REFLECTOR, FEED AND SYSTEM

WAVEGUIDE INTERCONNECTIONS

WARNING

VOLTAGES USED IN THIS EQUIPMENT CAN ENDANGER LIFE.

ISOLATE THE EQUIPMENT FROM POWER SUPPLIES BEFORE MAKING INTERNAL ADJUSTMENTS.

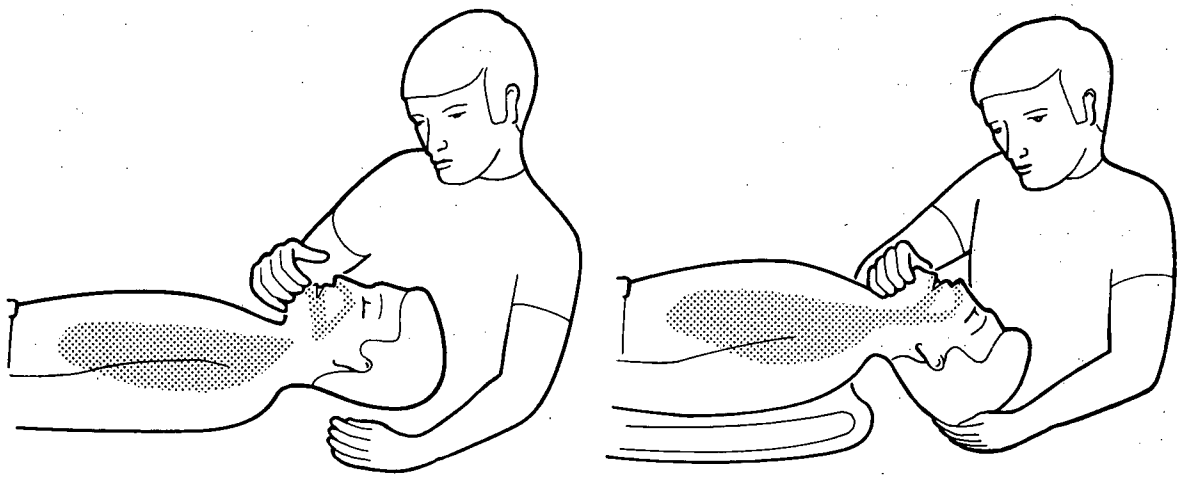
IF IT IS ESSENTIAL TO WORK ON LIVE EQUIPMENT, THE WORK MUST ONLY BE PERFORMED BY QUALIFIED PERSONNEL WHO ARE AWARE OF THE RISKS INVOLVED AND WHO HAVE TAKEN ADEQUATE PRECAUTIONS.

THE PROCEDURE TO BE ADOPTED IN CASES OF ELECTRICAL SHOCK IS GIVEN ON PAGE (iv).

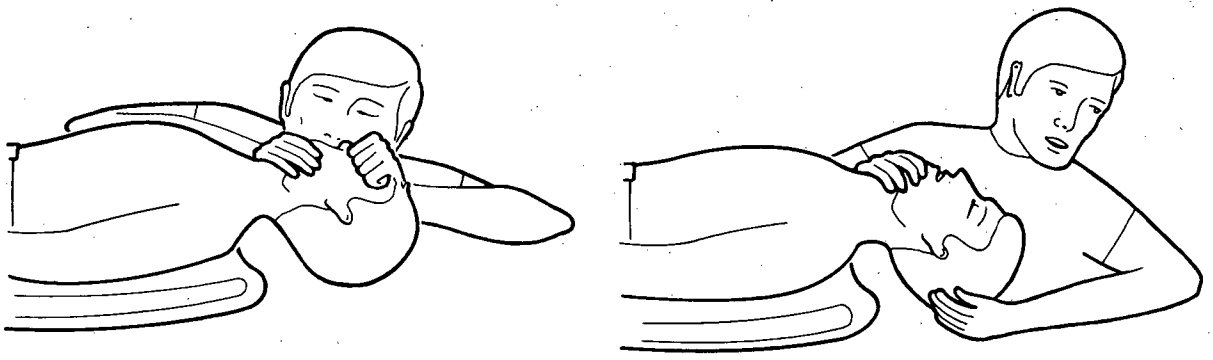
THE 'KISS OF LIFE' RESUSCITATION

WHEN BREATHING HAS STOPPED DUE TO ELECTRIC SHOCK

1. INITIAL PROCEDURE
Switch off the current. If this is impossible free the person using something made of rubber, cloth or wood or a folded newspaper; use the casualty's own clothing if dry. Do not touch his skin before the current is switched off. If the victim's breathing has stopped IMMEDIATE EFFORT to restart it is essential. EVERY SECOND COUNTS.



2. STARTING POSITION
Victim face up. Tilt head back and pull chin forward to open air passages.



3. INFLATION
Seal victim's nose by pinching nostrils. Open your mouth wide and inflate the victim's lungs by blowing air into his mouth.

4. EXHALATION
When you see the victim's chest rise remove your mouth to allow the air to escape from his lungs, and turn your head to one side. Continue with 3 & 4 until natural respiration returns.

Do not exceed 10-12 breaths per minute. If stomach contents are regurgitated, turn the victim's head to one side and clean out his mouth. When there are signs of natural respiration returning adjust your breathing to coincide with the victim.

E.C.O.'s

The following E.C.O.'s are applicable to the subject of this handbook:

0618 0708 0715	Noted but does not affect the handbook content
0052 1029 1030 1031 1075	Incorporated in handbook

REFLECTOR, FEED AND SYSTEM

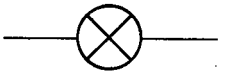
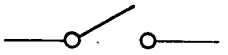
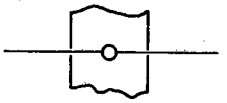
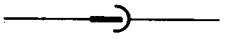
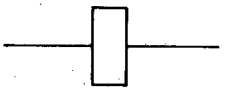
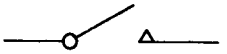
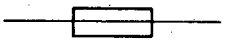
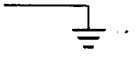
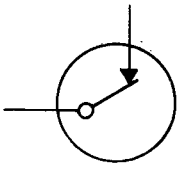
WAVEGUIDE INTERCONNECTIONS

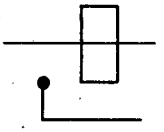
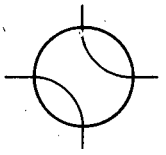
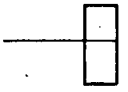
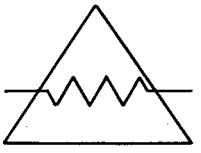
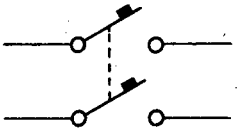
RECORD OF REVISIONS

Revision Number	Insertion Date	Signature	Revision Number	Insertion Date	Signature

CIRCUIT SYMBOLS

The following symbols are used in this handbook:

Circuit Reference	Function	Symbol
LP	Indicator lamp	
S	Switch	
	Terminal block connection	
	Plug and socket connection	
RL1	Relay coil	
RL1.1	Relay contact (make)	
Fs	Fuse	
	Earth point	
	Heater element	
	Thermostat	

Circuit Reference	Function	Symbol
	Waveguide Load	
	Waveguide Transformer, circular-to-square	
	Waveguide Transformer	
	Waveguide junction	
	Waveguide to Coax. transition	
	Waveguide switch	
	Flexible Waveguide	
	Coaxial cable	
	Waveguide shorting plate	
	Waveguide attenuator	
	Circuit Breaker	

REFLECTOR, FEED AND SYSTEM

WAVEGUIDE INTERCONNECTIONS

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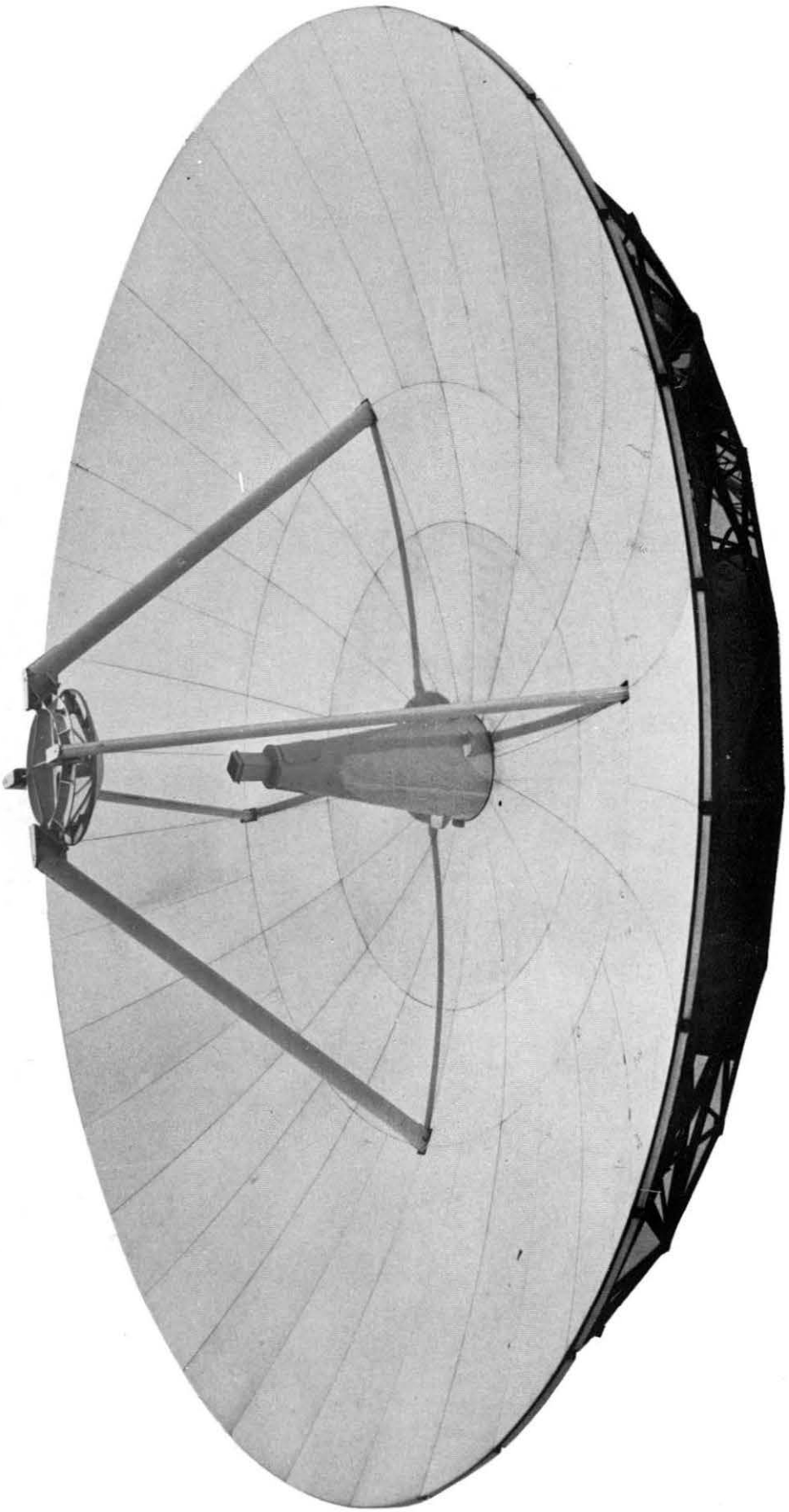

Reflector Assembly

PART ONE

TECHNICAL DETAILS

PART TWO

MAINTENANCE

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TECHNICAL DETAILS

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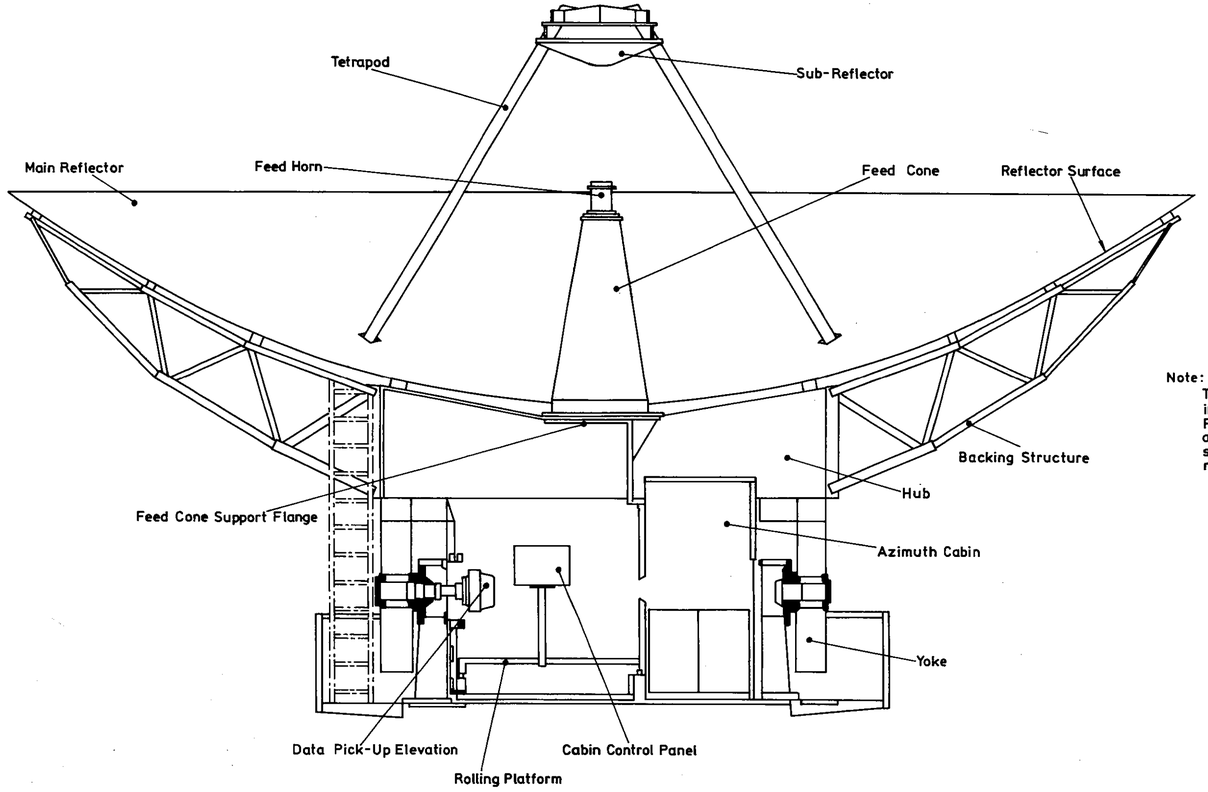


Note:
The reflector is shown in the vertical stow position. For further details of the antenna support structure see pedestal handbook number 602.

Antenna General Arrangement
Figure 2.1-1
Part 1

PART ONE

SECTION ONE

INTRODUCTION

1. GENERAL (Figure 1.1-1)

A modified Cassegrain configuration is used for the main antenna at each ground station. The antenna has three major sub-assemblies:

a. A main reflector, 12.8 metres (42 feet) in diameter, consisting of a central hub surrounded by 16 detachable segments.

b. A centrally-located, forward-looking feed array aligned with the antenna axis.

c. A sub-reflector, supported on a tetrapod structure, to transfer radiation between the feed assembly and the main reflector.

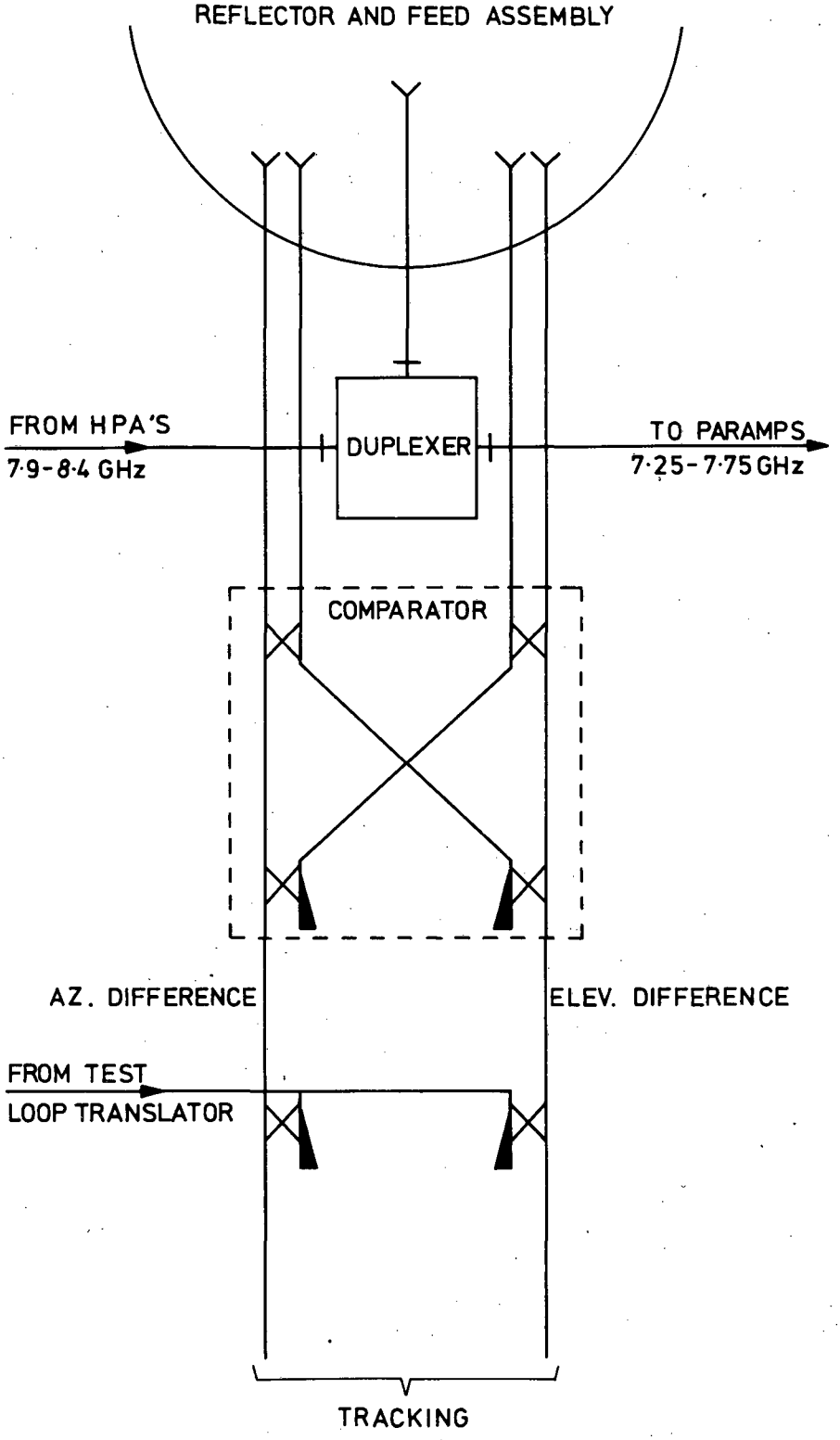
The profiles of the main and sub-reflectors are arranged to provide maximum forward antenna gain at the low end of the receive band (7.25 GHz).

A five-horn cluster in the feed array passes all the transmit and receive signals. The central circular horn passes the circular polarized transmit and receive communications signals together with the tracking reference ('sum') signals, and the four surrounding horns provide the error sensing signals for the tracking system.

Waveguide equipment linking the feed assembly to the transmitter and receiver sub-systems is also described in this handbook. The waveguide equipment is housed in the azimuth and elevation equipment cabins mounted behind the central part of the main reflector.

Some of the waveguide equipment is pressurized with dried air. By pressurizing the waveguide, the ingress of dust and moisture is prevented. Details of the pressurization unit are given in Handbook No. 909 (Spinner).

A heating system is provided in the feed assembly to prevent icing of the assembly and feed radome in cold weather. The heating is thermostatically-controlled and is selected from the control console in the electronic equipment room.



Simplified Block Diagram

PART ONE

SECTION TWO

TECHNICAL DESCRIPTION

1. GENERAL

Figure 2.1-1 shows the general arrangement of the complete antenna, which comprises a modified Cassegrain reflector system supported on an elevation-over-azimuth mount.

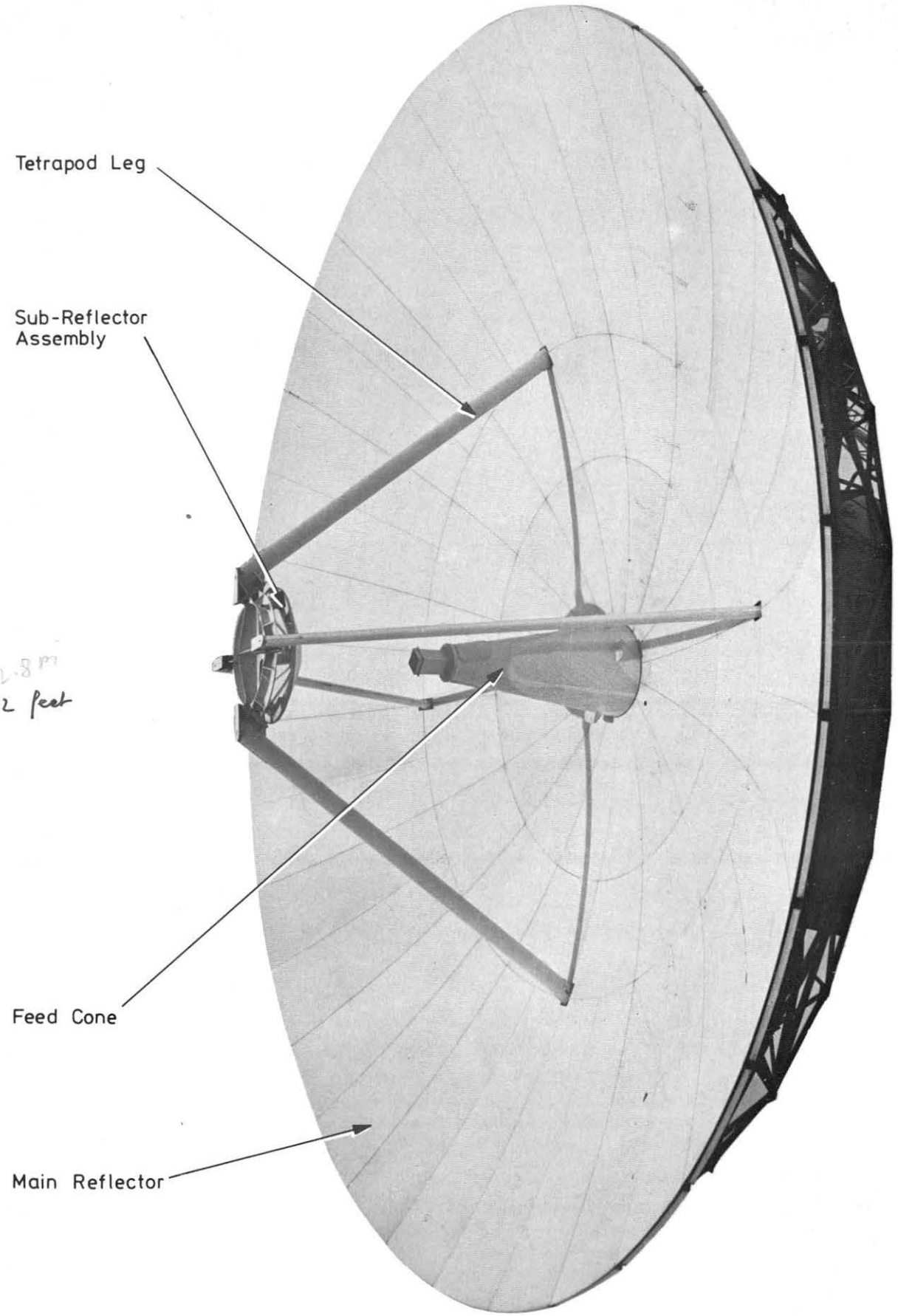
Each axis is driven by two pairs of d.c. motors through two gear boxes over a working range of ≈84° in elevation and ≈392° in azimuth. The r.f. portions of the duplicated transmitting and receiving equipment are mounted in protective cabins immediately behind the reflector vertex: the cabins provide full access for maintenance without interruption of normal station operation.

2. REFLECTOR SYSTEM (Figures 2.2-1 and 2.2-2)

The reflector system consists of a main reflector, a sub-reflector, and waveguide and feed equipment, arranged in the Cassegrain configuration, but with the surface profiles modified to produce optimum antenna gain. The main reflector is a 12.8 m quasi-paraboloid with a focal length of approximately 4.1 m, and consists of shaped aluminium panels supported on an open backing structure and central hub.

The sub-reflector is a quasi-hyperboloid machined aluminium casting of approximately 1.37 m diameter and 0.31 m depth. It is supported on a tetrapod, which is attached to the main reflector. The tetrapod legs are elliptical in section to minimize shadowing.

The feed is a five-horn cluster suitable for operation with circularly polarized signals. It is described in detail in sub-section 3.



Reflector Assembly

The reflector system is optimized for maximum forward gain at approximately 7.25 GHz. This is achieved by shaping the sub-reflector to give substantially uniform illumination over the whole of the main reflector aperture, except for the central portion directly in the sub-reflector shadow. The main reflector contours equalize the phase distribution across the aperture. Although the optimization is theoretically correct only at the bottom of the receive band, in practice the efficiency degrades only slightly at the top of the transmit band at 8.4 GHz. This is because the narrower feed pattern at the higher frequencies, although degrading the illumination efficiency, causes the spillover losses to decrease as well; these two effects tend to cancel each other out. The main reflector profile and the sub-reflector position are set in the factory, and the assembly method ensures that close tolerances will be retained throughout a number of dismantling/re-erection cycles. Field adjustments are not normally necessary.

3. FEED ASSEMBLY

3.1 GENERAL

The feed assembly comprises four main parts:

a. A five-horn cluster (Figure 2.3-1) consisting of a central conical horn surrounded by four shaped, but essentially square, horns.

b. Five polarization duplexers (Figures 2.3-2 and 2.3-3) one for each of the five horns.

c. A tracking comparator (Figure 2.3-4) connected via polarizers to the four outer horns.

d. Transmit/Receive waveguide (Figure 2.3-5).

The feed assembly covers a frequency band of 7.25 to 8.4 GHz but is used in SATCOM as follows:

i Received signals: 7.25 to 7.75 GHz, left hand circular polarization.

ii Transmitted signals (central horn only) 7.9 to 8.4 GHz, right-hand circular polarization.

The feed aperture is closed by a pressure window or radome of Kapton 500HH sheet, and the complete feed assembly together with the interconnecting waveguides is pressurized with dry air at approximately 0.03 kg/cm^2 (0.5 psi). (See Spinner Handbook No. 909 for description of pressurizing unit.)

