 and PV892.

32. The purpose of the unit is to energise the 10 dB signal amplifiers fitted in the Antenna Distribution Units. This can be achieved in two modes; local or remote. For operation in either mode, a suitable mains supply must be available at the MAINS plug, 3PL1.

33. For local operation, set the MAINS switch (3S1) to ON. This energizes the PSU (3PS1), which outputs 17V d.c. to the ganged wipers of the LOCAL/REMOTE switch (3S2). This switch is set to LOCAL, and routes the +17V to the wiper of the 8-30 MHz switch (3S3) and the 1.5-10 MHz switch (3S4). With the 8-30 MHz and 1.5-10 MHz switches set to ON, the +17V d.c. is routed, via 3SKT1 and 3SKT2, to the Antenna Distribution Units. The +17V d.c. then provides the power for the signal amplifiers, and energizes relays (RL1) in the ADU to switch the amplifiers into circuit, thus relays (RL1) in the ADU to switch the amplifiers into circuit, thus increasing the signal level at the

Antenna Distribution Unit outputs by 10 dB. The 17V d.c. is also routed via socket 3SKT3 to the MAINS indicating lamp (mounted at the top of the Beam Forming Cabinet) and to the coils of remote control relays 8-30 MHz (3RL1) and 1.5-10 MHz (3RL2).

34. For remote operation, set the MAINS switch (3S1) to ON and the LOCAL/ REMOTE switch (3S2) to REMOTE. The remote operator then sets a switch which connects 2SKT4 pin A to pin C and pin B to pin D, energizing the remote control relays 3RL1 and 3RL2. The relay contacts 3RL1A and 3RL2A then route the +17V d.c., via 2SKT1 and 2SKT2, to the Antenna Distribution Units.

35. In more elaborate systems, where a test monopole (PV869) is used, this will normally be controlled by an Antenna Control Unit PV876. This unit contains a switch suitable for remotely controlling the signal amplifiers used in this system. Otherwise, any normal 'make' switch is suitable at the remote site.

NOTE: The maximum permissible remote cable resistance recommended is 250 ohm measured between 3SKT4 pins A and C, and between 3SKT4 pins B and D. It is recommended that a minimum resistance of 10 ohm is present between pins A and C (earth), and between pins B and D (earth). This is to prevent over dissipation of the remote relay occurring due to adverse operating conditions. The fitting of a series 10 ohm 0.5 watt resistor will, in these circumstances, be quite adequate.

36. When operated in either mode, the 8-30 MHz and 1.5-10 MHz indicating lamps are illuminated.

37. Lightning protection is supplied by gas discharge tubes connected to 3RL1 and 3RL2.

Dual Band-Pass Filter Unit (PV133K) 630/1/27962

38. Each antenna ring, with its beam-forming network, is intrinsically broad-band, and each overlaps the band of the other, so that, if the beams were combined without filters, the resultant would be the vector sum of the contributions from the two rings. The individual amplitudes, relative phases and beam widths would add together in an unacceptably haphazard manner, this effect being accentuated by the choice of gain available in both sets of beam-forming networks (amplifiers in or out of use).

39. The use of filters rationalises the problem, except over a very narrow band at the crossover point. The response in this region has been optimised by the use of particular lengths of antenna feeder and connecting cables.

40. In this system, therefore, the 48 (two sets of 24) beams are combined in 12 Plessey type PV133K filter units. Each filter unit consists of a pair of dual band-pass filters covering the range 1.5-9.7 MHz and 9.7-35 MHz with a common output socket.

41. Each beam formed from the larger antenna ring is fed to a lower frequency band-pass filter, whilst the beam, pointing in the same direction, produced by the smaller antenna ring is passed through the associated upper frequency band-pass filter. The filter's output is thus the combination of these two inputs. This output comprises all signals received between 1.5 and 35 MHz, and the filter-combining technique ensures that any particular signal (other than those at frequencies around the filter crossover point)

is derived solely from the antenna ring having the better directional properties at that frequency. In the region of 9.7 MHz, the beams formed from each ring of antennas contribute to the filter output. The lengths of the feeder cables for each ring have been arranged to minimise signal nulls caused by combining the pairs of beams.

42. The lower band-pass filter also assists in reducing the intermodulation products which large m.f. signals could cause in the receivers when operating in the lower part of the band covered by the system.

43. The twelve filter units are mounted, one above the other, in the lower section of the Beam Forming Cabinet.

44. Two filters are mounted, side by side, on a standard 483 mm x 44 mm (19 in x 1¾ in) panel. The pass bands of the filters are 1.5-9.7 MHz and 9.7-35 MHz.

45. The filters are fitted with BNC output sockets, and the insertion loss of each filter is less than 1.0 dB in the pass band.

46. The BEAM SUM OUTPUT leads are connected to the filters in accordance with the instruction label inside the cabinet (right-hand side as viewed from the rear). Connections to the outputs of the filters are made in accordance with the instruction label fixed to the cabinet door.

Feedthrough Panel 681/1/02170

47. The feedthrough panel, which is positioned below the filters, is used when the filter outputs are to be routed under the cabinet.

CHAPTER 4

MAINTENANCE AND COMMISSIONING PROCEDURES

INTRODUCTION

1. This chapter describes the recommended maintenance procedures for the PVS1120 Antenna System. These are given in order of increasing time interval between maintenance periods. Also included are commissioning test procedures, and tables to facilitate fault location.

TEST EQUIPMENT

2. The following is a list of the test equipment required to maintain and commission a PVS1120 system:

(a) Multimeter, FSD 3V-3kV, 50μA-10A, 1 kilohm-10 Megohm: e.g. Avo. 8, 9, or No. 1.

(b) Admittance Bridge, 5-30MHz: e.g. Wayne-Kerr Type B801 (c/w Bridge Source Type S161B and Bridge Detector Type B161).

(c) RF Signal Generator, 1-30MHz, 50 or 75 ohm output impedance, output level up to 1V r.m.s.: e.g. Hewlett Packard 8640A.

(d) Frequency Counter, 1-10MHz, sensitivity 100mV r.m.s., input impedance greater than 50 kohm shunted by less than 50pF: e.g. Racal 9911.

(e) RF Voltmeter, FSD 1mV-3V r.m.s., 10kHz-50MHz, input impedance greater than 50 kohm shunted by less than 10pF: e.g. Racal 9301.

(f) Beam Selector Set PVS560 (DV3) plus associated HF Receiver (100kHz I.F), e.g. Plessey Series PR155.

NOTE: This item is not required if the fixed beam outputs are not to be used, i.e. if the system forms part of a DF system to be used solely for DF.

(g) RF Signal Generator, 1-30MHz, 50 or 75 ohm output impedance, output level up to 3V r.m.s: Hewlett Packard 8640A (for permanent use with Antenna Control Unit PV876 (PO-10) and Test Monopole PV869 (PA-48)).

(h) Test Unit PV865 (TU-36), complete with cable assemblies type 5, 6 and 25.

(i) Test Unit PV884 (TU-45). (This unit is not called up in these procedures, but is required for more detailed testing of the antenna distribution and combining cards).

(j) Adaptor, Type C female - BNC female, 75 ohm: Greenpar Inter-Series: 8 off.

(k) BNC Terminations, 75 ohm, male: 2 off.

(l) BNC Tee Adaptors, 75 ohm: 6 off.

(m) BNC male - BNC male coaxial cables, 75 ohm: various.

ROUTINE MAINTENANCE

3. The aims of these maintenance procedures are to give maximum protection against system failure from any cause, to cause minimum disturbance to the system as a whole during maintenance periods, and to require a minimum of special test equipment.

4. If the PVS1120 system to be maintained forms part of a Plessey DF System, it is assumed that the full system is present, including at least one Bearing and Display Console, and, therefore, the maintenance procedures which follow should be carried out in addition to those detailed in the PV860 System Handbook.

5. If, however, the PVS1120 (AX-19) system does not form part of a DF system, a Beam Selector Set PVS560 (DV-3), with associated PR1550 series receiver and Test Monopole PV869 (PA-48), must be sited at the centre of the antenna arrays. An Antenna Control Unit PV876 (PO-10) and suitable signal generator are also required. The full list of test equipment required is given below.

6. All routine tests are carried out in-situ with all equipments and units switched on, including the PVS1120 antenna amplifiers for both bands, unless otherwise specified. It is assumed that both sets of antenna amplifiers are under remote control from the Antenna Control Unit PV876 (PO-10).

7. The following are the recommended periods for carrying out the tests:

Operators Confidence Checks	-	Daily
In-situ Tests	-	14 day intervals
Periodic Checks	-	2 monthly intervals

Operator Confidence Checks

8. The checks given in the following paragraphs should be carried out daily. Items of test equipment required are as follows:-

RF Signal Generator.

Beam Selector Set PVS560 (DV-3) plus HF Receiver (Plessey Series PR1550).

9. If the fixed beam outputs are in use, proceed as follows:

(a) Connect the output of the signal generator to the RF input of the Antenna Control Unit PV876 (PO-10). Ensure that there is a feeder connecting the RF/DC output of the PV876 (PO-10) to the input of the Test Monopole PV869 (PA-48).

(b) Connect the RF output of the Switching Unit PV562 (SU-66) (part of PVS560) to the antenna input of the receiver. Connect the IF output of the receiver to the appropriate input of the Display Unit PV561 (DK-10) (part of PVS560). Ensure that all 24 combined sum outputs of the Beam Forming Cabinet are input correctly to the PV562, and that the PV561 and PV562 are working together satisfactorily via their interconnecting cable (reference PVS560 System Manual, Plessey Publication No. 404). Set the PV561 SWEEP WIDTH to 1-24.

(c) Tune the receiver to the frequency found in paragraph 75.

(d) Adjust the output frequency of the signal generator to correspond with that to which the receiver is tuned, and set the output level to 50mV r.m.s. Tune the receiver accurately to this signal. Set the bandwidth to 1.4kHz and the PV561 Scan Rate selector to position 3 (750Hz). Select SWEEP.

(e) Switch off the antenna amplifiers for both bands at the PV876. (This assumes that the REMOTE/LOCAL switch in the Beam Forming Cabinet Power Unit PV883 is set to REMOTE).

(f) With AGC off, set the RF/IF gain of the receiver so that the height of the leftmost vertical bar on the PV561 display is 25mm. Check that no bar height differs by more than ±5mm, and that no group of 8 consecutive bars is less in height than the remainder. Switch on the Low-Band Antenna Amplifiers at the PV876. Check that all 24 bars have uniformly increased in height, reducing the output level of the signal generator until the height of the leftmost bar is again 25mm. Check that this reduction of the signal generator output is approximately 10dB.

(g) Repeat steps (c) through (f), this time selecting the optimum frequency found in paragraph 77, and switching on the High-Band Antenna Amplifiers in step (f).

(h) Switch off the signal generator. The system may now be operated normally. If any faults are detected, consult the paragraphs dealing with fault location.

<u>In-Situ Tests</u>

10. In-situ element failure tests should be made at intervals of 14 days. It should be noted, however, that these tests are not required if the PVS1120 forms part of a Direction Finding System, since the operator confidence checks called up for the DF perform the same function in a simpler manner.

11. Test equipment required for the tests is as for operator confidence checks (paras. 8-9), plus RF Voltmeter.

12. Proceed as follows:

(a) Carry out steps (a) to (f) inclusive of the operator confidence check paragraph 9. The amplifiers for both bands should be switched on.

(b) Connect the voltmeter to the IF output of the receiver in parallel with the input to the PV561 (DK-10).

(c) Select beam No. 1, and adjust the RF/IF gain of the receiver until the voltmeter reads approximately 22mV r.m.s. Note this reading.

(d) Select beams 2 through 12 in turn, and in each case note the reading on the voltmeter. Do not alter the receiver gain setting. The range of the voltmeter may be altered as required. (This should not be necessary).

(e) Select beam 1, and check that the IF output level has not altered from the initial setting in (c). If there is a difference, reset the RF/IF gain to give an output of -20dB, and check back from beam 12 downwards until the readings are again in agreement, noting the new values.

(f) Select, in turn, beams 13 through 24, noting the readings as before.

(g) Re-check the output of beam 1 as in (e) and, if necessary, repeat the readings from beam 24 downwards until agreement is obtained.

(h) Reset the output frequency of the signal generator to the frequency selected in paragraph 9 (g).

(i) Repeat steps (c) through (g) for the high-band sub-system.

(j) The readings obtained for each band should be compared with those taken the previous week. The suggested method of comparison is as follows:

Beam	1	2	3	4	. . .	24
Result Week n (dB)	20	20.5	19	20	. . .	21
Results Week n-1 (dB)	20	21	19	20.5	. . .	21.5
Subtract (dB)	0	-0.5	0	-0.5	. . .	-0.5
Subtract most frequently occurring difference, eg -0.5dB (dB)	+0.5	0	+0.5	0	. . .	0

13. The result for each beam taken the previous week is subtracted from the corresponding result noted this week. The most frequently occurring difference (-0.5dB in the above example) is then subtracted from each difference value to give the change in each beam assuming that the majority are unchanged. Any significant variations (1dB or greater) should be investigated.

14. If any faults are detected, consult the paragraphs dealing with fault location.

PERIODIC CHECKS

15. Periodic checks should be made at intervals of 2 months, and necessitate an inspection of the physical conditions of the equipment, together with electrical checks.

Physical Inspection

16. The physical condition of certain items of equipment should be inspected.

Antenna Arrays

17. Proceed as follows:-

(a) Check each antenna in each array for corrosion or damage. No maintenance of the antenna structure should be required. All Terylene guys, including those of the Test Monopole PV869.(PA-48), should be visually inspected for signs of fraying, particularly at the splices. Check that all ground anchors are secure and undamaged. Check the guy tension and, if necessary, adjust the rigging screws as given in Chapter 2, para. 55.

(b) Check the condition of the earthing braids at the foot of each antenna, and that each is securely attached. (If counterpoises are included, see step (c)). Braid replacement is carried out by first unscrewing the appropriate nut on the antenna foot and raising the associated earth stake. The old braid is then removed, and the stake driven back in until it protrudes about 30mm above the ground surface. The new braid is then secured to the stake and the antenna foot.

(c) If counterpoises are employed, check the security of the wire connections to each antenna foot.

Beam Forming Cabinet

18. Proceed as follows:-

(a) The feeder connections to each Rack Mounting Assembly, the internal cable connections to the combining filters, and the beam output cables should be inspected.

CAUTION: The Antenna Distribution Unit and Combining Unit (DX-6, DX-7, and CV-2) cards should only be removed at intervals of 12 months for routine checking as in (b) of this paragraph.

(b) Switch off the PV883 (PP-88) power supply, and remove and examine each Antenna Distribution Unit and Combining Unit card for component damage and joint failure. With the cards removed from the assemblies, check that all edge connectors are undamaged.

NOTE: If the Antenna Distribution Unit cards are removed one at a time and then replaced, normal system operation will not be interrupted. Removal of the Combining Unit cards causes loss of one beam, and should be co-ordinated with users.

Rack Mounting Units

19. The separate rack mounting units, Intercoms Type PV864 (MX-6) (if present), and the Control Unit PV876 (PO-10) and its associated signal generator should be given a thorough visual inspection. Each unit should be cleaned internally and externally with a soft brush and a clean, dry, low pressure air jet if available.

Test Monopole PV869

20. The security of the antenna base, connector, feeder, and mounting should be checked, and also that of the antenna and counterpoise rods (and the guy attachments as in step (a) of paragraph 17).

Electrical Checks

21. First carry out the in-situ tests detailed in paragraphs 10-14. If the electrical performance of the system is suspect, carry out the commissioning tests in the sequence given.

(a) Antenna and Feeder Impedance Measurements, Paras. 39-41.

(b) Beam Forming Cabinet, Paras. 42-71.

COMMISSIONING TESTS

22. These tests should be performed when the installation and setting-up procedures are complete. They also form the basis of the electrical checks that may be carried out at intervals of two months ('periodic checks' detailed in paragraphs 15-21), and may be used as an aid to fault finding (paragraph 80).

23. Testing should be carried out in the correct sequence, which progresses logically through the system. The antennas and feeders are checked first, and the sequence ends with a check on the complete system.

PV865 (TU-36) Test Unit

24. This unit is required to test the Beam Forming Cabinet, and should be tested as detailed below before it is used to commission the system. Items of test equipment required are as follows:-

RF Signal Generator.
Test Unit PV865 (TU-36).
RF Voltmeter

25. Using the voltmeter terminated in 75 ohms, set the signal generator output to a convenient reference on the dB scale at approximately 1V and a frequency of 30MHz ± 0.5MHz.

26. Connect the signal generator to the RF INPUT socket on the PV865, and connect the voltmeter, terminated in 75 ohms, to each RF OUTPUT socket in turn.

27. Check that, with the output being measured switched on all other outputs switched off, the thirty measured values from the PV865 lie in a range not exceeding 1.0dB between the limits 21.5dB and 23.0dB below the reference level. Check that, with the output being measured switched off, the measured levels are lower than -40dB below the reference level.

28. Repeat the measurements with the signal generator output set to 5.0MHz ± 0.5MHz.

29. With the signal generator set as in paragraph 25, measure the attenuation of all the delay lines in the PV865. The results should be as follows:

Delay line	Attenuation	Delay line	Attenuation
HIGH BAND D4	1.3dB ± 0.5dB	LOW BAND D4	4.1dB ± 0.5dB
HIGH BAND D3	0.8dB ± 0.5dB	LOW BAND D3	2.5dB ± 0.5dB
HIGH BAND D2	0.5dB ± 0.5dB	LOW BAND D2	1.3dB ± 0.5dB
HIGH BAND D1	<0.5dB	LOW BAND D1	0.5dB ± 0.5dB
HIGH BAND D0	<0.5dB	LOW BAND D0	<0.5dB

Antenna Feeder Continuity and Isolation

30. These tests should be carried out on initial installation, or after major overhaul, and with the feeder cables for both bands in position, but with both ends disconnected. The cable ends at the array centre should be coiled near the hut to take up the excess in such a way that each is readily identifiable. At each antenna, the feeder may be clamped in position to the mast with sufficient slack for the connection to the aerial transformer to be made.

31. A multimeter is the only item of test equipment required for these tests.

High Band Feeders

32. Carry out the following procedure:-

(a) Take the end of the feeder from high-band antenna number 1 at the array centre into the centre hut and to the Beam Forming Cabinet. The excess cable may be left beneath the hut floor. With the multimeter set to OHMS x 100 and calibrated, check that the isolation between the inner and outer of the feeder is greater than 10 Megohms.

(b) At high-band antenna number 1, attach the specified additional cable marker to the feeder and connect it to the Antenna Transformer Assembly. In the centre hut, set the multimeter to OHMS ÷ 100 range, calibrate, and check that there is continuity between the inner and outer of the feeder. The measured resistance should be approximately 1 ohm. Attach the specified additional marking, and connect the feeder to high-band input number 1 of the Beam Forming Cabinet (the exteme left input connector of the lower Rack Mounting).

(c) Repeat steps (a) and (b) for high-band feeders number 2 to 24 in turn.

Low Band Feeders

33. Repeat steps (a), (b) and (c) of the above procedure for the low-band feeders from antennas 1 to 24. In this case, in step (b), the measured resistance should be approximately $2\frac{1}{2}$ ohms.

NOTE: The continuity measurement above is made via the secondary of the Antenna Transformer Assembly with the feeder connected.

Comparison of Antenna Feeder Lengths

34. The following test procedures are intended to check the matching in electrical length of all 24 antenna feeders for low or high-band antenna arrays. They may be employed to check the feeders on installation or to manufacture a replacement should a feeder be damaged and no spare is readily available. Each feeder should be in position between an element of the array and the centre hut so that a fair comparison may be made. The following items of test equipment are required.

RF Signal Generator.
RF Voltmeter.
Frequency Counter.

Low Band

35. Connect the signal generator, millivoltmeter, frequency counter and the antenna feeder cable in the Beam Forming Hut as shown in Fig. (e). Disconnect the feeder from the antenna, and leave it open circuit. Set the signal generator output to approximately 1V at 4MHz. Increase the signal generator frequency until a null is detected on the millivoltmeter. Record the frequency at which the null occurs. Re-connect the feeder to the antenna and repeat the measurement for the remaining 23 low-band feeders. Calculate the average frequency. This should be 4.52MHz ± 45kHz, and the maximum spread ± 13kHz.

36. The electrical length of the low-band feeders can be calculated from:

$$L_e = \frac{675}{f}$$

where f is the frequency in MHz.

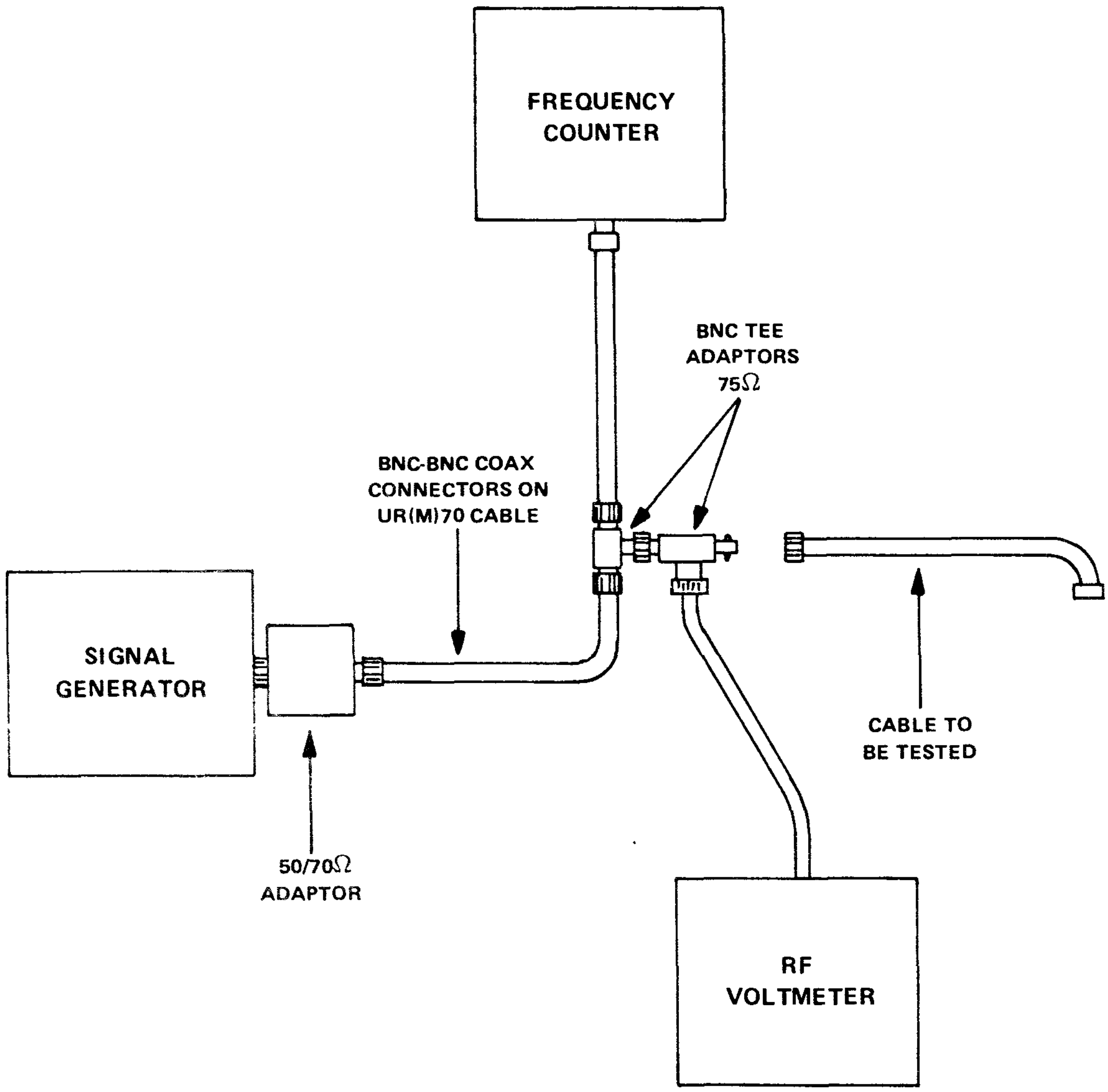
High Band

37. Repeat paragraph 35 on the high-band antenna feeders. The average frequency should be 4.32MHz ± 40kHz, and the maximum spread ± 12kHz.

38. The electrical length of the high-band feeders can be calculated from

$$Le = \frac{225}{f}$$

where f is the frequency in MHz.



(Fig. (e)

Antenna and Feeder Impedance Measurements

39. The impedance of each antenna and feeder is measured to ensure that they are in working order, and also to give some indication of the degree of consistency of the ground conductivity of the site. This should be carried out initially on installation after the feeders have been checked

by the procedures given in paragraphs 30 to 38. A table of the results obtained for each band should be retained for reference.