A de-icing heater is fitted to the flange at the base of the feed horn; this heats the whole horn structure including the horn radome. Two bar heaters are used, each nominally 250 watts, and are controlled by a switch indicator on bay 4, panel 3 of the control console. A thermostat is fitted on the feed horn to control the temperature. A thermal cut-out is fitted to prevent overheating. Details of the circuit are provided in Figure 2.3-6.

The complete assembly is shown in Figure 4.2-1.

3.2 FEED HORN ARRANGEMENT (Figure 2.3-1)

The central circular horn carries the communications transmit and receive signals, and also provides a reference ('sum') signal for the autotrack system. The horn terminates in a circular-to-square transition, which interfaces with the polarization duplexer. The primary radiation pattern of the central horn at a frequency of 7.25 GHz is the basis for calculating reflector profiles, thus optimizing the antenna gain at this frequency.

The four outer horns are used in conjunction with the tracking comparator to derive error signals for the autotrack system. This function is described in more detail in sub-section 3.4.

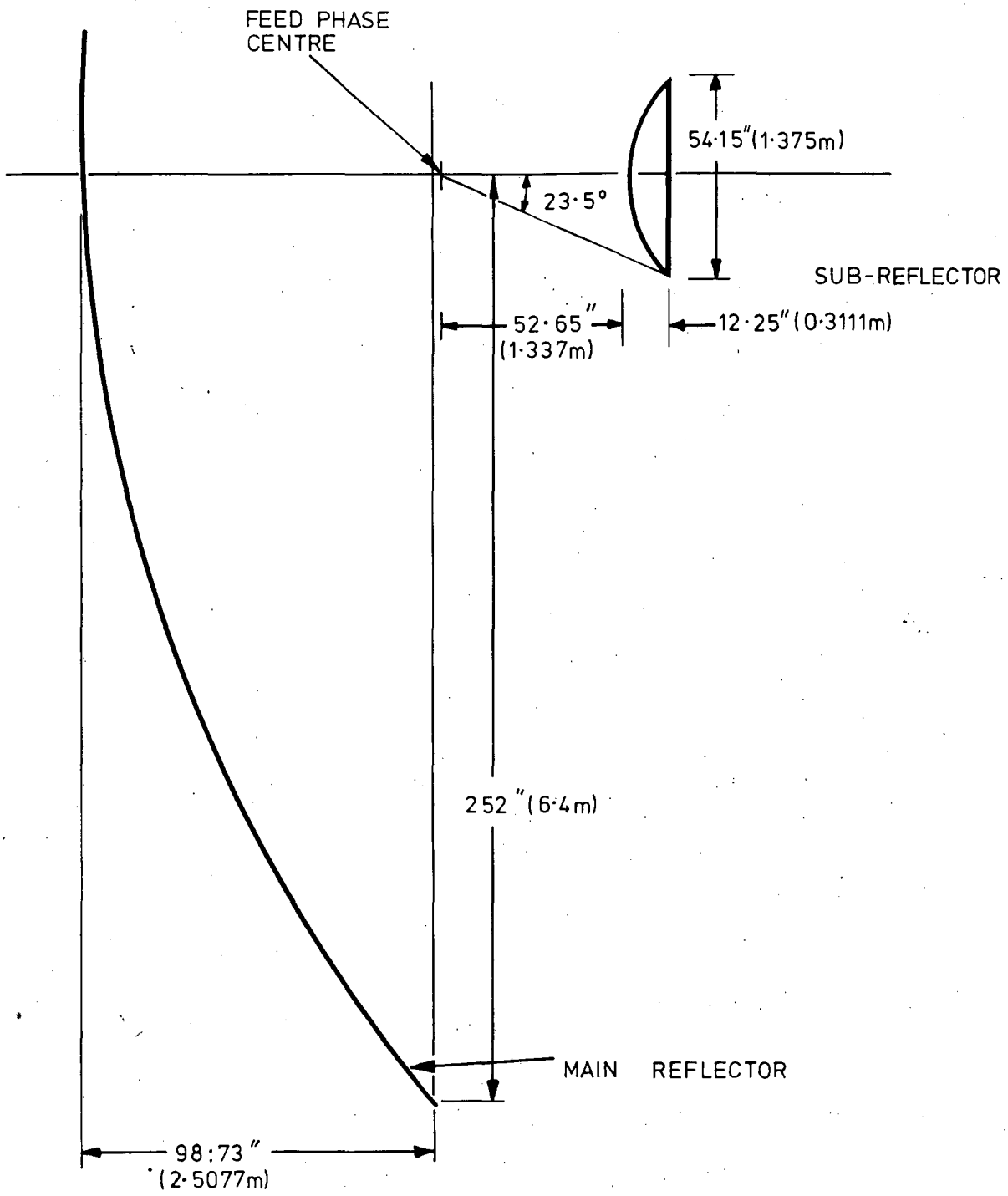
3.3 POLARIZATION DUPLEXER (Figures 2.3-2 and 2.3-3)

The duplexers have the following functions:-

a. Communications Feed Horn:

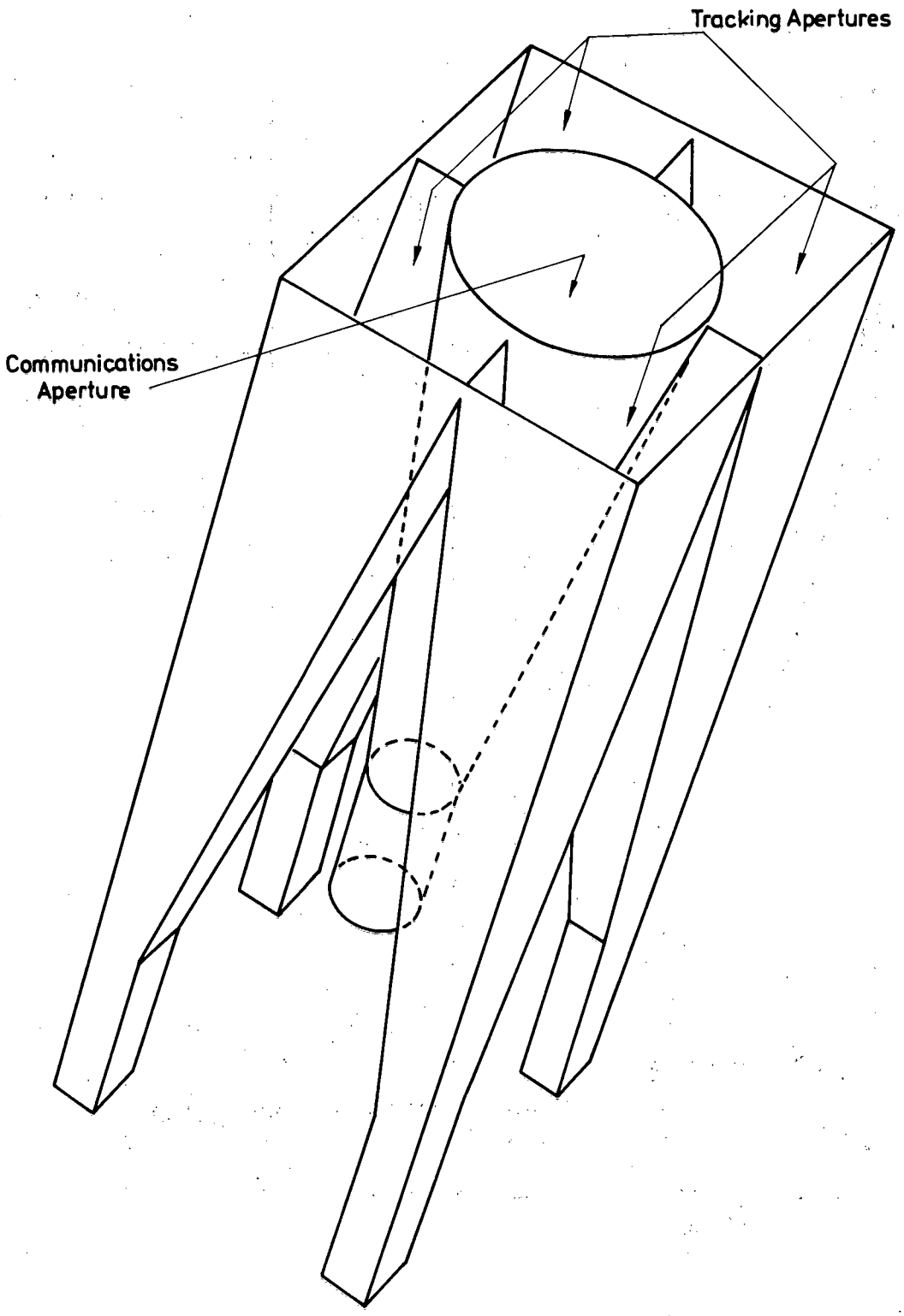
i To perform transformations from linear polarized to circular polarized transmit signals and circular polarized to linear polarized receive signals.

ii To isolate transmitted and received signals.



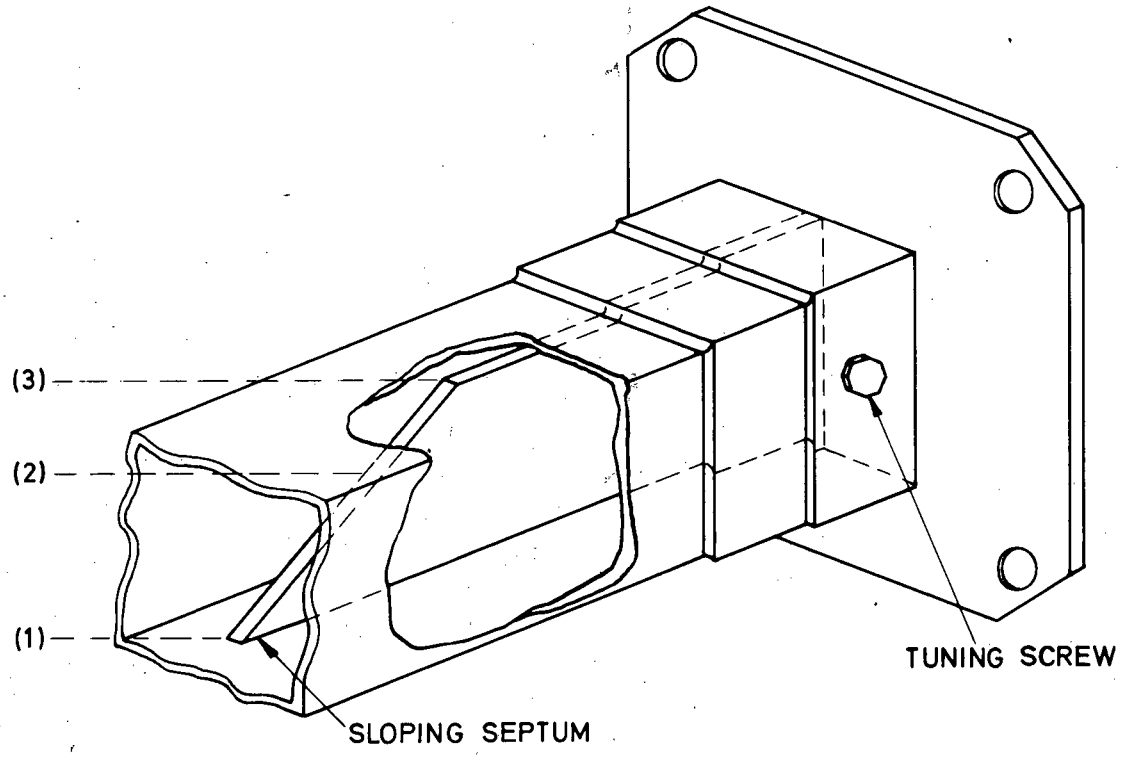
Antenna Geometry

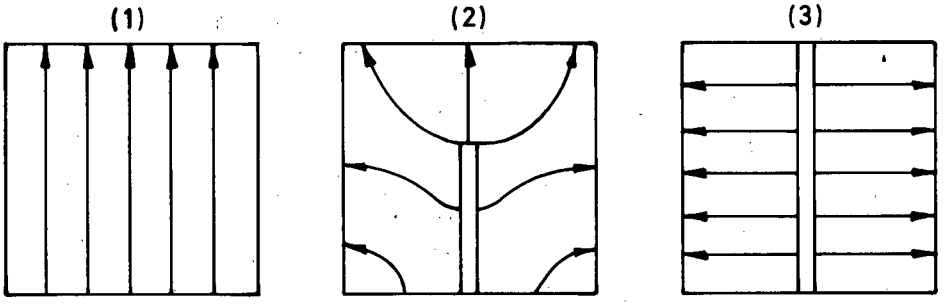
Fig. 2.2-2



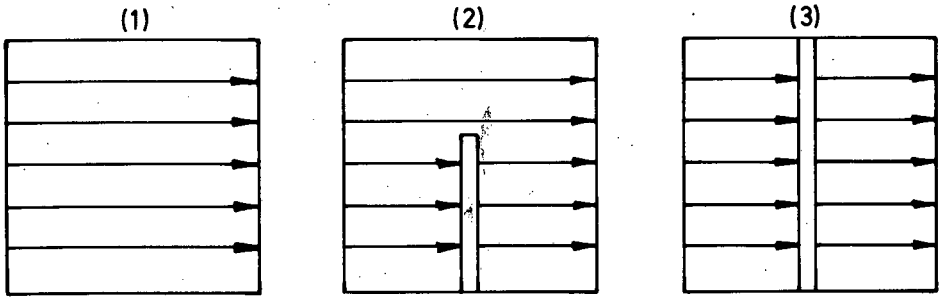
Feed Horn Arrangement

Fig. 2.3-1

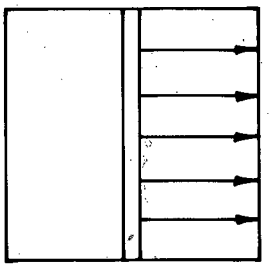




PARALLEL COMPONENT



NORMAL COMPONENT



TOTAL FIELD

Polarization Duplexer View A

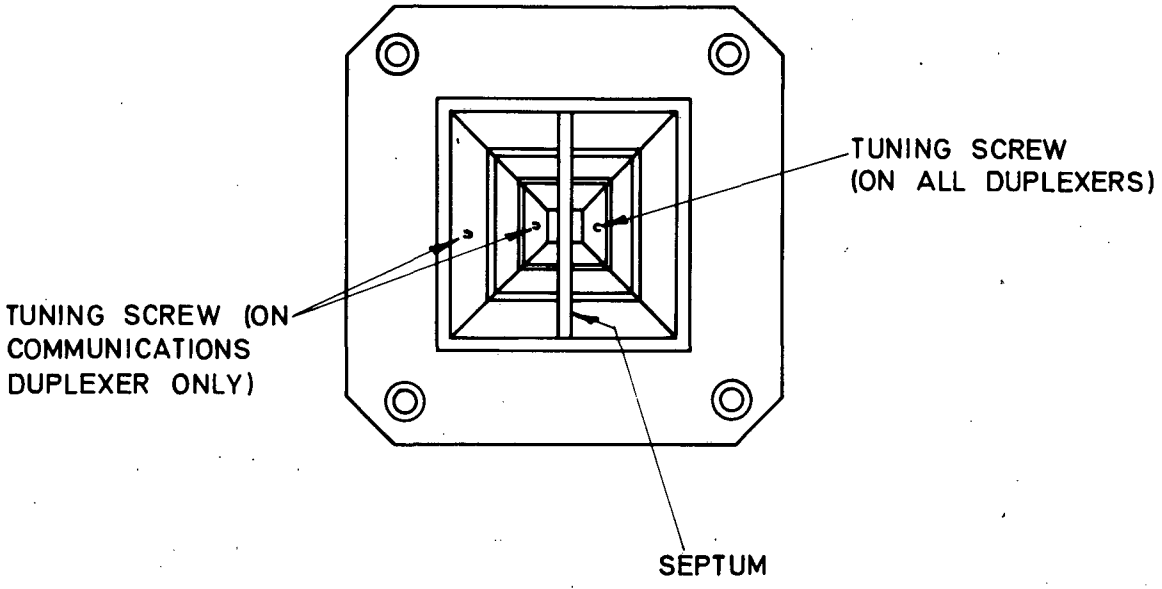
b. Tracking Horns:

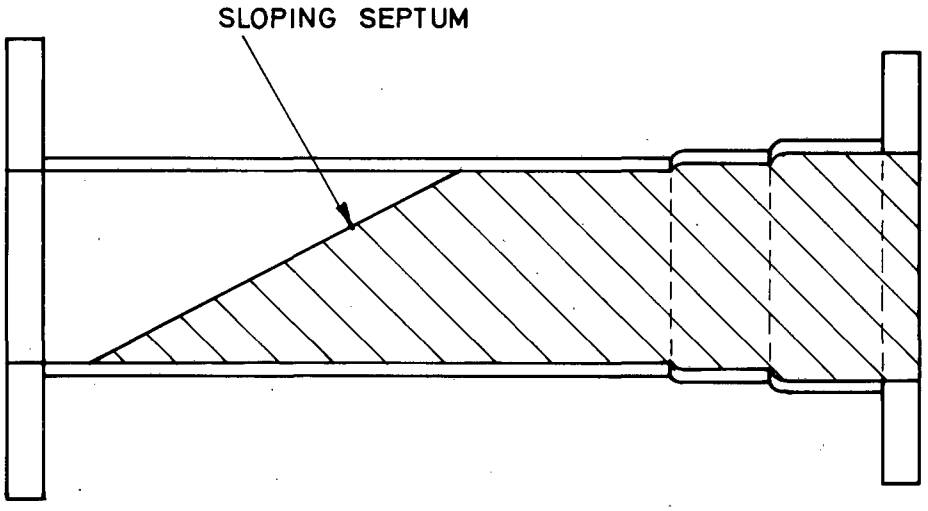
i To perform transformation from circular polarized to linear polarized receive signals.

Each duplexer consists of a length of square waveguide divided by a tapered septum into two rectangular sections. Linearly polarized energy fed into either of these rectangular ports produces a circularly polarized signal in the square waveguide. Conversely, circularly polarized energy in the square waveguide is transformed to a linear signal in one of the rectangular ports depending on the sense of circular polarization (see Figure 2.3-2).

Consider the circularly polarized receiver signal coupled directly from the horn into the square section of the duplexer. This signal may be regarded as two components, orthogonal in time and space, one normal to the septum and one parallel to it. As the signal propagates down the septum the normal component divides into two signals, one in each rectangular section. The parallel component propagates along the septum so that the E vector is always normal to the boundaries. This results in the two signals coupled into the rectangular waveguides being of equal amplitude but anti-phase (in space). Additionally, while progressing along the septum, the guide wavelength of the parallel component is changing. Hence the electrical path length along the septum is different for the two orthogonal components. The length of the septum is so chosen that the differential phase shift between the two components, due to the different electrical path length, is 90^{o}. Thus in one of the rectangular waveguides the two anti-phase signals cancel and in the second rectangular waveguide the two in-phase signals combine to provide a linearly polarized received signal.

Circular polarization of one sense couples to one rectangular port, circular polarization of the opposite sense couples to the second rectangular port. Thus if transmit signals are fed into one rectangular port to provide a given direction of circular polarization, then oppositely polarized received signals are coupled out of the second rectangular port.





Polarization Duplexer View B

Fig. 2.3-3

The performance of each duplexer is optimized for a particular function by means of pre-set screw adjustments. These provide for a small mechanical variation to the waveguide wall so that accurate phase relationships can be established. Adjustments are made at the factory and the screws should not be moved after this.

3.4 TRACKING COMPARATOR (Figure 2.3-4)

The function of the tracking comparator is to combine the outputs from the four outer (tracking) horns into two error signals representing antenna/satellite misalignment.

The output from each horn is added in a conventional comparator network to provide azimuth and elevation error signals as shown in Figure 2.3-7. The sum signal available from this comparator is not used and is terminated in a matched load.

The path lengths of the network are arranged to be identical so that the system will operate without adjustment over the full receiver bandwidth of 7.25 to 7.75 GHz. This feature also minimizes temperature effects.

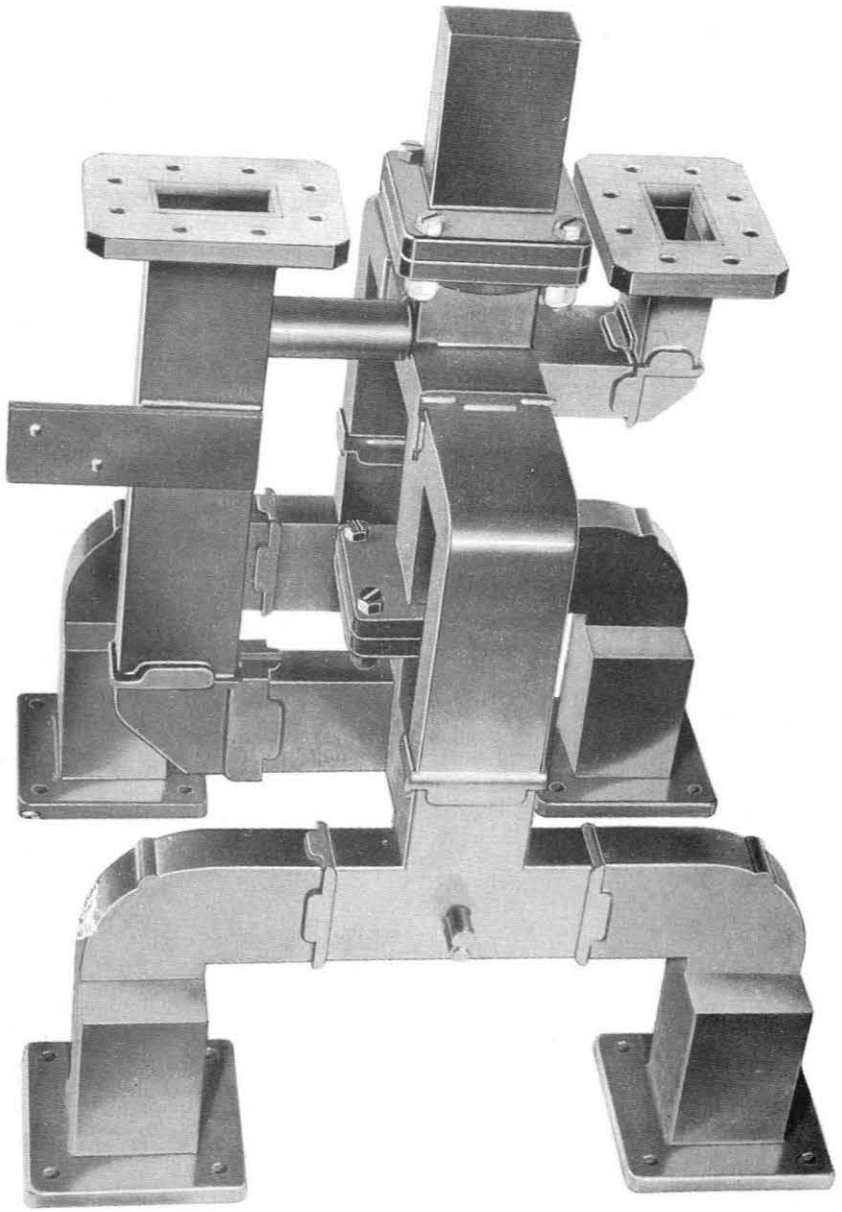
3.5 TRANSMIT/RECEIVE WAVEGUIDE (Figure 2.3-5)

A section of interconnecting waveguide is required to link the centre communications horn to the transmit/receive waveguide runs to the various r.f. sub-systems. This section of waveguide is integral with the tracking comparator within the feed cone.

4. WAVEGUIDE INTERCONNECTIONS

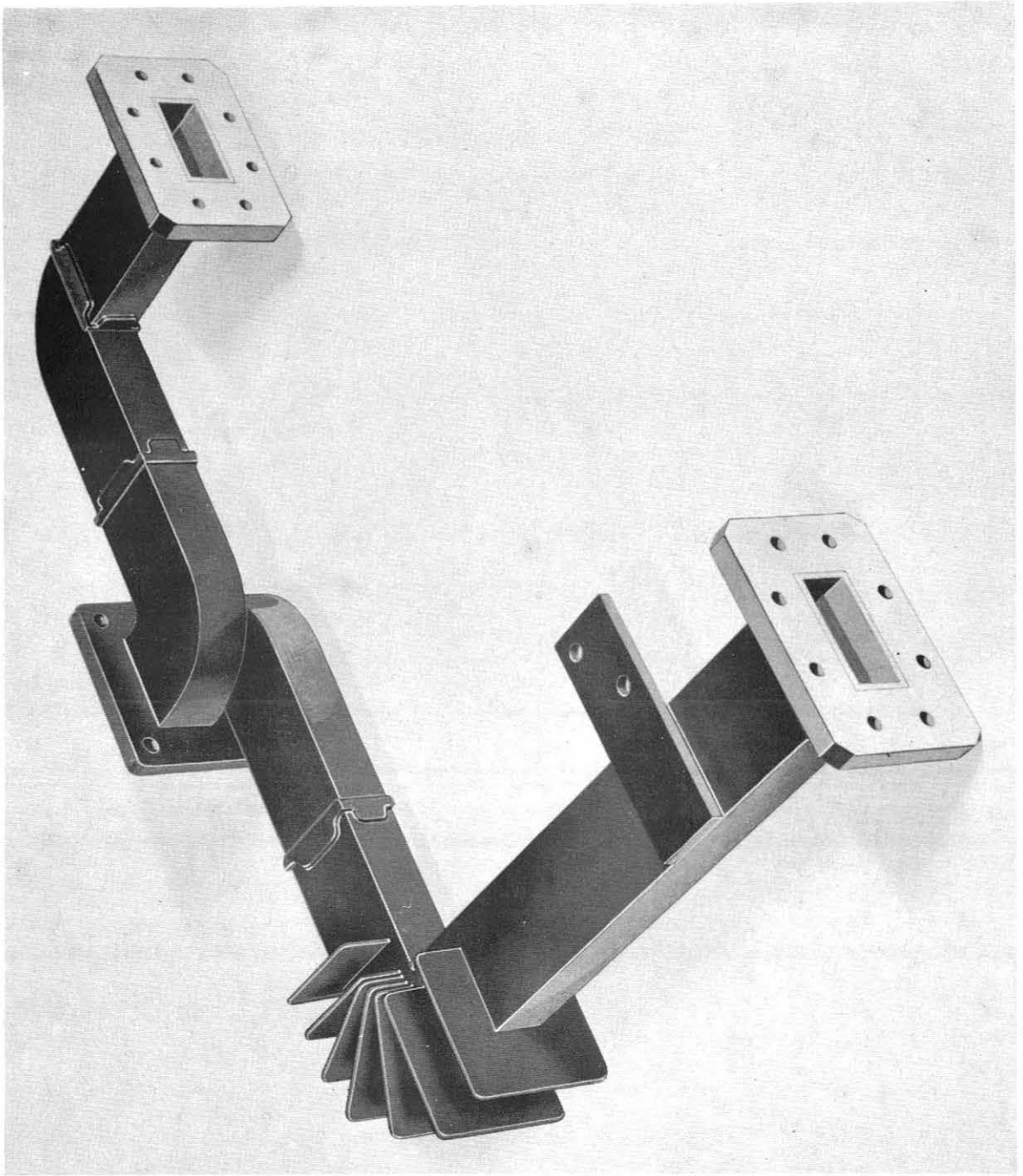
4.1 GENERAL

The waveguide interconnections between the feed and the various r.f. sub-systems in the antenna cabins are shown in Figure 2.4-1. The diagram also includes microwave components that form part of the Low Noise Receiver (LNR) and High Power Amplifier (HPA) sub-system, but which are mounted external to the LNR and HPA enclosures; these items, which are enclosed within the dashed lines showing the sub-system boundaries, are described in the relevant sub-system manuals.