40. The items of test equipment required are as follows:

Admittance Bridge.

Bridge Detector and Source.

Type C female to BNC female Adaptor, 75 ohm.

BNC male to open coaxial cable, 75 ohm, approx. 2m in length. Mark and retain this cable for future use.

41. Carry out the following:

(a) Set up the admittance brdige, with its associated source and detector, in the array centre hut so that the bridge terminals are within reach of all antenna feeders to the Beam Forming Cabinet when extended via the adaptor and cable specified in the test equipment. Switch on the source and detector, and allow a 15 minute warm-up period.

(b) Disconnect low (or high) band feeder No. 1 at the Beam Forming Cabinet and connect the adaptor and extension cable. With the bridge terminals open circuit, set the frequency of the detector to a quiet spot between 5 and 7MHz (low band) or to between 14 and 18MHz (high band). Tune the source to this frequency so that a tone is heard in the headset, zero the bridge controls, trim, and then connect the open end of the extension cable to the bridge terminals. Adjust the controls to balance the brdige. If a balance cannot be obtained, adjust the frequency to a different value within the above limits, and try again. Repeat until a balance is obtained. This is necessary because the limited range of the bridge control may preclude the obtaining of a balance at some frequencies.

(c) Note the values of conductance and susceptance. Disconnect and replace feeder No. 1. Remove and connect feeder Nos. 2 through 24, in turn, finding the balance point and noting the values in each case. Draw up a table of the measurement obtained against each feeder number.

(d) Repeat the above steps for the other band of antennas and feeders, using the appropriate frequency.

(e) If so wished, a scatter diagram for each band may be drawn with conductance and susceptance as the horizontal and vertical axis, choosing suitable scales depending on the measured values obtained. The units of susceptance may be converted to millisiemens by multiplying the capacity by 2π times the appropriate frequency if desired. This will show clearly any of the antennas and feeders in a band which have a widely varying impedance from the average.

(f) By examining the tables of measurements, or from the scatter diagram, the nature of the variation in impedance of the antennas and feeders may be determined. If one or two are widely different from the average, the antennas and feeders should be checked physically as in paragraph 30. If a group or groups of antennas have similar impedances which differ from the remainder by a fixed amount, the nature of the ground at these antennas should be investigated. In this case, the impedances of the corresponding antennas and feeders in the other band may show a similar variation. If the variation in impedance throughout either or both bands is very great, the addition of counterpoises may improve the situation. This may also reveal itself in the later tests when the output levels of the beams are compared while radiating an equal signal to all antennas in each ring from the Test Monopole PV869 (paragraph 9).

(g) A further simple maintenance check to verify each antenna and feeder is to radiate a signal from the Test Monopole as described in paragraph 9, and to check the IF output level of an HF receiver connected to each feeder in turn, with the receiver tuned to the radiated frequency. Precautions should be taken to avoid errors due to drift in radiated and/or receiver frequency, and change in receiver gain. If the results of the impedance measurement procedure and later tests comparing beam amplitudes are satisfactory, this additional test is superfluous.

(h) When testing is complete, check that all feeders of both bands are correctly reconnected to the Rack Mounting Assemblies in the Beam Forming Cabinet.

Beam Forming Cabinet

42. The following procedures are intended to check the complete Beam Forming Cabinet. The power unit and combining filters are checked as separate items, whilst the antenna distribution and combining cards are tested in the cabinet.

Power Unit PV883

43. A multimeter is required for these tests.

44. Check that the following connections are made:-

(a) d.c. supply leads from the rack mounting to 3SK1 and 3SK2 on the PV883 (PP-88).

(b) lead from Antenna Control Unit PV876 to 3SK4.

(c) flying lead from mains indicator lamp to 3SK3 on PV883.

(d) mains input lead to 3PL1.

45. Set the LOCAL/REMOTE switch to LOCAL, and the 1.5-10MHz and 8-30MHz switches to off.

46. Set the MAINS switch to on, and check that the mains indicator lamp is on. Also check that the 1.5-10MHz and 8-30MHz lamps are off.

47. Set the MAINS switch to off, and remove the 1.5-10MHz and 8-30MHz lamp bulbs. Set the 1.5-10MHz and 8-30MHz switches to on.

48. Set the MAINS switch to on, and check that the voltage applied to the 1.5-10MHz and 8-30MHz bulb holders is +17V ± 1V.

49. Set the MAINS switch to off, and replace the 1.5-10MHz and 8-20MHz bulbs.

50. Set the MAINS switch to on, and check that lamps are lit or extinguished, as required, for all combinations of switch settings.

51. Set the LOCAL/REMOTE switch to REMOTE, and check that lamps are lit or extinguished, as required, when switching from the remote end or the Antenna Control Unit PV876.

Band Pass Filter Unit PV133K

52. The following items of test equipment are required:

RF Signal Generator (75Ω source impedance).
RF Voltmeter.

53. Set up the voltmeter (terminated in 75Ω), and then adjust the output of the signal generator for approximately 100mV on the voltmeter at a frequency of 2MHz. Note the output level indicated by the voltmeter.

54. Connect the output of the signal generator to the low-band filter input, and connect a 75 ohm load to the high-band filter input.

55. Connect the voltmeter (terminated in 75Ω) to the filter output, and check that the filter response is as follows:-

Frequency (MHz)	1.2	1.3	1.5	2	3-8	9	9.7	11	15
Attenuation	>40	>20	<9	<2	<1	<2	<5	>18	> 50

56. Interchange the input connections to the filter, and, using a frequency of 10MHz, check that the signal generator output level if 100mV. Check that the filter response for the high band is as follows:

Frequency (MHz)	7.5	9	9.7	10.5	11.5-30	32	34	38
Attenuation (dB)	>40	>14	<5	<2	<1	<2	<9	>20

57. Check that the attenuation at 917MHz of one half of the filter is within 1dB of the attenuation of the other half.

58. Re-connect the filter to the Beam Forming Cabinet, and repeat the tests for all the other filters.

Low-Band Outputs

59. The following items of test equipment are required:

RF Signal Generator (75Ω source impedance).
RF Voltmeter.
Test Unit PV865 (TU-36).

60. Switch on the Power Unit PV883, and disconnect the antenna feeder cables from the Beam Forming Cabinet.

61. Connect the output of the signal generator to the Test Unit PV865 (TU-36) RF INPUT. Set the signal generator output to approximately 300mV at 8MHz ± 0.5MHz. Connect eight of the RF OUTPUTS to the appropriate LOW BAND delays with eight short leads, and connect the output from the delays to low-band ANTENNA FEEDER INPUTS using eight equal length (1m) cables in the following manner:-

PV865 RF OUTPUT	1	3	5	7	23	25	27	29
LOW BAND Delay	D3	D2	D1	D0	D0	D1	D2	D2
ANTENNA FEEDER INPUT	1	2	3	4	5	6	7	8

62. Disconnect the cable to ANTENNA FEEDER INPUT No. 1, and connect it to the RF Voltmeter terminated in 75 ohms. Adjust the signal generator output for a convenient reference on the dB scale of the meter.

63. Re-connect the D3 delay output cable to ANTENNA FEEDER INPUT No. 1, and connect the terminated RF voltmeter to ANTENNA AUXILIARY OUTPUT No. 1. Check that the level is +6dB ± 0.5dB relative to the reference level.

64. Reduce the signal generator frequency to 700kHz. Check that the level is -25dB ± 5dB relative to the result obtained in paragraph 63.

65. Set the signal generator to 8MHz ± 0.5MHz, and transfer the RF voltmeter to BEAM DIFFERENCE OUTPUT No. 1. Check that the level is less than -20dB relative to the reference level.

66. Switch each input off in turn, and check that the level increases each time.

67. Transfer the meter to the output of filter (PV133K) No. 1. Check that the level is +4dB + 1dB -0.5dB relative to the reference level.

68. Switch each input off in turn, and check that the output drops by at least 0.5dB.

69. Repeat the tests detailed in paragraphs 60-68 for ANTENNA FEEDER INPUTS 2 to 9, 3 to 10, etc. up to 24 to 7. In each case, the output is measured at the ANTENNA AUXILIARY OUTPUT, BEAM DIFFERENCE OUTPUT and

filter output corresponding to the first ANTENNA FEEDER INPUT number. The order of connections shown below must be strictly followed.

Measure AUX. Output etc.	PV865 RF OUTPUT 1	3	5	7	23	25	27	29
1	1	2	3	4	5	6	7	8
2	2	3	4	5	6	7	8	9
3	3	4	5	6	7	8	9	10
24	24	1	2	3	4	5	6	7

High-Band Outputs

70. Repeat the tests detailed in paragraphs 59-69 with the signal generator set to 20MHz ± 0.5MHz and using the HIGH BAND delays in the PV865. The levels measured should be as follows:

ANTENNA AUXILIARY OUTPUT	+7dB ± 0.5dB relative to reference level.
ANTENNA AUXILIARY OUTPUT at 5MHz	-25dB ± 5dB relative to level measured above.
BEAM DIFFERENCE OUTPUT	-14dB relative to reference level.
Filter Output	+5dB + 1dB -0.5dB relative to reference level.

71. Reconnect all the antenna feeder cables to the Beam Forming Cabinet.

Tests Using Test Monopole

Beam Forming Check

72. Connect the signal generator to the Antenna Control Unit PV876. Set the signal generator level to approximately 20mV, and switch on both ANTENNA AMPLIFIERS. Connect the PVS560 (DV-3) and the receiver as described in paragraph 9(b).

73. Tune the PR155 receiver to a quiet spot at any frequency between 1.5 MHz and 9MHz. Set the signal generator to this frequency, reduce the receiver bandwidth, as necessary, to obtain a noise free signal, and set the SCAN RATE to correspond to the bandwidth of the receiver.

74. With the receiver AGC off, adjust the RF/IF GAIN so that the average height of the vertical bars on the display is 25mm. If the bar heights appear to be varying randomly with time, connect a 10dB attenuator between the Switching Unit PV562 and the receiver antenna input. If the random time variation does not cease, then connect in a 20dB attenuator, and check that the time variation has stopped. If a PVS860 (DF-1) Direction Finding System is being used, switch on the antenna amplifiers and check that the amplitude modulation of a single beam at the goniometer rotation frequency is less than 2%.

75. Note the maximum amplitude variations of the bar heights. Repeat paragraphs 73-74 at different frequencies within the range 1.5MHz to 9MHz, and note the frequency that gives the smallest bar amplitude variation. The maximum bar amplitude variation should be not greater than ±5mm. Record the amplitudes of all the bars. If eight consecutive bar heights are different from the others, a fault from one antenna path is indicated.

76. Switch off the LOW BAND ANTENNA AMPLIFIER on the PV876, and check that the display decreases to approximately 8mm. Switch on the ANTENNA AMPLIFIER.

77. Repeat the tests detailed in paragraphs 73 to 76 for the high-band system (frequency range 10-30MHz).

FAULT LOCATION

78. As the PVS1120 is a multiple beam system, faults may be located by substitution or path interchange at the junctions between units. It is a simple matter to interchange two adjacent feeders if, for example, a fault is suspected on one of them, and then to check whether the fault is in the same path or has shifted to that associated with the other feeder. If the fault does 'move' with the change it must precede the point at which the interchange was made, or be later in the path if it does not move.

79. There follows a table describing the symptoms, probable sources and location procedures for various faults which may occur in the system.

Fault Finding Procedure

80. Before fault location in the PVS1120 system is commenced, the external equipments associated with the system should be checked, unless the symptoms are such that the source is obviously within the system. These checks are included below, where appropriate.

Fault	Probable Source	Procedure
1. All sum beams low or absent:	(a) PVS560 (DV-3) or receiver.	See relevant handbooks, and check connections.
	(b) Beam Distribution System	Check.
-if no increase in level when amplifiers are switched in remotely but LOCAL operation correct.	(c) PV876 (PO-10) switches, interconnecting cables, relays in PV883 (PP-88).	Check whether both bands (above and below 9.7MHz) are affected. Repair or replace items as necessary.
-if no increase in level on LOCAL or REMOTE amplifier switching for both bands (above and below 9.7MHz).	(d) Mains supply to PV883 (PP-88).	Check mains indicator lamp on Beam Forming Cabinet.

Fault	Probable Source	Procedure
	(e) PV883 (PP-88) Power Unit	Check output voltage present on power pack (Indicator lamps). Check fuse and power connections. Replace items as necessary.
-if no increase in level above or below 9.7MHz on switching amplifiers in.	(f) External lead to Rack Mounting	Check voltage present on PV883 output socket.
	(g) PV883 (PP-88) failure (inter-connecting leads etc.)	Remove and check PV883.
2. One sum beam only low or absent:	(a) PVS560 (DV-3) or input connection.	Check connection by substitution. See PVS560 handbook.
	(b) Distribution System.	Check, by substitution if possible.
-both above and below 9.7MHz.	(c) PV133K filter or output connection.	Check by substitution. Replace filter if necessary.
	(d) PV133K filter or input connection.	As (c).
	(e) Combining unit (CV-2) card (output) in Low or High (below or above 9.7MHz) Rack Mounting Assembly.	Check by substitution. Replace with spare and repair if possible.
-if the Combining Unit card is satisfactory.	(f) Antenna Distribution Unit (ADU) cards.	Check each of the 8 ADU cards which contribute inputs to form the beam at (e).
3. Eight adjacent beams low relative to the remainder, high or low band, (Fault present either above or below 9.7MHz) with amplifiers in and out:	(a) Combining Unit (CV-2) cards (inputs).	As (e) above.
	(b) ADU (DX-7) card (Low Band) or ADU (DX-6) card (High Band).	As (e) above. Determine which which single ADU card contributes an input to form each faulty beam and check by substituting a card which is known to be working.
if the cards are satisfactory.	(c) See 4(c).	

Fault	Probable Source	Procedure
4. Eight adjacent beams are low when amplifiers are switched in for appropriate band but are normal with amplifiers out.	(a) Faulty relay on ADU (Low) or ADU (High) card.	Check relay connections and coil continuity on the faulty card found by substitution as in (b) above. Replace the relay if necessary.
	(b) Faulty amplifier or phase-inverting transformer on ADU card	Find faulty card as in (b) above. Check all joints, etc. Remove and check transistor. Replace if necessary. Otherwise substitute a spare card.
-if the ADU card is satisfactory.	(c) Antenna, matching transformer, or feeder.	Find by substitution the faulty Antenna/ feeder. Check that the feeder and transformer are in order by the procedure given in paragraph 30. (Feeder continuity via trans- former secondary). Check the connections to the upper and lower elements of the antenna, and the earth braids and stakes.

THUNDERSTORMS

81. The PVS1120 Antenna System may sustain damage during a severe local thunderstorn. The two stages of lightning protection incorporated protect against induced strokes and static, but would not stand up to a direct strike. It is recommended that all antennas are inspected for damage, and that at least the daily check is carried out to verify the system following such a storm.

SYSTEM CALIBRATION

82. The accuracy of the absolute and relative directions of the fixed beams of the PVS1120 system are entirely dependent upon that with which the high and low-band arrays are marked out, provided that satisfactory results are obtained for the acceptance tests. The site should, in addition, be such that the bases of the monopoles are coplanar, and this plane should be inclined at 2 degrees or less to the horizontal. No calibration of the system is required as such as the beam directions bisect the angles between adjacent radials on which the array elements are situated.

83. The directions given in Chapter 2, Installations, assume that the array has been oriented so that beam No. 1 points due North. In this case,

antenna No. 1 is situated on a radial pointing 52.5° West of North. The remaining beams are at 15° intervals.

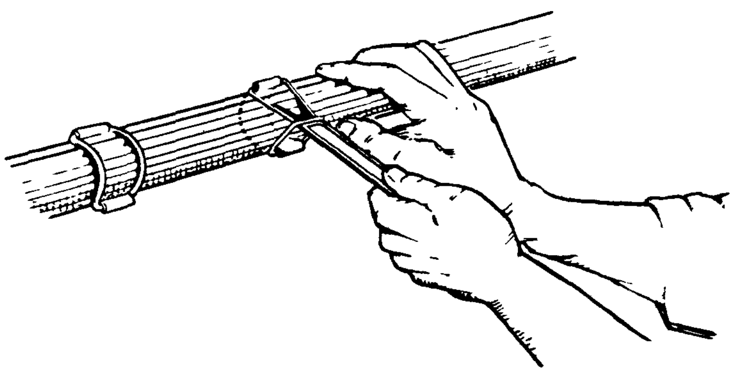
84. Alternative orientations of the beams are possible, depending on the requirements of the user.

SYSTEM RESITING

85. It may be necessary to dismantle the Antenna System from time to time and re-erect it elsewhere. It is desirable that the antennas are dismantled in the reverse order to that described in the installation instructions.

APPENDIX

USE OF THE CRADLECLIP HOOKER



(1) Hook rubber clip in the cradle lip.

(2) Insert Cradleclip Hooker through the centre of the rubber clip.

(3) Snap rubber clip over the other cradle lip by turning the Cradleclip Hooker around wire or cable bundle.

(4) Disengage Cradleclip Hooker from cradle.

CHAPTER 5

COMPONENTS LISTS

Multiple Beam HF Receiving Antenna System (1.5-30MHZ) 686/0/02210/001-002

Description	Plessey Part No.	Number Off	
		PVS1120	PVS1120A
Antenna Kit (8-30MHz)	686/1/02155	24	24
Antenna Kit (1.5-10MHz)	686/1/02156	24	24
Beam-forming Cabinet (1.5-30MHz)	686/1/02211	1	1
Antenna Ancillary (Counter-poise) kit (8-30MHz)	686/1/02250	-	24
Antenna Ancillary (Counter-poise) kit (1.5-10MHz)	686/1/02251	-	24
Anchoring Rope	686/2/02191	1	1
Assembly Pack	686/1/02197	1	1
Tool Kit	686/1/02198	2	2
*Cable Marker, White '0'	915/4/98749/001	92	92
*Cable Marker, White '1'	915/4/98749/002	52	52
*Cable Marker, White '2'	915/4/98749/003	32	32
*Cable Marker, White '3'	915/4/98749/004	12	12
*Cable Marker, White '4'	915/4/98749/005	12	12
*Cable Marker, White '5'	915/4/98749/006	8	8
*Cable Marker, White '6'	915/4/98749/007	8	8
*Cable Marker, White '7'	915/4/98749/008	8	8
*Cable Marker, White '8'	915/4/98749/009	8	8
*Cable Marker, White '9'	915/4/98749/010	56	56

*Supplied with the system, in packets of 25, and to be fitted on installation to the antenna feeder cables (see Chapter 2, paragraphs 40, 42, 63 and 65).

Antenna Kit (8-30MHz) 686/1/02155

Description	Manufacturers Ref. or Ref. No.	Plessey Part No.	No. Off
Antenna Assembly		686/1/02102	1
Cable, Antenna, Feeder		686/1/02186/001	1
Cable Binder B2	Insuloid	915/4/98727	3
Cable Clip 07 (Butyl)	Insuloid	915/4/98774/003	3

Antenna Assembly (8-30MHz) 686/1/02102

Description	Plessey Part No.	No. Off
Antenna Foot Assembly	686/1/02145	1
Antenna Element (7'-0")	686/1/02149	1
Antenna Element (13'-0")	686/1/02153	1
Mast Insulator	686/2/02154	1
Antenna Transformer Assembly (8-30MHz)	686/1/02132	1
Houndsplate	686/2/02140	1
Clamp Assembly	686/1/02135	1
'D' Shackle ½" dia. x 15/16" dia. Pin	753/4/98008/002	3
'D' Shackle Cat.No. 1591-6 7/16"x 7/16" Galv. Stl.	686/4/02272	3
Stay Assembly (Blue)	686/1/02160/004	3
Chain Galv. Stl. Long Link ¼" x 8"lg.	686/4/02271	3
Tirfor Ground Anchor 6" dia. x 30" lg.	753/4/98002/001	2
Rigging Screw Cat.No. 1491-4 7/16" Galv. Stl.	686/4/02270	3
Earth Stake	686/2/02141	2
Connector Assembly	686/1/02142	2
Screw, ¼-28UNF x 1" lg. Hex.Hd. St.Stl.	991/4/01449/028	4
Screw, 3/8-16UNC x 1¼"lg. Hex.Hd St.Stl.	991/4/01485/018	1
Nut ¼-28UNF Hex- Full St.Stl.	991/4/01996/002	6
Washer ¼ Crinkle Beryl.Cu. Elect.Tin	999/4/01130/010	4
Washer 3/8 Crinkle Beryl.Cu. Elect.Tin	999/4/01130/012	1
Tube	686/2/02275	1
Cap	686/2/02276	1

Antenna Transformer Assembly (8-30MHz) 686/1/02132

Description	Manufacturers Ref. or Ref. No.	Plessey Part No.	No. Off
Bracket Riverting Ass'y		686/1/02130	1
Lead Assembly		705/1/11607	1
Terminal Post		686/2/02128	1
Spacer		686/2/02126	2
Transformer		406/8/11107	1
Bulk head Socket Type 'C'	Greenpar GE27508	508/4/28585	1
Fairlead Tubular		630/2/07008/003	2
Surge Voltage Protector B1-C90	Siemens	516/4/98077/000	1
Yoke		686/2/02125	1
Screw, 10-32UNF x $\frac{3}{4}$" lg. Slotted Pan, St.Stl.		991/4/00004/058	2
Screw, 4-40UNC Rec.Pan. Hd. 3/8" lg. Brass, Electro-Tin		999/4/00942/112	1
Washer 6BA Crinkle Beryl Cu. Electro-Tin		999/4/01130/005	1

Antenna Ancillary (Counterpoise) Kit (8-30MHz) (PVS1120A) 686/1/02250

Description	No. Off	Plessey Part No.
Earth Stake	8	686/2/02141
Screw, $\frac{1}{4}$-28UNF x 1" lg. Hex.Hd. St.Stl.	12	991/4/01449/028
Nut $\frac{1}{4}$-28UNF Hex.Ord.St.Stl.	24	991/4/01996/002
Washer, $\frac{1}{4}$ Crinkle, Beryl.Cu. Electro-Tin	32	999/4/01130/010
Cable, Counterpoise	4	686/2/02193/001

Antenna Kit (1.5-10MHz) 686/1/02156

Description	Manufacturers Ref. or Ref. No.	Plessey Part No.	No. Off
Antenna Assembly		686/1/02105	1
Cable, Antenna, Feeder		686/1/02186/003	1
Cable Binder B2	Insuloid	915/4/98727	4
Cable Clip 07 (Butyl)	Insuloid	915/4/98774/003	4

Antenna Assembly (1.5-10MHz) 686/1/02105

Description	Plessey Part No.	No Off
Antenna Foot Assembly	686/1/02145	1
Antenna Element 3.95m (13'-0")	686/1/02153	3
Mast Insulator	686/2/02154	1
Antenna Transformer Assembly (1.5-10MHz)	686/2/02158	1
'D' Shackle ½" dia. x 15/16", 3/16" dia.Pin	753/4/98008/002	9
Stay Assembly (Red)	686/1/02160/001	3
Stay Assembly (Yellow)	686/1/02160/002	3
Stay Assembly (Green)	686/1/02160/003	3
Chain, Galvanised Stl. Long Link ¼" x 8' lg.	686/4/02271	9
'D' Shackle Cat.No. 1591-6 7/16" x 7/16" Galv.Stl.	686/4/02272	9
Rigging Screw Cat.No. 1491-4 7/16" Galv.Stl.	686/4/02270	9
Tube	686/2/02275	1
Cap	686/2/02276	1
Tirfor Ground Anchor 6" dia. x 30"	753/4/98002/001	2
Earth Stake	686/2/02141	2
Connector Assembly	686/2/02142	2
Screw, ¼"-28UNF x 1" lg. Hex.Hd. St.Stl.	991/4/01449/028	4
Screw, 3/8"-16UNC x 1¼" lg. Hex.Hd. St.Stl.	991/4/01485/018	1
Nut, ¼"-18UNF Hex. Full St.Stl.	991/4/01996/002	6
Washer ¼" Crinkle Beryl.Cu. Elect.Tin	999/4/01130/010	4
Washer 3/8" Crinkle Beryl.Cu. Elect.Tin	999/4/01130/012	1
Houndsplate	686/2/02140	3
Clamp Assembly	686/1/02135	3
Nut 3/8"-16UNC Hex. Full St.Stl.	991/4/01996/005	1
Set screw 3/8"-16UNC x 1¾" lg. Hex. Socket Steel	991/4/00300/157	1

Antenna Transformer Assembly (1.5-10MHz) 686/1/02158

Description	Manufacturers Ref. or Ref. No.	Plessey	No. Off
Bracket Riverting Ass'y		686/1/02130	1
Lead Assembly		705/1/11607	1
Terminal Post		686/2/02128	1
Spacer		686/2/02126	2
Transformer		406/8/11107/001	1
Bulkhead Socket Type 'C'	Greenpar GE27508	508/4/28585	1
Fairlead Tubular		630/2/07008/003	2
Surge Voltage Protector B1-C90	Siemens	516/4/98077/000	1
Yoke		686/2/02125	1
Screw, 10-32UNF x $\frac{3}{4}$" lg. Slotted Pan, St.Stl.		991/4/00004/058	2
Screw 4-40UNC Rec. Pan Hd. 3/8" lg. Brass, Electro.tin		991/4/00942/112	1
Washer, 6BA Crinkle Beryl. Cu. Electro.tin		999/4/01130/005	1

Antenna Ancillary (Counterpoise) Kit (PVS1120A) 686/1/02251

Description	No. Off	Plessey Part No.
Earth Stake	8	686/2/02141
Screw, $\frac{1}{4}$"-28UNF x 1" lg. Hex.Hd. St.Stl.	12	991/4/01449/028
Nut $\frac{1}{4}$"-28UNF Hex.Ord.St.Stl.	24	991/4/01996/002
Washer, $\frac{1}{4}$" Crinkle Beryl.Cu. Electro.tin	32	999/4/01130/010
Cable, Counterpoise	4	686/2/02193/002

Beam-forming Cabinet (1.5-30MHz) PV1121 686/1/02211

Description	Manufacturers Ref. or Ref. No.	Plessey Part No.	No. Off
Cabinet		686/1/02166	1
Rack Mounting (8-30MHz) PV882		686/1/02103/001	1
Rack Mounting (1.5-10MHz) PV892		686/1/02103/002	1
Power Unit (PV883)		686/1/02104	1
Dual Bandpass Filter (PV133K)		630/1/27962	12
Panel, Feed Through Assembly		686/1/02170	1
Cable Ass. (Lamp)		705/1/11601	1
Lampholder, Signal Ind. with Red lens.	Arcolectric Type SL90/SB 6210-99-970-1298	418/4/98187/001	1
Lamp, indicating 24V, 3W M.E.S.		517/4/98019/004	1

Rack, Mounting (8-30MHz) (PV882) 686/1/02103/001

Description	Manufacturers Ref. Or Ref. No.	Plessey Part No.	No. Off
Rack, Mounting	[illegible]	686/1/02124	1
Antenna Distribution Unit (8-30MHz)	5820-99-618-2435	419/1/10437	24
Combining Unit		419/1/10334	24
Plug, Co-axial, Free	Greenpar GE37570C12 5935-99-954-4765	508/4/28579	48
Cable Marker, White '0'	Critchley Bros. Type 'C' No.600	915/4/98760/078	1
Cable Marker, White '9'	Critchley Bros. Type 'C' No.600	915/4/98760/087	25

Rack, Mounting (1.5-10MHz) (PV892) 686/1/02103/002

Description	Manufacturers Ref. or Ref. No.	Plessey Part No.	No. Off
Rack, Mounting	[illegible]	686/1/02124	1
Antenna Distribution Unit (1.5-10MHz)	[illegible]	419/1/10441	24
Combining Unit	[illegible] 618-2034	419/1/10334	24
Plug, Co-axial, Free	Greenpar GE37570C12 5935-99-954-4765	508/4/28579	48
Cable Marker, White '0'	Critchley Bros. Type 'C' No.600	915/4/98760/078	26

Rack, Mounting 686/1/02124

Description	Manufacturers Ref. or Ref. No.	Plessey Part No.	No. Off
Edge Connector (Polarized)		686/2/02161/001	24
Edge Connector (Polarized)		686/2/02161/002	24
Cable Assy. (Input)		705/1/11595	24
Cable Assy. (Auxiliary)		705/1/11597	24
Cable Assy. (Difference)		705/1/11598	24
Cable Assy. (Interconnection)		705/1/11599	192
Cable Assy. (HT)		705/1/11600	1
Comb		686/2/02123	48
Pillar		686/2/02114	96
Handle (11¼" CTR'S)		630/2/99407	2
Card Guide	Shire Hall Elect. Type CDP 134	419/4/98055	96
Earth Tag 6BA Brass Electro-Tin		703/4/98111/001	48
Clamp		686/2/02231	1
Cable Marker, White '0'	Critchley Bros. Type 'C' No.600	915/4/98760/078	11
Cable Marker, White '1'	Critchley Bros. Type 'C' No.600	915/4/98760/079	13
Cable Marker, White '2'	Critchley Bros. Type 'C' No.600	915/4/98760/080	8
Cable Marker, White '3'	Critchley Bros. Type 'C' No.600	915/4/98760/081	3
Cable Marker, White '4'	Critchley Bros. Type 'C' No.600	915/4/98760/082	3
Cable Marker, White '5'	Critchley Bros. Type 'C' No.600	915/4/98760/083	2
Cable Marker, White '6'	Critchley Bros. Type 'C' No.600	915/4/98760/084	2
Cable Marker, White '7'	Critchley Bros. Type 'C' No.600	915/4/98760/085	2
Cable Marker, White '8'	Critchley Bros. Type 'C' No.600	915/4/98760/086	2
Cable Marker, White '9'	Critchley Bros. Type 'C' No.600	915/4/98760/087	2
Cable Assy. (Output)		705/1/11596/001	24

Cct. Ref.	Description	Manufacturers Ref. or Ref. No.	Plessey Part No.
	Strap		686/2/02163
C17,23,29	Capacitor, Polystyrene, 64p ± 1%	Suflex HS30V	400/4/98001/321
C13,15,19, 21,25,27 31,33,36	Capacitors, Polystyrene, 67p ± 1%	Suflex HS30V	400/4/98001/311
C2	Capacitor, Polystyrene, 156p ± 2½%	Suflex HS30V	400/4/98001/307
C1,C3	Capacitor, Polystyrene, 280p ± 2½%	Suflex HS30V	400/4/98001/317
C4,C6,C7, C8	Capacitor, Metallised 0.1µ ± 10% 100V Wkg.	Plessey 'Minibox'	435/1/33214/104
C9,10,39,42	Capacitor, 2.2p ± 5%, 200V	Erie Style YD-NPO	400/4/98648/005
C11,C34	Capacitor, 4.7p ± 5%, 200V	Erie Style YD-NPO	400/4/98648/006
C16,22,28	Capacitor, Silvered Ceramic, Tub.Insul. Synthetic Resin, 4.7p ± 10%	Lemco 310-NPO	400/4/98322/056
C12,18,24,	Capacitor, Silvered Ceramic, Tub.Insul. Synthetic Resin, 9.1p ± 10%	Lemco 310-NPO	400/4/98322/063
C14,20,26,	Capacitor, Silvered Ceramic, Tub.Insul. Synthetic Resin, 20p ± 10%	Lemco 310-NPO	400/4/98322/071
R4	Resistor, Fixed, Metal Oxide 27Ω ± 5% to DEF5115, Style RFG5-F	5905-99-013-6401	403/4/78126/011
R5	Resistor, Fixed, Metal Oxide 68Ω ± 5% to DEF5115, Style RFG5-F	5905-99-013-6411	403/4/78126/021
R3	Resistor, Fixed, Metal Oxide 560Ω ± 5% to DEF5115, Style RFG5-F	5905-99-013-6433	403/4/78126/043
R2	Resistor, Fixed, Metal Oxide 3.3KΩ ± 5% to DEF5115, Style RFG5-F	5905-99-013-6451	403/4/78126/061

Antenna Distribution Unit (8-30MHz) 419/1/10437 (Continued)

Cct. Ref.	Description	Manufacturers Ref. or Ref. No.	Plessey Part No.
R1	Resistor, Fixed, Metal Oxide 91Ω ± 2% to DEF5115, Style RFG5-E	5904-99-013-5970	403/4/78127/424
R6-R13 incl.	Resistor, Fixed, Film 37.4Ω ± 1%	Electrosil C5	403/4/78363/065
D1,D3	Diode, Double Plug	IN4148	415/4/98393
D2,D4	Zener Diode, 2.7V ± 5%	STC, ZF 2.7	415/4/98083/051
VT1	Silicon Transistor NPN	Type 2N 3866	417/4/98358
RL1	Relay, Min, Sealed 675Ω 2 C/O Contacts	5945-99-946-5474	507/8/02207/004
L1, L2	Inductor, 1.27μ		406/1/29630
T1	Phase Inverting Transformer		406/1/29625
T2	Feedback Transformer		406/1/29633
T3-T10 incl.	Hybrid Transformer		406/1/29623
Used with VT1	Transistor Mounting Pad	Jermyn Type T05-001	915/4/98734
Used with VT1	Transistor Heat Sink	Jermyn Type 205	418/4/98607/004

Combining Unit 419/1/10334

Cct. Ref.	Description	Manufacturers Ref. or Ref. No.	Plessey Part No.
T8	Impedance Transformer		406/1/29624
T1-T7 incl.	Hybrid Transformer		406E1/29623
R1-R6	Resistor, Fixed 37.4Ω ± 1%, 1/8W	Electrosil C5 E96 Series	403/4/78363/065

Antenna Distribution Unit (1.5-10MHz) 419/1/10441

Cct. Ref.	Description	Manufacturers Ref. or Ref. No.	Plessey Part No.
	Strap		686/2/02163
C17,23,29	Capacitor, Polystyrene, 200p ± 2½%	Suflex HS30V	400/4/98001/157
C13,15,19 21,25,27, 31,33,36 38,41	Capacitor, Polystyrene, 210p ± 2½%	Suflex HS30V	400/4/98001/302
C2	Capacitor, Polystyrene, 820p ± 2½%	Suflex HS30V	400/4/98001/237
C1,C3	Capacitor, Polystyrene, 1420p ± 2½%	Suflex HS30V	400/4/98249/013
C4,C6,C7 C8	Capacitor, Metallised Polyester 0.1μ ± 10% 100V Wkg.	Plessey 'Minibox'	435/1/33214/104
C12,14,16, 18,20,22, 24,26,28, 30,32,35 37,40	Capacitor, Silvered Ceramic, Tub.Insul. Synthetic Resin, 56p ± 10%	Lemco 310-N750	400/4/98172/102
R4	Resistor, Fixed, Metal Oxide, 27Ω ± 5% to DEF5115, Style RFG5-F	5905-99-013-6401	403/4/78126/001
R5	Resistor, Fixed, Metal Oxide, 68Ω ± 5% to DEF5115, Style RFG5-F	5905-99-013-6411	403/4/78126/021
R3	Resistor, Fixed, Metal Oxide, 560Ω ± 5% to DEF5115, Style RFG5-F	5905-99-013-6433	403/4/78126/043
R2	Resistor, Fixed, Metal Oxide, 3.3kΩ ± 5% to DEF5115, Style RFG5-F	5905-99-013-6451	403/4/78126/061
R1	Resistor, Fixed, Metal Oxide, 91Ω ± 2% to DEF5115, Style RFG5-E	5905-99-013-5970	403/4/78127/424
R6-R13	Resistor, Fixed, Film 37.4Ω ± 1%, 1/8W	Electrosil C5	403/4/78363/065
D1,D3	Diode, Double Plug	IN4148	415/4/98393
D2,D4	Zener Diode, 2.7V ± 5%	STC, ZF 2.7	415/4/98083/051
VT1	Silicon Transistor NPN	Type 2N 3866	417/4/98358

Antenna Distribution Unit (1.5-10MHz) 419/1/10441 (Continued)

Cct. Ref.	Description	Manufacturers Ref. or Ref. No.	Plessey Part No.
RL1	Relay, Min, Sealed, 675Ω 2 C/O Contacts	5945-99-946-5474	507/8/02207/004
L1,L2	Inductor, 6.6μ		406/1/29631
T1	Phase Inverting Transformer		406/1/29625
T2	Feedback Transformer		406/1/29633
T3-T10 incl.	Hybrid Transformer		406/1/29623
Used with VT1	Transistor Mounting Pad	Jermyn Type T05-001	915/4/98734
Used with VT1	Transistor Heat Sink	Jermyn Type 205	418/4/98607/004

Power Unit (PV883) 686/1/02104

Description	Manufacturers Ref. or Ref. No.	Plessey Part No.	No. Off
Relay, Miniature, Sealed 12V, Type CF	Plessey	507/8/02207/003	2
CF Relay Skt Assembly	Plessey A100 Black	507/8/02096	2
Free Socket, Round Flange 3 Pole Size 1 S04A4F1-3/5	5935-99-013-0938	508/8/07001/225	1
Free Plug, Round Flange 6 Pole Size 1 P04A4F1-6/0	5935-99-013-0653	508/8/07023/220	1
Insulator, Stand-Off DEF5334-B	Oxley DEV. Colour (Red)	703/4/98261/007	1
Insulator, Stand-Off DEF5334-B	Oxley DEV. Colour (Black)	703/4/98261/003	1
Lampholder, Midget Insulated Body	Thorn 80/10/2048	418/4/98041/001	2
Ind. Lamp Cap	Thorn 80/10/0069/Red	418/4/98194/001	2
Midget Panel Lamp (Atlas) 28V, .04A, 4 Lumens S6/8 Cap	Thorn L1004	517/4/98018/007	2
Switch, Lever, DEF5151 QMQB SL3	5930-99-051-0554	408/4/98065/004	4
Outlet Accessory Kit Straight Outlet	Plessey	508/8/02719/301	2
Modular Power Supply 15-30V 5A 9Set to +17V)	Advance Electronics PM51	605/4/98020/020	1

Panel Feed Through Assy 686/1/02170

Description	Plessey Part No.	No. Off
Panel Feed Through	686/2/02172	1
Grommet, Flexiform G51HC	686/4/70192/004	Length as reqd.
Boscoprene Cement No.2762, Part 1	99/0513)) Required) to fix	))) as required
Boscoprene Cement No.2762, Part 2 (Catalyst)	99/0512) grommet)	))

Assembly Pack 686/1/02197

Description	Plessey Part No.	No. Off
Cradle-clip Hooker	558/4/98041/000	5
Silicone Grease MS4 (to DTD 900/4298	99/4816	2 (8oz. tubes)
Anti-scuffing pase (to DTD 5530)	99/2701	1 lb tin

Tool Kit 686/1/02198

Description	Plessey Part No.	No. Off
Spanner, Antenna	686/1/02196	2
Spanner, box, with tommy bar	558/4/98042/001	1
Hex, Wrench 3/16" AF	558/4/98003/006	1

Coaxial Cables manufactured as required on site (not supplied)

Function	Quantity	Coding (fitted on installation)	Plessey reference
Beam sum output PV133K filter to receiver station (see Fig. 18)	24	9015 (1 cable path) 9025 (1 cable path) etc. through 9245 (1 cable path)	Cable Assembly (9) 705/1/11671
Low-band beam difference output to external connection (Required only for certain d.f. applications) See Fig. 17	24	8010 (1 cable path) 8020 (1 cable path) etc. through 8240 (1 cable path)	Cable Assembly (8) 705/1/11666
High-band beam difference output to external connection (Required only for certain d.f. applications) See Fig. 17	24	8019 (1 cable path) 8029 (1 cable path) etc. through 8249 (1 cable path)	Cable Assembly (8) 705/1/11666

CHAPTER 6

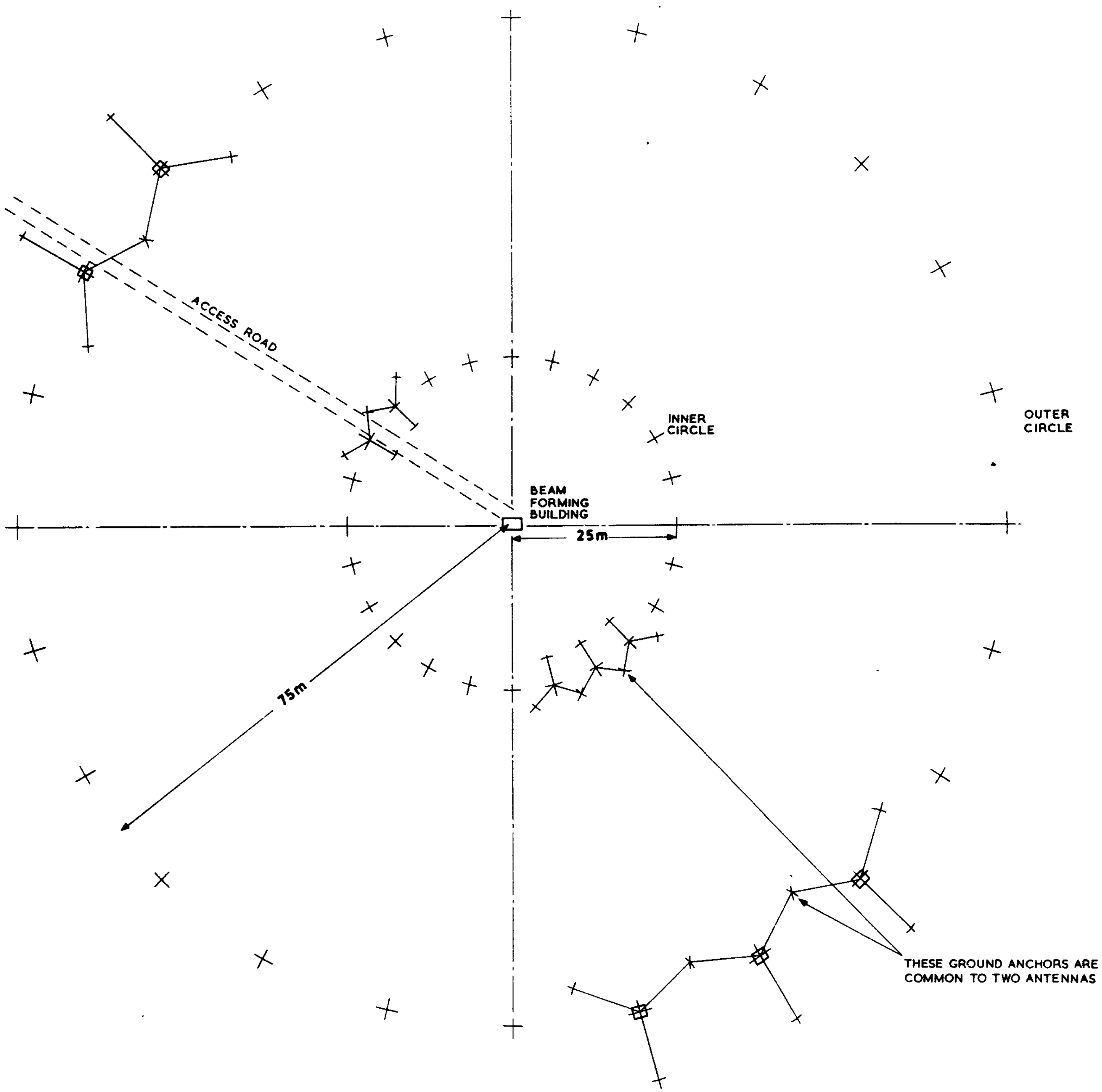
ILLUSTRATIONS

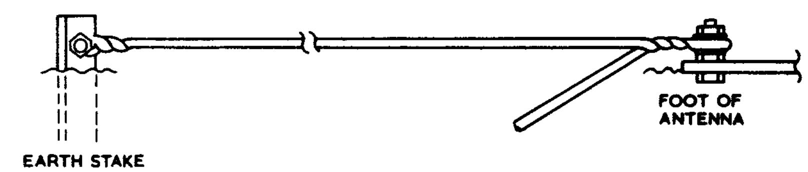
OUTER CIRCLE

1. ANTENNAS EQUALLY SPACED ON 75 METRES P.C RADIUS CHORDAL DISTANCE BETWEEN ANTENNAS 19·58 METRES (64 FT. 3 IN) APPROX.
2. GROUND ANCHORS POSITIONED ON 10 6 METRES (34 FT. 9 IN.) P.C. RADIUS, CHORDAL SPACING 18.32 METRES (60 FT. 1 IN.) APPROX

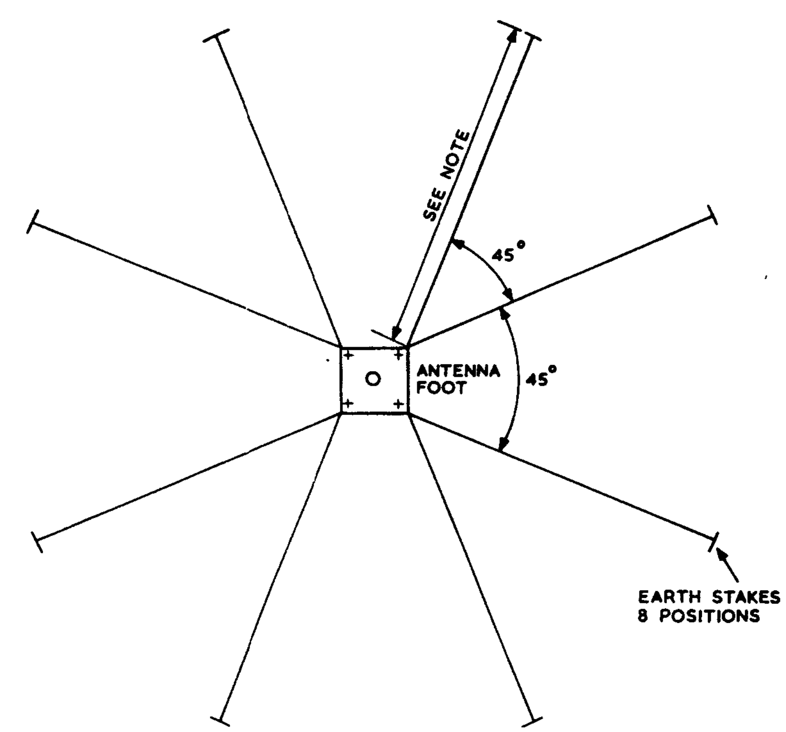
INNER CIRCLE

1. ANTENNAS EQUALLY SPACED ON 25 METRES P.C. RADIUS CHORDAL DISTANCE BETWEEN ANTENNAS 6·53 METRES (21 FT. 5 IN.) APPROX
2. GROUND ANCHORS POSITIONED ON 4·1 METRES (13 FT. 6 IN.) P.C. RADIUS, CHORDAL SPACING 7·14 METRES (23 FT. 5 IN.) APPROX





COUNTERPOISE FITTING

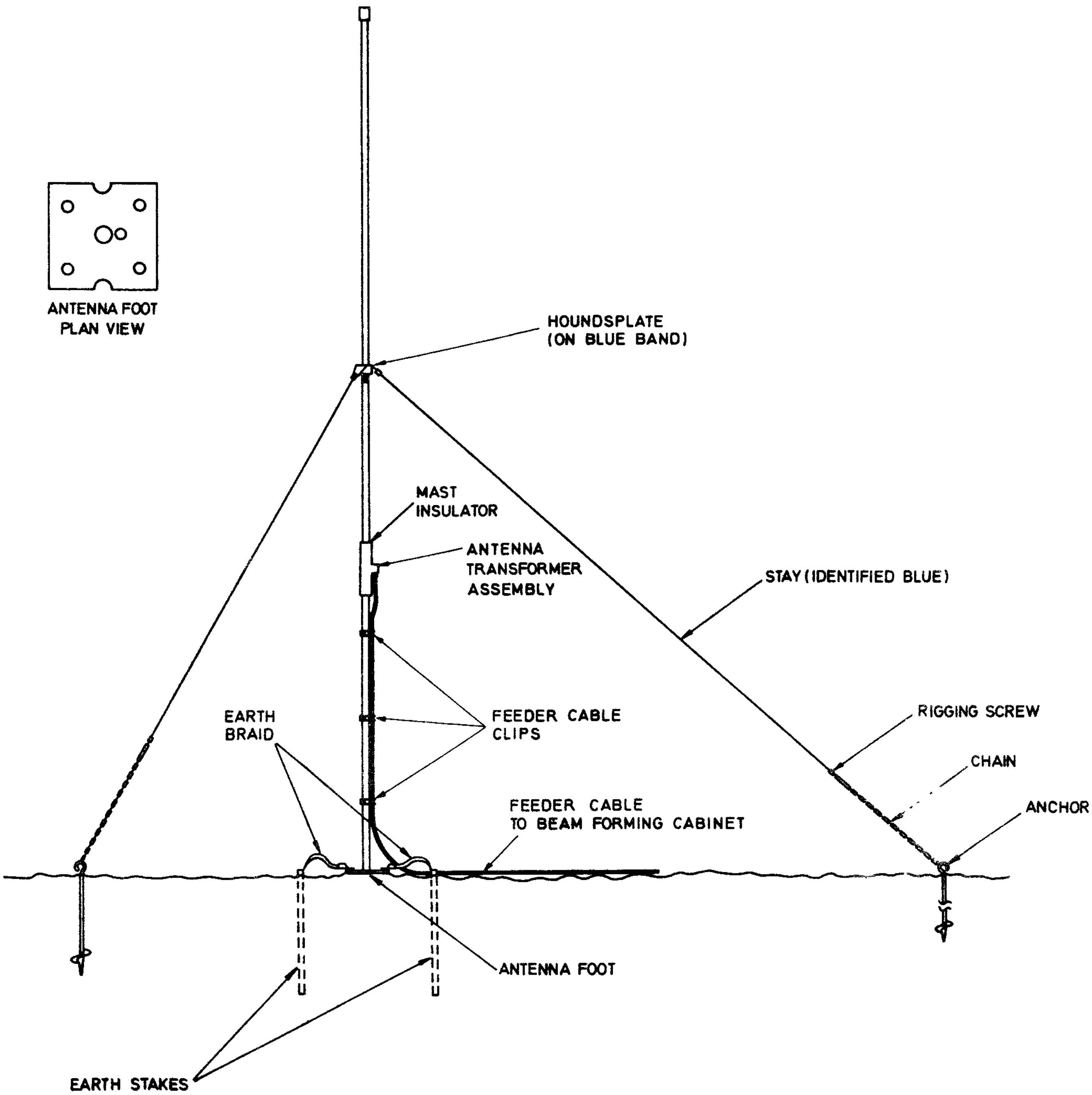


LAYOUT OF COUNTERPOISE
(FITTED ON PVS1120A ONLY)