Comparator Assembly General View

Fig. 2.3-4



Transmit Receive Waveguide

Brief details of the main interconnecting paths are given in the following paragraphs.

4.2 HPA TO FEED ASSEMBLY

This section of the waveguide run is constructed of WR137 high-conductivity copper to minimize losses, with copper tapers to WR112 at each end. A flexible section 45 cm in length continues the run between the two cabins and flexes up to $\pm 45^{o}$ as the antenna moves in elevation. This flexible section is finned to improve heat dissipation; the heat dissipation from the black painted surface of the rest of the run is adequate up to the rated maximum power level of 10 kW. The whole run is pressurized together with the parts of the HPA sub-system; see Spinner Handbook No. 909 for details.

4.3 FEED ASSEMBLY TO LNR SELECT WAVEGUIDE SWITCH

This waveguide run is also constructed of WR137 high-conductivity copper to minimize losses, with a taper to WR112 at the feed end and a quarter-wave transition to WR112 at the LNR select waveguide switch. A short flexible section is included in this run to counteract possible differential expansion problems.

The run is pressurized, with a pressure window built into the waveguide switch.

4.4 FEED ASSEMBLY TO TRACKING DOWN-CONVERTERS

These waveguide runs are constructed from brass WR112, with copper tapers to WR137 at the tracking down-converters. Apart from the waveguide sections each arm also includes the following:

a. A pressure window (only the feed end of the run is pressurized). The window is made from a Melinex sheet in a brass enclosure.

b. A test coupler, manufactured from brass, for injection of test signals.

c. An invar band-reject filter tuned to the transmitter frequency (see sub-section 4.8).

d. An invar image-rejection filter (see sub-section 4.9).

4.5 IPA TO HPA

These consist of unpressurized runs constructed of copper WR112.

4.6 LNR TO DOWN-CONVERTERS

These consist of unpressurized runs constructed of brass WR112 with copper tapers to WR137 at the down-converters. Each run also includes the following:

a. An image rejection filter, constructed from invar.

b. A short flexible section to take up installation tolerances.

4.7 TEST INTERCONNECTIONS

These consist of unpressurized runs constructed of brass WR112 and RG214 coaxial cable, connecting the following:

a. HPA (low power output) to the Test Loop Translator (TLT) (coaxial cable).

b. TLT to LNR system via the TLT waveguide switch.

c. Nitrogen-cooled load to LNR system via the Test Translator waveguide switch.

d. TLT tracking test output to tracking couplers (coaxial cable).

The cooled load is described separately in the TLT Handbook No. 703.

4.8 BAND-REJECT FILTERS

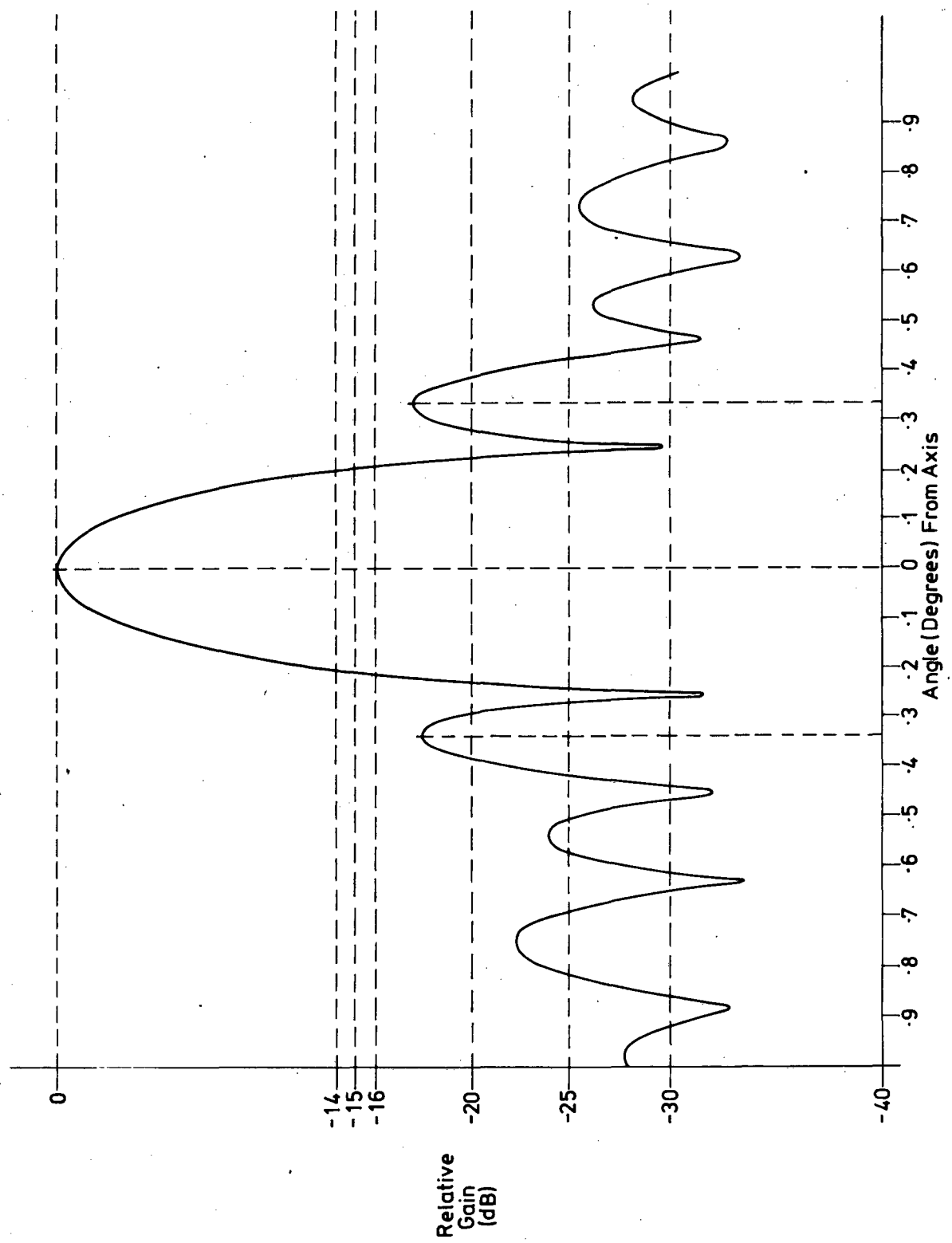
The band-reject filters have an equal-element waveguide design consisting of eight resonators. The filters are tunable without being removed from the system. A decoupled probe incorporated on each filter allows it to be tuned to the desired frequency.

4.9 IMAGE-REJECT FILTERS

The image reject filters are tunable band-pass filters consisting of four elements. Each filter is tunable without being removed from the system. A decoupled probe incorporated on each filter allows it to be tuned to the desired frequency.

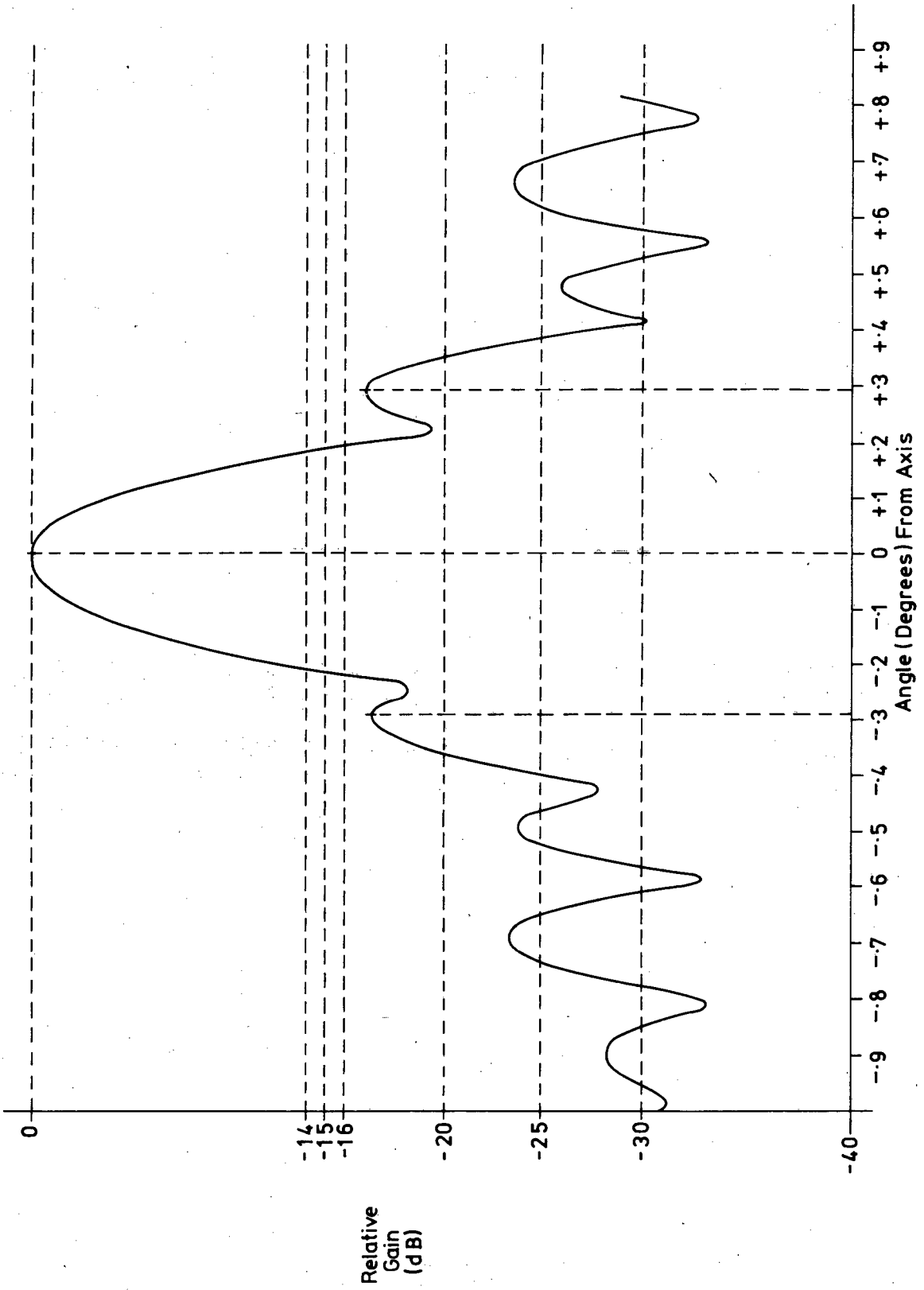
5. ANTENNA PATTERN

Figures 2.5-1 and 2.5-2 show typical receive antenna patterns in the azimuth and elevation axes respectively.



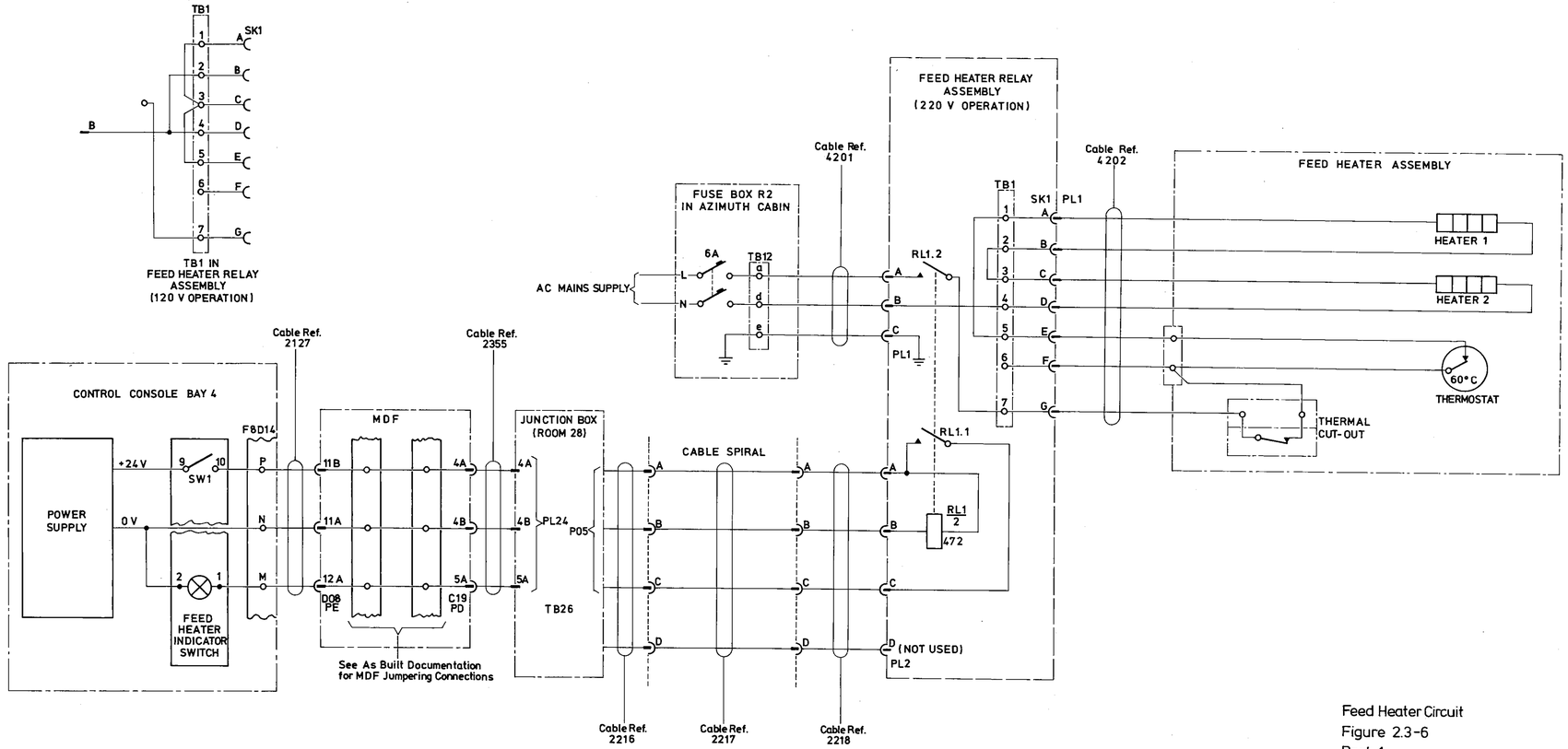
Antenna Pattern-Azimuth

Fig. 2.5-1

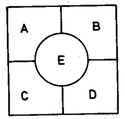


Antenna Pattern-Elevation

Fig. 2.5-2



Feed Heater Circuit
Figure 2.3-6
Part 1



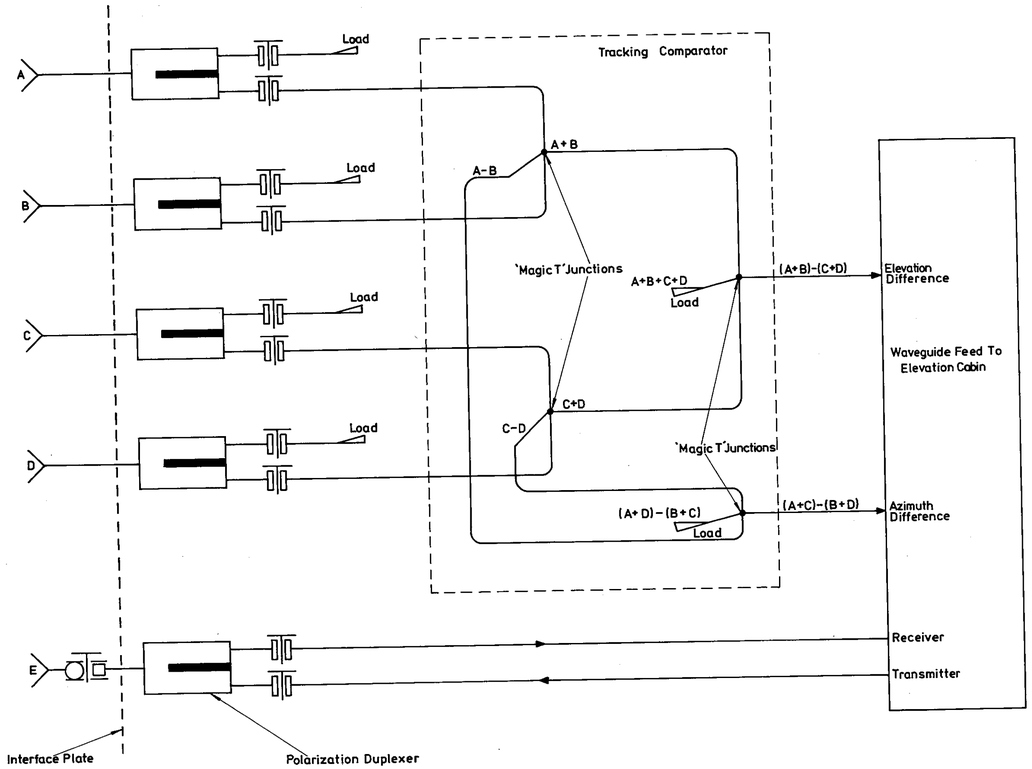
Front View On
Feed Horns

A,B,C,D = Tracking Horns

E = Communications Horn

= Circular-To-Square Waveguide Transformer

= Waveguide Transformer



Antenna and Comparator
Figure 2.3-7
Part 1

PART ONE

SECTION THREE

PERFORMANCE SPECIFICATION

1. ANTENNA

Environmental Specifications	:	Category 1 as defined in the ICB Part Five, Section 1, Para 1.1.3.
Weight	:	11,800 lb (5360 kg); (main reflector assembly, sub-reflector and support assembly, and feed support).
Dimensions	:	See Figure 2.2-2
Frequency range	:	7.9 -8.4 GHz Transmit 7.25-7.75 GHz Receive
Antenna gain (7.25 GHz)	:	58 dB min. } measured at feed output port
Antenna gain (8.4 GHz)	:	59 dB min. } measured at feed output port
Side lobe levels:		
$\pm 5^{\circ}$	:	At least 15 dB down
$\pm 5^{\circ}$ to $\pm 10^{\circ}$	:	At least 30 dB down
$\pm 10^{\circ}$ to $\pm 170^{\circ}$	:	At least 35 dB down
$180^{\circ} \pm 10^{\circ}$	:	At least 59 dB down (back lobe average).
Polarization:		
Transmit	:	RH Circular (IEEE Standard)
Receive	:	LH Circular (IEEE Standard)

Alignment of tracking and communication axes	:	Better than or equal to 0.01°.

2. FEED

2.1 PRIMARY RADIATION PATTERN

Beamwidth at 7.25 GHz	:	$\pm 20^{\circ}$ at the -10 dB points.
Tracking null depths	:	Not less than 25 dB with respect to peaks of difference patterns.
Polarization axial ratios:		
Within the 1 dB beamwidth of communications beam	:	Not greater than 1.5 dB at all frequencies.
On peaks of the tracking patterns	:	Not greater than 2 dB over the frequency band 7.25 to 7.75 GHz.

2.2 VSWR

Looking into receive port	:	Not greater than 1.18 over the frequency band 7.25 to 7.75 GHz.
Looking into transmit port	:	Not greater than 1.18 over the frequency band 7.9 to 8.4 GHz.
Looking into difference ports	:	Not greater than 1.25 over the frequency band 7.25 to 7.75 GHz.

2.3 ISOLATION

Isolation between transmit and receive ports	:	Greater than 25 dB over the frequency band 7.25 to 7.75 GHz. Greater than that defined by linear fall in dB from 25 dB at 7.9 GHz to 15 dB at 8.4 GHz. (Subject of Change Request No.20)

Isolation between transmit and tracking ports	:	Greater than 40 dB over the band 7.9 to 8.4 GHz.

2.4 ENVIRONMENT

Air leakage	:	The pressure in the sealed waveguide system should fall at a rate not greater than 100 mm (from 300 mm to 200 mm) water gauge in 5 minutes.

2.5 FEED HEATING SYSTEM

Heater type	:	Bar heaters (2 provided).
Heater rating	:	110 V, 250 watts each (nominal). (Connected in series for 220 V and in parallel for 120 V.)
Heating time	:	7 minutes maximum to reach operating temperature.
Heater supply	:	220 V ± 10% a.c. (120 V ± 10% for N. American stations) 45 to 65 Hz.
		NOTE: See Figure 2.3-6 for details of links required to suit appropriate mains voltage.
Relay supply (Control Console)	:	24 V d.c.

2.6 WEIGHTS

Feed Cone	:	196 lb (89 kg).
Feed Assembly	:	90 lb (41 kg).

3. WAVEGUIDE INTERCONNECTIONS

The VSWR and insertion loss of the main waveguide runs are detailed in Table 3.3-1. VSWR values apply only when the run concerned is terminated in a matched load. For actual loss values refer to commissioning test reports for appropriate sites.

Table 3.3-1

VSWR and Insertion Loss Values

Waveguide Run Designation	Section of Waveguide Run	Maximum VSWR	Maximum Insertion Loss (dB)	Frequency (GHz)
Transmit Waveguide Run	HPA to Feed	1.2	0.57	7.9 to 8.4 7.9
Receive Waveguide Run	Feed to LNR Select Waveguide Switch	1.1 1.13	0.21	7.25 7.75 7.75
	Paramp to Down Converter	1.2		7.25 to 7.75
Tracking Waveguide Runs	Feed to Filter Interface	1.2	1.0	7.25 to 7.75 7.5
	Tracking Test Input to Filter Interface	1.2	32 ±1.5	7.25 to 7.75
Test Waveguide Runs (TLT to TLT switch, and TLT switch to Paramp W/G switch	Test Loop Translator to Paramp W/G Switch	1.1	0.4	7.25 to 7.75 7.5
	Cooled Load to Paramp	1.1	0.2	7.25 to 7.75 7.5
	Test Loop Translator Load	1.05		7.25 to 7.75
	Cooled Load	1.2		7.25 to 7.75
	Cooled Load Stabilized at its Working Temperature	1.2		7.25 to 7.75

TLT Waveguide Switch Isolation = more than 60 dB

Table 3.3-1 (Cont'd) Band-Reject Filter

(see Handbook No. 504 - Paramp)

Tunable Reject Frequency (fo)	Rejection	Maximum Incident Power	Receive Frequency (fr)	Insertion Loss
7.925 to 8.375 GHz	72 dB min. over fo ±25 MHz >80 dB typically measured	+70 dBm cw	Anywhere in 7.250-7.750 GHz band with no less than 500 MHz separation from fo	0.15 dB maximum over entire receive frequency band

Image-Reject Filter

(see Handbook No. 504 - Paramp)

Tunable Frequency Passband (fo)	0.4 dB Bandwidth about fo	Rejection at fo - 115 MHz	Insertion Loss
7.275 to 7.725 GHz	±25 MHz minimum	40 dB minimum	1 dB maximum

4. WAVEGUIDE PRESSURIZATION

Air at 0.03 kg/cm^2 (0.5 p.s.i.g.). (See Spinner Handbook, No. 909.)

PART ONE

SECTION FOUR

CONSTRUCTIONAL DETAILS

1. REFLECTOR SYSTEM (Frontispiece and Figures 2.2-1 and 4.1-1)

1.1 GENERAL

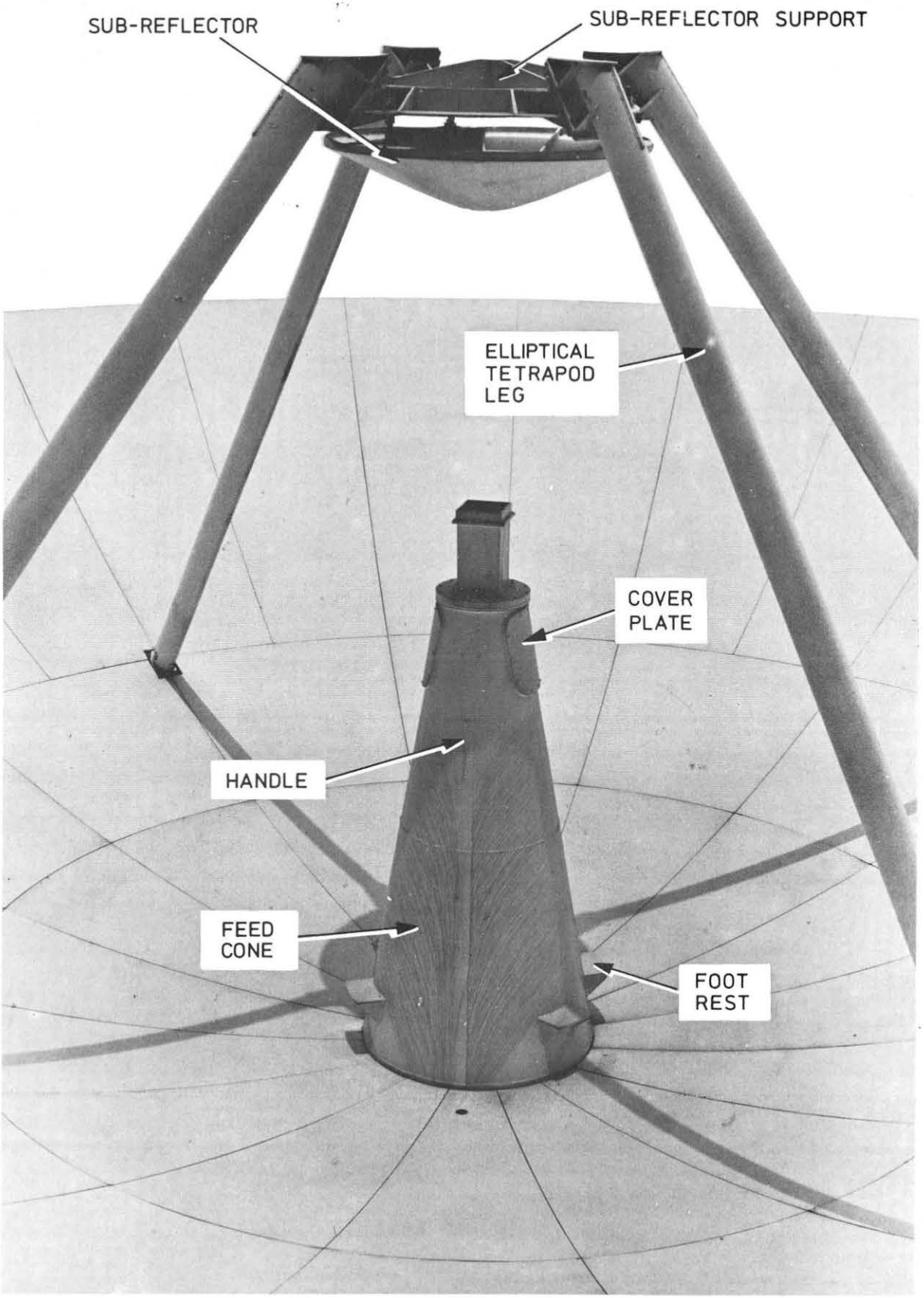
The antenna structure consists of 64 panel sections forming a reflecting surface of 12.8 m peripheral diameter as shown in Figure 2.2-1. Rigidity and support is provided by a backing structure consisting of open framework sections bolted together and centred on a hub. The main reflector paraboloid has a focal length of 4.087 m and a focal length-to-diameter ratio of 0.319 : 1.

The sub-reflector, 1.375 m diameter, is contoured to produce uniform illumination of the main reflector and is supported on a tetrapod bolted to the backing structure of the main reflector. The whole construction can be dismantled, transported and re-erected without re-adjustment by virtue of the sectionalized design, the various parts being interconnected using fitted bolts.

1.2 DESIGN FEATURES

To keep weight and inertia to a minimum, and to eliminate as far as possible the problems of differential expansion, the hub, backing structure and panels are made of aluminium.

The hub is fabricated to provide a high rigidity/weight ratio: a large recess is cut into the yoke mating face of the hub to provide accommodation for positioning the LNR and



Sub-Reflector Supported by Tetrapod

down converters within the elevation cabin. For ease of transport the hub is made in two halves. An elongated dowel hole caters for differential expansion between the aluminium hub and the steel mount.

The backing structure is designed for quick, but precise site assembly. Speed and precision are achieved by means of fitted bolts which secure the 16 sections to the hub and to each other. The sectors are made undersize and gaps between the bolting pads are set on an assembly jig and bonded with aluminium-loaded resin (Devcon F) during manufacture.

The reflector panel support brackets are designed for rigidity and precise panel setting, 25 mm of vertical adjustment being built into each bracket by means of a pair of elongated holes. These are subject to factory adjustments and are made permanent by rivetting.

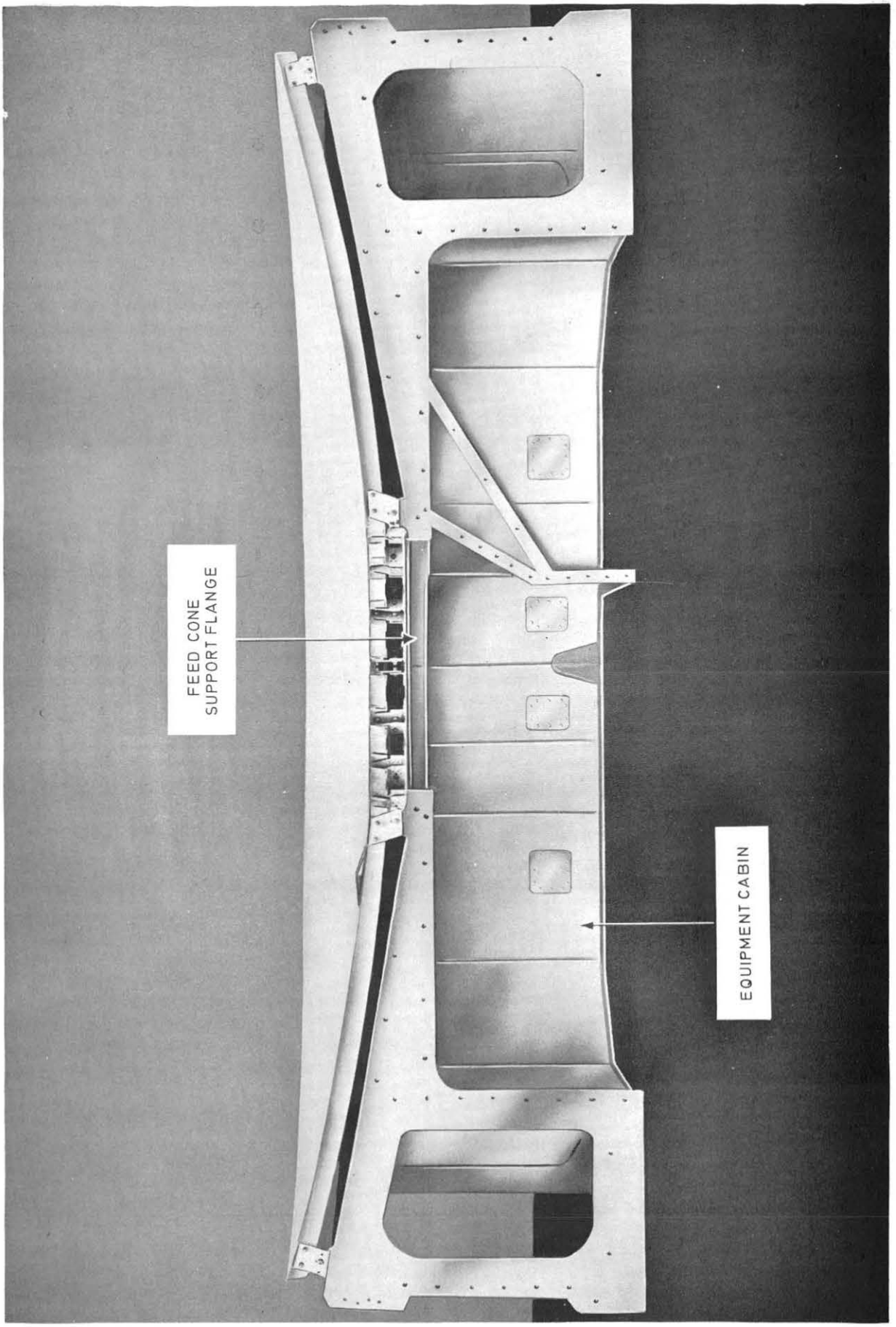
The lightweight panels (8.5 kg/m^2) are made from stretch-formed aluminium sheet, bonded and rivetted to stretch-formed aluminium sections. They are manufactured to an accuracy of 0.5 mm r.m.s. and set to give an overall reflector accuracy of 0.64 mm r.m.s. A sweep template is used in the factory for setting the panels.

The sub-reflector is an aluminium casting machined to an accuracy of 0.13 mm r.m.s. It is positioned by a cast aluminium support bracket and three threaded rods which facilitate sub-reflector alignment in all three planes. These adjustments are factory set and locked.

The tetrapod legs are made of elliptical tube approximately 200 mm by 100 mm, with a wall thickness of 6 mm. These dimensions were chosen for maximum vertical stiffness consistent with minimum obscuration.

1.3 HUB CONSTRUCTION (Figure 4.1-2)

The central hub is in two halves which are bolted together across the diameter. Each part is a welded fabrication of aluminium alloy plates, with eight inner reflecting panels permanently attached to it. The complete hub is composed of a front and rear diaphragm and the outer



Hub Half

peripheral wall connected to the inner wall by several radial webs. Part of the rear diaphragm is a rectangular flange on to which are welded aluminium pads. These pads are machined and drilled to provide the interface connection between the reflector and the elevation yoke. The front diaphragm carries the mounting flange for the feed cone. The overall hub diameter is approximately 4.8 m.

In addition to its structural functions, the hub, with the elevation yoke and the associated equipment cabin, houses the LNR and down-converter racks immediately behind the feed cone.

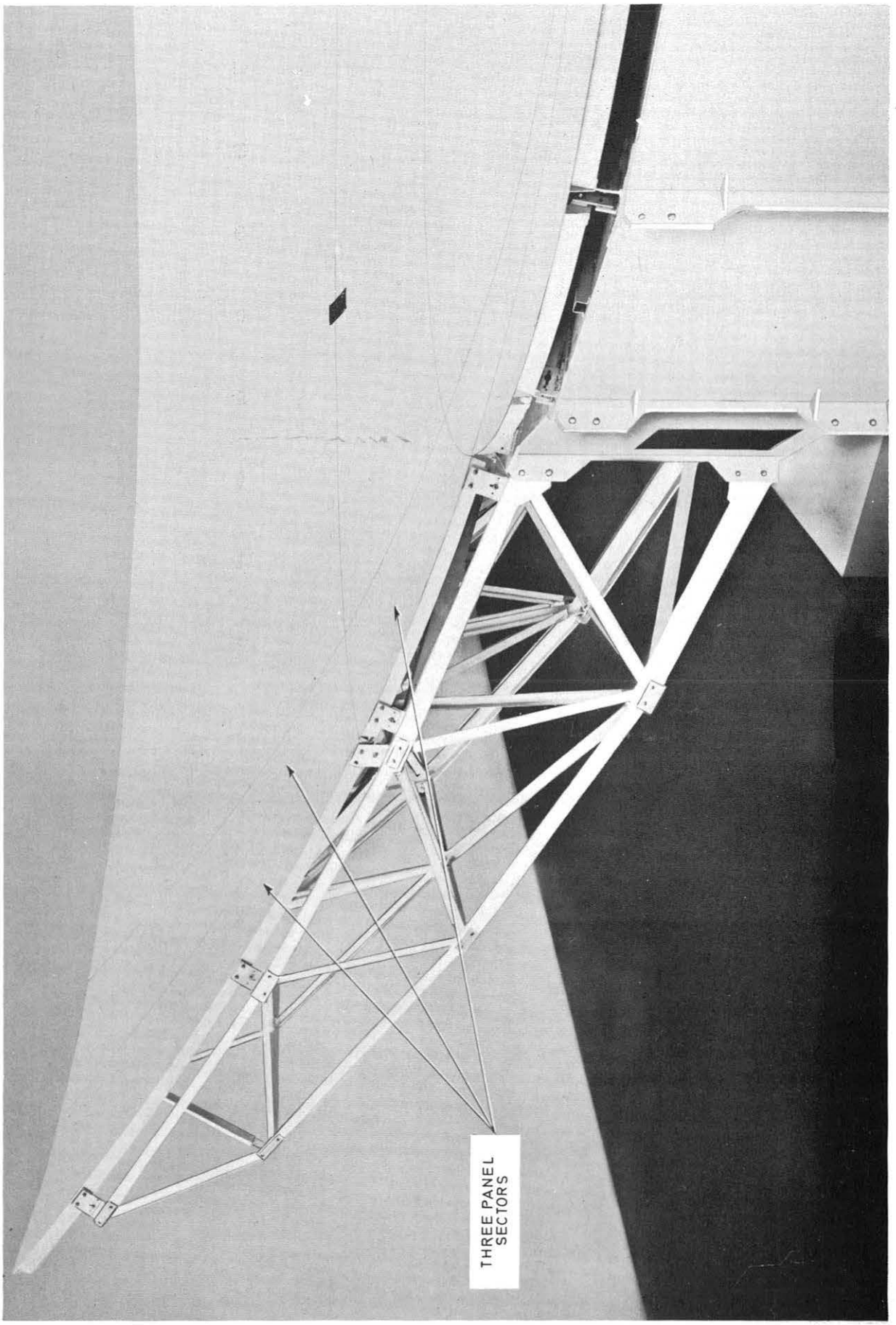
1.4 BACKING FRAMEWORK (Figure 4.1-3)

The reflector backing structure consists of an open framework 11.98 m in diameter supported from the central hub.

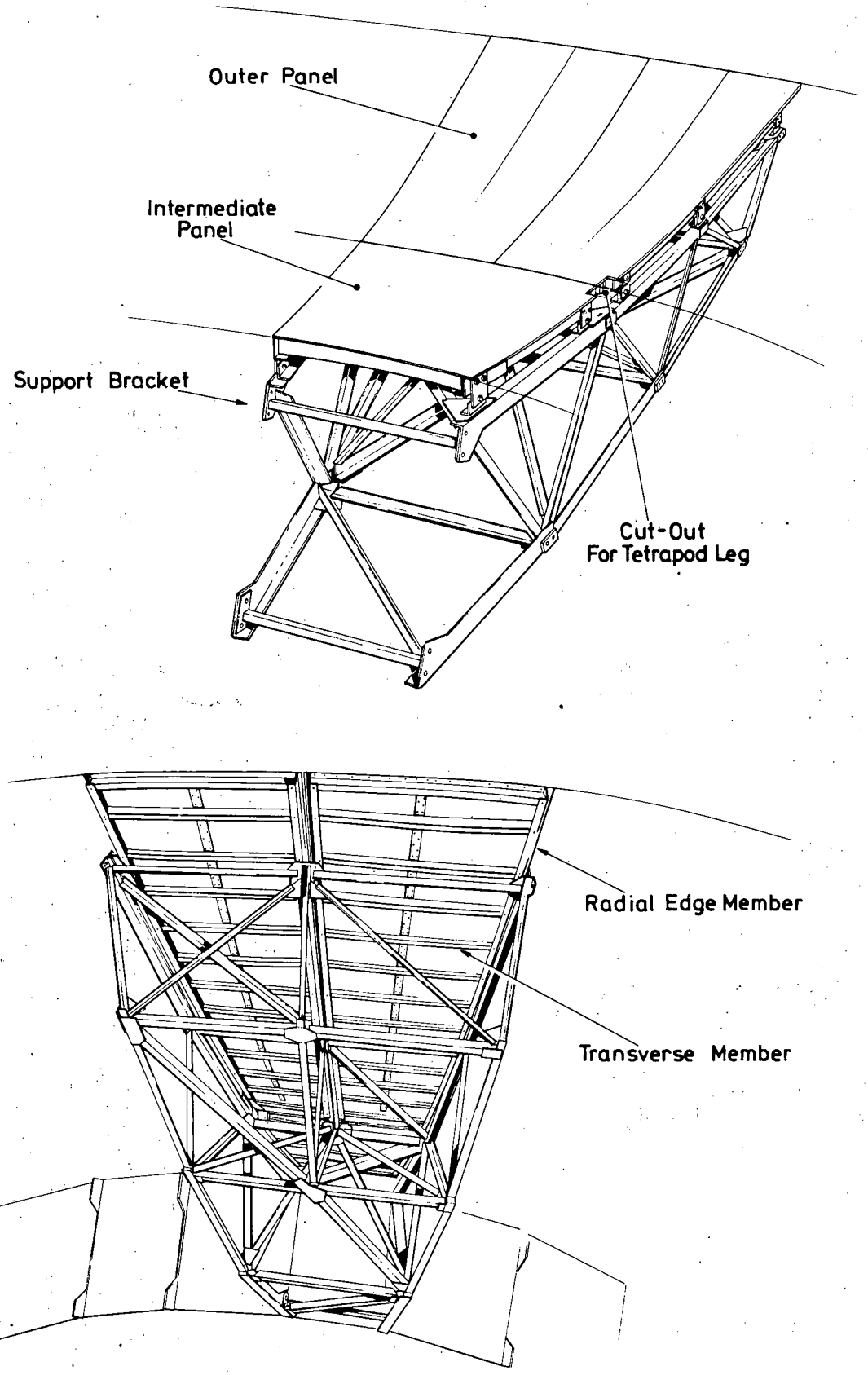
The framework comprises 16 similar segment frames, equally spaced around the hub. The framework members are made of aluminium alloy, mainly of angular section. Each segment framework consists of two radial frames with an intermediate radial frame between them, providing rigid nodes for the panel connecting links. These frames are cross-braced to provide three lattic ring girders in addition to front and rear diagonal face bracing. Each segment framework is an all-welded unit which with one intermediate and two outer segment panels forms one of the transportable sections of the antenna. When erected, the sections of the framework are connected to the hub and to each other by stainless steel fitted bolts.

1.5 PANELS AND PANEL SUPPORTS (Figure 4.1-4)

The complete reflecting surface is composed of 16 inner segment panels located over the hub, 16 intermediate, and 32 outer segment panels located over the framework of the backing structure and overhanging it by 41 cm. One intermediate and two outer panels with one of the 16 framework segments form one of the transportable sections of the antenna. Another transportable section is formed by 8 inner panels and one half of the hub. The aggregate area of the interpanel gaps is less than 0.4% of the entire reflector.



Profile of Panel Backing Structure



Panel Sector-Two Views

The panels are constructed of 1 mm aluminium alloy sheet, reinforced by two radial edge members and a number of transverse members, all of 'Z' section 75 mm deep. The reflecting sheet and the reinforcing members are stretch-formed, cut to the required shape and size, and finally bonded and rivetted together on an assembly jig. The panels are finished in matt white epoxy resin paint (DTD 5555) which effectively scatters solar radiation, so preventing the sub-reflector from becoming overheated should the antenna be pointed directly at the sun. The backing framework is coated with gloss white paint. Both finishes are hard and normally last at least ten years.

The main reflector panels are bolted to the backing structure by a system of support brackets which are positioned at the rigid nodes formed by the backing framework near the periphery of each panel. The system gives firm support, having high rigidity normal to the surface, while allowing for fine adjustment when the panels are being set in the factory. After setting, the adjustment is locked by drilling and rivetting.

1.6 SUB-REFLECTOR AND TETRAPOD (Figures 2.2-1 and 4.1-1)

The sub-reflector is a modified hyperboloid with a circular aperture 1.375 m diameter, and approximately 0.31 m deep. It is an aluminium alloy casting, machined to give the required profile, the surface is coated in a similar manner to the main reflector with durable matt white paint (DTD 5555), which effectively scatters reflected solar radiation.

The sub-reflector is attached to a tetrapod support casting by three screwed rods with spherically seating nuts which, with slotted interface flanges, permit fine adjustment in all planes. These adjustments are made and locked in the factory. The tetrapod legs are tubes of aluminium alloy, elliptical in section and measuring approximately 200 mm by 100 mm with a wall thickness of 6 mm. Their major axes point inwards to minimize obscuration. At the top, each of the legs terminates in a rectangular flange which is fastened to the support casting by six bolts, two of which are close-fitting, to provide accurate location.

The feet of the tetrapod are supported on four of the radial frames of the main reflector backing structure. Each tube terminates in an aluminium alloy plate, into which is fitted a stainless steel spherical bearing. This is connected by a stainless steel pin to an aluminium alloy casting bolted to the radial frame. The bearings permit the tetrapod legs to be adjusted before being locked in their correct position.

In a similar manner to the main reflector backing structure, the tetrapod support structure is finished in gloss white epoxy resin paint to minimize heat distortion by reflecting solar radiation. Tubular members are sealed to resist corrosion.

1.7 FEED SUPPORT CONE (Figure 4.1-5)

The feed cone supports the feed from the centre of the reflector hub. The top provides the fixing flange for the feed while the base is bolted and dowelled to the front diaphragm of the hub. The flange at the cone base allows the cone to be removed from the reflector surface without removing any panels.

The lower section of the feed support structure is a cylinder of 6 mm aluminium alloy, 1.1 m in diameter and 160 mm long. It protrudes through the reflector surface and is welded to a conical section 4.7 mm thick which tapers up to the feed mounting flange. Overall it is 2.35 m long and weighs 85 kg.

Two apertures in the cone provide access to the comparator assembly inside. When not in use each is concealed behind a cover plate which is screwed in place. Four foot rests and four hand grips are fitted on the cone to allow access for installation and maintenance.

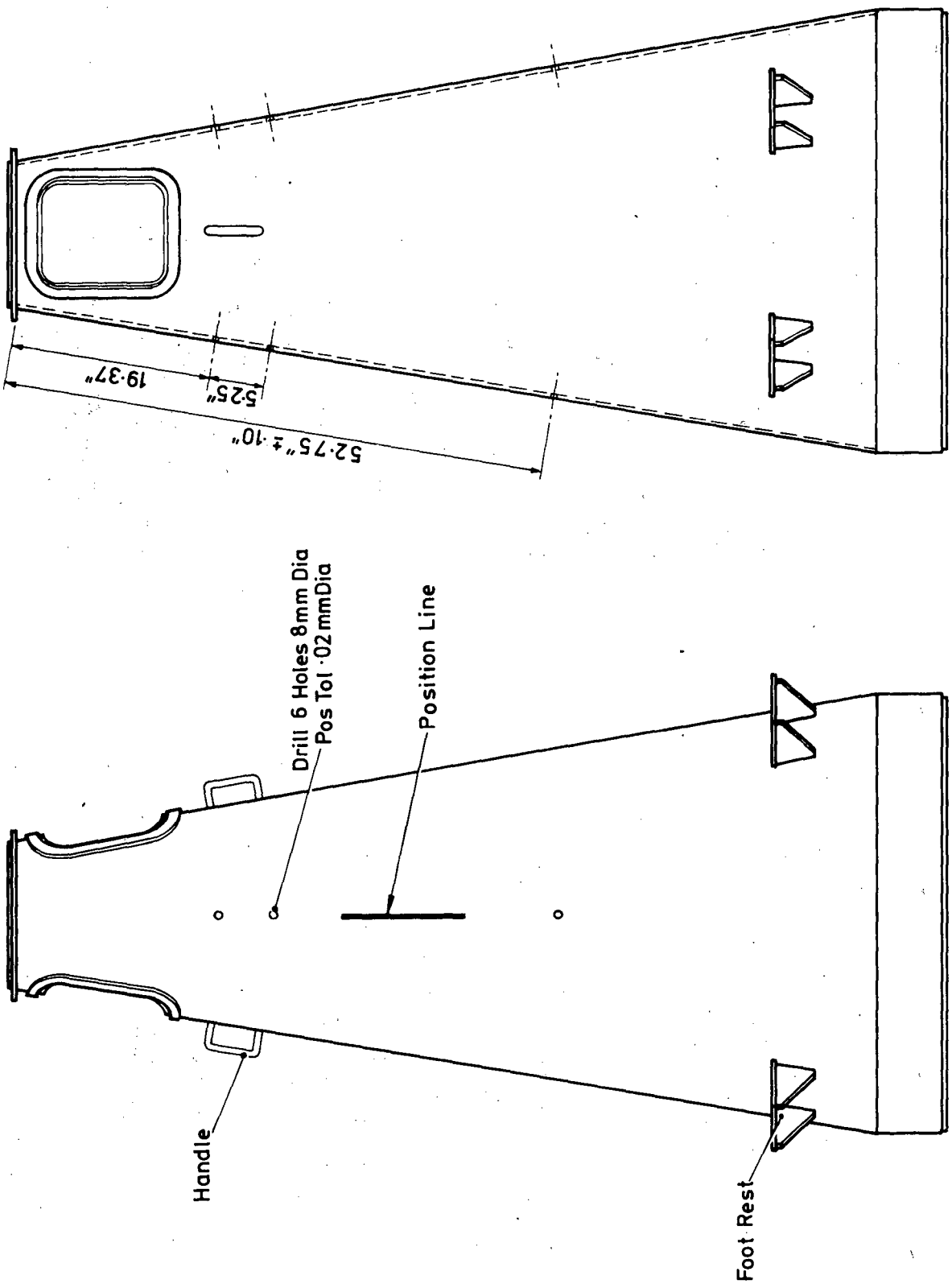
2. FEED ASSEMBLY (Figure 4.2-1)

2.1 GENERAL

The feed assembly is formed by the following main sub-assemblies:

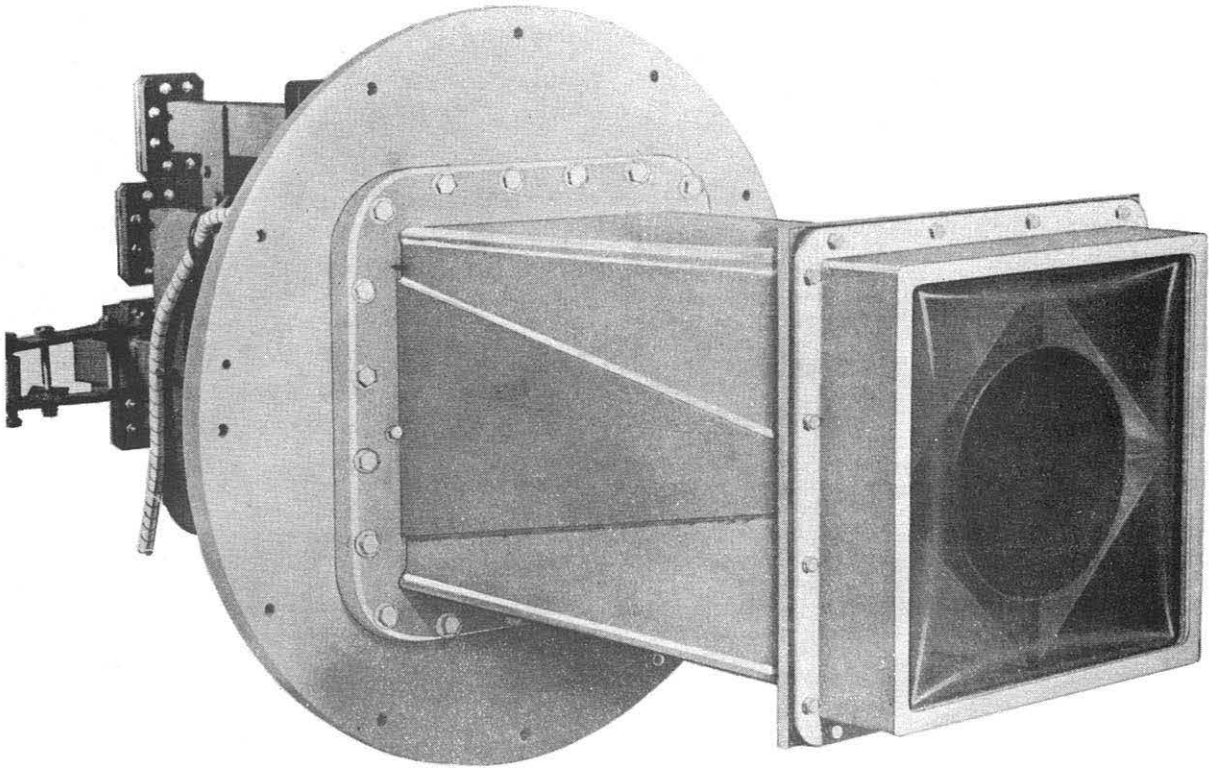
Feed horn assembly (Figure 4.2-2)

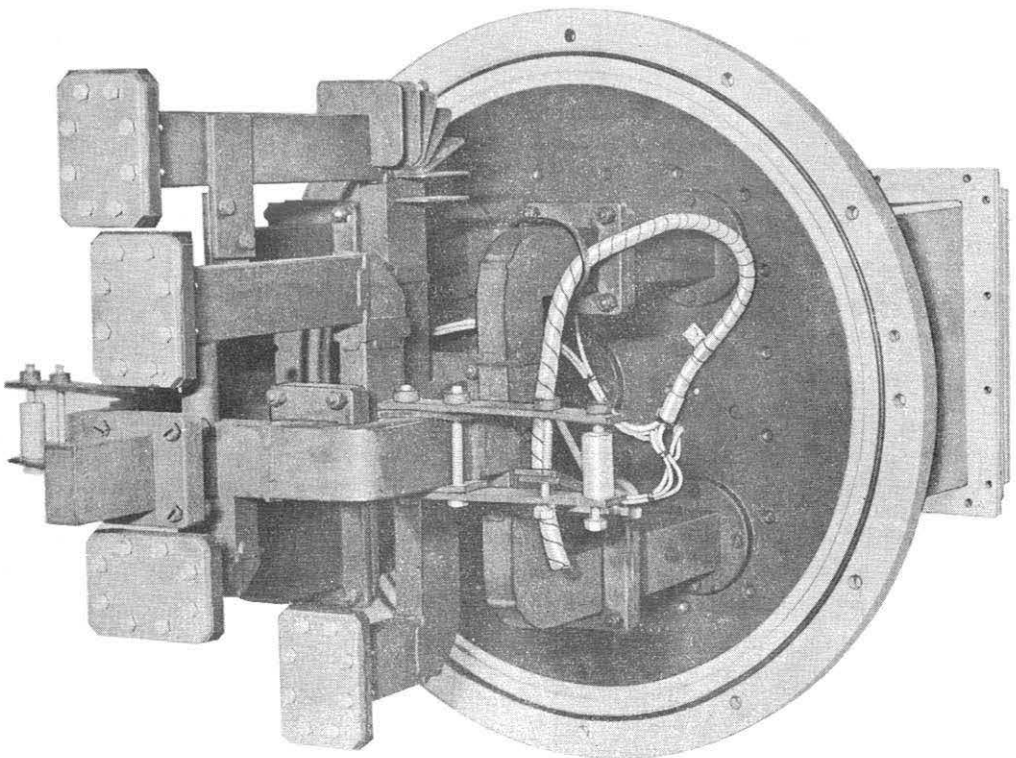
Horn radome (Figure 4.2-3)



Feed Cone

Fig. 4.1-5





Communications Feed

Fig. 4.2-1

Interface plate (Figure 4.2-4)

Polarization duplexers (Figure 4.2-5)

Comparator assembly (Figure 4.2-6)

The complete assembly, shown in Figure 4.2-1, is mounted on the top of the feed support cone (see sub-section 1.7), and is connected by waveguides to the transmitting and receiving equipment in the antenna cabins.