NOTE: DIMENSION SHOWN = 25 METRES $^{+0}_{-\cdot 15}$ METRES (INNER CIRCLE)
= 75 METRES $^{+0}_{-15}$ METRES (OUTER CIRCLE)

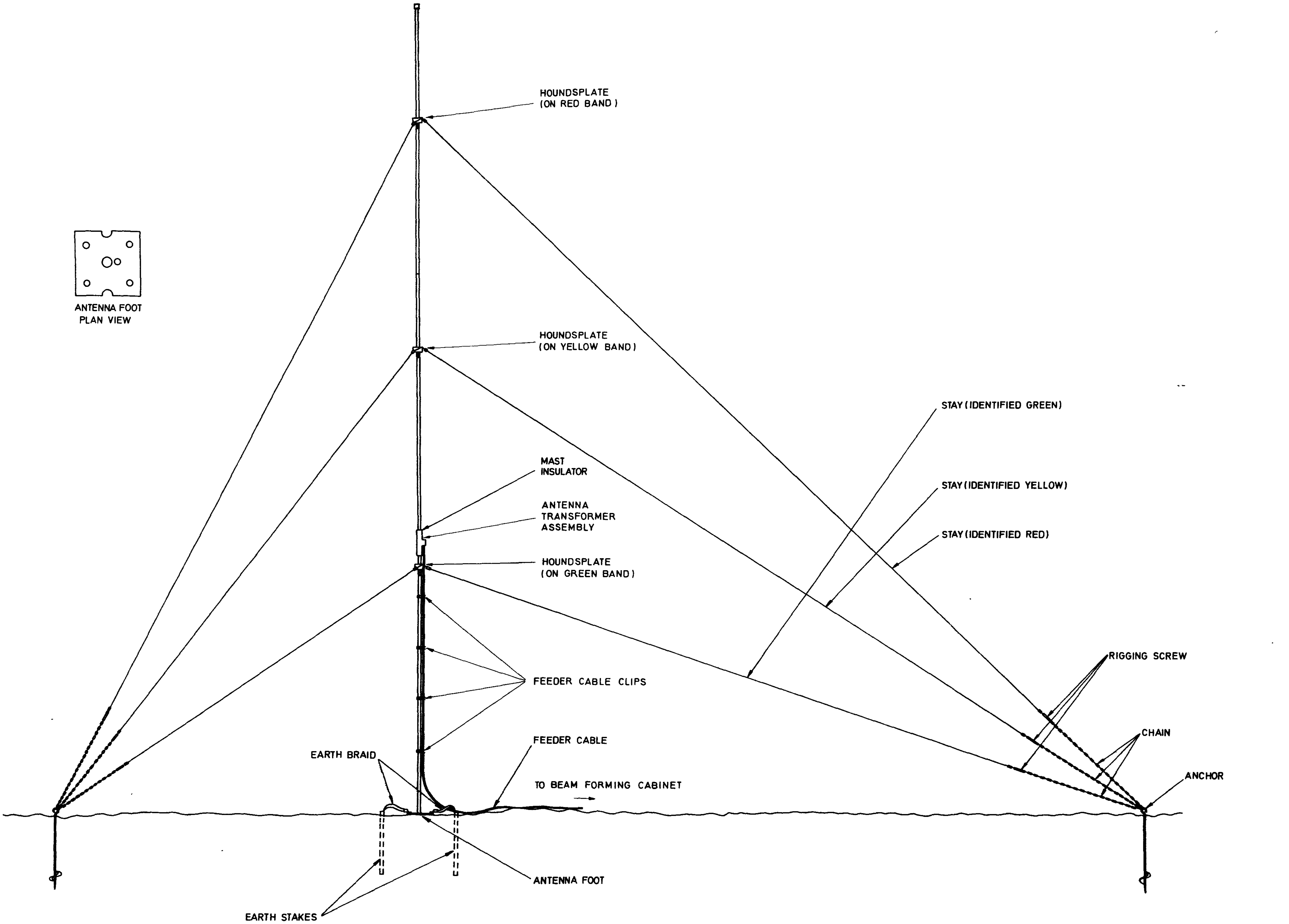
MULTIPLE BEAM HIGH FREQUENCY RECEIVING ANTENNA SYSTEM (1·5–30MHz) PVS1120 & PVS1120A

FIG. 1



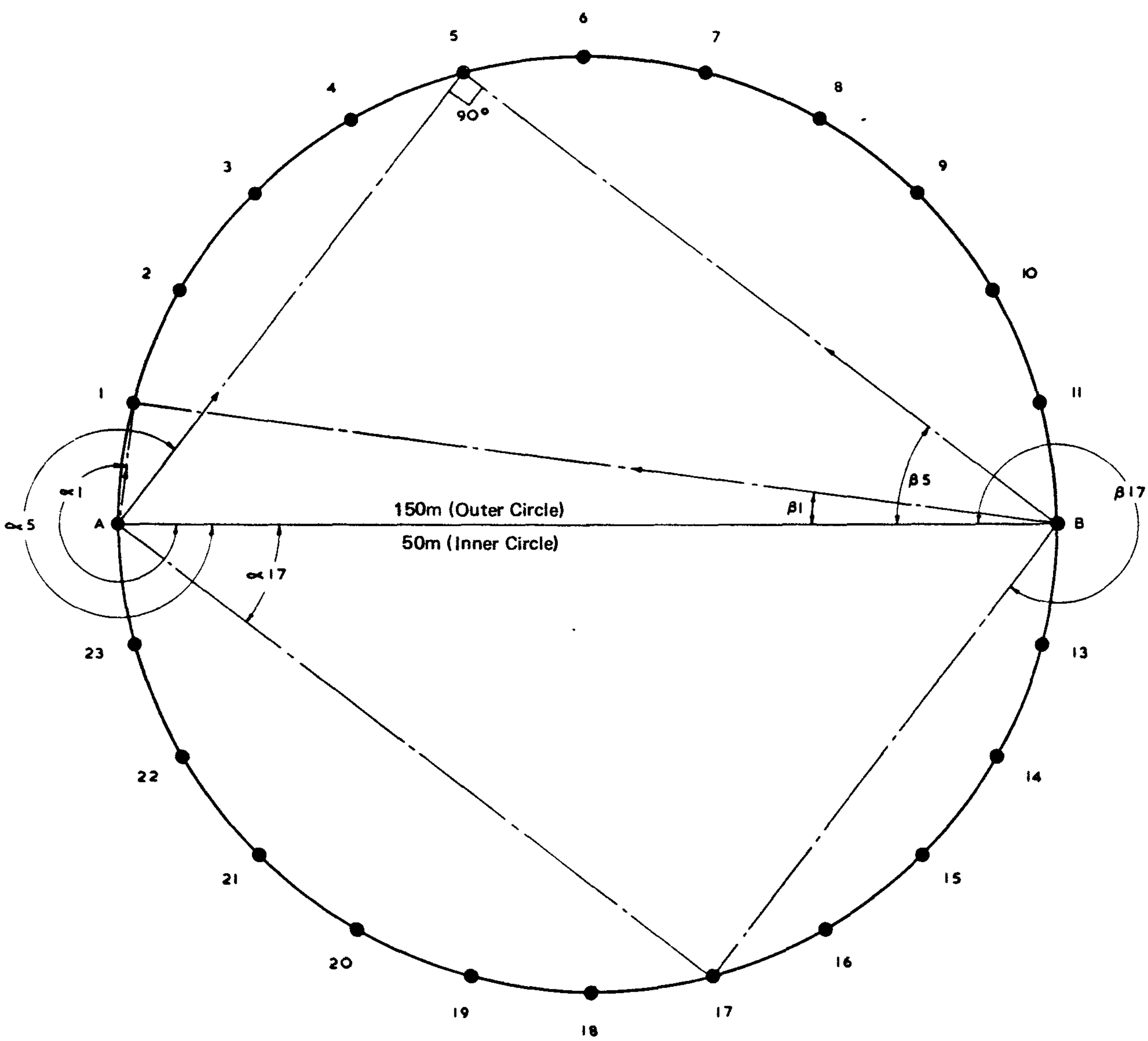
ANTENNA KIT (8-30 MHz)

FIG. 2

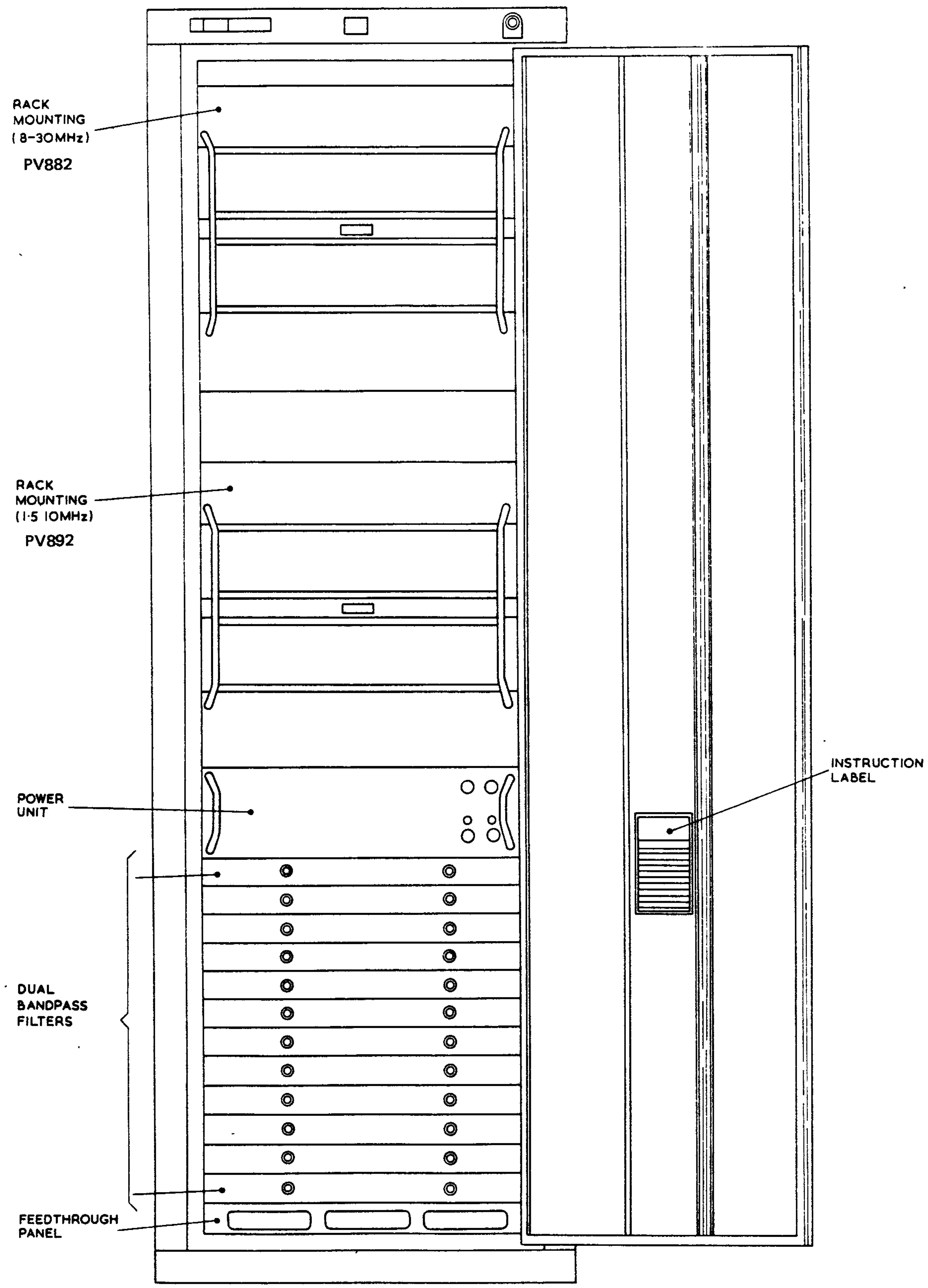


ANTENNA KIT (1·5–10 MHz) FIG. 3

ANTENNA No.	THEODOLITE A ANGLE α, DEGREES	THEODOLITE B ANGLE β, DEGREES	ANTENNA No	THEODOLITE A ANGLE α, DEGREES	THEODOLITE B ANGLE β, DEGREES
1	277 1/2	7 1/2	13	7 1/2	277 1/2
2	285	15	14	15	285
3	292 1/2	22 1/2	15	22 1/2	292 1/2
4	300	30	16	30	300
5	307 1/2	37 1/2	17	37 1/2	307 1/2
6	315	45	18	45	315
7	322 1/2	52 1/2	19	52 1/2	322 1/2
8	330	60	20	60	330
9	337 1/2	67 1/2	21	67 1/2	337 1/2
10	345	75	22	75	345
11	352 1/2	82 1/2	23	82 1/2	352 1/2

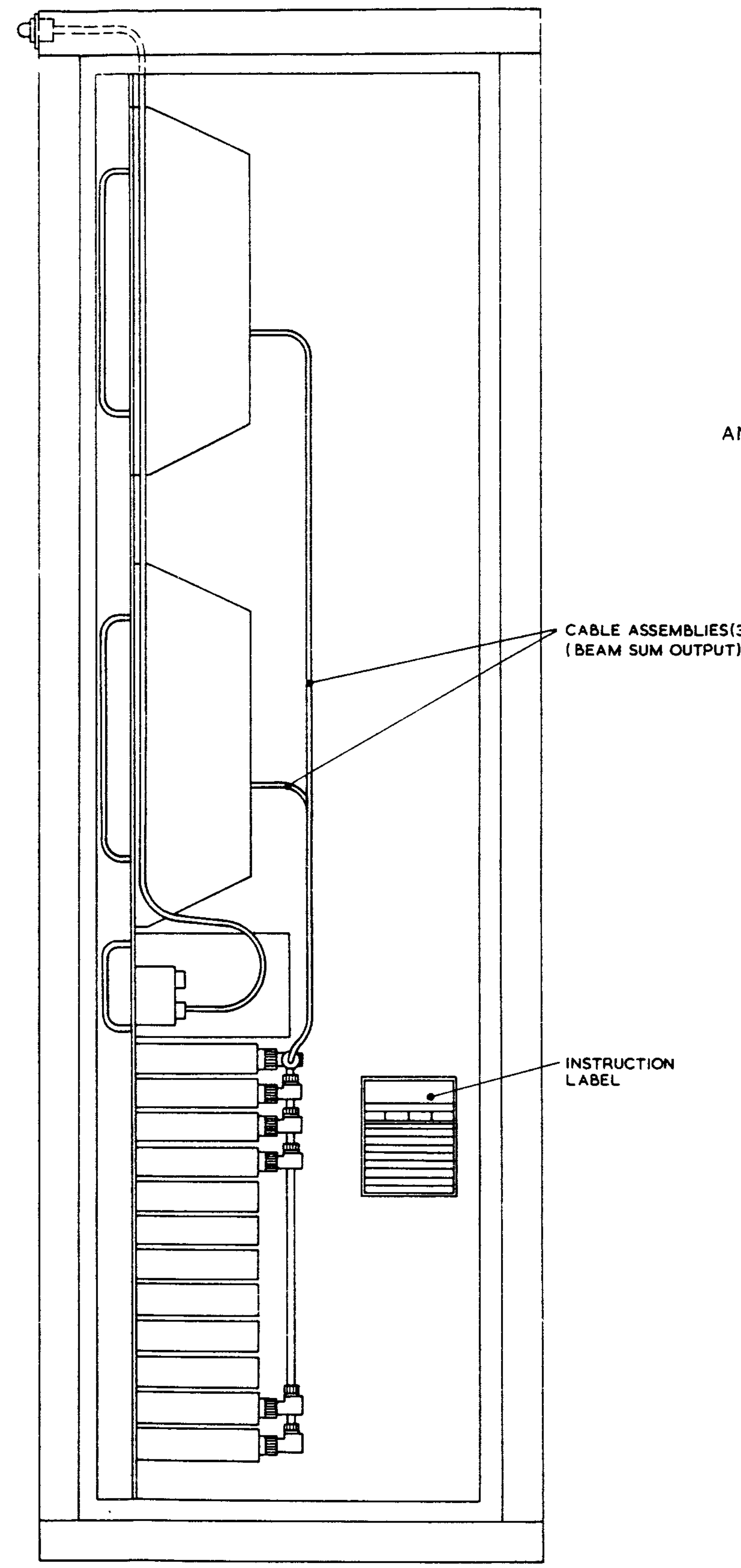


MARKING OUT THE ANTENNA SITE (METHOD 2) FIG. 4

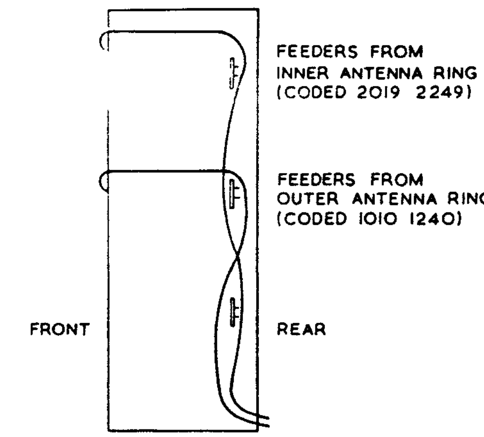


FRONT VIEW WITH DOOR OPEN

A BLANK PANEL REPLACES ANY ITEM
OMITTED FROM CABINET



SIDE VIEW WITH SIDE PANEL REMOVED



ANTENNA FEEDER CABLE ROUTE
IN BEAM
FORMING CABINET

NOTES.

1. THE COAXIAL CABLES SHOWN IN THIS FIGURE ARE CODED IN A 4-DIGIT SYSTEM THE FIRST DIGIT REPRESENTS THE CABLE TYPE REFERENCE, THIS BEING DEFINED BY A DRAWING. THE SECOND AND THIRD DIGITS GIVE THE SERIAL NUMBER OF THE PARTICULAR CABLE, e.g. 05, 17, AND THE LAST DIGIT DENOTES THE SYSTEM FREQUENCY COVERAGE (0 FOR 1·5-10MHz, 5 FOR 1·5-30MHz, 9 FOR 8-30MHz).

2. ALTHOUGH RACK MOUNTINGS HAVE BEEN SHOWN WITH 8-30MHz IN THE UPPER POSITION, THESE POSITIONS MAY BE INTERCHANGED TO SUIT ANY INSTALLATION AS THEIR CABLE ASSEMBLIES (SUM BEAM OUTPUT) ARE OF EQUAL LENGTH.

3. FIRST CONNECT THE APPROPRIATE ANTENNA FEEDER CABLES TO THE LOWER RACK MOUNTING. THE FEEDER CABLES SHOULD BE LAID IN THE CABINET SO THAT SERIAL NUMBER-01-RISES ON THE RIGHT HAND SIDE WHEN VIEWED FROM THE REAR. CLIPS ARE PROVIDED WITH THE CABINET TO SECURE THE CABLES IN POSITION.

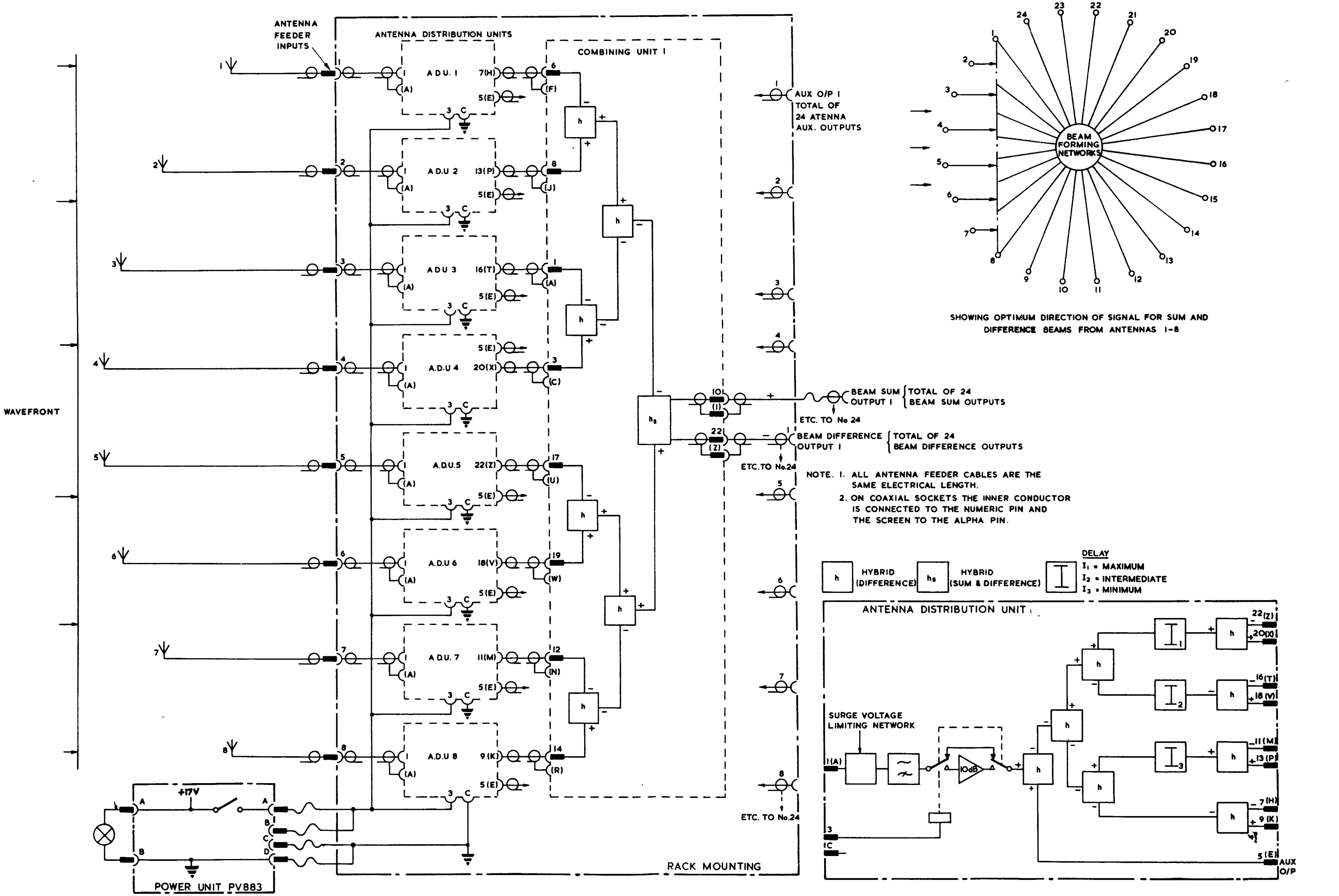
4. THE 48 CABLE ASSEMBLIES (3) (BEAM SUM OUTPUT) (PART OF RACK MOUNTINGS) ARE CODED 3010, 3020 ETC. THROUGH 3240 (1·5-10MHz) AND 3019, 3029 ETC. THROUGH 3249 (8-30 MHz). THEY ARE TO BE RUN AS SHOWN AND CONNECTED TO THEIR RESPECTIVE FILTER IN ACCORDANCE WITH THE LABEL SECURED TO THE SIDE PANEL.

5. THE 24 CABLE ASSEMBLIES (9) (BEAM SUM COMBINED OUTPUT) FOR CONNECTION TO THE FILTER OUTPUTS ARE NOT SUPPLIED WITH THE STANDARD EQUIPMENT AND ARE NORMALLY MANUFACTURED ON SITE AS REQUIRED. THEY ARE DEFINED BY DRAWING 705/1/11671 (FIG.18) AND THE RECOMMENDED CODING IS 9015, 9025 ETC THROUGH 9245 THEY ARE TO BE CONNECTED TO THEIR RESPECTIVE FILTERS IN ACCORDANCE WITH INSTRUCTIONS ON THE LABEL FITTED ON THE INSIDE OF THE CABINET DOOR.