2.2 FEED HORN ASSEMBLY (Figure 4.2-2)

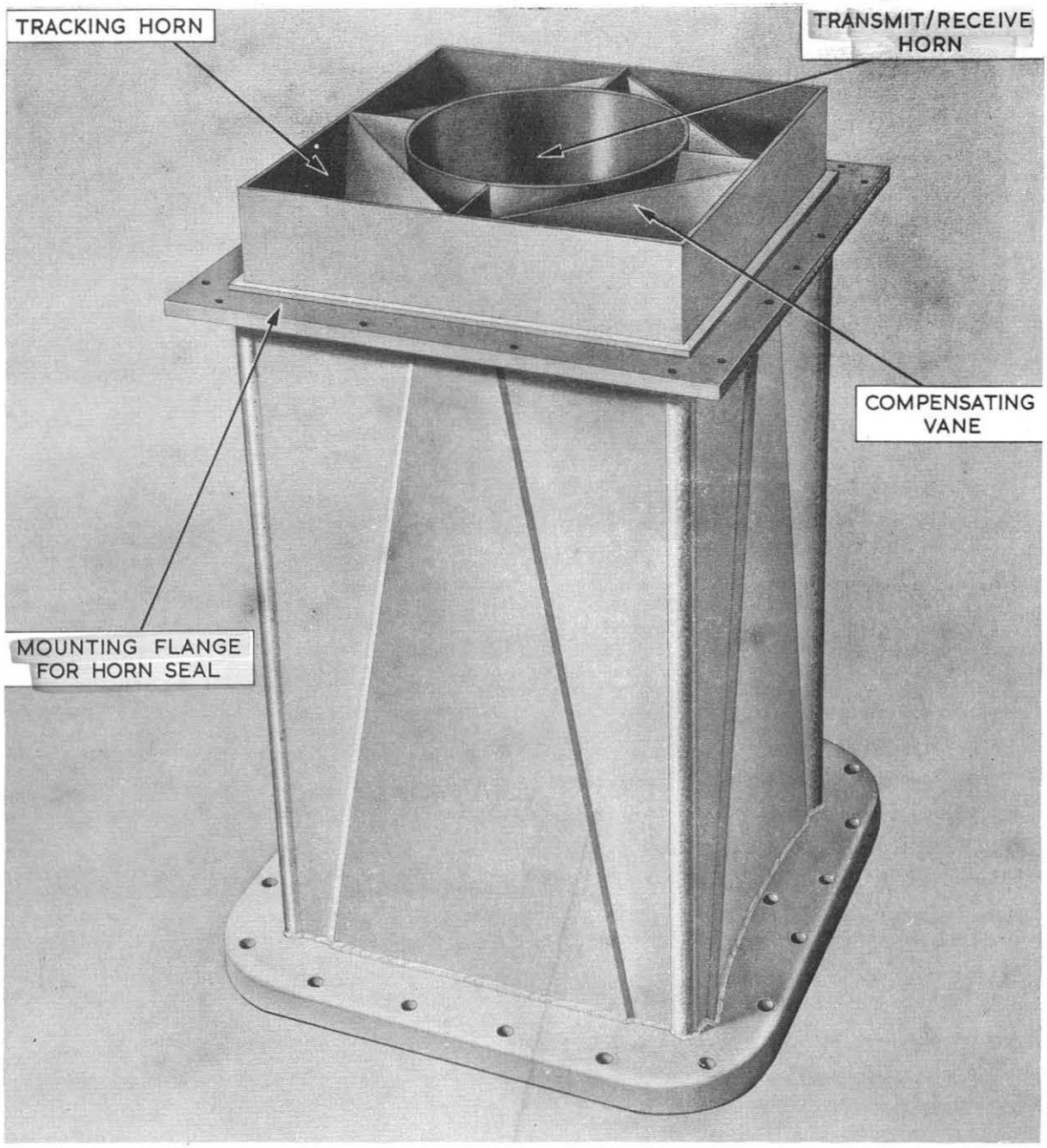
The central communications horn and the four tracking horns are separately electro-formed from copper, and silver soldered together on a brass mounting flange to form the complete assembly. All four tracking horns terminate in square waveguide to interface with the polarizers; the circular communication horn requires a transition before the interface. The four tracking horns contain diagonal dielectric vanes to compensate for their asymmetrical shape, which would otherwise distort the circularity of the polarization.

2.3 HORN RADOME (Figure 4.2-3)

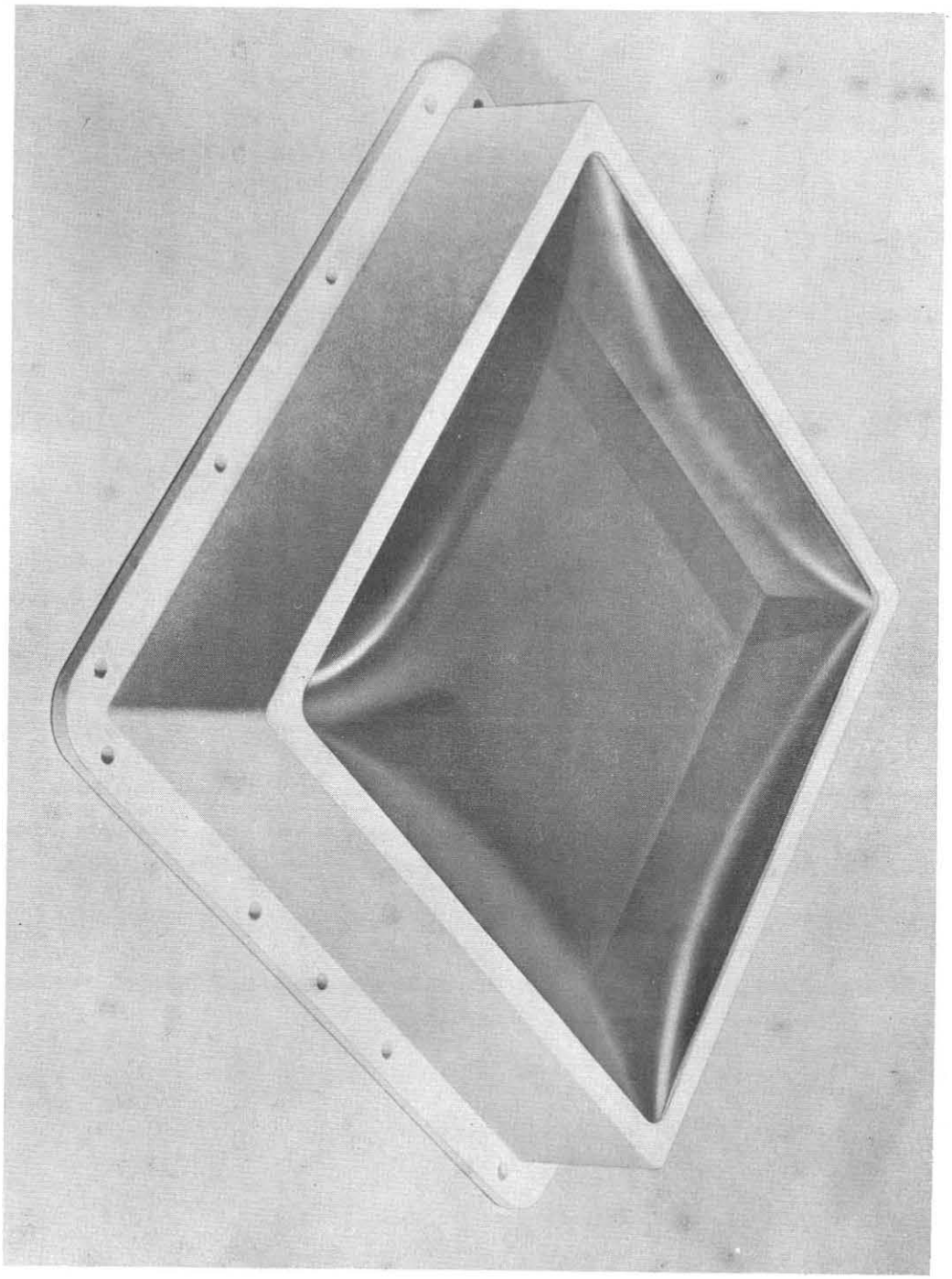
The radiating aperture of the horn assembly is closed by a small radome, consisting of a frame and window. The frame is a square, rigid, fibreglass pressing, which is screwed to a flange near the outer end of the horn assembly. The window is cut from Kapton 500 H sheet, chosen for its low-loss characteristics and resistance to ultra-violet radiation. The radome seals the front end of the horn assembly against internal air pressure of up to 1 p.s.i., and under the normal working pressure of 0.5 p.s.i., it bows outwards into a slightly convex shape. This is an essential feature of the design, as it destroys the phase coherence of the residual reflections from the window, and prevents the occurrence of a significant frequency-dependent effect on feed isolation.

2.4 INTERFACE PLATE (Figure 4.2-4)

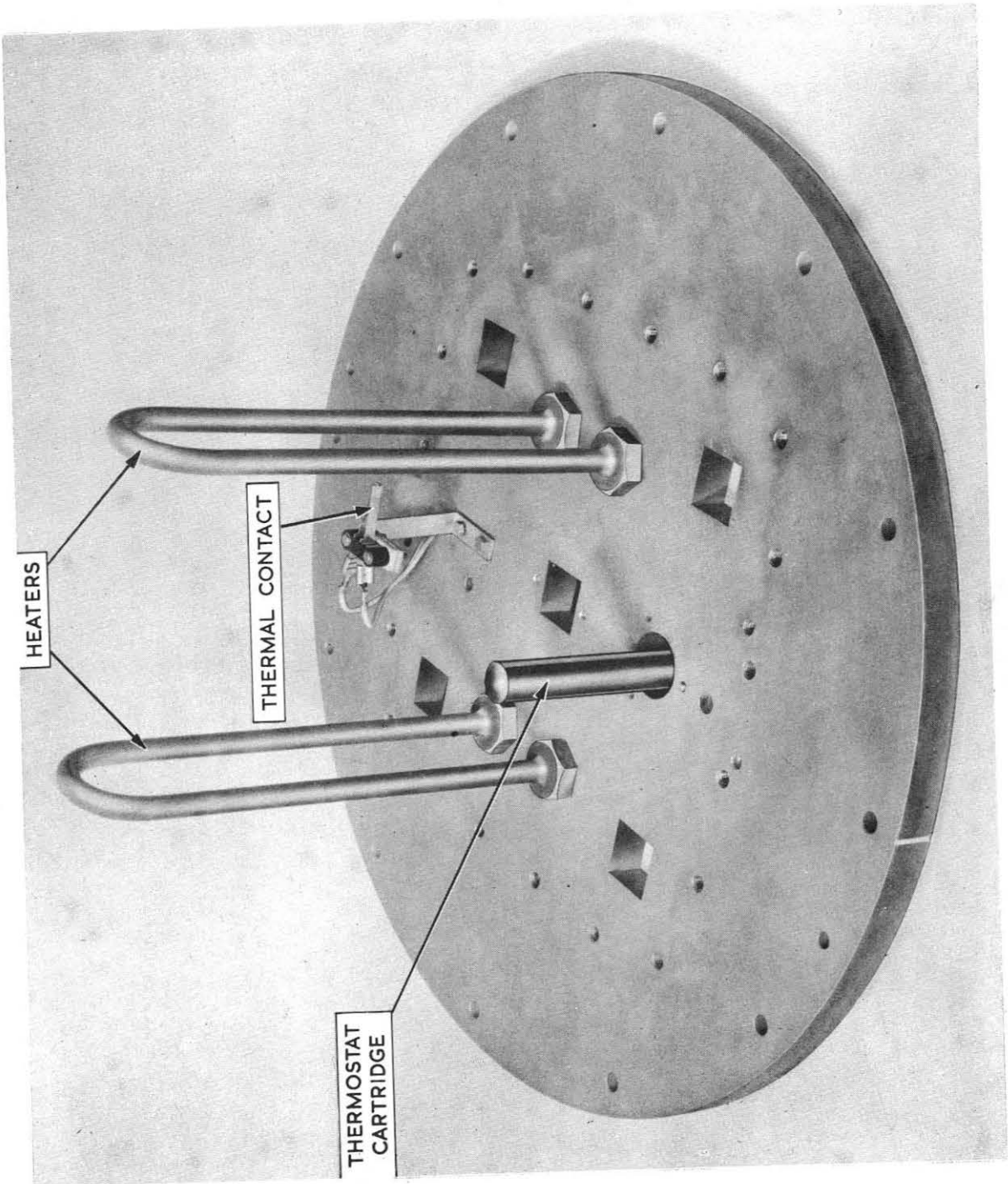
The interface plate acts as the base upon which the whole feed assembly is built up and is made from a disc of anodized aluminium. The horn assembly is mounted on one side of the plate, with the five square waveguide outlets from the



Feed Horn Assembly



Horn Seal and Radome



Interface Plate Showing Feed Heater Components

Fig. 4.2-4

horn accurately aligned with five square machined apertures in the plate. The five polarization duplexers are bolted to the other side of the plate, again in alignment with the square apertures. The interface plate also carries the feed heater elements, thermostat, and thermal cut-out.

The joints between the waveguide components and the interface plate are double sealed, using rubber rings and a special sealing paint applied after assembly. The fixing bolts are all located outside the rubber seals.

2.5 POLARIZATION DUPLEXERS (Figure 4.2-5)

The polarization duplexers, one for each horn, are mounted immediately behind the interface plate and are bolted to it. In manufacture, the septum is machined from copper and the square section casing electro-formed around it. Thus at one end, the waveguide port is square (2.33 cm) while the septum divides the other end into two isolated rectangular ports, which are then transformed to WR112. Brass flanges are silver-soldered to each end.

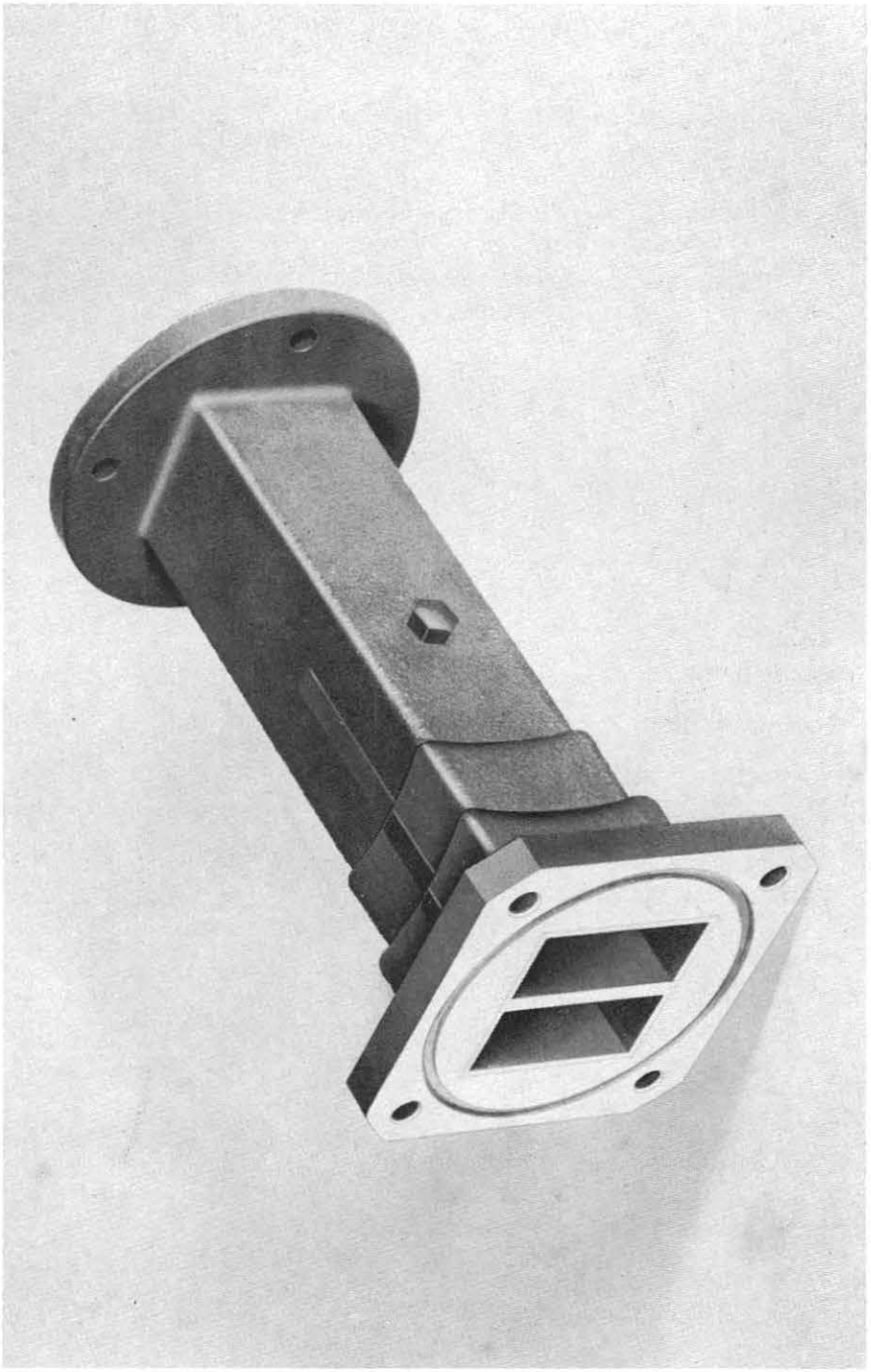
2.6 COMPARATOR ASSEMBLY (Figure 2.3-4)

The output from each polarizer is fed to a conventional comparator network to provide azimuth and elevation error signals. The comparator assembly is mounted immediately behind the duplexers and forms part of the feed assembly. It is made from investment castings using a copper-based alloy.

3. WAVEGUIDE INTERCONNECTIONS

The four waveguides from the feed pass down the feed support cone and through a heat shield into the elevation cabin. The heat shield is used to isolate the interior of the feed support cone, which has no thermal lagging, from the lagged and air-conditioned cabins; without it, cold air from the feed cone could impose an excessive load on the air-conditioning system in very cold weather.

To overcome differential expansion problems, the main receive waveguide includes a short flexible section situated half-way along the feed cone. The transmit waveguide has one flexible section located at the interface between the elevation and azimuth cabins.



Polarization Duplexer

The tracking waveguide runs have no flexible sections since their layout allows for expansion without undue stress.

Within the elevation cabin, waveguides link the various receiver and test units in the most direct manner practicable. The transmit waveguide passes via a flexible section (to allow 0-90° elevation movement) into the azimuth cabin, and then to the high-power waveguide switch between the two transmitters. Separate waveguide runs within the azimuth cabin connect each IPA unit to the HPA inputs.

In both cabins, and within the feed cone, waveguides are supported at carefully chosen points to minimize stresses. The transmit waveguide, where it passes between the two cabins, is protected by metal shields; this serves the dual purpose of protecting the otherwise exposed waveguide from damage, and protecting personnel from accidential contact with hot surfaces. (It is possible for parts of the run to reach uncomfortably high temperatures when transmitting maximum power.)

Throughout the waveguide interconnections, with certain exceptions identified below, rolled-edge copper gaskets are used between each pair of flanges, to provide both a pressure seal and an r.f. seal. The gasket must be renewed whenever a flange pair is re-assembled, as the gasket is distorted under pressure and will not seal correctly a second time.

Exceptions to the use of copper rolled-edge gaskets are as follows:

a. UG51 flanges require Metex gaskets (Monel mesh embedded in a silicone compound). These gaskets are re-usable if handled with care.

b. Other interfaces between dissimilar metals require chrome-plated rolled-edge gaskets. They are not re-usable.

The waveguide sub-assemblies are identified in detail in Part Three, Section Two.

4. SPECIAL HANDLING INSTRUCTIONS

These are given in Part One, Section Five.

PART ONE

SECTION FIVE

INSTALLATION AND COMMISSIONING

1. INTRODUCTION

The 12.8 m reflector is relatively easy to transport and erect by virtue of its sectionalized design, the various parts being inter-connected by fitted bolts. It arrives on site in the following packages:

a. Two halves of the hub, each with eight inner panels.

b. Sixteen sectors of backing structure, each with one inner and two outer panels.

c. Four legs, the sub-reflector, the sub-reflector support and the feed cone.

The equipment which is assembled and set in the factory is made mainly from light aluminium alloy. As the reflector profile is set to very close limits, the greatest care must be taken in handling and fitting. The reflector surfaces are constructed from 1 mm sheet aluminium alloy and are particularly vulnerable. The segment assemblies are numbered sequentially for ease of erection. When lifting these assemblies using slings, the slings must be kept clear of the reflecting surface and of the edges in particular. Special bracket assemblies, W 3018308 and lifting strap X 3018311 are provided for this purpose.

2. ASSEMBLY PROCEDURE

2.1 PREPARATION (Figure 5.2-1)

a. Ensure that a suitable area is cleared for the assembly of the reflector and that allowance is made for crane manoeuvres during this and the

subsequent lifting on to the elevation yoke. Meanwhile, commence erection of the communications feed and feed cone (see sub-section 2.4).

b. Mark out a rectangle 3.5 m x 2.4 m, the maximum inside dimensions of 16 cross baulks of timber (Figure 5.2-1) used to support the hub (Figure 5.2-2). Ensure that, where baulks of timber are placed, the ground surface is as level as possible. A spirit level and wooden wedges can be used to level the base.

2.2 HUB (Figure 5.2-2)

a. Unpack and inspect the two halves of the hub and clean the mating surfaces; recommended cleaning fluid is Petroleum spirit 60/80 grade. Using the sealing compound supplied (Bostik 692) deposit three 5 mm bands of sealant around the outer periphery of these faces (Figure 5.2-3) approximately 2 mm thick.

b. Lift half hub 1 on to the baulks of timber using the lifting gear supplied (Figure 5.2-4).

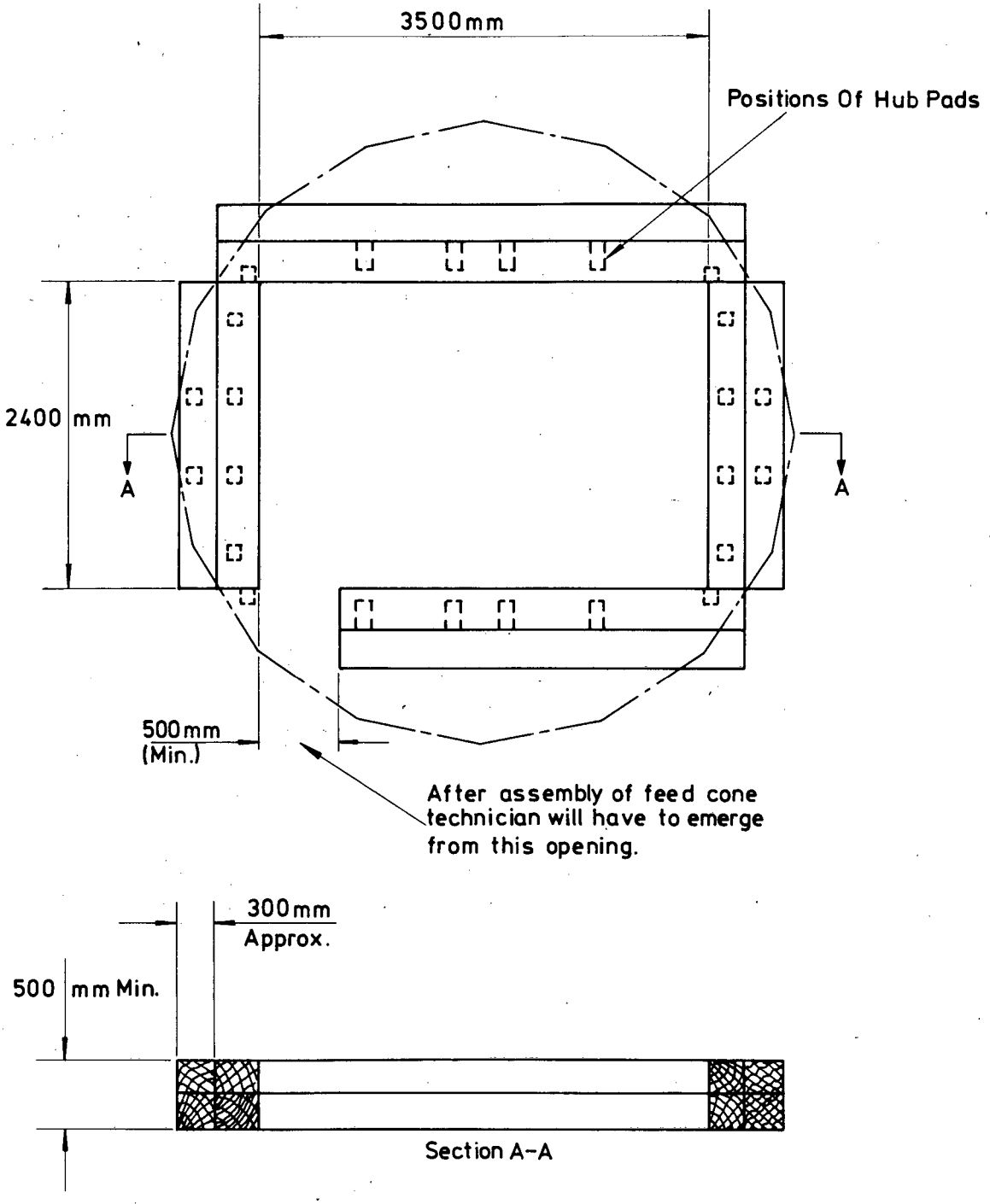
c. Insert the pivot pins through the bottom flange holes in the half hub 1 (Figure 5.2-2).

d. Lift half hub 2 on to the baulks of timber to bring the mating faces 15 cm apart.

NOTE: When lifting half hub 2, it is essential that the bolts securing the lifting tackle to the hub are inserted as shown in Figure 5.2-2, Inset 2, so that they can be withdrawn after the two halves have been aligned.

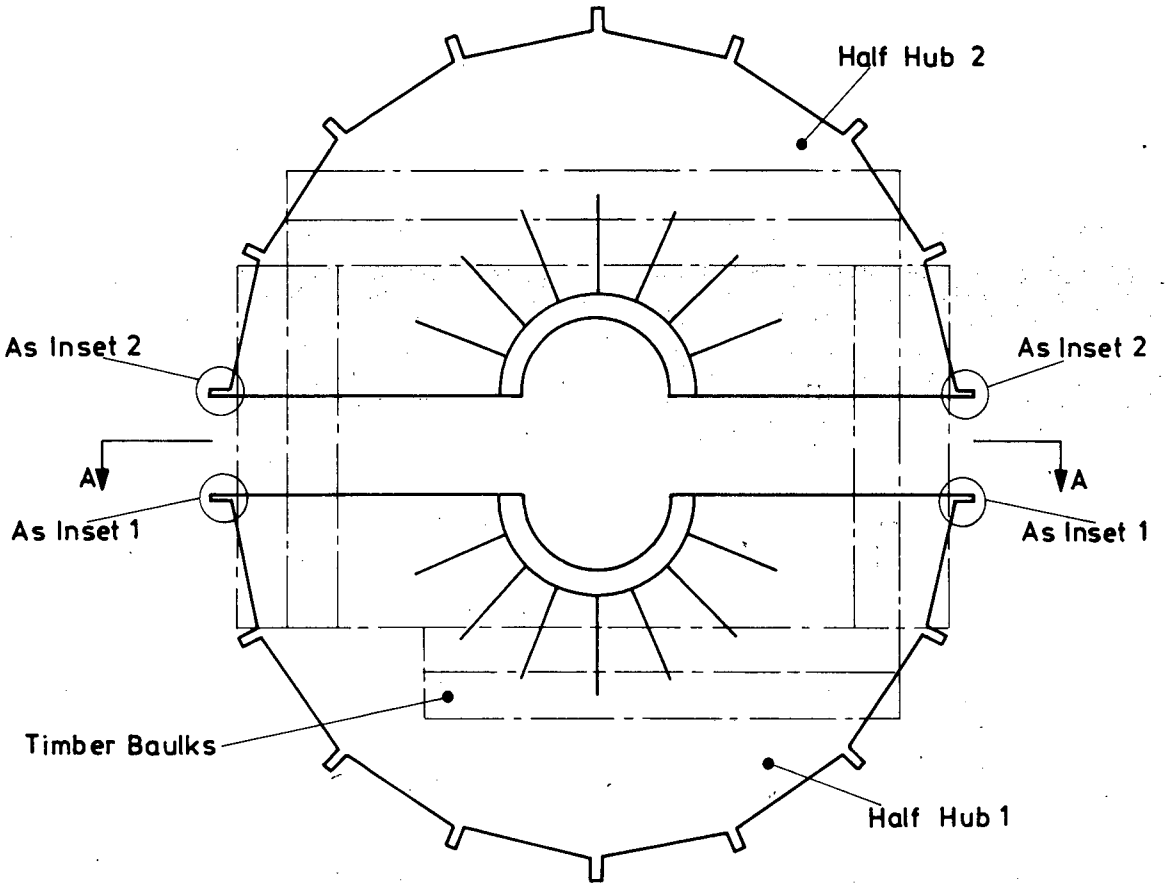
e. With the slings supporting the weight of the half hub 2, carefully align the two halves of the hub until they are about 5 cm apart and locate the pivot pins in the corresponding flanges of half hub 2.

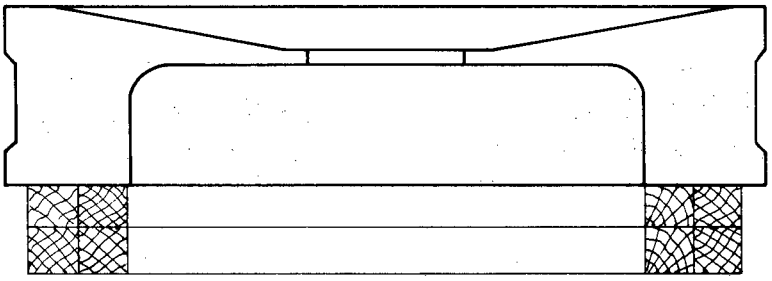
f. Release and remove the lifting tackle.

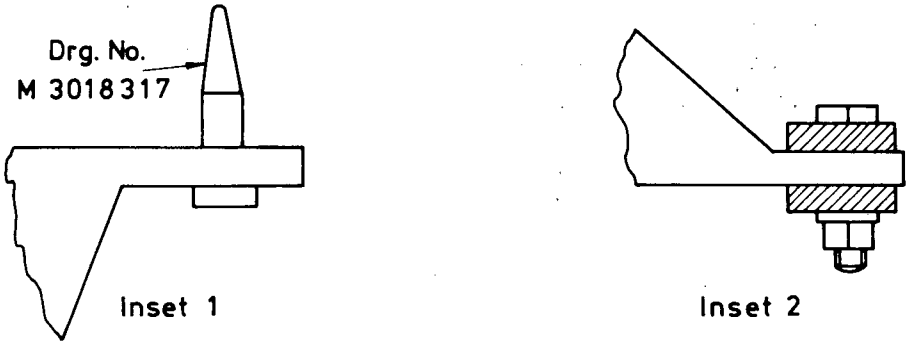


Timber Baulks

Fig.5.2-1

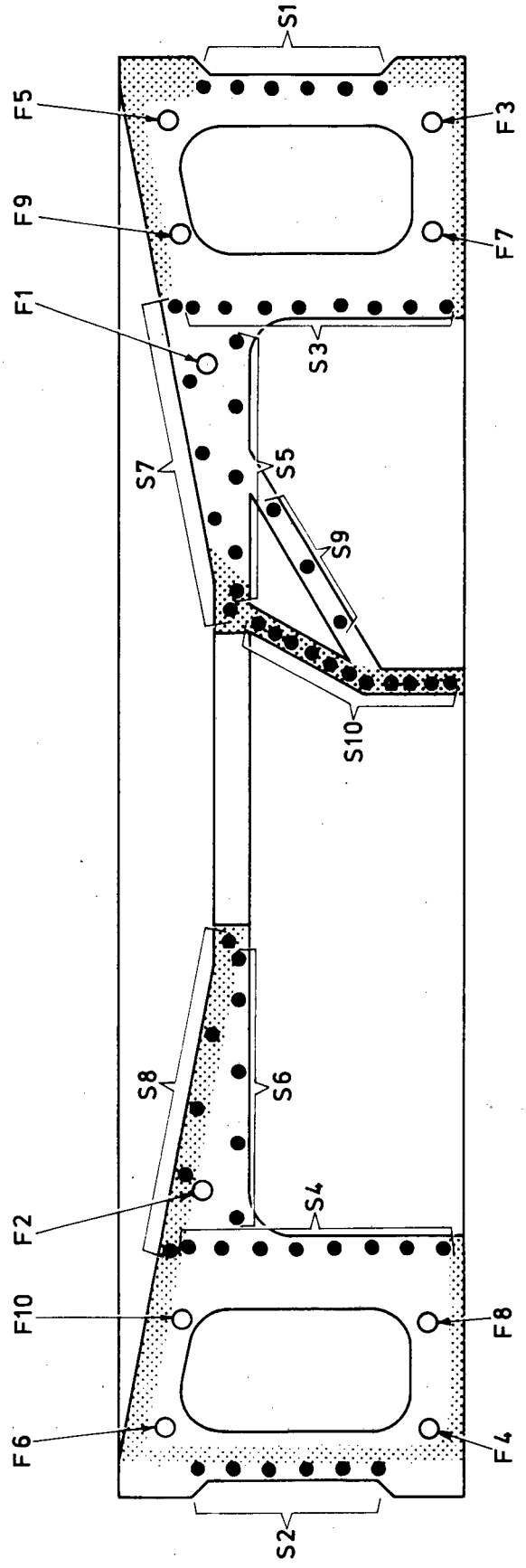






Hub Halves

Fig. 5.2-2



● Approximate position of standard bolts for joining the hub halves (62-off)

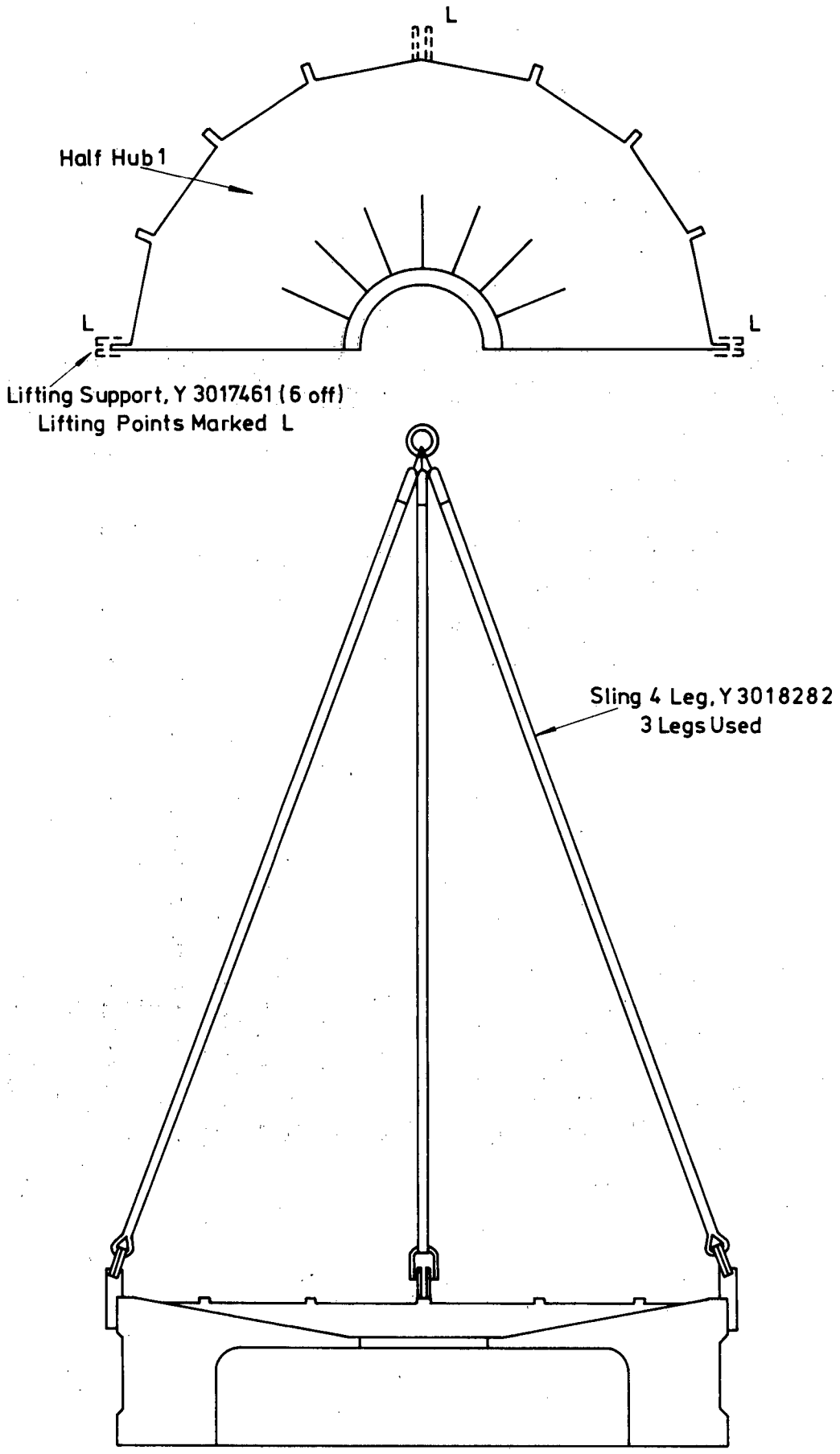
○ Fitting bolts (10-off)

▨ Three 5mm bands of sealing Bostic 692

Tighten bolts in order shown, 'F' numbers first, 'S' numbers second.

Hub, Cross-Section View

Fig 5.2-3



Hub and Lifting Slings

Fig.5.2-4

g. With the use of hand clamps draw the two halves of the hub together. To ensure correct alignment, insert a pivot pin in one fitted bolt hole on each side of the hub (Figure 5.2-3). Insert and assemble the 18 mm fitting bolts (F) and the 16 mm standard bolts (S) in accordance with the numbering system given in Figure 5.2-3.

CAUTION: IT IS ESSENTIAL TO AVOID THE USE OF FORCE DURING THE INSERTION OF FITTING BOLTS AT ANY STAGE IN THE ASSEMBLY.

Tighten the bolts in the order stated to the torque values in Figure 5.2-7.

2.3 REFLECTOR

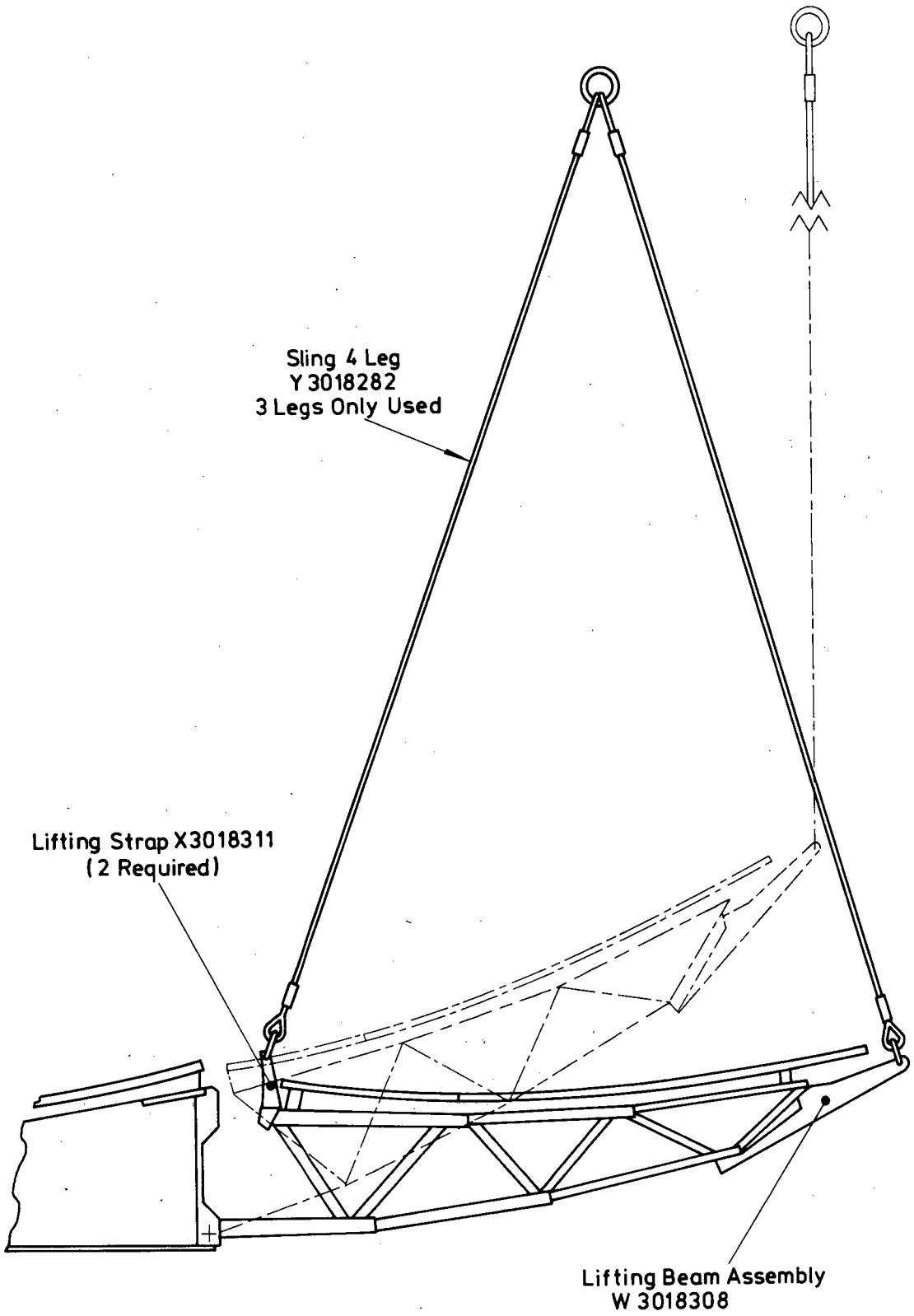
CAUTION: PERSONNEL ARE PROHIBITED FROM WALKING ON THE SURFACE OF THE REFLECTOR UNLESS IT IS ESSENTIAL, IN THIS EVENT SOFT RUBBER-SOLED SHOES ARE TO BE WORN, AND PERSONNEL SHALL ONLY WALK ABOVE THE PANEL RIBS.

a. Unpack and inspect the segment assemblies numbered 1 and 9, using the special lifting gear and slings provided (Figure 5.2-5).

b. Lift segment 1 and align the bottom holes in the front legs with the bottom fixing holes in hub segment 1, using the pivot pins. The numbers painted on the hub correspond to similar numbers painted on the segments.

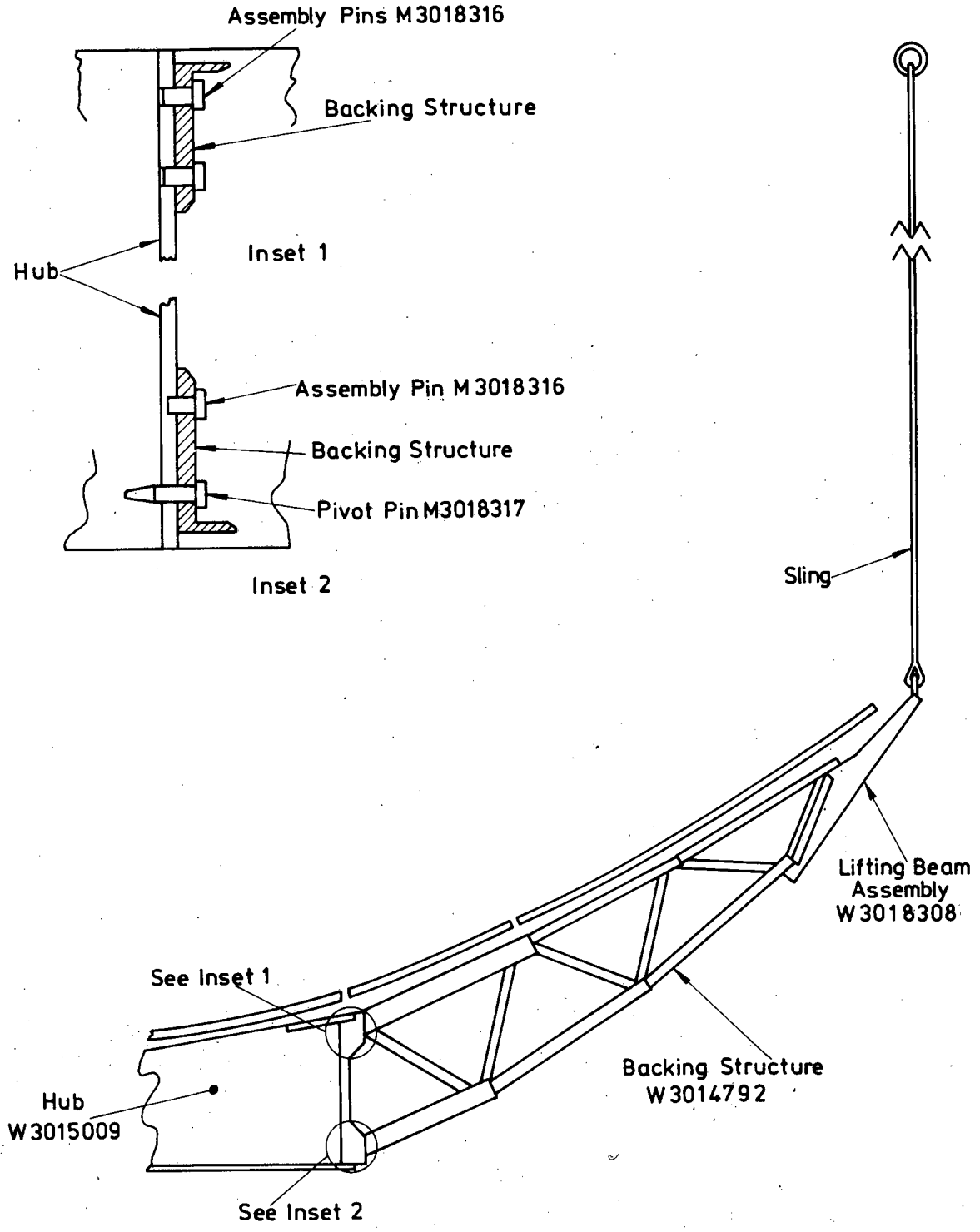
c. Push the pins through from the inside of the segment into the hub flanges.

d. Release the inner lifting strap. With the outer sling still bearing the load and with the segment pivoting about the bottom inner pins, lift it to bring the fitting bolt holes in the upper hub flanges into line. Insert the assembly pins. (See Figure 5.2-6 Insets 1 and 2).



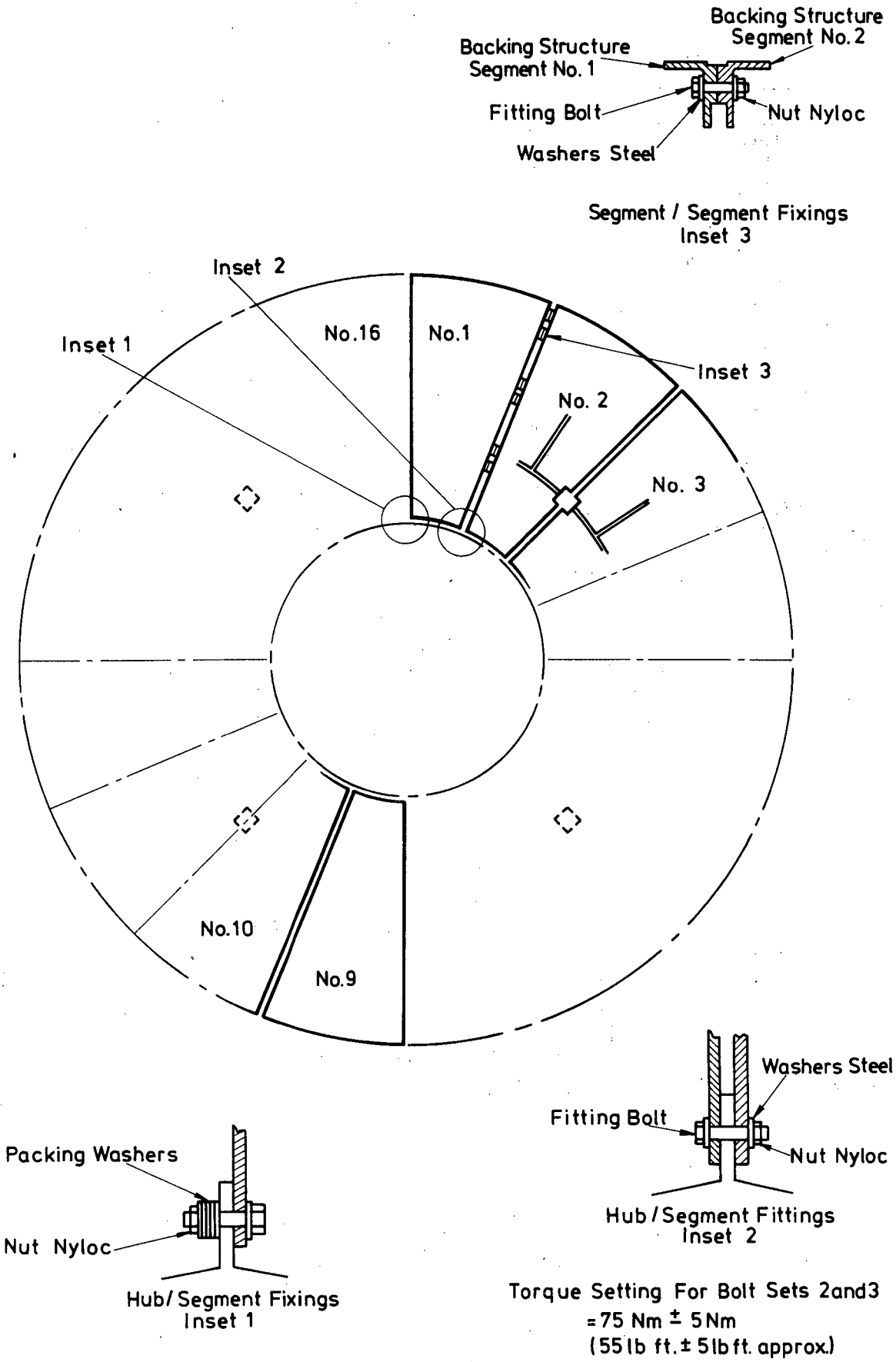
Lifting Sling Arrangement (1)

Fig. 5.2-5



Lifting Sling Arrangement (2)

Fig.5.2-6



Reflector Segment Locations

Fig. 5.2-7

e. Remove one fitting pin from segment 1 on the side adjacent to where segment 16 will be installed, and substitute a 22 mm fitting bolt and nut (Figure 5.2-7, Inset 1). DO NOT TIGHTEN. Repeat until all the pins on this side of the segment have been replaced. Support the segment by placing a wooden pole under the edge of the top centre bracket of the segment, to prevent possible distortion of the segment or the hub during installation.

f. Remove the slings and lifting gear.

g. Repeating the procedure given in a. to f., lift segment 9 and position it diametrically opposite segment 1, substituting fitting bolts and nuts for the assembly pins between segment positions 8 and 9.

h. Partially withdraw the pivot pin between segments 1 and 2, to prevent it from protruding beyond the hub flange. Lift segment 2 as detailed in a. to d.

j. In the hub flange separating segments 1 and 2, remove one fitting pin and substitute a 22 mm fitting bolt and nut. Repeat until all the pins between these two segments have been replaced. Tighten the bolts to the torque settings in Figure 5.2-7, Inset 2.

k. Proceed down the segment faces and assemble the 18 mm and 16 mm fitting bolts to each of the six pads (Figure 5.2-7, Inset 3).

m. Support segment 2 with a wooden pole and remove the outer slings.

n. Repeat the procedure in paragraphs h. to m. with segments 10, 3, 11, 4, 12, 5, 13, 6, 14, 7 and 15 in that sequence. The reflector is now complete except for segments 8 and 16.

p. Before fitting these two last segments, remove the fitting bolts in the segment-to-hub joints between segments 8 and 9, and 1 and 16, replacing them with the special assembly pins (see Figure 5.2-6).

q. Assemble segments 8 and 16, fitting the permanent bolts when the segments are in position.

r. Inspect the work so far carried out to ensure that all nuts are tightened to their correct setting (see Figure 5.2-7), and that all panel edges are aligned with the edges of adjacent panels.