BEAM FORMING CABINET (1·5-30MHz) PV1121 686/1/02211

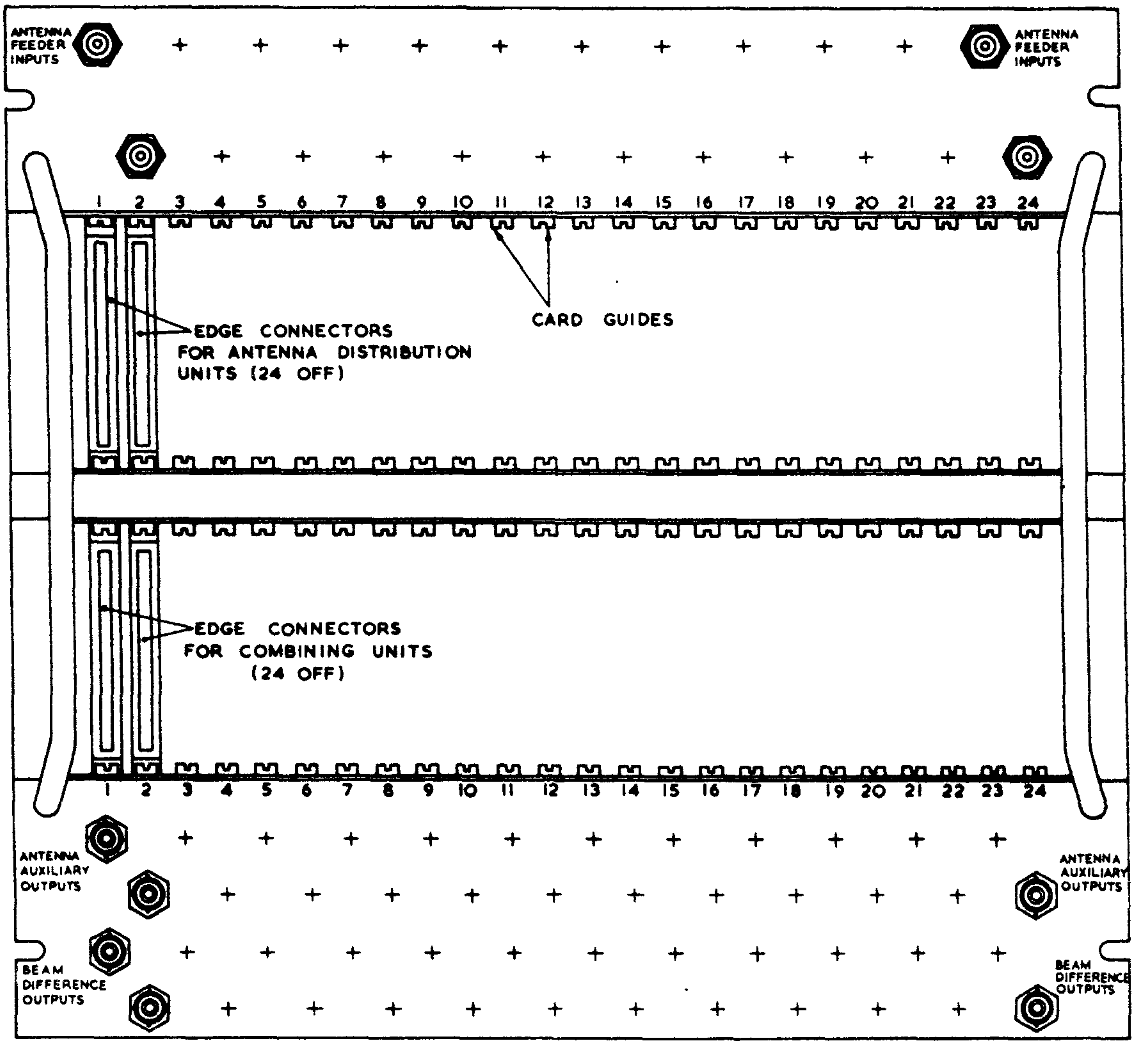
FIG. 5

ISS. 2



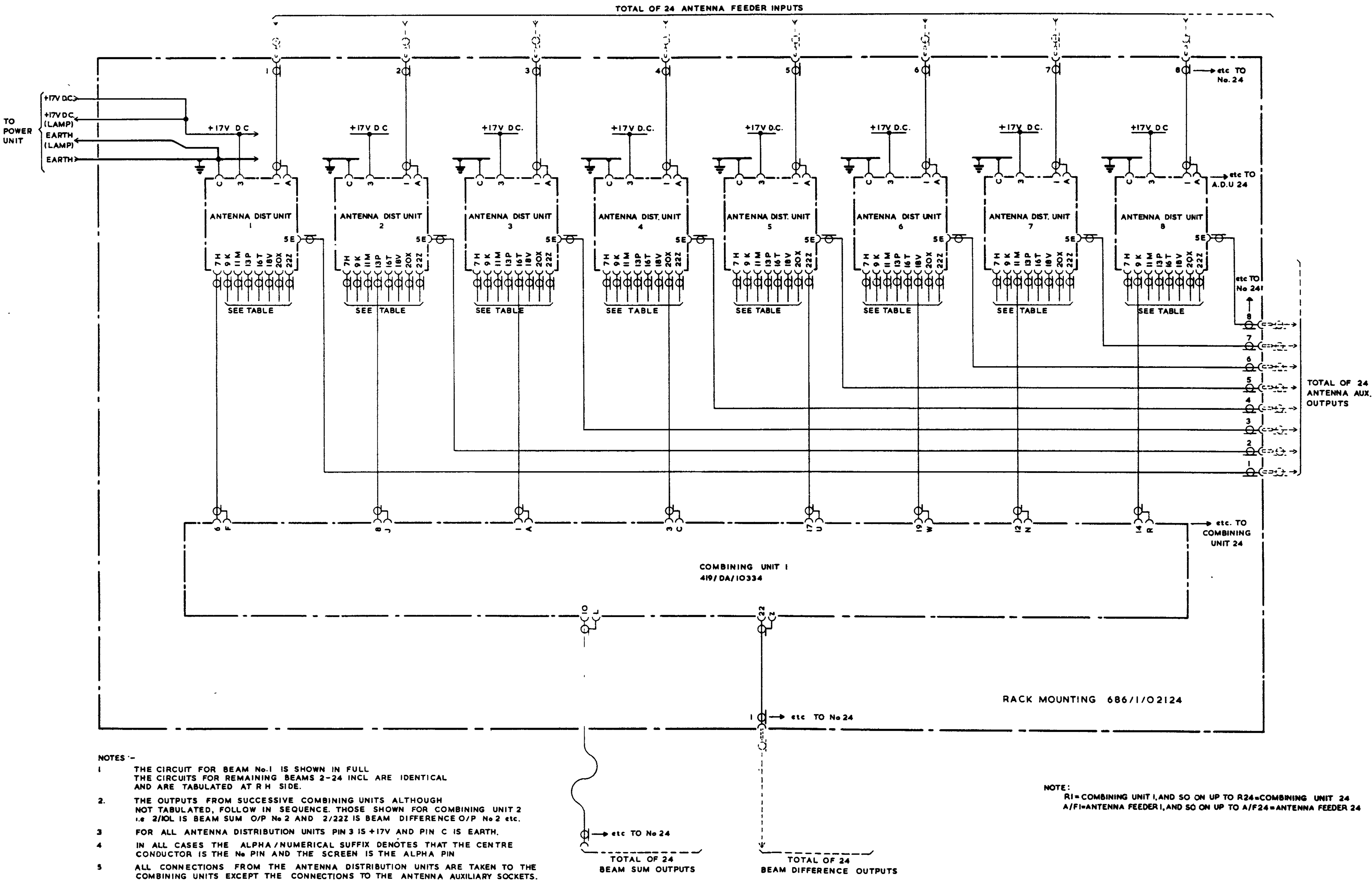
BEAM FORMING NETWORKS
SCHEMATIC DIAGRAM

FIG. 6



RACK MOUNTING

FIG. 7



NOTES :-

1 THE CIRCUIT FOR BEAM No.1 IS SHOWN IN FULL
THE CIRCUITS FOR REMAINING BEAMS 2-24 INCL ARE IDENTICAL AND ARE TABULATED AT R H SIDE.

2. THE OUTPUTS FROM SUCCESSIVE COMBINING UNITS ALTHOUGH NOT TABULATED, FOLLOW IN SEQUENCE. THOSE SHOWN FOR COMBINING UNIT 2 i.e 2/10L IS BEAM SUM O/P No 2 AND 2/22Z IS BEAM DIFFERENCE O/P No 2 etc.

3 FOR ALL ANTENNA DISTRIBUTION UNITS PIN 3 IS +17V AND PIN C IS EARTH.

4 IN ALL CASES THE ALPHA/NUMERICAL SUFFIX DENOTES THAT THE CENTRE CONDUCTOR IS THE No PIN AND THE SCREEN IS THE ALPHA PIN

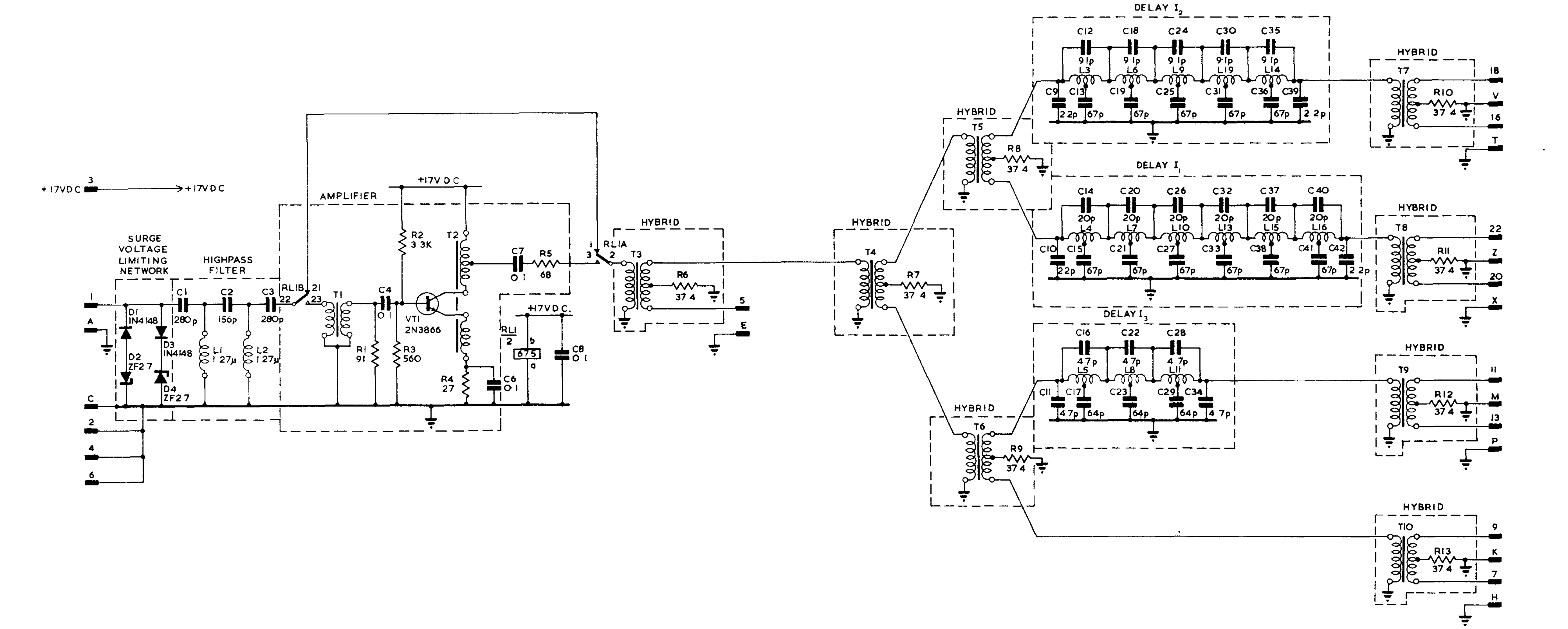
5 ALL CONNECTIONS FROM THE ANTENNA DISTRIBUTION UNITS ARE TAKEN TO THE COMBINING UNITS EXCEPT THE CONNECTIONS TO THE ANTENNA AUXILIARY SOCKETS.

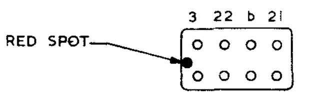
NOTE:
R1=COMBINING UNIT 1, AND SO ON UP TO R24=COMBINING UNIT 24
A/F1=ANTENNA FEEDER 1, AND SO ON UP TO A/F24=ANTENNA FEEDER 24

ADU	TO	ADU	TO	ADU	TO
1/9K	R18/14R	11/22Z	R7/17U	20/13P	R19/8J
1/11M	R19/12N			20/16T	R18/1A
1/13P	R24/8J	12/1A	A/F12	20/18V	R15/19W
1/16T	R23/1A	12/5E	AUX12	20/20X	R17/3C
1/18V	R20/19W	12/7H	R12/6F	20/22Z	R16/17U
1/20X	R22/3C	12/9K	R5/14R		
1/22Z	R21/17U	12/11M	R6/12N	21/1A	A/F.21
		12/13P	R11/8J	21/5E	AUX.21
2/7H	R2/6F	12/16T	R10/1A	21/7H	R21/6F
2/9K	R19/14R	12/18V	R7/19W	21/9K	R14/14R
2/11M	R20/12N	12/20X	R9/3C	21/11M	R15/12N
2/16T	R24/1A	12/22Z	R8/17U	21/13P	R20/8J
2/18V	R21/19W			21/16T	R19/1A
2/20X	R23/3C	13/1A	A/F.13	21/18V	R16/19W
2/22Z	R22/17U	13/5E	AUX.13	21/20X	R18/3C
		13/7H	R13/6F	21/22Z	R17/17U
3/7H	R3/6F	13/9K	R6/14R		
3/9K	R20/14R	13/11M	R7/12N	22/1A	A/F22
3/11M	R21/12N	13/13P	R12/8J	22/5E	AUX.22
3/13P	R2/8J	13/16T	R11/1A	22/7H	R22/6F
3/18V	R22/19W	13/18V	R8/19W	22/9K	R15/14R
3/20X	R24/3C	13/20X	R10/3C	22/11M	R16/12N
3/22Z	R23/17U	13/22Z	R9/17U	22/13P	R21/8J
				22/16T	R20/1A
4/7H	R4/6F	14/1A	A/F14	22/18V	R17/19W
4/9K	R21/14R	14/5E	AUX.14	22/20X	R19/3C
4/11M	R22/12N	14/7H	R14/6F	22/22Z	R18/17U
4/13P	R3/8J	14/9K	R7/14R		
4/16T	R2/1A	14/11M	R8/12N	23/1A	A/F.23
4/18V	R23/19W	14/13P	R13/8J	23/5E	AUX.23
4/22Z	R24/17U	14/16T	R12/1A	23/7H	R23/6F
		14/18V	R9/19W	23/9K	R16/14R
5/7H	R5/6F	14/20X	R11/3C	23/11M	R17/12N
5/9K	R22/14R	14/22Z	R10/17U	23/13P	R22/8J
5/11M	R23/12N			23/16T	R21/1A
5/13P	R4/8J	15/1A	A/F15	23/18V	R18/19W
5/16T	R3/1A	15/5E	AUX15	23/20X	R20/3C
5/18V	R24/19W	15/7H	R15/6F	23/22Z	R19/17U
5/20X	R2/3C	15/9K	R8/14R		
		15/11M	R9/12N	24/1A	A/F24
6/7H	R6/6F	15/13P	R14/8J	24/5E	AUX24
6/9K	R23/14R	15/16T	R13/1A	24/7H	R24/6F
6/11M	R24/12N	15/18V	R10/19W	24/9K	R17/14R
6/13P	R5/8J	15/20X	R12/3C	24/11M	R18/12N
6/16T	R4/1A	15/22Z	R11/17U	24/13P	R23/8J
6/20X	R3/3C			24/16T	R22/1A
6/22Z	R2/17U	16/1A	A/F16	24/18V	R19/19W
		16/5E	AUX.16	24/20X	R21/3C
7/7H	R7/6F	16/7H	R16/6F	24/22Z	R20/17U
7/9K	R24/14R	16/9K	R9/14R		
7/13P	R6/8J	16/11M	R10/12N		
7/16T	R5/1A	16/13P	R15/8J		
7/18V	R2/19W	16/16T	R14/1A		
7/20X	R4/3C	16/18V	R11/19W		
7/22Z	R3/17U	16/20X	R13/3C		
		16/22Z	R12/17U		
8/7H	R8/6F				
8/11M	R2/12N	17/1A	A/F.17		
8/13P	R7/8J	17/5E	AUX17		
8/16T	R6/1A	17/7H	R17/6F		
8/18V	R3/19W	17/9K	R10/14R		
8/20X	R5/3C	17/11M	R11/12N		
8/22Z	R4/17U	17/13P	R16/8J		
		17/16T	R15/1A		
9/1A	A/F9	17/18V	R12/19W		
9/5E	AUX.9	17/20X	R14/3C		
9/7H	R9/6F	17/22Z	R13/17U		
9/9K	R2/14R				
9/11M	R3/12N	18/1A	A/F18		
9/13P	R8/8J	18/5E	AUX.18		
9/16T	R7/1A	18/7H	R18/6F		
9/18V	R4/19W	18/9K	R11/14R		
9/20X	R6/3C	18/11M	R12/12N		
9/22Z	R5/17U	18/13P	R17/8J		
		18/16T	R16/1A		
10/1A	A/F10	18/18V	R13/19W		
10/5E	AUX10	18/20X	R15/3C		
10/7H	R10/6F	18/22Z	R14/17U		
10/9K	R3/14R				
10/11M	R4/12N	19/1A	A/F.19		
10/13P	R9/8J	19/5E	AUX.19		
10/16T	R8/1A	19/7H	R19/6F		
10/18V	R5/19W	19/9K	R12/14R		
10/20X	R7/3C	19/11M	R13/12N		
10/22Z	R6/17U	19/13P	R18/8J		
		19/16T	R17/1A		
11/1A	A/F11	19/18V	R14/19W		
11/5E	AUX11	19/20X	R16/3C		
11/7H	R11/6F	19/22Z	R15/17U		
11/9K	R4/14R				
11/11M	R5/12N	20/1A	A/F20		
11/13P	R10/8J	20/5E	AUX.20		
11/16T	R9/1A	20/7H	R20/6F		
11/18V	R6/19W	20/9K	R13/14R		
11/20X	R8/3C	20/11M	R14/12N		

RACK MOUNTING 686/DA/02103/001 & 002
CIRCUIT DIAGRAM

FIG. 8



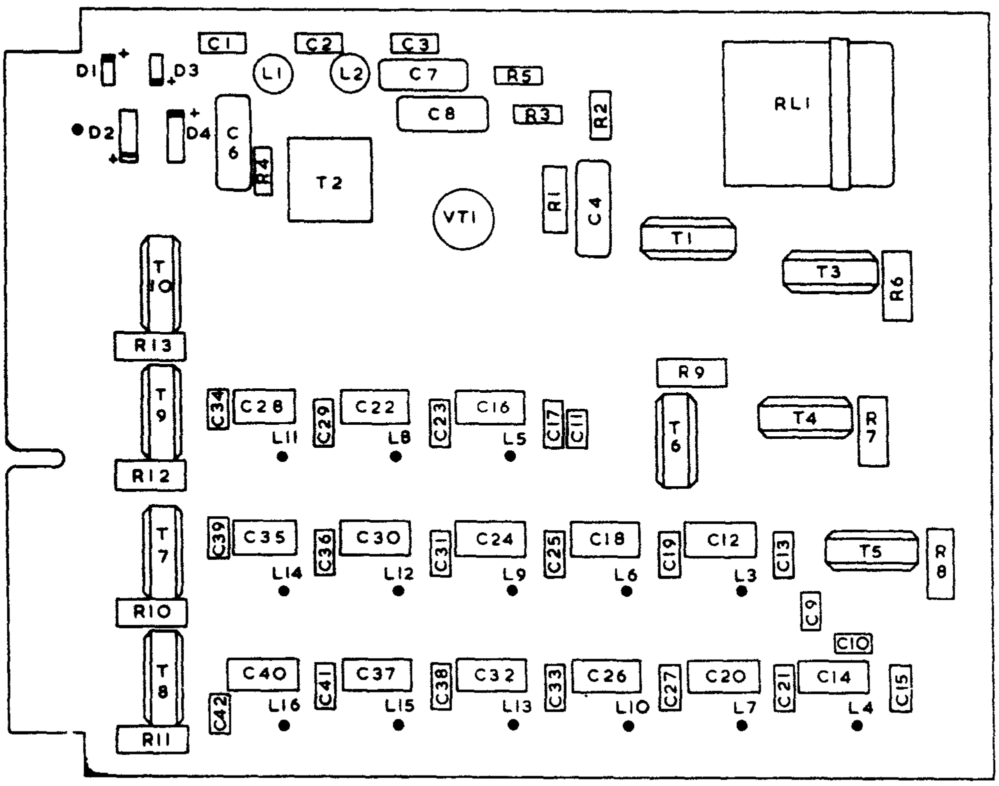


VIEW ON PINS OF RL1

NOTES:
1 PINS 8,10,12,14,15,17,19,21 & R NOT FITTED
2 REMAINING ALPHABETIC PINS NOT SHOWN ARE COMMONED TO EARTH
3 L3-L16 ARE PRINTED INDUCTORS

ANTENNA DISTRIBUTION UNIT (8-30MHz) 419/DA/10437 **FIG. 9**

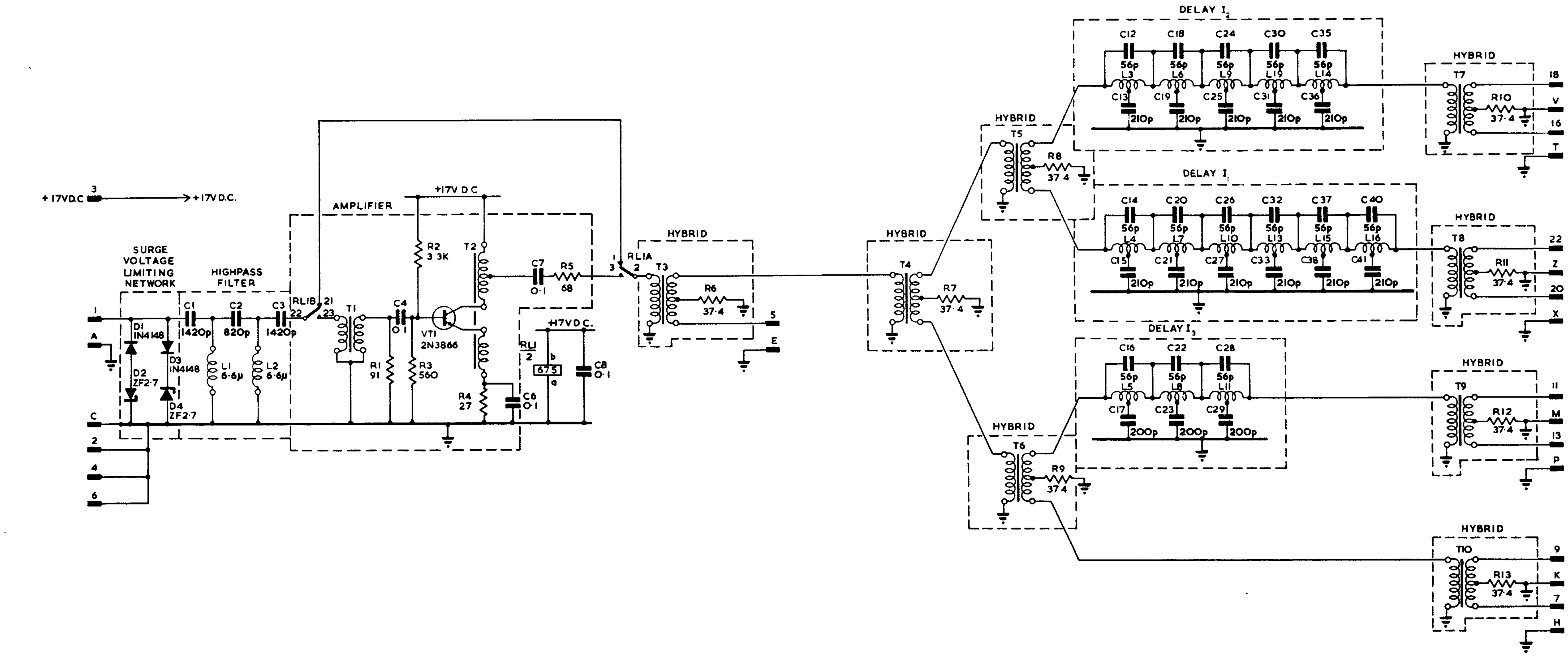
CIRCUIT DIAGRAM

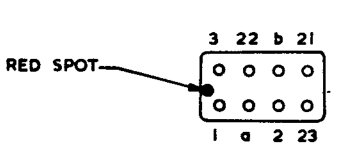


L3-L16 ARE PRINTED INDUCTORS

ANTENNA DISTRIBUTION UNIT (8 - 30 MHz) 419/1/10437
COMPONENT LAYOUT

FIG. 10



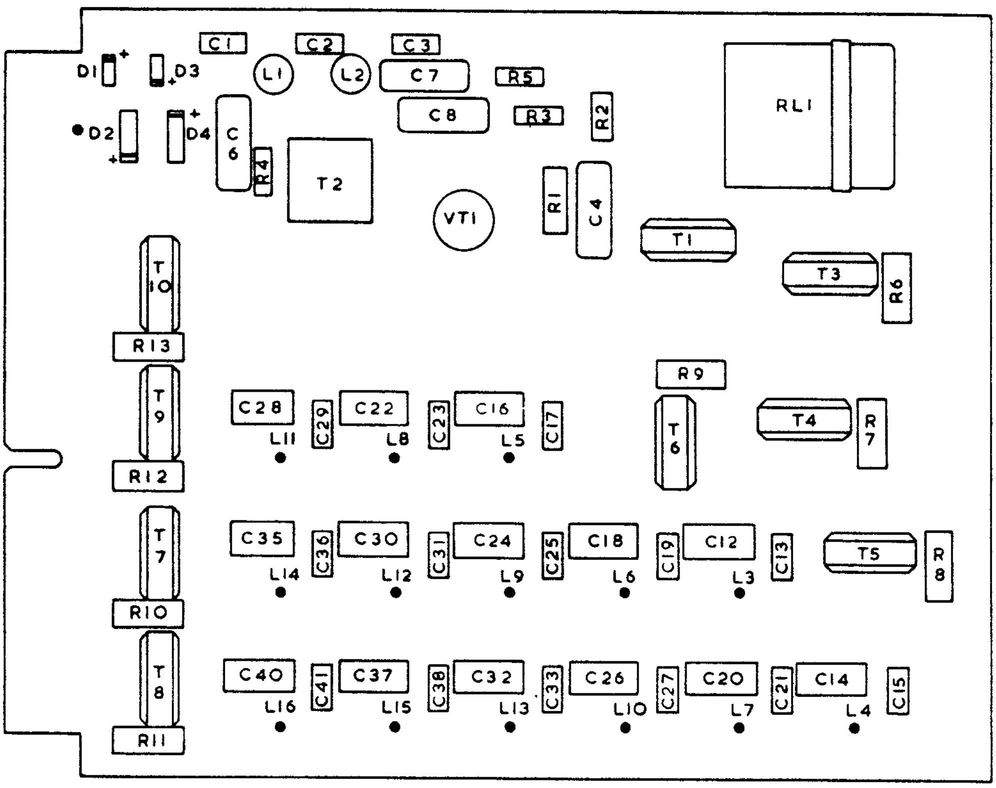


VIEW ON PINS OF RL1

NOTES:
1. PINS 8,10,12,14,15,17,19,21 & R NOT FITTED
2. REMAINING ALPHABETIC PINS NOT SHOWN ARE COMMONED TO EARTH
3. L3-L16 ARE PRINTED INDUCTORS

ANTENNA DISTRIBUTION UNIT (1·5-10 MHz) 419/DA/10441
CIRCUIT DIAGRAM

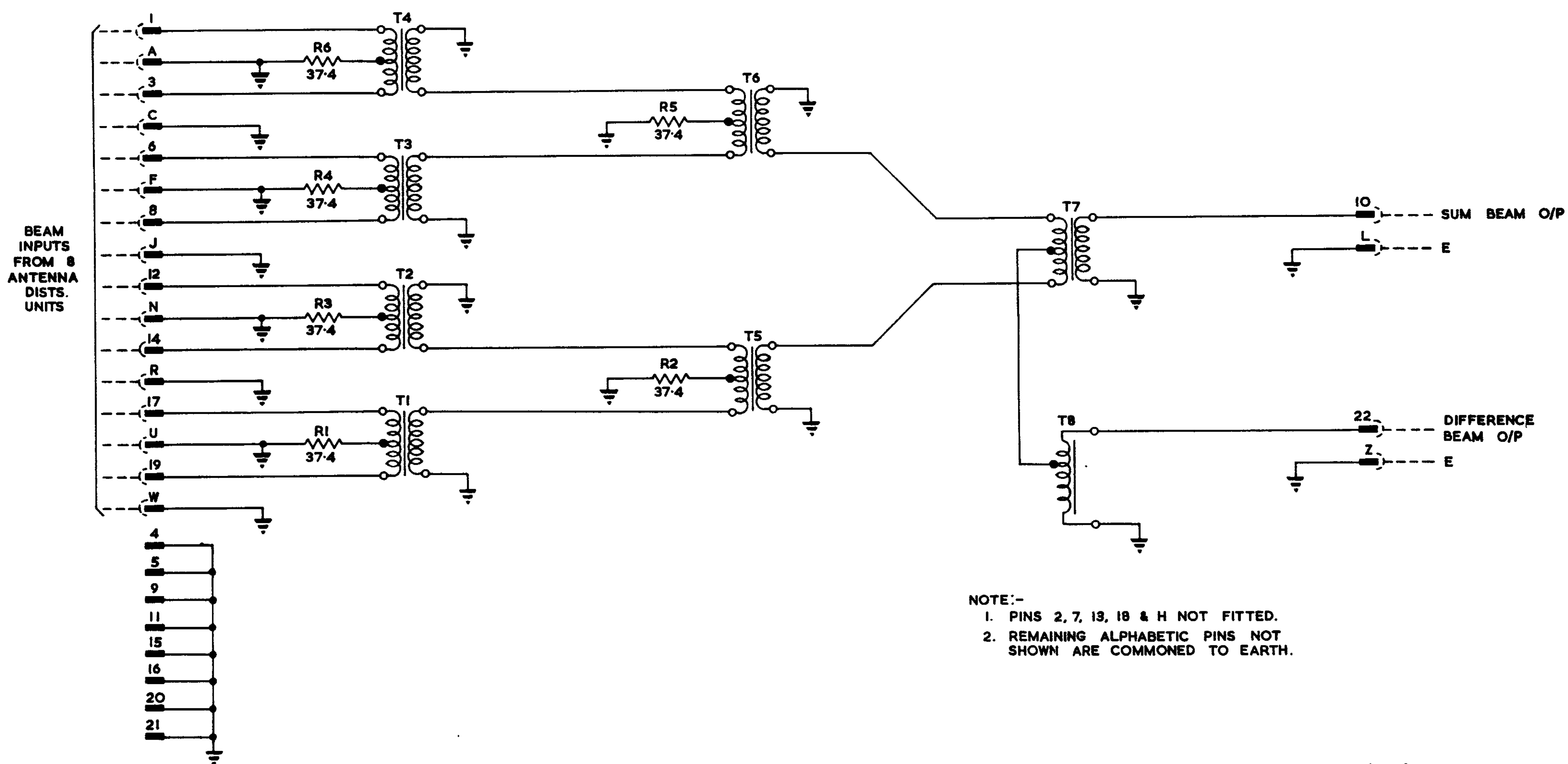
FIG. 11



L3-L16 ARE PRINTED INDUCTORS

ANTENNA DISTRIBUTION UNIT (1·5–10 MHz) 419/1/10441
COMPONENT LAYOUT

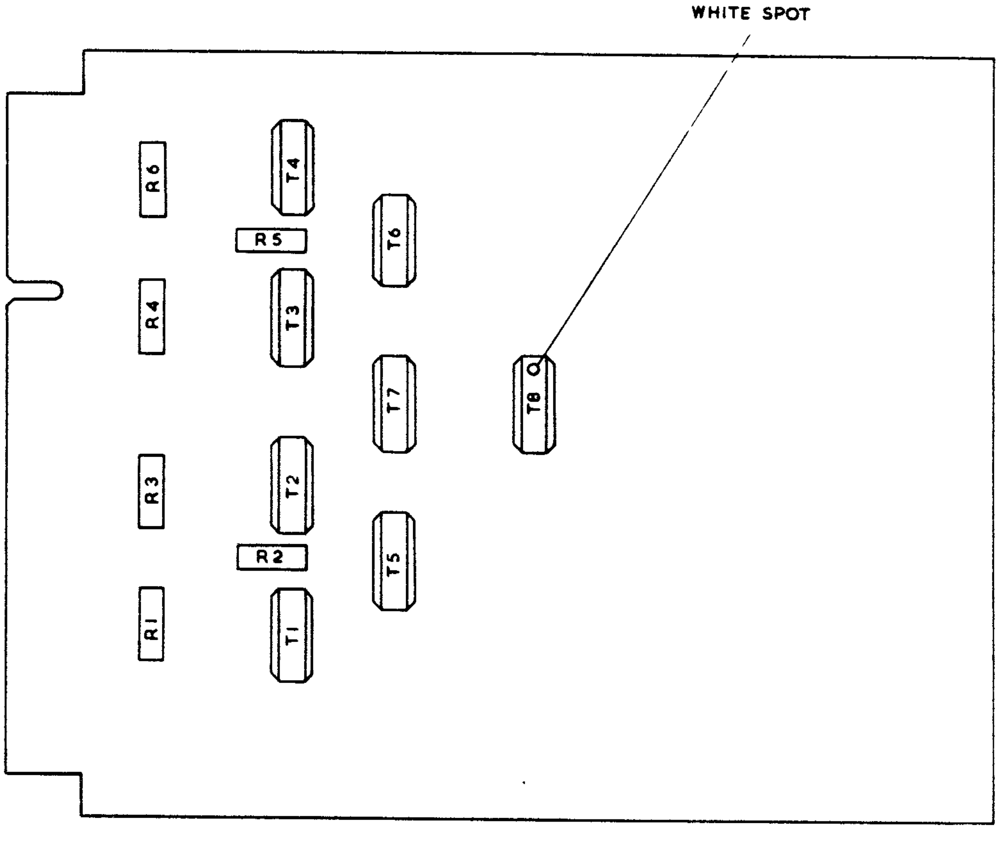
FIG. 12



NOTE:-
1. PINS 2, 7, 13, 18 & H NOT FITTED.
2. REMAINING ALPHABETIC PINS NOT SHOWN ARE COMMONED TO EARTH.

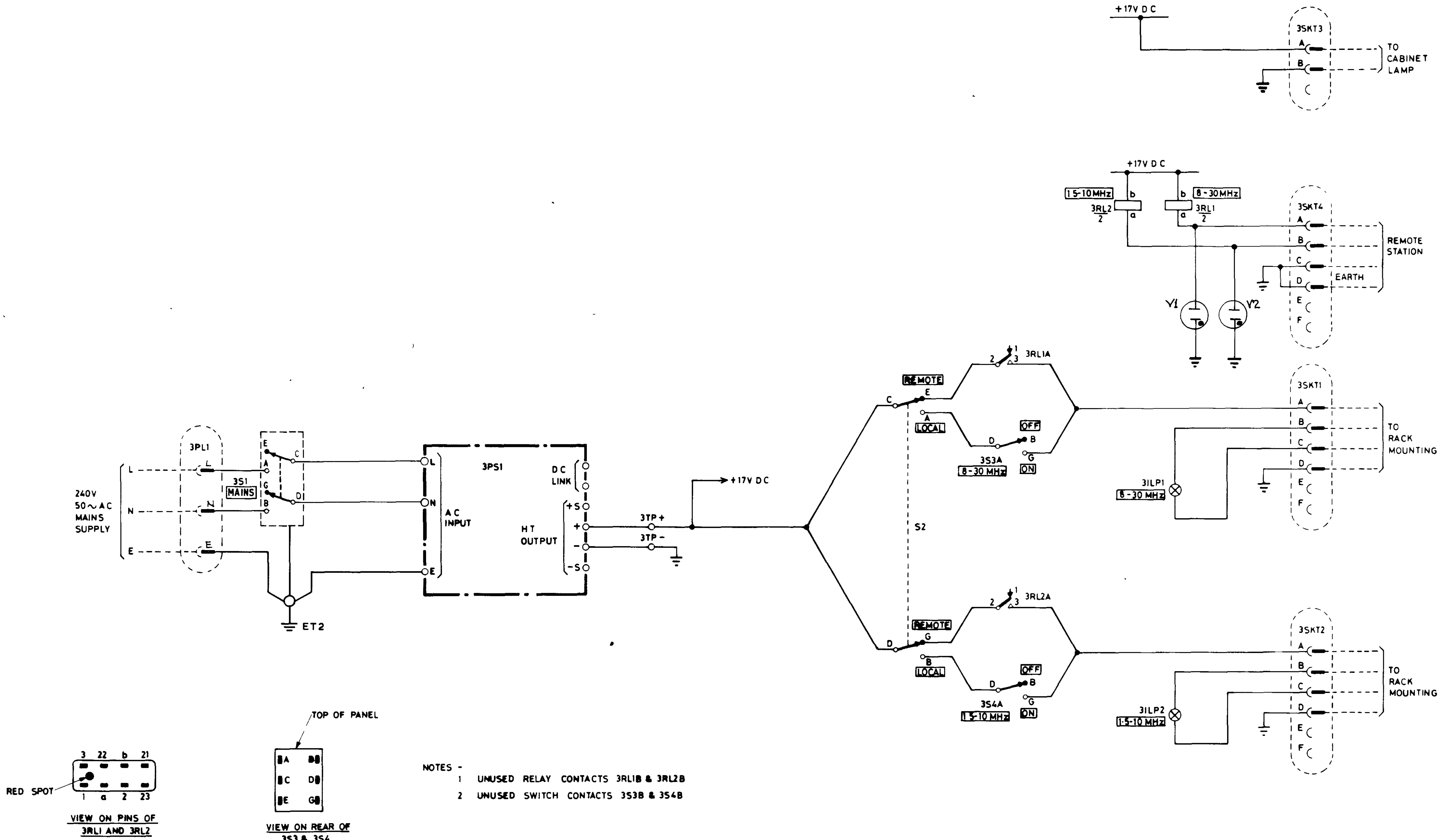
COMBINING UNIT 419/DA/10334
CIRCUIT DIAGRAM

FIG. 13



COMBINING UNIT 419/1/10334
COMPONENT LAYOUT

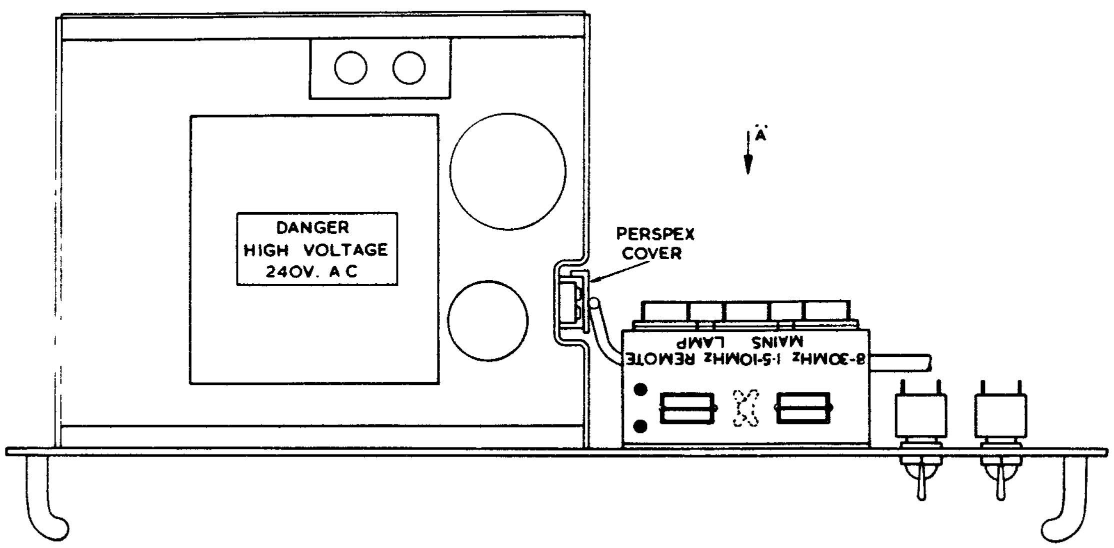
FIG. 14

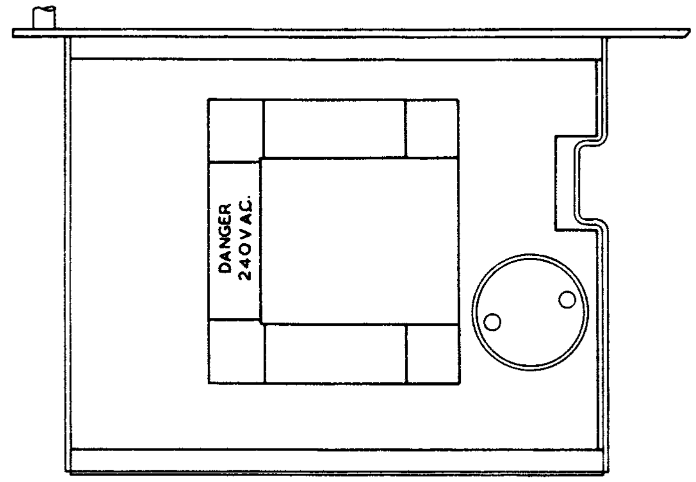


NOTES -
1 UNUSED RELAY CONTACTS 3RL1B & 3RL2B
2 UNUSED SWITCH CONTACTS 3S3B & 3S4B

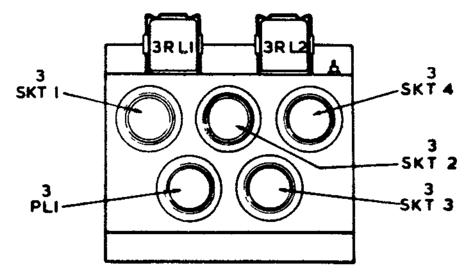
POWER UNIT (PV883) CIRCUIT DIAGRAM 686/DA/02104

FIG. 15

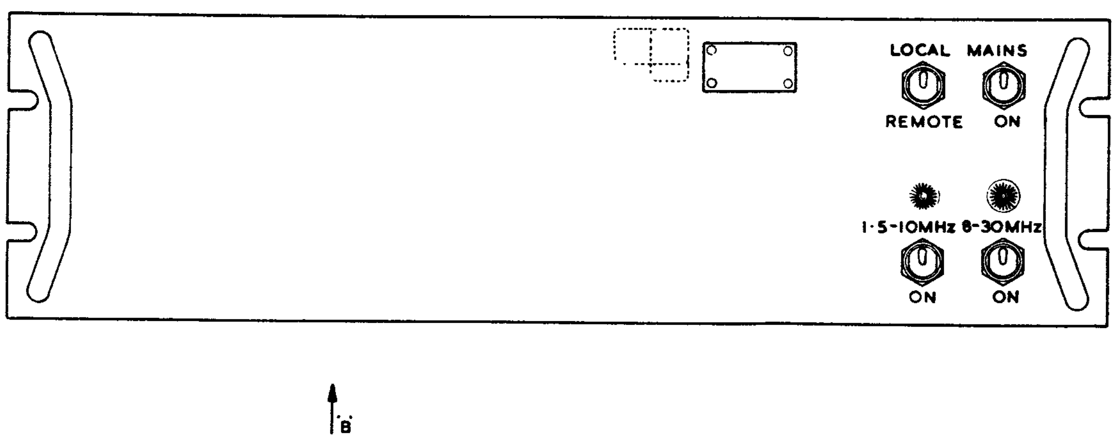


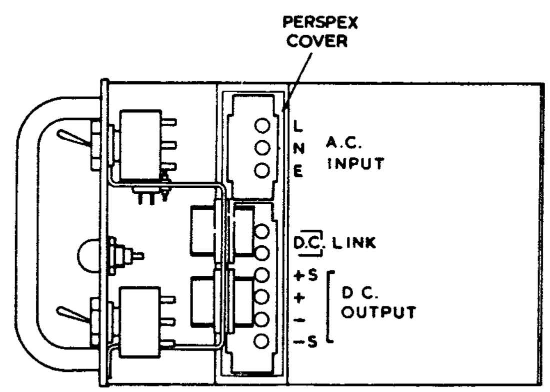


VIEW ON ARROW 'B'



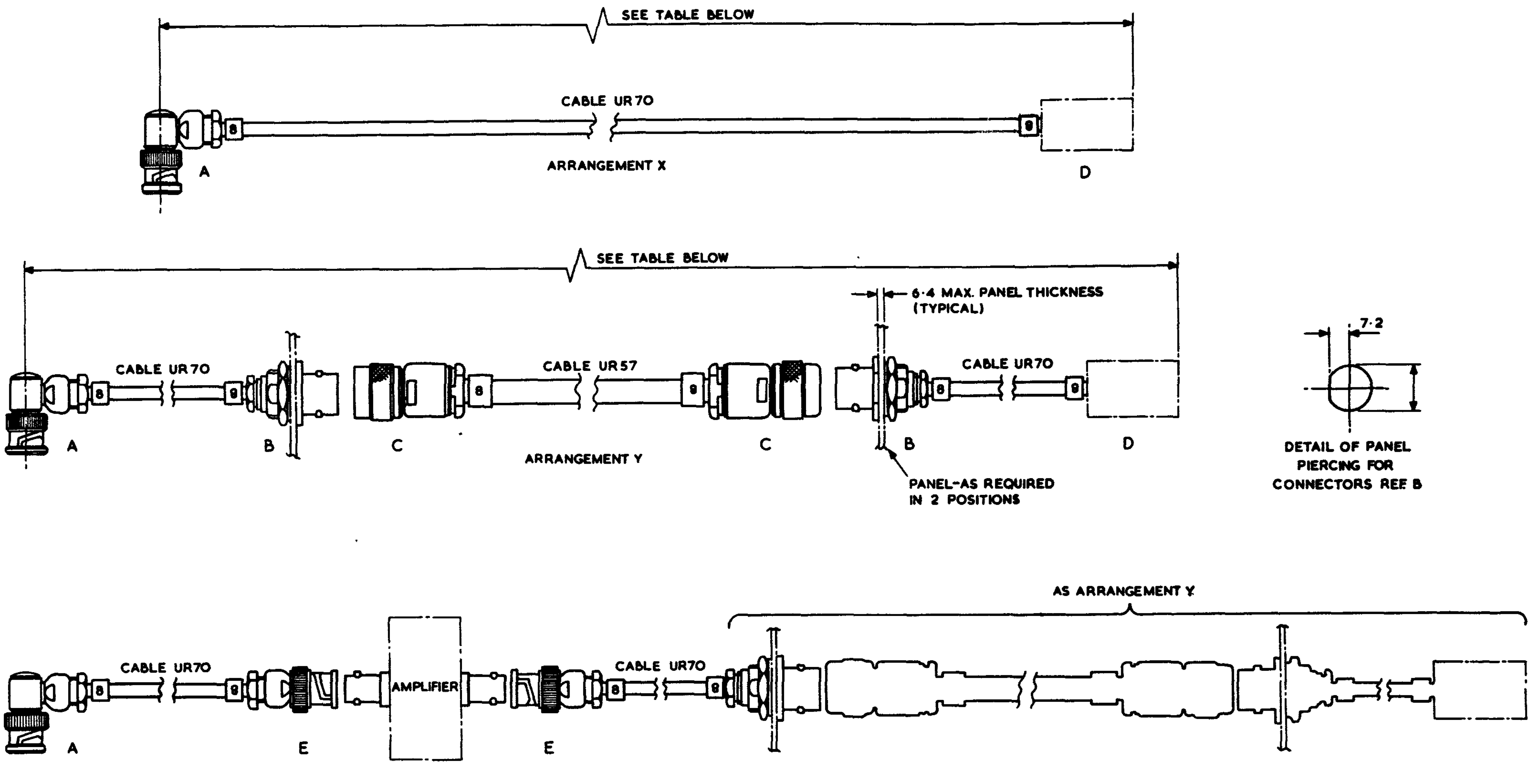
VIEW ON ARROW 'A'