2.4 COMMUNICATIONS FEED AND CONE ASSEMBLY

a. Unpack and inspect the Communications Feed and Cone Assembly.

NOTE: This work is to be carried out under cover, during the time that the reflector segments are being installed.

b. Mount the cone in a horizontal position on the ground. Support on timber blocks.

c. Check that the channel bracket bolt holes have been drilled in each side of the cone. Install the channel bracket (see Figure 4.1-5).

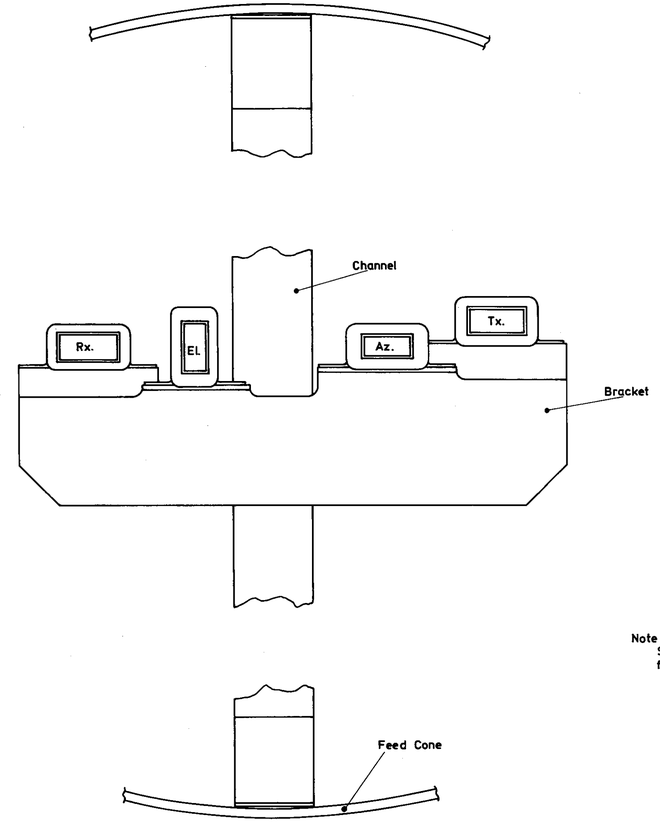
NOTE: Cone No. 1 to No. 7 bolt holes may not have been drilled, in which case the bolt holes should be drilled on site.

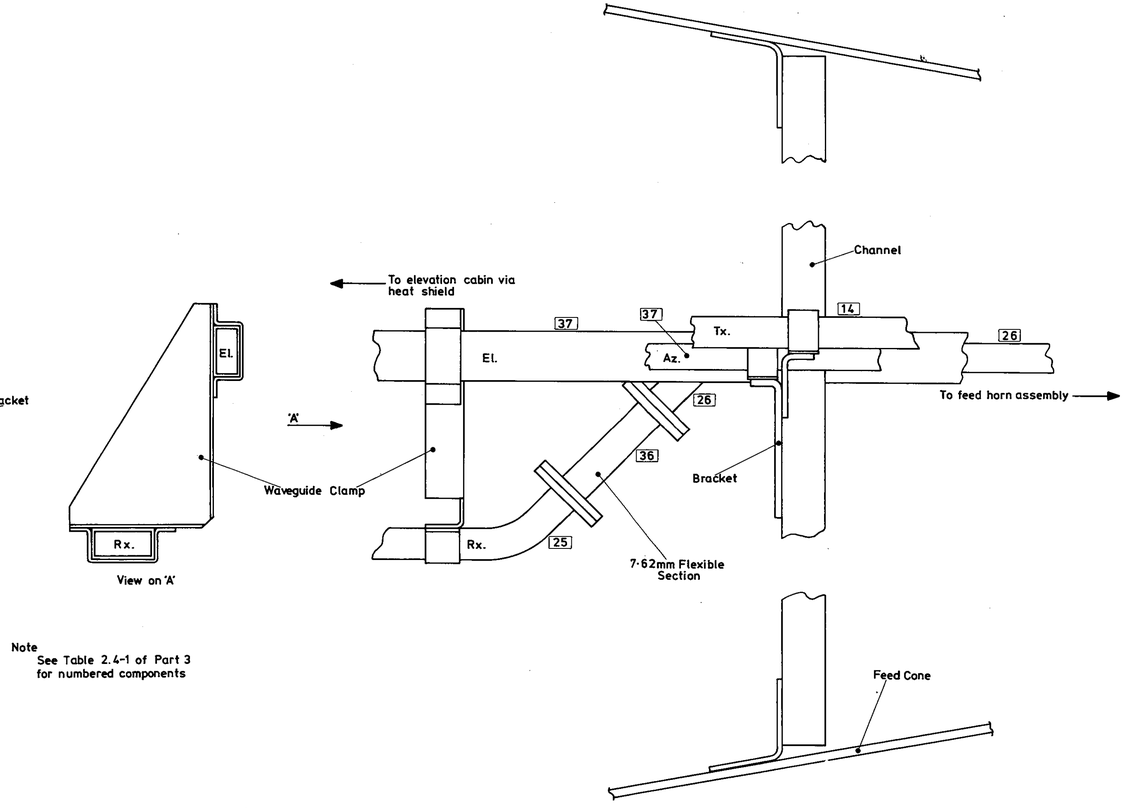
d. Remove protective paper from the top end of cone flange. Ensure that the surface is clean. Smear the flange surface liberally with grease (XG 274). This will hold the 'O' ring in position and prevent the ingress of moisture.

e. Lift the Communications Feed Assembly into position at the top end of the cone, correct alignment being defined by the dowel pins, and bolt on to the cone.

f. Remove both hatch covers from the top end of the cone.

g. Bolt the waveguide support bracket to the channel bracket across the centre of the cone. (Bolts will be finger tight only until the waveguide has been correctly aligned in the cone.) (Figure 5.2-8.) Secure the feed heater cable in its clip.





Note
See Table 2.4-1 of Part 3 for numbered components

Waveguide Supports in Feed Cone
Figure 5.2-8
Part 1

h. Bolt one half of heat shield in position, onto the base of the cone. This is a temporary measure, to assist the correct alignment of waveguide sections.

j. Fit the 7.62 cm flexible waveguide to the RX section of waveguide plus grommet (see Table 5.2-1 for bolt sizes). Bolt loosely on to the communications feed flange, ensuring that the gasket has been inserted between waveguide and flange, before bolting together. Clamp this section on to the waveguide support bracket. (See also Figure 2.4-1 of Part One for waveguide details.)

k. Insert separately the AZ, EL and TX waveguide sections, with rubber grommets fitted, bolt each section loosely to the communications feed flanges, and clamp each section on to the waveguide support bracket.

m. Insert RX section of the waveguide and bolt in position on the 7.62 cm flexible waveguide. Fit the waveguide clamp in position between RX and EL waveguide sections.

n. Ensure correct alignment of the four waveguide sections with the cut-outs on the heat shield and support bracket before tightening the bolts on the feed flanges.

p. Tighten the bolts on waveguide support bracket.

q. Replace the hatch covers on the cone.

r. With the endless manilla rope sling (see Figure 5.2-9) lift the Cone Assembly to a convenient height, approximately 1.5 m from the ground. Remove the half section heat shield. Smear grease (XG 274) liberally around the base of the cone to hold the '0' ring and prevent ingress of moisture.

Table 5.2-1

WG Flange Fixings

Drawing Ref. No. (Fig. 2.4-1)	Name	Qty.	Colour Code	Group
1	8 U.N. Facing Washer 8 U.N. Crinkle Washer M4 Ordinary Nut Gasket - PDR 84 M4 Bolt (.87" Long)	8 8 8 1 8	RED	Flange to Flange PDR 84
2	10 U.N. Facing Washer 10 U.N. Crinkle Washer M5 Ordinary Nut Gasket - PDR 70 M5 Bolt (1.06" Long)	8 8 8 1 8	YELLOW	Flange to Flange PDR 70
3	8 U.N. Washer 8 U.N. Crinkle Washer 8 U.N. Ordinary Nut Gasket - UG 51 8 U.N.C. Bolt (1.75" Long)	4 4 4 2 4	BLUE	Pressure Window (UG 51) (Cooled Load) AZ TRKG W/G Run
4	10 U.N. Crinkle Washer Gasket - PDR 70 M5 Bolt (.85" Long)	4 1 4	GREEN	PDR 70 to Down Converter
5	10 U.N. Crinkle Washer Gasket - PDR 70 M5 Bolt (.70" Long)	8 1 8	GREY	PDR 70 to L.N.R. Switch
6	8 U.N. Facing Washer 8 U.N. Crinkle Washer 8 U.N.C. Ordinary Nut Gasket UG 51 8 U.N.C. Bolt (.75" Long) (AIL Screw with Allen-Style Head also Exists)	4 4 4 1 4	WHITE	Flange to Flange UG 51
7	8 U.N. Crinkle Washer 8 U.N.C. Bolt (0.53" Long) Gasket UG-51	4 4 1	BLACK	UG 51 to TLT Isolator (Ref. ECO 0049)
8	8 U.N. Crinkle Washer Gasket - PDR 84 M4 Bolt (.53" Long)	8 1 8	DARK GREEN	PDR 84 to LNR Switch or I.P.A.
9	8 U.N. Crinkle Washer Gasket - UG 51 8 U.N.C. Bolt (.53" Long) (AIL Screw with Allen-Style Head also Exists)	4 1 4	PINK	UG 51 to TLT Switch or Paramp Port or L.N.R. Switch

Table 5.2-1 (Cont'd.)

Drawing Ref No. (Fig. 2.4-1)	Name	Qty.	Colour Code	Group
10	8 U.N. Crinkle Washer Gasket - PDR 84 8 U.N.C. Screw (.53" Long)	8 1 8	ORANGE	CRP 112 to HPA Switch
11	8 U.N. Facing Washer 8 U.N. Crinkle Washer 8 U.N.C. Ordinary Unit Gasket - PDR 84 8 U.N.C. Screw (1.0" Long)	8 8 8 1 8	LIGHT BLUE	Flange to Flange CRP 112
12	8 U.N.C. Allen-Headed AIL Screw (0.53" Long) Gasket UG 51 Pressure Window (ECO 0701)	4 2 1	PINK	UG 51 to Quarter Wave Transistion (LNR)
13	8 U.N. Washer 8 U.N. Crinkle Washer 8 U.N.C. Ordinary Nut 8 U.N.C. Bolt (1.75" Long) 8 U.N.C. Studding (2" Long) Gasket UG 51	1 8 6 2 2 2	BROWN	Pressure Window (UG 51) Elevation Tracking Run Only

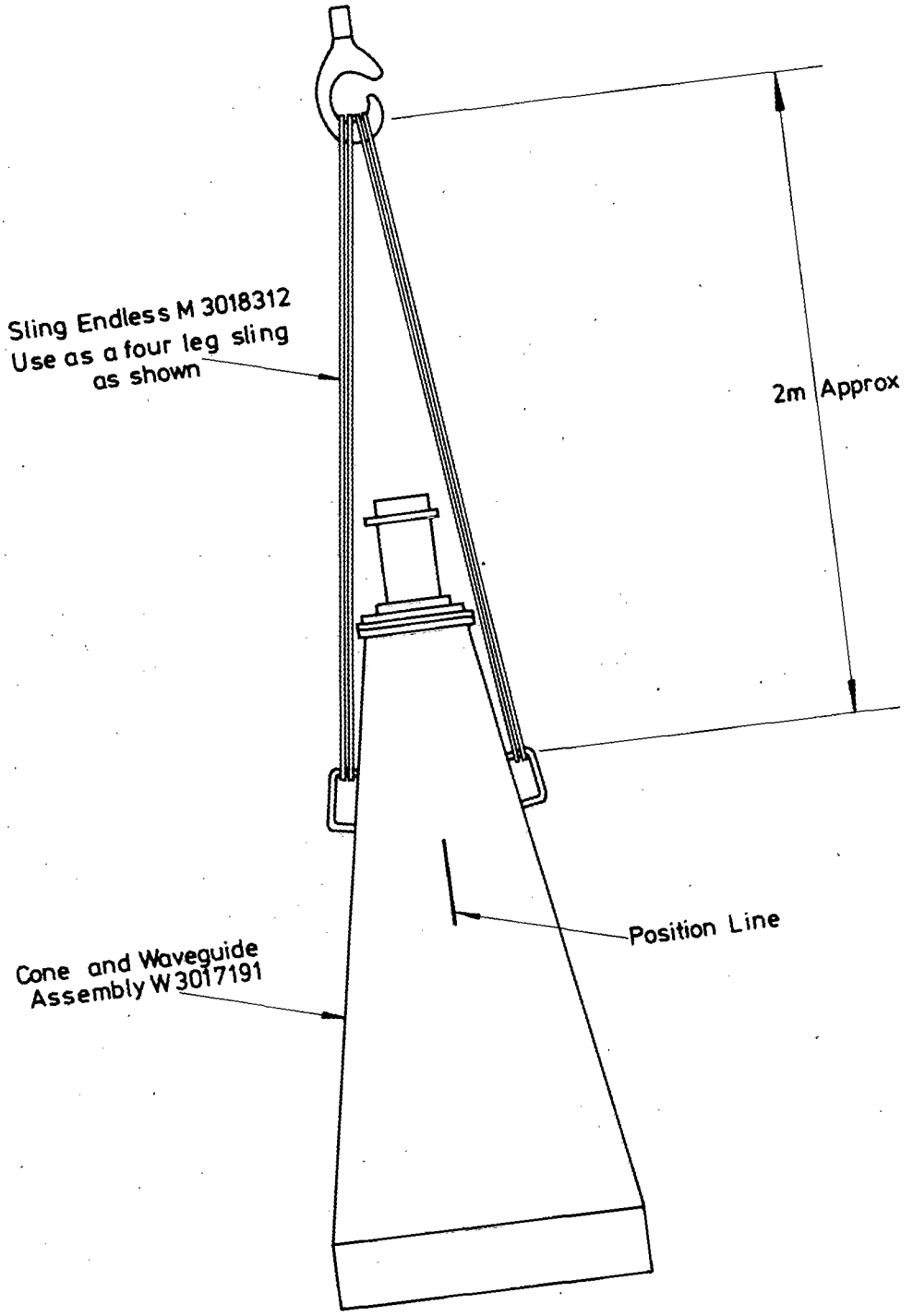
NOTES: 1. Where a packing piece is used between flanges to take up tolerances, longer bolts (see Items Lists) and an extra gasket must be used.

2. Gasket material is shown on Figure 2.4-1.

s. Lift the feed cone into the reflector. Align the 'position line' on the feed cone with the 'arrow' painted on the rim of reflector surface, locating the cone with the dowel pins, then bolt to the hub flange.

NOTE: This task will be performed by a technician working inside the hub cavity.

t. Fit one half of the heat shield in position on the hub, and locate the waveguide sections and feed heater cable in the correct slots. Clamp in position, with the special locking devices. Fit the second half of the heat shield in position, and lock in a manner similar to the previous section.



Feed Cone and Lifting Sling Arrangement

Fig. 5.2-9

1-5

NOTE: Waveguide bolt torques:

M5	23 lb in.	(26.45 kg cm)
M4	18 lb in.	(20.7 kg cm)
8 UNC	18 lb in.	(20.7 kg cm)

2.5 REFLECTOR LIFTING PROCEDURE

a. From behind the reflector, release the hatch (Figure 5.2-10) by withdrawing the four locking pins and unscrewing the four quick release captive screws.

b. Lift the hatch panel clear and replace the locking pins to prevent them damaging the reflector surface. Carefully lower the hatch onto the reflector, clear of the hatchway. Note that the hatch has four rubber feet to protect the surface.

c. One technician should now climb through the hatchway to assist in the following operations.

d. Fit and bolt the four steel lifting feet assemblies in position (see Figures 5.2-10 and 5.2-11).

e. Remove all covers from the hub to allow access to the interface bolts, see Figure 5.2-12.

f. Assemble the reflector lifting gear (see Figure 5.2-11). The technician should then get off the reflector.

g. Raise the reflector to a convenient height. Inspect and clean the mounting pads with Molykote (see Figure 5.2-12).

h. Lift the reflector and lower it on to the elevation yoke, so that the join between segments 12 and 13 lines up with the elevation bearing on the azimuth cabin side. Locate using the yoke guide bolts (see Pedestal Handbook).

j. Bolt in position, tighten the bolts to a torque of 17 kg m (123 lb ft).

k. Replace all internal covers in the hub.

m. Replace all external covers in the hub, sealing them with Bostik 692.

n. Remove the steel lifting feet, and replace them with tetrapod feet, using the 16 mm bolts and dowels provided. (See Figure 5.2-11.) (The tetrapod feet must be correctly located in their numbered positions.)

2.6 TETRAPOD AND SUB-REFLECTOR

a. Unpack and inspect the tetrapod legs and sub-reflector.

b. Connect the four stay rods which are match-marked to ensure correct assembly to the 'black' corner brackets. The legs are numbered 1 to 4 in a clockwise direction (see Figure 5.2-13).

c. Erect an assembly trestle 2.5 m high between the tetrapod legs and use it as an aid to assemble the sub-reflector to the tetrapod with the 18 mm fitted bolts provided. (See Figure 5.2-13.)

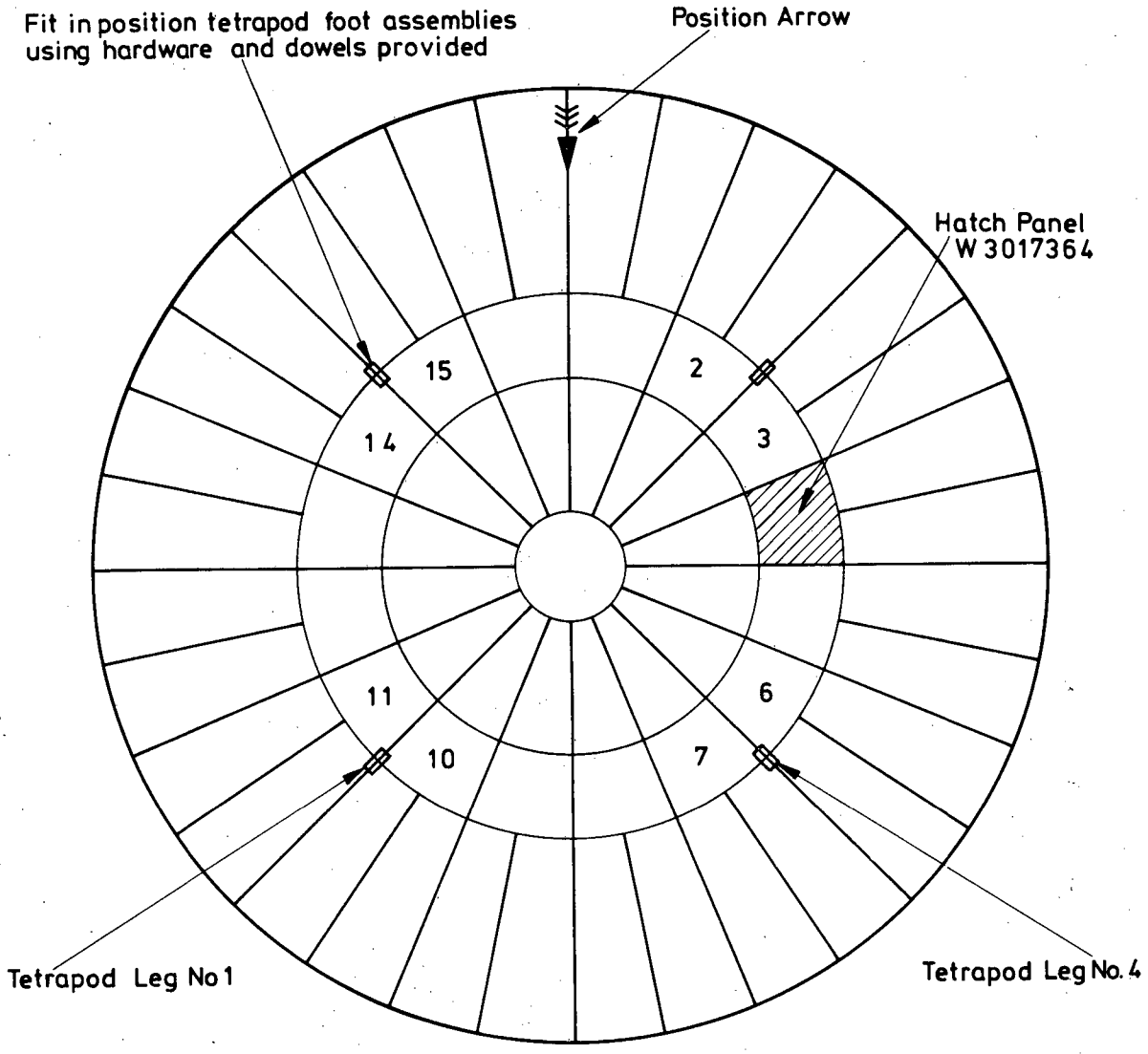
d. Carefully inspect this stage of the assembly; check that all the nuts are tightened to the torque values in Figure 5.2-7.

e. With the lifting gear (see Figure 5.2-14) raise the assembly over the main reflector and lower it into position.

f. Locate leg 1 precisely. Insert the 18 mm fitting bolt, secure with nut and washer.

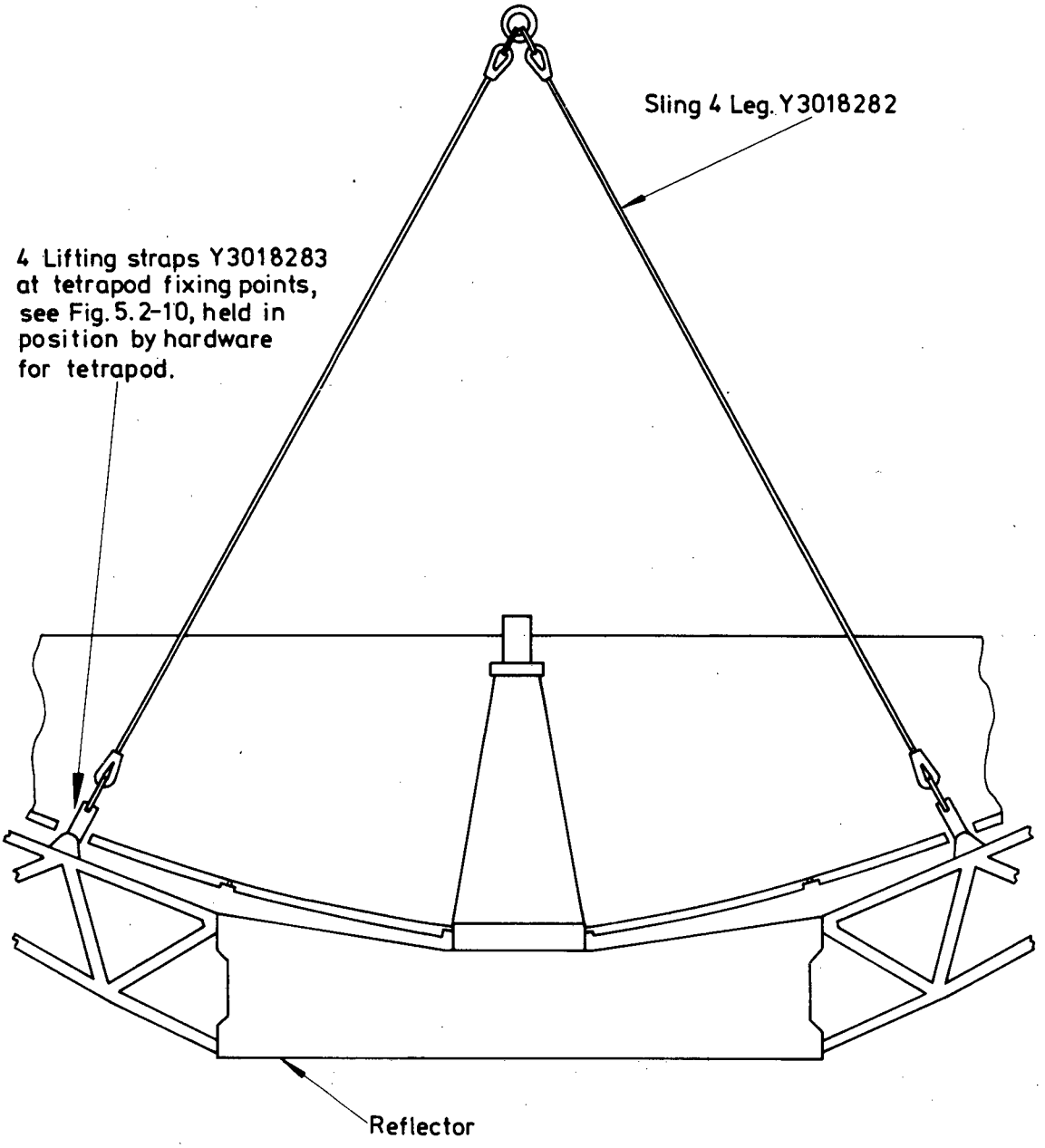
g. Locate and fix leg 3.

h. Locate and fix legs 2 and 4. Tighten all tetrapod bolts to a torque of 75 Newton metres ±5 Newton metres (55 lb ft ±5 lb ft).