POWER UNIT (PV883) 686/1/02104
COMPONENT LAYOUT

FIG. 16

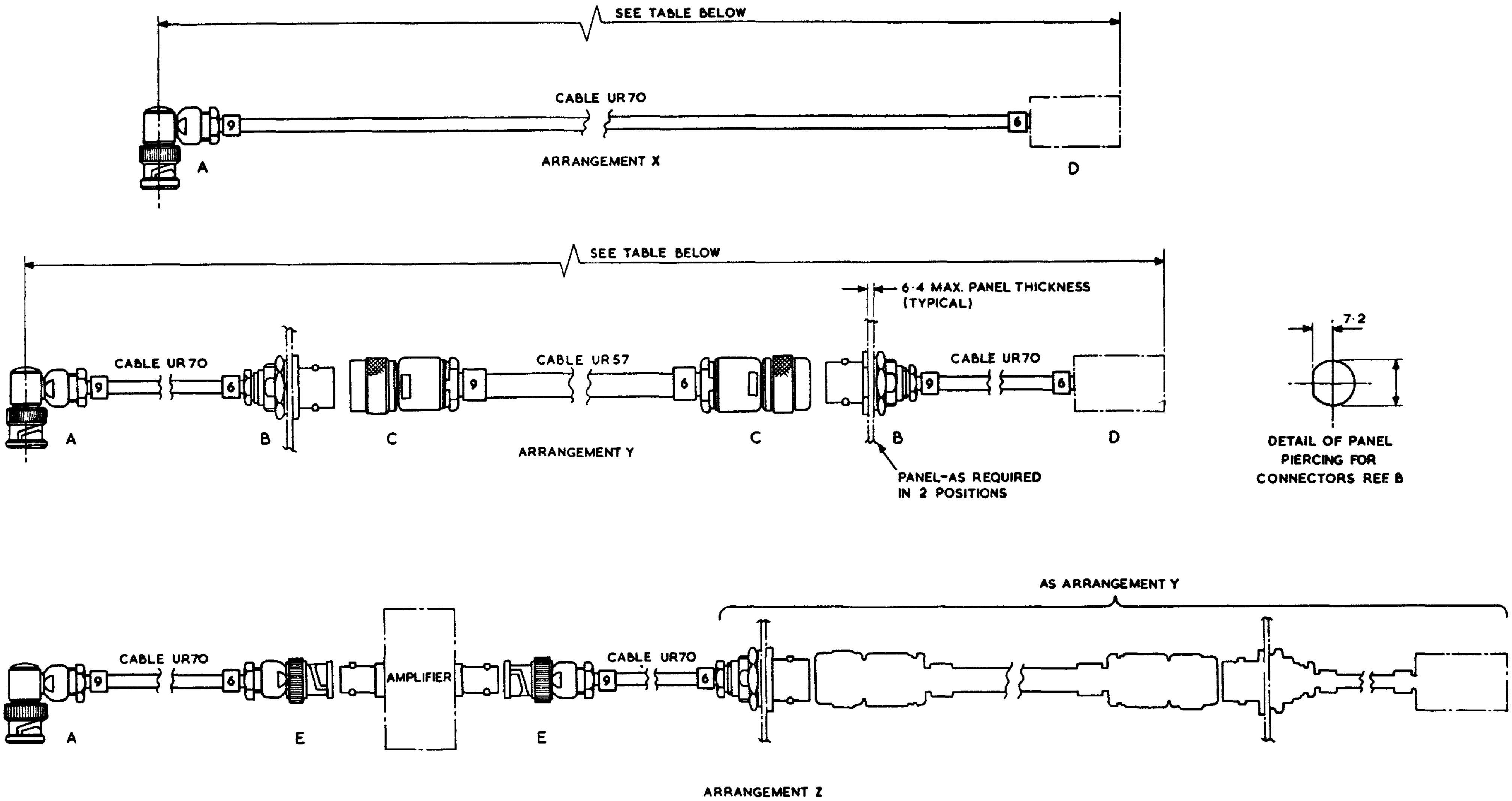


ARRANGEMENT Z

DATA TABLE		
CONNECTORS AND ACCESSORIES	REF. A	PLUG ELBOW, FREE, BNC, COAXIAL, 75 Ω 5935-99-520-0910 GREENPAR TYPE GE 37502 C12 (PLESSEY DRG. No. 508/4/28968/003) THE ABOVE IS SUPPLIED WITH THE ASSOCIATED UNIT (612/0/31738/ETC.)
	REF. B	JACK BULKHEAD, TYPE C, COAXIAL, 75 Ω GREENPAR TYPE GE 27570C12 (PLESSEY DRG. No. 511/4/98103) NOT SUPPLIED.
	REF. C	PLUG, FREE, TYPE C, COAXIAL, 75 Ω 5935-99-433-4198 GREENPAR TYPE GE 27519 C1 (PLESSEY DRG. No. 508/4/29268) NOT SUPPLIED.
	REF. D	THIS CONNECTOR IS NOT SUPPLIED, BUT MUST SUIT CUSTOMERS SITE REQUIREMENT.
	REF. E	PLUG, FREE, BNC, COAXIAL, 75 Ω 5935-99-954-4765 GREENPAR TYPE GE 37570 C12 (PLESSEY DRG No. 508/4/28579) NOT SUPPLIED.
CABLE	TYPE	UR 70 IF LOSS < 6 dB. SEE ARRANGEMENT X
		UR57 & UR70 IF LOSS > 6dB SEE ARRANGEMENT Y
	LENGTH.	TO SUIT INDIVIDUAL INSTALLATION (CONSULT DESIGN OR INSTALLATION AUTHORITY)
	ELECT. DATA	LOSS NOT TO EXCEED 6dB USE AMPLIFIERS IF REQUIRED – SEE ARRANGEMENT Z
IDENTIFICATION SLEEVES		HELLERMANN 'HELVIN' P SERIES, WHITE SLEEVES OF THE APPROPRIATE SIZE PRINTED WITH BLACK NUMERALS AS SHOWN TO BE FITTED SO THAT NUMBER 8 IS READABLE FROM CONNECTOR ENDS.

CABLE ASSEMBLY 8

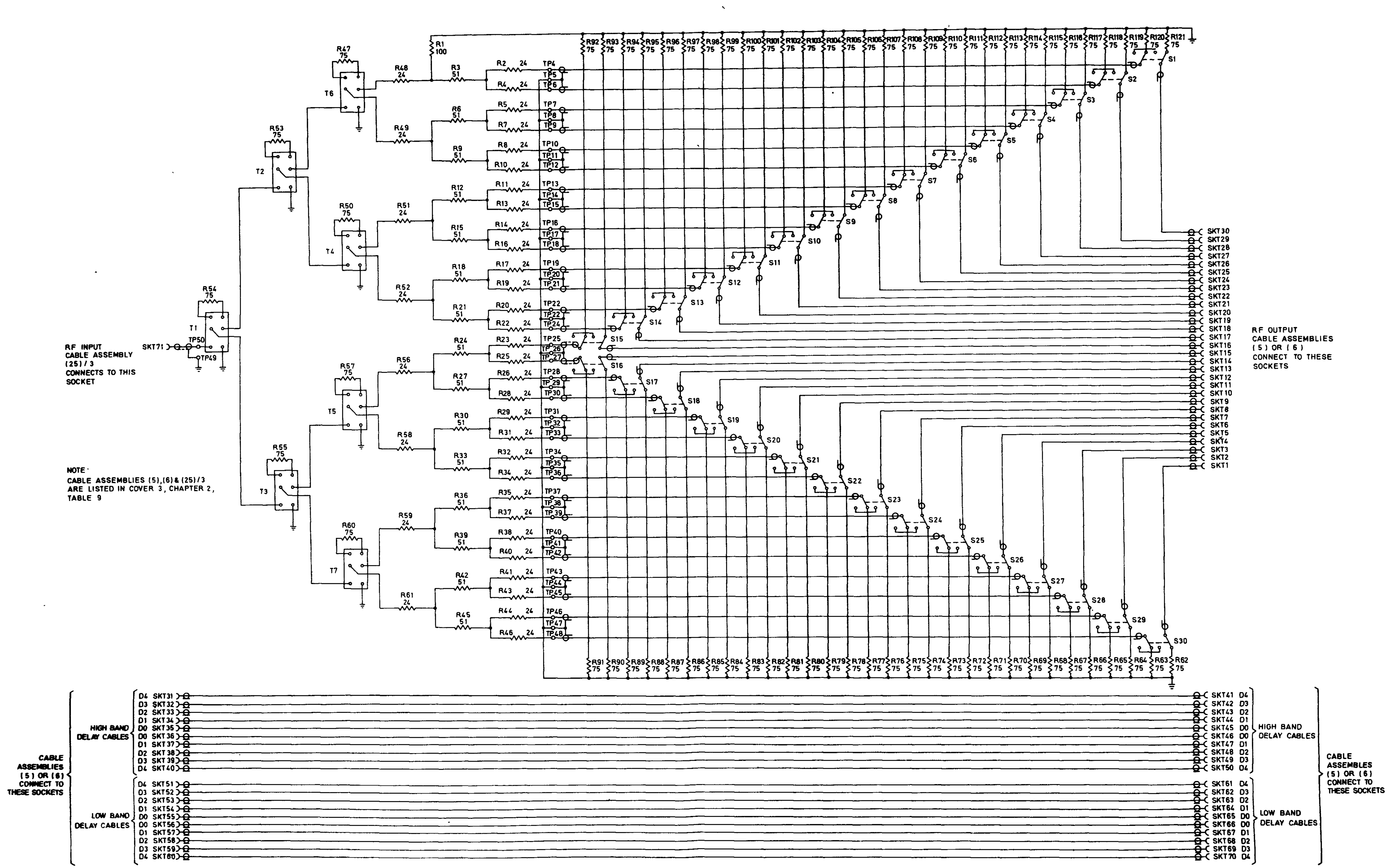
FIG. 17



DATA TABLE		
CONNECTORS AND ACCESSORIES	REF. A	PLUG ELBOW, FREE, BNC, COAXIAL, 75 Ω 5935-99-520-0910 GREENPAR TYPE GE 37502 C12 (PLESSEY DRG. No. 508/4/28968/003) THE ABOVE IS SUPPLIED WITH THE ASSOCIATED UNIT (612/0/31738/ETC.)
	REF. B	JACK BULKHEAD, TYPE C, COAXIAL, 75 Ω GREENPAR TYPE GE 27570C12 (PLESSEY DRG. No. 511/4/98103) NOT SUPPLIED.
	REF. C	PLUG, FREE, TYPE C, COAXIAL, 75 Ω 5935-99-433-4198 GREENPAR TYPE GE 27519C1 (PLESSEY DRG. No. 508/4/29268) NOT SUPPLIED.
	REF. D	THIS CONNECTOR IS NOT SUPPLIED, BUT MUST SUIT CUSTOMERS SITE REQUIREMENT.
	REF. E	PLUG, FREE, BNC, COAXIAL, 75 Ω 5935-99-954-4765 GREENPAR TYPE GE 37570 C12 (PLESSEY DRG No. 508/4/28579) NOT SUPPLIED.
CABLE	TYPE	UR 70 IF LOSS < 6 dB SEE ARRANGEMENT X
		UR57 & UR70 IF LOSS > 6dB SEE ARRANGEMENT Y
	LENGTH.	TO SUIT INDIVIDUAL INSTALLATION (CONSULT DESIGN OR INSTALLATION AUTHORITY)
	ELECT. DATA	LOSS NOT TO EXCEED 6dB USE AMPLIFIERS IF REQUIRED – SEE ARRANGEMENT Z
IDENTIFICATION SLEEVES		HELLERMANN 'HELVIN' P SERIES, WHITE SLEEVES OF THE APPROPRIATE SIZE PRINTED WITH BLACK NUMERALS AS SHOWN TO BE FITTED SO THAT NUMBER 9 IS READABLE FROM CONNECTOR ENDS.

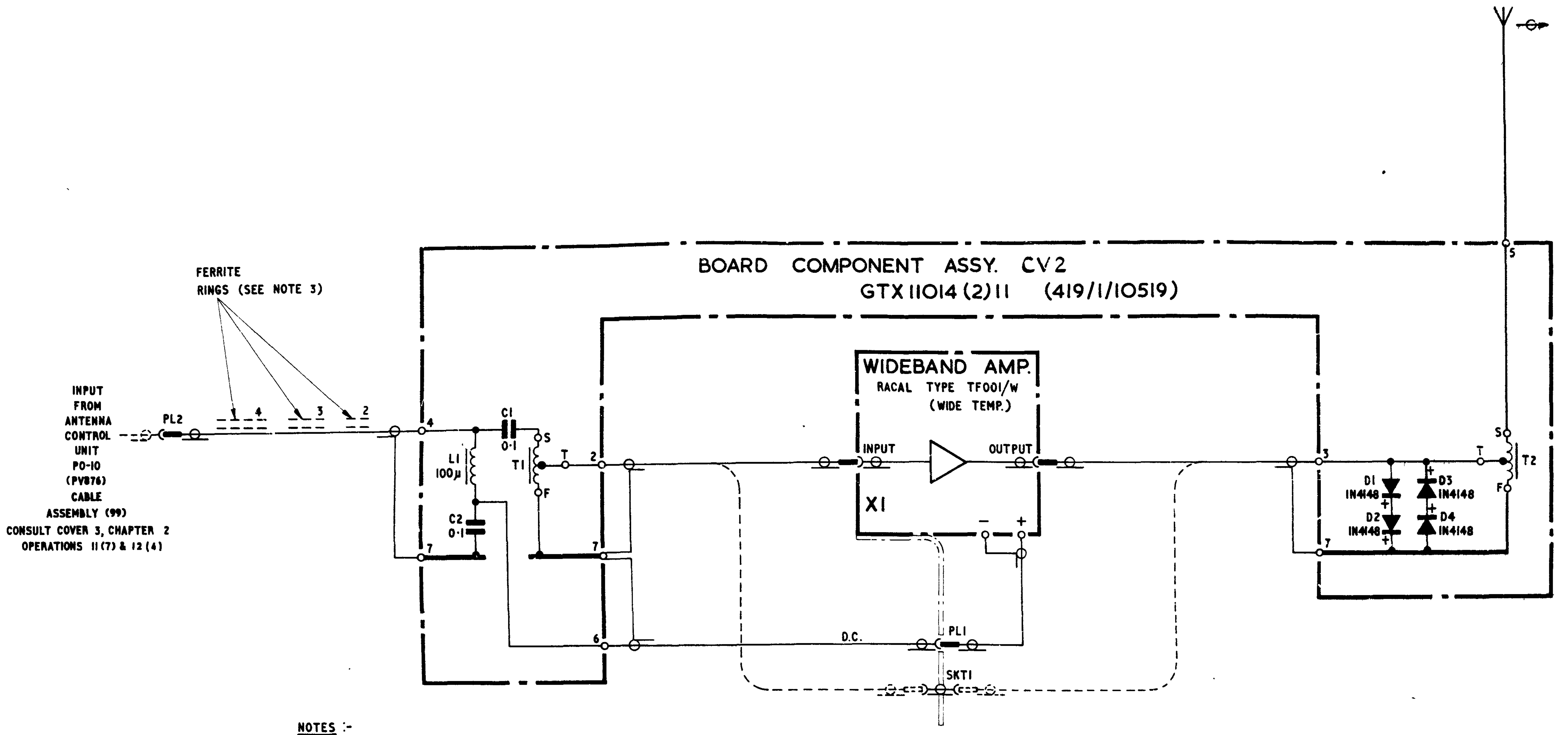
CABLE ASSEMBLY 9

FIG. 18



TEST UNIT TU-36 (PV865) GTX11015(0)2(612/DA/31715) – CIRCUIT DIAGRAM

FIG.19

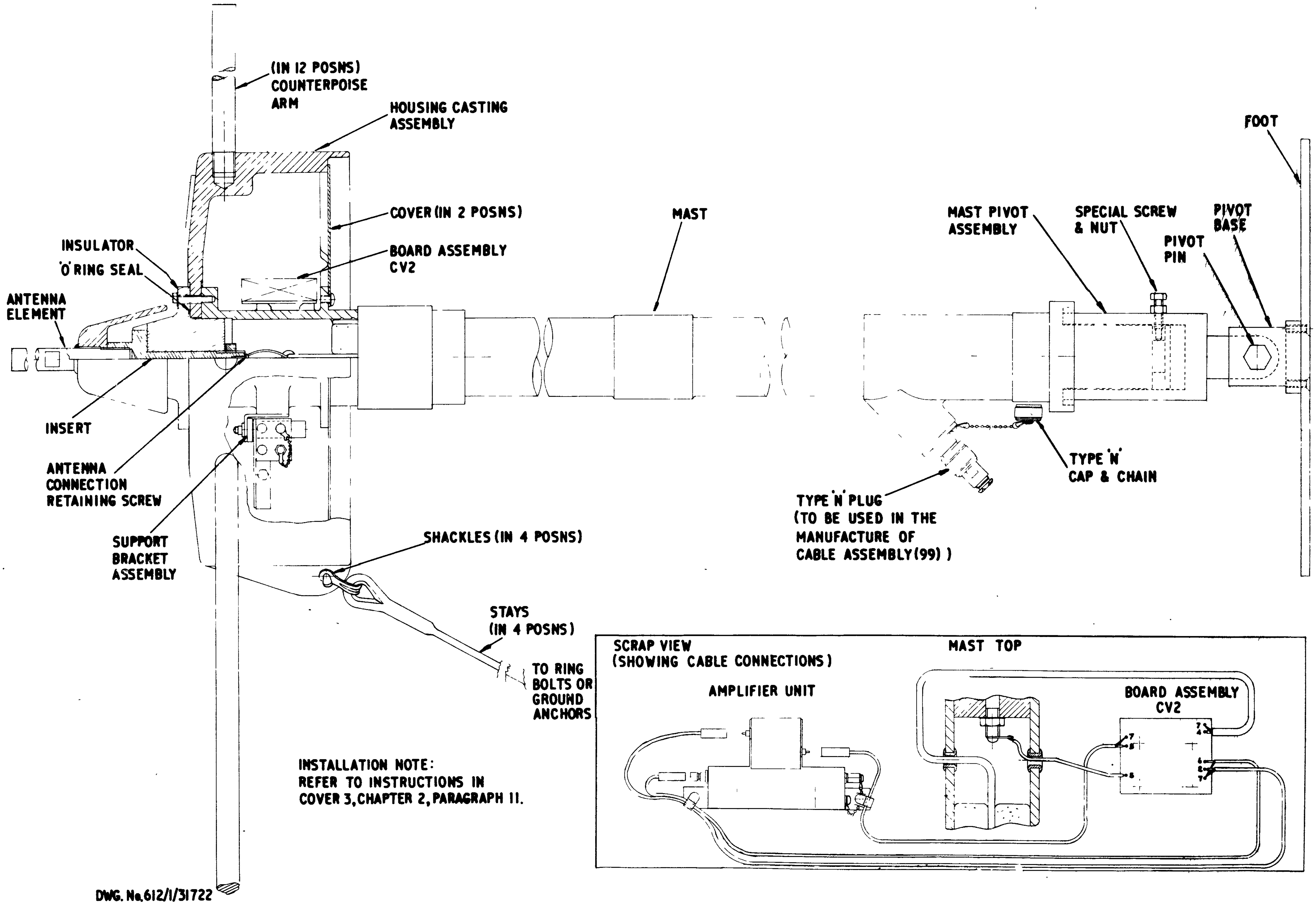


NOTES :-

1. COAXIAL LEADS TO WIDEBAND AMP. (INPUT & OUTPUT) MAY ALSO BE CONNECTED TO FEED THRO' CONNECTOR SKT1 THUS BY-PASSING THE AMPLIFIER.
2. TRANSFORMERS T1 & T2 HAVE FERRITE CORES
3. THE NUMERALS SHOWN AGAINST THE FERRITE RINGS ON INPUT LEAD DENOTE THE NUMBER OF RINGS IN EACH GROUP.

CIRCUIT DIAGRAM

ANTENNA ASSEMBLY (TEST MONOPOLE) PA-48 (PV869) GTX11014(2)2 (612/DA/31722) FIG. 20



ANTENNA ASSEMBLY (TEST MONOPOLE) PA-48 (PV869) FIG. 21

APPENDIX 1

DOUBLET ANTENNA SYSTEMS

CONTENTS LIST

TABLES

ILLUSTRATIONS

APPENDIX 1

DOUBLET ANTENNA SYSTEMS

INTRODUCTION

1. The performance of the PVS1120 Multiple-beam High-frequency Receiving Antenna System and the associated PVS860 Direction-finding System may be improved by replacing either the Low-band, the High-band, or both antenna arrays by the use of end-fire doublet antennas in place of the standard omni-directional monopoles.

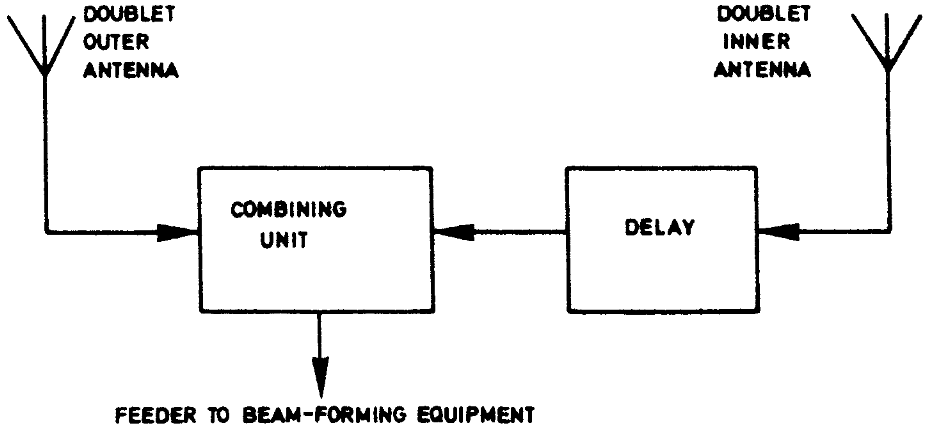
2. Each doublet antenna consists of a pair of interconnected monopole antennas. This combination has a directional pattern which provides optimum reception from incident signals travelling from the doublet antenna to the array centre; sensitivity to signals received from the opposite direction is reduced. The doublet system as a whole, therefore, gives improved reception due to the lower response to signals received from directions other than the beam-pointing direction, i.e. reduced side-lobe levels. When used in conjunction with the PVS860 Direction-finding Equipment, the same benefits accrue, but with the additional advantage of a greatly improved DF display due to the reduction of side-lobe levels.

3. Each doublet antenna pair replaces one monopole in the standard array. The pair of antennas is deployed radially, and functions as an end-fire sub-array. The two antennas are located 11m (12 yds) apart in the case of the Low-band array, and 3.67m (4 yds) apart in the case of the High-band array.

4. Both of the two antennas in each doublet sub-array receive an incident signal at equal strength, but with phase differences existing between the signal vectors at each antenna depending on the direction of arrival of the incident wavefront. Figure (a) shows the essentials of the doublet sub-array and also shows a typical doublet horizontal response pattern: the 0° point is defined as the bearing of a signal arriving from a direction in line with the doublet, the outer antenna being nearer to the signal source. The radial spacing of the antennas taken in conjunction with the delay incorporated between the doublet inner antenna and the combining unit produces a zero signal response to signals arriving from azimuthal directions $\pm 140^\circ$ relative to the 0° line. The response is also small for signals received from directions of up to $\pm 180^\circ$. The required delay (27 nanosecond Low-band, 9 nanosecond High-band) is obtained by making the cable from the inner antenna to the combining unit greater in electrical length than the cable to the outer antenna. Cables of the correct electrical length are supplied.

5. The combining unit consists of a hybrid transformer which accepts the antenna signals at its side ports. The output from the combining unit is taken from the hybrid transformer difference port, and is a combination of the signals from the two antennas. The signal from the inner antenna undergoes a phase-reversal in the hybrid transformer.

6. The phase differences existing between the outputs from the 24 doublet combining units are preserved by employing feeder cables matched in electrical length to carry the signals to the beam-forming equipment. In addition, the electrical lengths of these cables are tailored with respect to those of the other array in order that destructive interference between the beams does not occur in the PV133K filters at the 9.7 MHz high-band/low-band cross-over point.



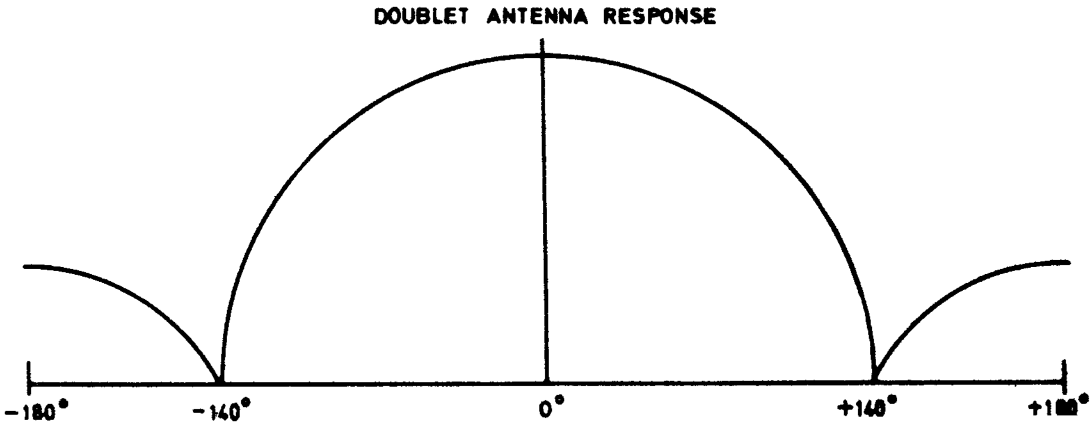


Fig.(a) Doublet response pattern

MECHANICAL DESCRIPTION

7. Each doublet antenna pair consists of two monopole antenna assemblies which are identical with the assemblies used in the standard PVS1120 array. The two antennas of a Low-band pair are placed 11m (12 yds) apart: the two antennas of a High-band pair are placed 3.67m (4 yds) apart. Between the two antennas a U-section metal stake is driven into the ground: this stake carries the Combining Unit, which houses a hybrid transformer. One feeder cable runs from each of the two antennas to the Combining Unit, the cable from the inner antenna being the longer of the two. The feeder cable to the building at the array centre runs from the Combining Unit to the centre of the array.

8. Because of the positioning of the antennas, more than six guys are secured to some ground anchors. In the case of the Low Band array, where each antenna is guyed from three points along its length, some ground anchors carry twelve guys. These ground anchors are fitted with Anchor Plates which, when bolted to the ground anchors, provide a steel plate with a number of shackle holes in the upper edge to which the guys are attached.

9. It should be noted that after the arrays are erected it is not possible to drive a vehicle wider or higher than 1.67m (5 ft 6 ins) to the centre of the site without disconnecting guys to let it pass. It is therefore recommended that the building and its contents be in place before the antennas on either side of the vehicular access road to the building are erected.

INSTALLATION

Marking Out the Antenna Site (Figs.1 and 2)

10. The methods employed to mark out the site are the same as those used to mark out a standard PVS1120 array site except that a large number of stakes must be positioned. A monopole 'ring' calls for one circle of 24 stakes, while a doublet 'ring' calls for three circles of stakes. To mark out a doublet site, therefore, follow the instructions given in paragraphs 7 to 22 of Chapter 2, driving in additional stakes in the positions defined in Table 1. When using Method 2 (paragraphs 17 to 21 of Chapter 2), refer to Figure 2 of this appendix in place of Figure 4 of Chapter 6.

TABLE 1 DOUBLET STAKE POSITIONS

LOW-BAND ARRAY

ITEM	RADIUS	CHORD
OUTER ANTENNA	75m (245' 3")	19.58m (64' 3")
COMBINER UNIT	72.2m (236')	Not critical
INNER ANTENNA	64m (209' 3")	16.7m (54' 7")

HIGH-BAND ARRAY

ITEM	RADIUS	CHORD
OUTER ANTENNA	25m (81' 9")	6.53m (21' 4")
COMBINER UNIT	24.08m (78' 9")	Not critical
INNER ANTENNA	21.33m (69' 9")	5.57m (18' 3")

Antenna Assembly and Erection

11. Antenna assembly is identical with that for the standard PVS1120 array, and therefore the instructions given in paragraphs 23 to 26 (High-band) and in paragraphs 43 to 46 (Low-band) are applicable. After assembling the antennas, the following erection instructions should be used.

Preparation for antenna erection

12. Before erecting the antennas, it is recommended that all ground anchors are secured in position. The ground anchors, which resemble single-turn corkscrews, are sited on a pitch circle radius 10.68m (34 ft 11 ins) for the Low-band array and on a pitch circle radius of 3.56m (11 ft 8 ins) for the High-band array. In the outer antenna circle of both doublet arrays (75m or 25m radius) one ground anchor is positioned radially outward from each antenna. In the inner antenna circle of both doublet arrays (64m or 21.33m radius) one ground anchor is positioned radially inward from each antenna. Two further ground anchors are placed on the intercept points of the two pitch circles; these anchors are each common to four antennas, and have twelve guys secured to them in the Low-band array and four in the High-band array.

13. The anchors are screwed vertically into the ground as described in paragraph 29 of Chapter 2. The plane of the eye of the anchor shall be situated on a line joining the two antennas of a doublet pair except in the case of the anchors common to four antennas; here, the plane of the eyes shall be at 90° to the array circle radius.

14. The anchors common to four Low-band antennas each carry two Anchor Plates 630/2/34477. Place two M8 x 55 mm bolts in the central holes of an Anchor Plate, and pass both through the anchor eye. The ears of the Anchor Plate face away from the anchor eye, with the shackle holes on the upper edge. Fit an Anchor Plate Spacer 630/2/34478 over each bolt, and offer up a second Anchor Plate. Secure with a plain washer, a spring washer, and a nut on each bolt so as to clamp the anchor eye between the two Anchor Plates.

Antenna erection

15. The instructions given in paragraphs 31 to 38 (High-band) and paragraphs 51 to 61 (Low-band) of Chapter 2 are applicable, with the addition of a recommendation in respect of sites using counterpoises. If such a site is not on rock, the feeders will be run in trenches. This should be done before the counterpoises are fitted in order that the counterpoise wires may pass over the feeders. At a rock site (where the feeders will be run on the surface) the counterpoises should be fitted before the feeders. If it is necessary to run the feeder cables on the surface, it is recommended that they are protected by telephone cable tiles.

Doublet combining units

16. Each Doublet Combining Unit assembly comprises a U-section steel stake, a Combining Unit, and a cover. The Combining Unit assemblies are situated on the 72.2m (Low-band) or 24.08m (High-band) radius marker stake positions, one between each radial pair of antennas.

17. Drive a Combining Unit stake into the ground at each marker stake position on the appropriate circle or circles. If the ground is hard, the top of the stake should be protected from hammer blows by a block of hardwood to prevent distortion or severe burring of the edges. The base of the U-section shall be radial to the array circle, and facing in the direction shown in Figure 1. The stakes shall be driven into the ground until 490 mm (19 ins) projects above the surface.

18. If the ground is either rock or soft sand, then the method of driving in a stake described in paragraph 17 will be unusable. In rock, the stake is best concreted into a hole dug at the appropriate spot: in soft sand, the stake is best set into the centre of a large enough volume of concrete to hold firm by virtue of its weight.

19. If the site is hard rock, it may be decided to lay the feeder cables on the surface, if so, disregard this paragraph. Dig trenches for the feeder cables as defined in Figure 1 of this Appendix, and lay a layer of sand about 25 mm (1 in) deep at the bottom of the trenches to form a bed for the cables.

20. Fit a Combining Unit 630/1/34355 to each stake. Fit a spacer 991/4/10600/005 to each stud and then offer up the Combining Unit into the channel of the stake, with the connectors facing downwards so that the two M4 studs pass through the two M4 clearance holes in the stake. Secure the Combining Unit to the stake with two M4 nuts and plain washers.

WARNING: NEVER HAMMER A STAKE WHICH HAS A COMBINING UNIT FITTED IN PLACE.

21. Loosen the four captive screws on each stake, and slide a cover in place, closed end uppermost. Tighten the captive screws to secure the covers.

Feeders

22. All feeders are received on site bearing a code identification of their function. Codes preceded by 'D' indicate cables which are special to doublet arrays. Function codes are:

D1 : Low-band main feeders
D2 : High-band main feeders
D3 : Low-band doublet inner antenna to combining unit feeders
D4 : Low-band doublet outer antenna to combining unit feeders
D5 : High-band doublet inner antenna to combining unit feeders
D6 : High-band doublet outer antenna to combining unit feeders

Each feeder is to be further coded by two digits relating it to a particular antenna, and by a third digit defining its frequency band. Antenna coding is 01 to 24. Frequency coding is 0 for Low-band and 9 for High-band. The High-band main feeder for antenna No 13, therefore, will be coded 2139. The further coding is to be applied to all feeders by means of the supplied cable-marker clips. The system can be seen in Figure 1 of this Appendix.

23. Refer to paragraph 15 if counterpoises are to be installed. Otherwise, proceed to install the feeders as described in the following paragraphs.

24. Connect an appropriate feeder cable to each doublet antenna, and secure it in three positions with a cable-binder 915/4/98727 and a clip 915/4/98774/003: use the tool provided. Alternately, secure the feeder with cable-ties 915/4/98775/006. Disconnect the feeder cable and fit tube 686/2/02275 over the cable. Reconnect the cable and slide the tube over the Antenna Transformer Assembly housing: snap cap 686/2/02276 into position. Each feeder cable is then laid in the appropriate trench and connected to the Combiner Unit (Short, SK2: Long, SK1). The cables should be covered with sand before filling in the trenches. Do not pull the cables hard for any reason, as their exact electrical length can be changed by stretching. On a rock site, protect the cables as suggested in paragraph 15.

25. The main feeder cables are fitted with Type C plugs at each end: the straight connector is fitted to the Combining Unit. Connect a feeder cable to each Combining Unit centre socket. Each feeder cable is then laid in as straight a line as possible to the centre of the array, and passed into the building. Surplus cable must not be removed, but shall be coiled as convenient near the hut.

Counterpoises

26. The instructions given in paragraphs 36 to 38 and in paragraphs 59 to 61 of Chapter 2 are applicable.

MAINTENANCE AND COMMISSIONING PROCEDURES

27. The maintenance and commissioning procedures laid down in Chapter 4 are applicable with the exception of the 'Feeder Continuity and Isolation tests'

and the 'Comparison of Antenna Feeder lengths' (paragraphs 30 to 37 in Chapter 4).

28. To check antenna feeder continuity and isolation, carry out the following procedure:

(1) Using a multimeter, check that the d.c. resistance reading across the inner and outer conductors of every feeder and combining cable is at least 10 Mohms when the cable under test is disconnected at both ends.

(2) Check that the d.c. resistance between inner and outer of each feeder cable in the Low-band array is 2.5 ohms when measured at the building end (connected at the remote end). Check that the d.c. resistance between inner and outer of each feeder cable in the High-band array is 1 ohm when measured at the building end (connected at the remote end). These readings are taken via the output winding of the Combining Unit hybrid transformer.

(3) Check that the d.c. resistance between inner and outer of each Combining Unit to Antenna cable is not greater than 0.5 ohms when measured at the end disconnected from the Combining Unit. This reading is made via the secondary winding of the Antenna Transformer.

29. When making comparisons of Antenna Feeder lengths, first carry out the tests laid down in paragraphs 34 to 36 of Chapter 4, disconnecting the feeder from the Combining Unit, and not from an antenna. Use the following figures in place of those specified in paragraph 35 of Chapter 4:

Average Frequency, 3.83 MHz ± 38 kHz
Maximum Spread, ± 11.5 kHz.

Next, carry out the following steps, which check the combining cables.

(1) At No 1 Low-band doublet, disconnect the inner (long) combining cable and the feeder from the Antenna Combining Unit. Join the two ends with a Type C female-female adaptor.

(2) Disconnect the combining cable from the inner antenna Antenna Transformer Assembly, leaving it open-circuit.

(3) At the Beam-forming Hut, disconnect antenna feeder No 1 and connect the test equipment listed in para.34, Chapter 4 in accordance with Figure (e) in Chapter 4.

(4) Carry out the operations detailed in paragraph 35 on all 24 feeders in turn. Set the frequency to 3 MHz. The mean average frequency shall be 3.34 MHz ± 31 kHz, and the maximum spread shall not exceed ± 8.8 kHz.

(5) Reconnect the inner (long) combining cables to the Antenna Combining Units and to the Antenna Transformer Assemblies.

(6) At No 1 Low-band doublet, disconnect the outer (short) combining cable from the Antenna Combining Unit, and connect it to the feeder with a Type C female-female adaptor.

(7) Disconnect the combining cable from the outer Antenna Transformer Assembly, leaving it open-circuit.

(8) Carry out the operations detailed in paragraph 35 on all 24 feeders in turn. Set the frequency to 3 MHz. The mean average frequency shall be 3.52 MHz ± 35 kHz, and the maximum spread shall not exceed ± 9.8 kHz.

(9) Repeat the complete procedure on the High-band doublet array, using the following figures:

Paras.34 to 36 of Chap.4: as defined in Para.37 of Chap.4

Step 4 : Frequency 3.5 MHz
Mean average frequency 3.67 MHz ± 33 kHz
Maximum spread ± 8.4 kHz

Step 8 : Frequency 3.5 MHz
Mean average frequency 3.84 MHz ± 36 kHz
Maximum spread ± 9.4 kHz

COMPONENTS LISTS

29. The following Component Lists cover the additional items which make up High-band and Low-band antenna arrays.

30. Doublet, Antenna Assembly Kit, Low-band, 630/1/34350/002

Description	Manufacturer Ref.	Plessey Part No.	No.off
Antenna Assembly	-	686/1/02105	24
Antenna Assembly	-	686/1/02105/001	24
Antenna (Counterpoise) Kit	-	686/1/02251	48
Cover	-	630/2/34352	24
Combining Unit Assembly	-	630/1/34351/002	24
Ground Stake Assembly	-	630/1/34357	24
Combining Cable	-	702/1/20094/001	24
Combining Cable	-	702/1/20094/002	24
Cable, Antenna Feeder	-	686/1/02186/004	24
Anchor Plate	-	630/2/34477	48
Anchor Spacer	-	630/2/34478	48
Cable Marker-PVC White, Critchley Type 661-13-C-0	-	915/4/98749/001	210
Cable Marker-PVC White, Critchley Type 661-13-C-1	-	915/4/98749/002	78
Cable Marker-PVC White, Critchley Type 661-13-C-2	-	915/4/98749/003	48
Cable Marker-PVC White, Critchley Type 661-13-C-3	-	915/4/98749/004	8
Cable Marker-PVC White, Critchley Type 661-13-C-4	-	915/4/98749/005	8
Cable Marker-PVC White, Critchley Type 661-13-C-5	-	915/4/98749/006	12
Cable Marker-PVC White, Critchley Type 661-13-C-6	-	915/4/98749/007	12
Cable Marker-PVC White, Critchley Type 661-13-C-7	-	915/4/98749/008	12
Cable Marker-PVC White, Critchley Type 661-13-C-7	-	915/4/98749/009	12
Cable Marker-PVC White, Critchley Type 661-13-C-7	-	915/4/98749/010	12
Bolt, Hex.Hd., M8 x 55 lg.	-		48
Washer, Spring Double coil M8	-		48
Washer, Flat M8	-		48
Washer, Flat, St.Stl., M4	-	991/9/10353/002	2
Nut, Hex. M8			

31. Doublet Antenna Kit Assembly - High-band (8-30 MHz) 630/1/34350/003 & /004

Description	Manufacturer Ref.	630/1/34350/003	630/1/34350/004	No.off
Antenna Assembly	-	686/1/02102	686/1/02102	24
Antenna Assembly	-	686/1/02102/001	686/1/02102/001	24
Antenna Counterpoise Kit	-		686/1/02250	48
Cover	-	630/2/34362	630/2/34362	24
Combining Unit Assembly	-	630/1/34351/002	630/1/34351/002	24
Ground Stake Assembly	-	630/1/34357	630/1/34357	24
Combining Cable	-	702/1/20094/003	702/1/20094/003	24
Combining Cable	-	702/1/20094/004	702/1/20094/004	24
Cable Antenna Feeder	-	686/1/02186/001	686/1/02186/001	24
Cable Marker-PVC White, Critchley Type 661-13-C-0	-	915/4/98749/001	915/4/98749/001	210
Cable Marker-PVC White, Critchley Type 661-13-C-1	-	915/4/98749/002	915/4/98749/002	78
Cable Marker-PVC White, Critchley Type 661-13-C-2	-	915/4/98749/003	915/4/98749/003	48
Cable Marker-PVC White, Critchley Type 661-13-C-3	-	915/4/98749/004	915/4/98749/004	18
Cable Marker-PVC White, Critchley Type 661-13-C-4	-	915/4/98749/005	915/4/98749/005	18
Cable Marker-PVC White, Critchley Type 661-13-C-5	-	915/4/98749/006	915/4/98749/006	12
Cable Marker-PVC White, Critchley Type 661-13-C-6	-	915/4/98749/007	915/4/98749/007	12
Cable Marker-PVC White, Critchley Type 661-13-C-7	-	915/4/98749/008	915/4/98749/008	12
Cable Marker-PVC White, Critchley Type 661-13-C-8	-	915/4/98749/009	915/4/98749/009	12
Cable Marker-PVC White, Critchley Type 661-13-C-9	-	915/4/98749/010	915/4/98749/010	12
Washer, Flat, St.Stl., M4	-	991/9/10353/002	991/9/10353/002	2

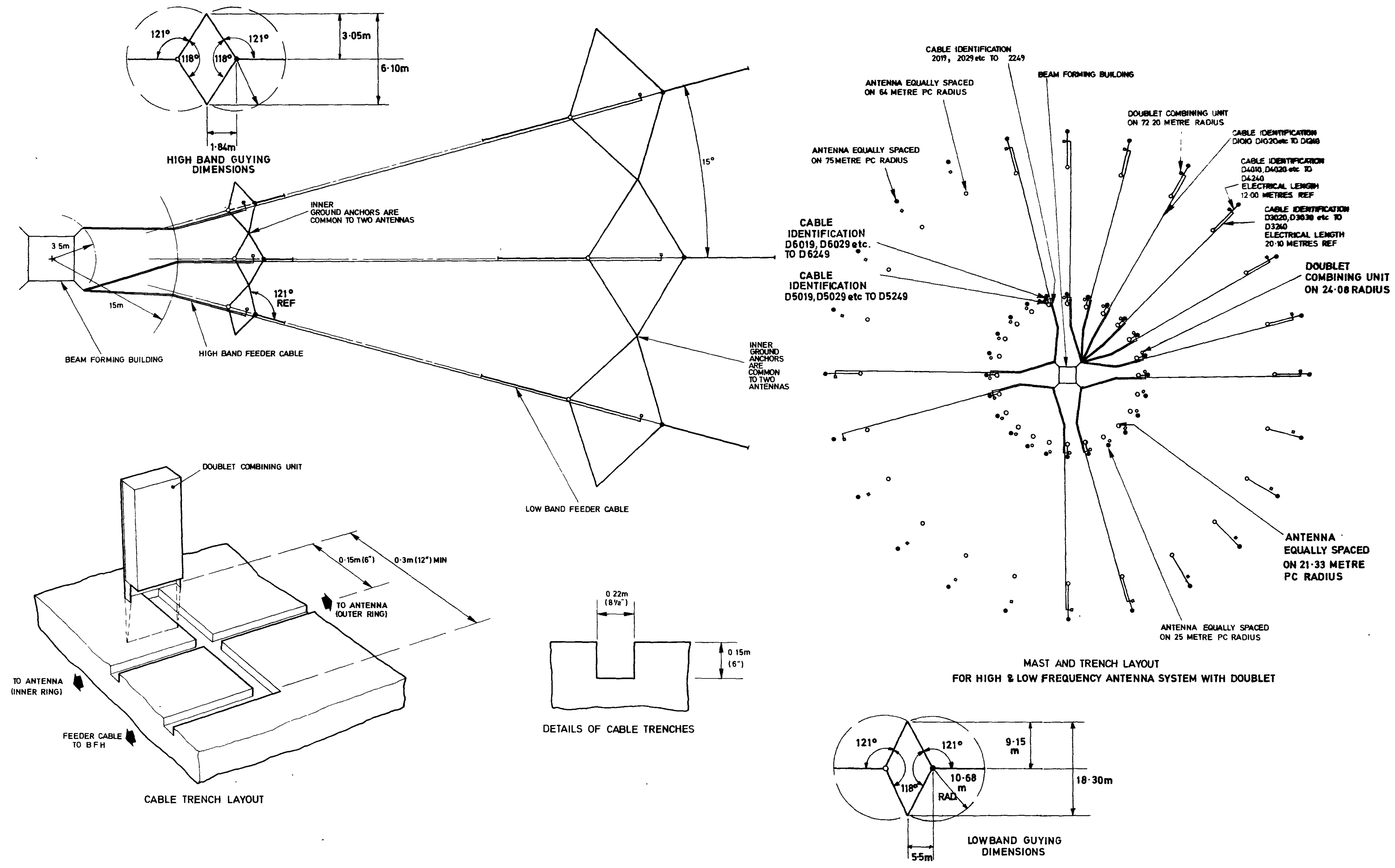


Fig. 1

Appendix 1

Installation of system with doublet arrays

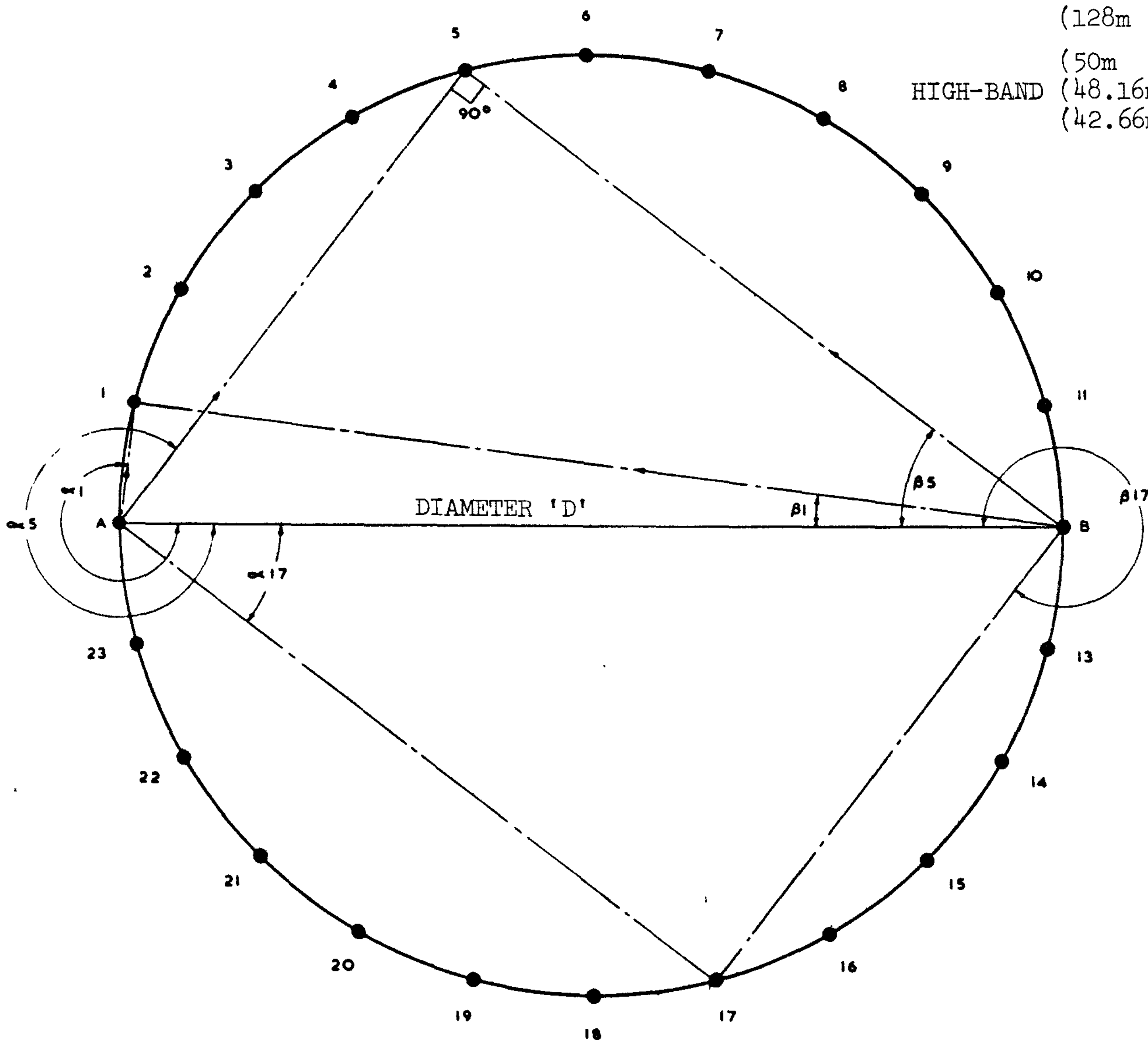
Fig.1

ANTENNA No	THEODOLITE A ANGLE α, DEGREES	THEODOLITE B ANGLE β, DEGREES	ANTENNA No	THEODOLITE A ANGLE α, DEGREES	THEODOLITE B ANGLE β, DEGREES
1	277½	7½	13	7½	277½
2	285	15	14	15	285
3	292½	22½	15	22½	292½
4	300	30	16	30	300
5	307½	37½	17	37½	307½
6	315	45	18	45	315
7	322½	52½	19	52½	322½
8	330	60	20	60	330
9	337½	67½	21	67½	337½
10	345	75	22	75	345
11	352½	82½	23	82½	352½

DIAMETER 'D'

LOW-BAND (150m (144.4m (128m

HIGH-BAND (50m (48.16m (42.66m



App.1 MARKING OUT THE ANTENNA SITE (METHOD 2) FIG.2