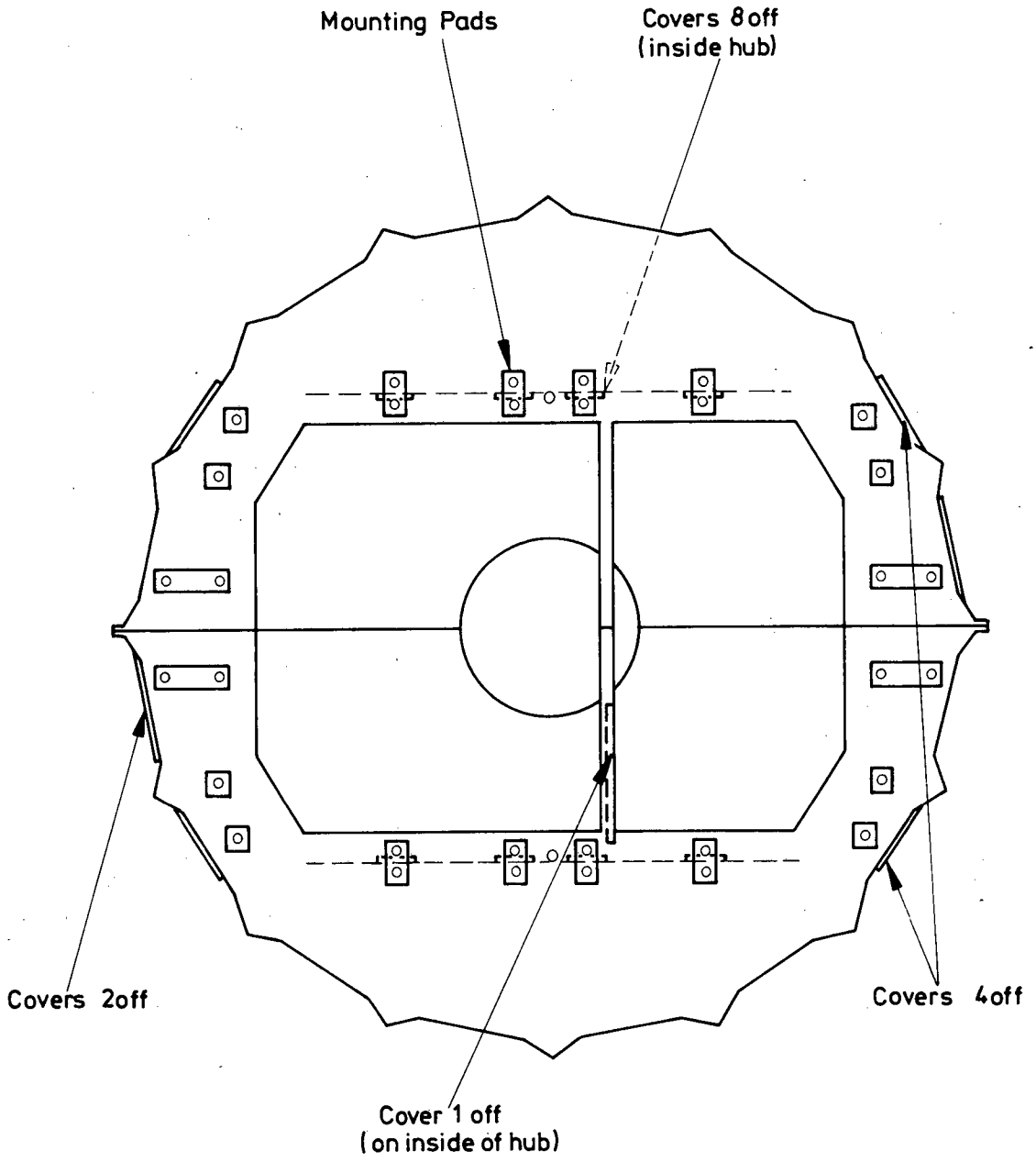
Front View Reflector

Fig.5.2-10



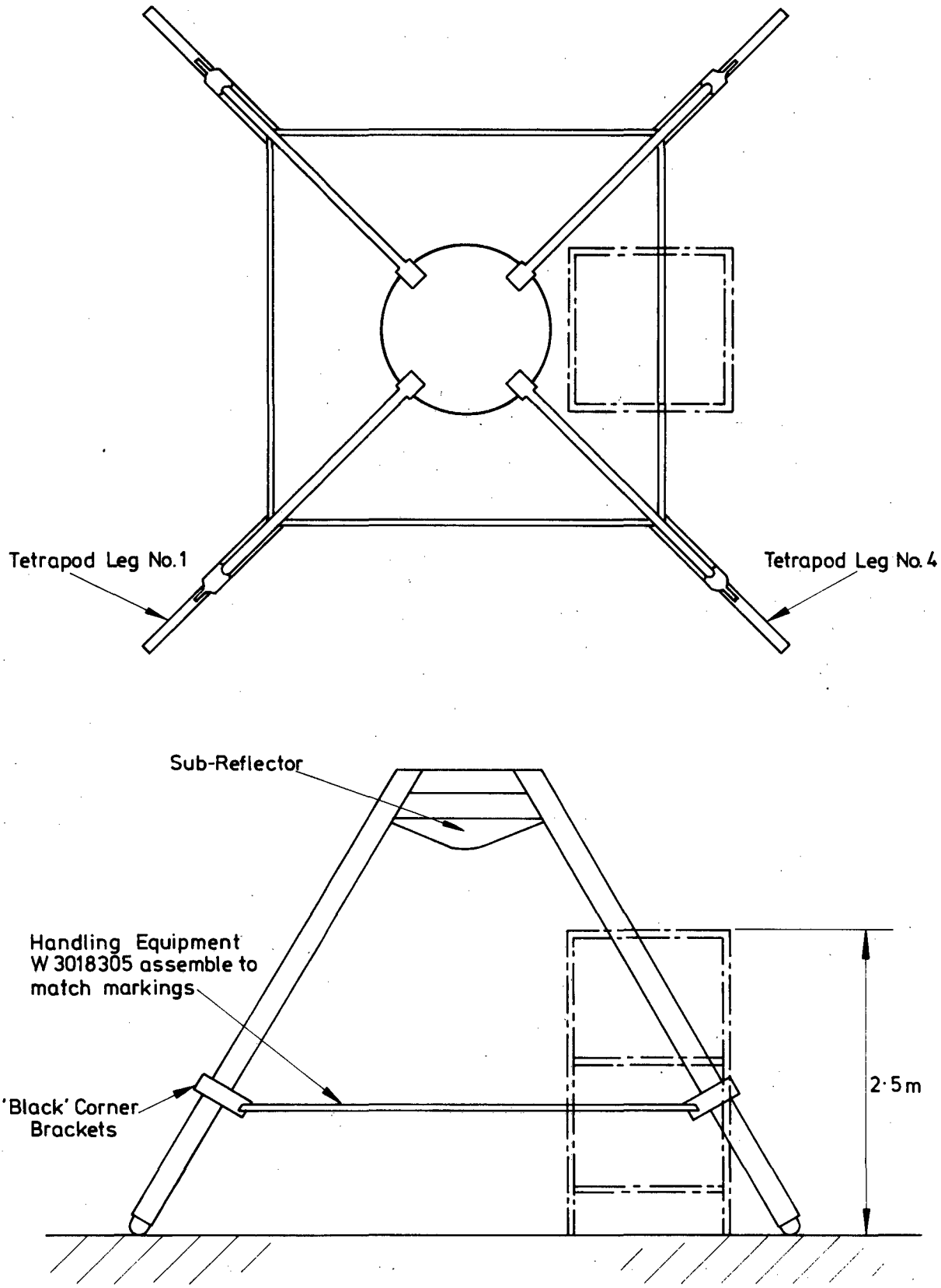
Reflector and Lifting Sling Arrangement

Fig.5.2-11



Hub Covers

Fig.5.2-12



Tetrapod and Sub-Reflector

j. Remove the lifting gear, stay rods and 'black' corner brackets.

CAUTION: EXTREME CARE MUST BE TAKEN WHEN DISMANTLING STAY RODS AND THE 'BLACK' CORNER BRACKETS. TO ENSURE THAT THE REFLECTOR SURFACE IS NOT DAMAGED, COVER THE REFLECTOR AREA DIRECTLY UNDER CORNER BRACKETS WITH PROTECTIVE MATS.

k. Remove the protective mats, all spare tools and hardware. Check that the reflector is clean and properly assembled.

m. Refit and secure the hatch panel.

NOTE: When dismantling the sub-reflector and tetrapod legs, the assembly procedure instructions e. to k. above must be reversed, i.e. the 'black' corner brackets and stay rods must be fitted to the tetrapod legs.

3. COMMISSIONING

The commissioning tests consist of the following:

Antenna commissioning

VSWR measurements

Isolation of the feed between the transmit and receive port

Side lobe amplitude between axes and antenna gain measurements

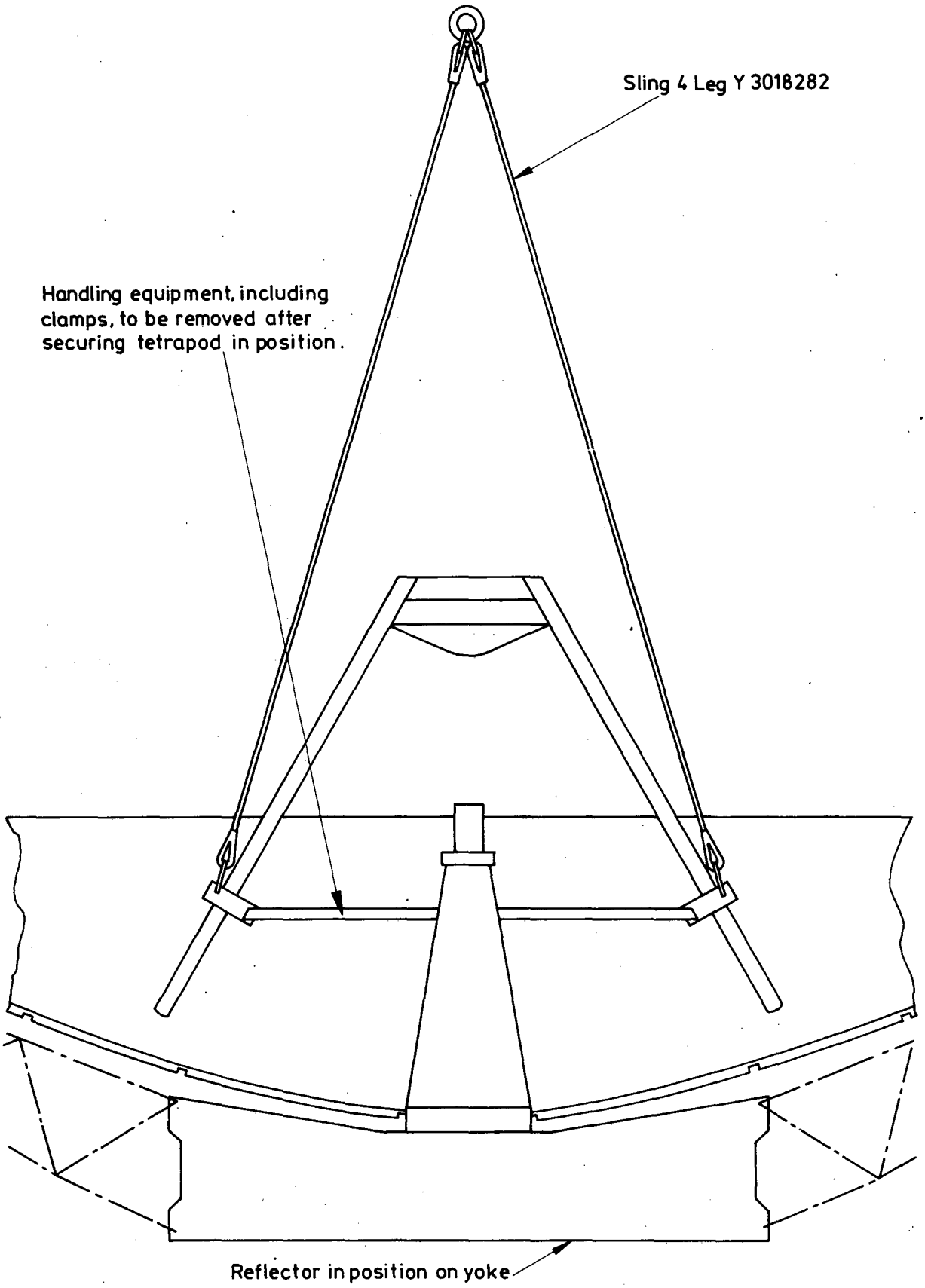
Check of the airtightness of the waveguide system

Feed heater tests

The parts of the waveguide system tested are as follows:

a. The transmit waveguide run between the transmitter high power waveguide switch and the feed input flange.

b. The communications receive waveguide run between the feed communications output flange and the input to the parametric amplifier waveguide switch.



Tetrapod and Lifting Sling Arrangement

Fig. 5.2-14

c. The azimuth and elevation tracking waveguide runs between the two feed tracking error flanges and the tracking filters.

d. The feed.

All other waveguide components are tested as integral parts of their relevant sub-systems.

3.1 STATION EQUIPMENT REQUIRED

Antenna and feed.

3.2 TEST EQUIPMENT REQUIRED

a.	Sweep generator	Marconi 6600A
b.	WG-Coax transition (3 off)	Philips PM7325H WR112/N or HP H281A
c.	WG attenuator	Marconi 6018/5
d.	Oscilloscope camera	
e.	Wavemeter	Hewlett Packard 537A or 532A
f.	Directional Coupler	Philips PM7250H
g.	Detector (2 off)	Alfred 1403 or HP423A
h.	Oscilloscope/Network Analyzer	Alfred 8000/7051
j.	XY Recorder	Hewlett Packard 135 or similar
k.	UG51/PDR84 flange adaptor (2 off)	
m.	WG right angle section	WR112 with PDR84 Flanges
n.	Waveguide short circuit	Philips PM7215H
p.	Waveguide termination	Philips PM7220H
q.	3 dB Pad	HP8491A or use Narda 711 set to 3 dB
r.	Test cables RG214 with N-type connectors	

s. Flexible WG section

t. Piece of straight WG section

u. Multimeter — Philips PM2411

v. Precision I.F. attenuator — AIL Type 32

w. Step attenuators — HP355C + D

x. Chart Recorder — HP7702B

y. Low pass filter — Made up locally (Fig. 5.3-3)

3.3 ANTENNA COMMISSIONING

The antenna commissioning tests detail the procedure for measuring the antenna gain and pattern.

Perform the tests given in Phase IV procedures, Section 19.

3.4 VSWR MEASUREMENT

NOTE: The highest VSWR measured at any input should be lower than the sum of the separate highest VSWRs of the feed assembly and the waveguide under test.

3.4.1 Calibration Procedure

a. Disconnect the transmit waveguide run at the high power waveguide switch.

b. Connect the test equipment as indicated in Figure 5.3-1 and allow a 20 minute warm-up time.

c. Using the wavemeter (item e.), set the sweep generator (item a.) to sweep from 7.20 GHz to 7.80 GHz and set markers at 7.25 GHz to 7.75 GHz for the receive channel tests.

Or set sweep from 7.85 GHz to 8.45 GHz with markers at 7.90 GHz and 8.4 GHz for the transmit channel tests.

d. Adjust the attenuator (item c.) to 10 dB.

e. Set the oscilloscope (item h.) to the following modes:

Vert. Display : channel 'A'

Sensitivity : 5 dB per division

f. Connect the waveguide short circuit (item n.) at the calibration point indicated in Figure 5.3-1.

g. Calibrate Alfred 8000/7051 (item h.) and set the oscilloscope trace to mid screen.

h. Preset channel 'A' attenuator to 0 dB.

j. Trace over the reference line with a fine felt tipped pen or a wax pencil.

3.4.2 Measurement Procedure

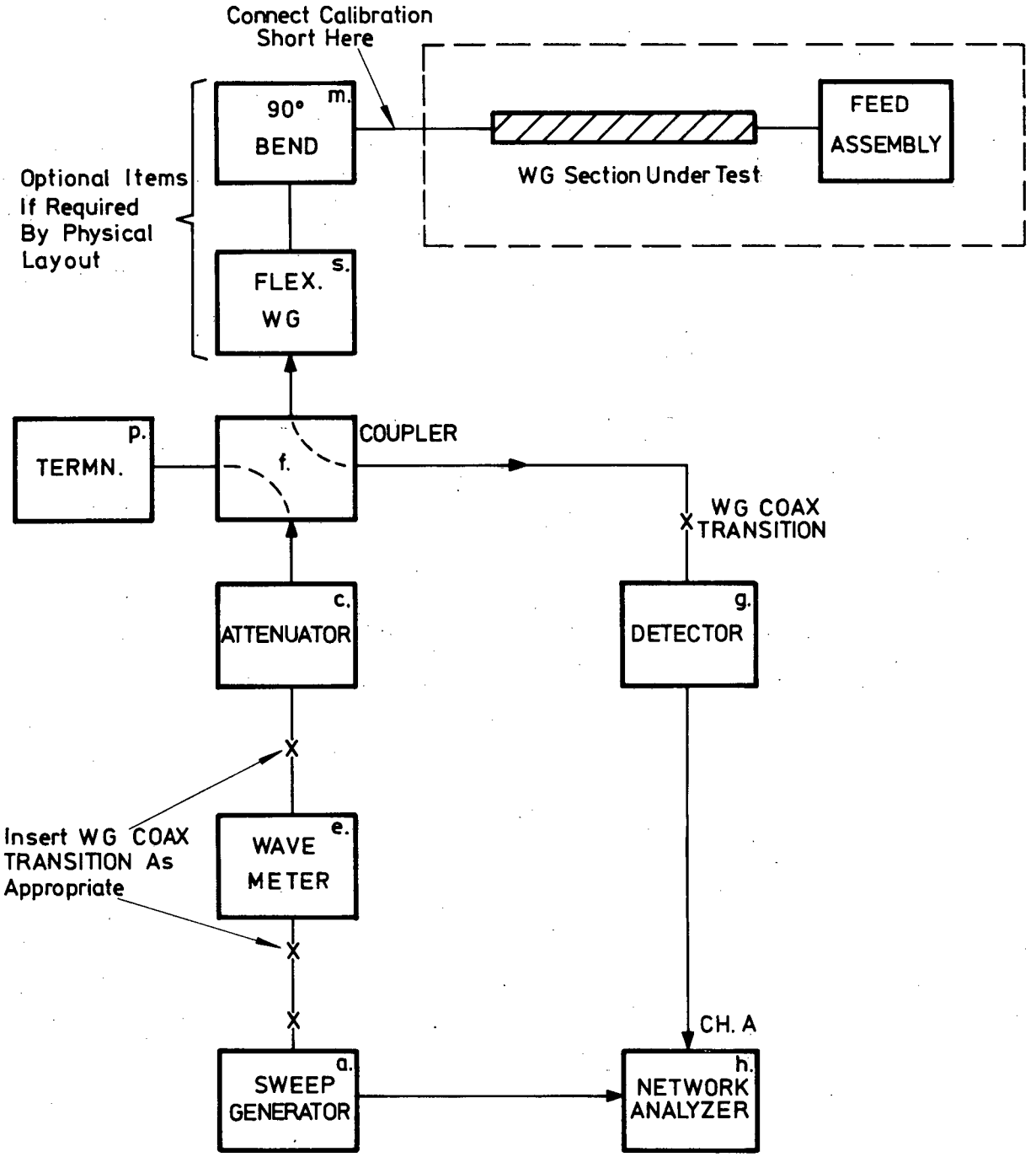
a. Remove the calibration short circuit and connect the test equipment to the transmit waveguide run as indicated in Figure 5.3-1.

b. Adjust the channel 'A' attenuator so that the highest point within the band just intersects the reference line marked in sub-section 3.4.1 j.

c. The channel 'A' attenuator reading is the minimum return loss in the band and this value is to be entered in the Test Report. The value should be 20 dB approximately.

NOTE: Ensure that the waveguide system is fully pressurized during this test.

d. A conversion table, return loss to VSWR, is given in Table 5.3-1.



VSWR Measurement

Fig. 5.3-1

Table 5.3-1

Return Loss to VSWR Conversion

Return Loss in dB	VSWR
14	1:1.5
15	1:1.4
16	1:1.4
17	1:1.3
18	1:1.3
19	1:1.3
20	1:1.2
21	1:1.2
22	1:1.2
23	
24	1:1.15
25	
26	1:1.11
27	
28	1:1.08
29	
30	1:1.07

3.4.3 Communication Receive Waveguide Run

Connect the test equipment to the receive waveguide run at the parametric amplifier WG switch and repeat steps 3.4.1 c. to 3.4.2 c.

3.4.4 Azimuth Tracking Waveguide Run

Connect the test equipment to the azimuth tracking waveguide run after removing the tracking channel filter and repeat steps 3.4.1 c. to 3.4.2 c.

3.4.5 Elevation Tracking Waveguide Run

Connect the test equipment to the elevation tracking waveguide run after removing tracking channel filter and repeat steps 3.4.1 c. to 3.4.2 c.

3.4.6 Accuracy of Measurement

The accuracy of the return loss measurement is determined by the following factors:

a. Directivity of the coupler (item f.).

b. The linearity of the oscilloscope and detectors (items h. and g.).

The coupler directivity will probably be in excess of 30 dB.

3.5 ISOLATION OF THE FEED BETWEEN THE TRANSMIT AND RECEIVE PORTS

3.5.1 Specification

The isolation in dB is not to be less than 25 dB between 7.25 GHz and 7.75 GHz and decreasing linearly to not less than 15 dB at 8.4 GHz when the whole system is fully pressurized.

3.5.2 Procedure

a. This test is to be performed including the transmit and communications receive waveguide. Test equipment connections are to be made at the flanges exposed by the removal of the transmitter high power waveguide switch and the parametric amplifier waveguide switch.

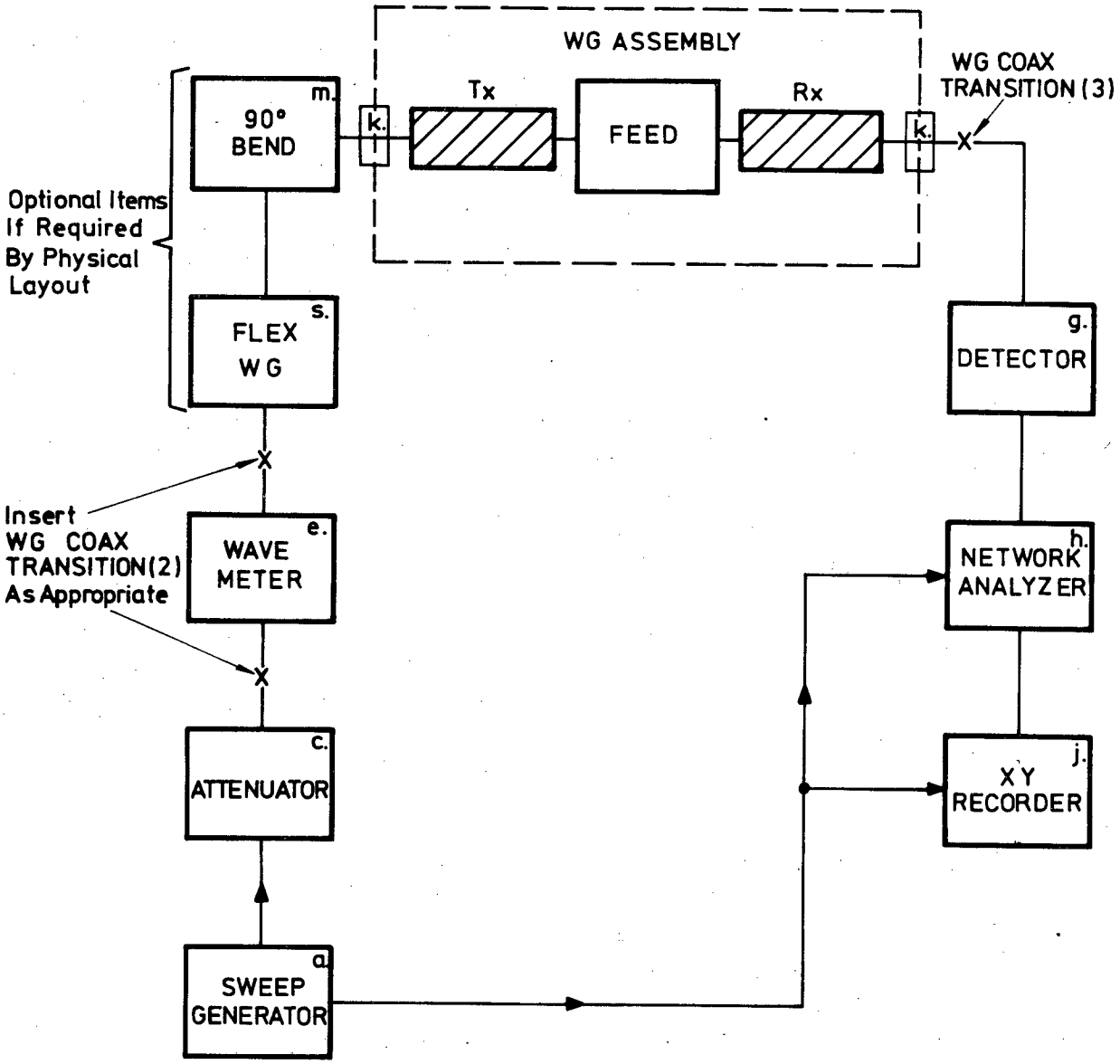
b. Connect the test equipment as indicated in Figure 5.3-2 and allow a 20 minute warm-up time. Initially connect the WG-coax transitions 2 and 3 back to back for calibration.

c. Using the wavemeter (item e.) set the sweep generator (item a.) for a sweep between 7.2 GHz and 8.4 GHz.

d. Set the sweep generator for a signal level of approximately 0 dBm at the input to the transmit waveguide.

e. Set the oscilloscope (item h.) as follows:

Display	:	Channel 'A' LOG
Vertical Sensitivity	:	5 dB per division



Feed Isolation

Fig.5.3-2

f. Set the oscilloscope trace to midscreen. Retain this setting and adjust the oscilloscope channel 'A' attenuator readout to 0 dB.

g. Before making calibration line at -15 dB, reset one of the markers to 7.75 GHz (check with wavemeter), by adjustment of the channel 'A' attenuator make calibration lines over ±15 dB in 5 dB steps on the XY recorder (item j.).

h. Reconnect the test equipment as shown in Figure 5.3-2.

j. Switch off the markers, readjust the channel 'A' attenuator to centralize the oscilloscope trace on the screen. Record the attenuator 'A' setting.

k. Record the trace on the calibrated XY recorder.

m. The isolation at a particular frequency is given by the setting on the oscilloscope attenuator, plus the trace deviation from the 0 dB reference line. Use XY recording sheet provided with Test Report. Discard example sheet and the unused recording sheets. Enter data on the used recording sheet as shown in the example.

NOTE: Ensure that the waveguide system is fully pressurized during this test.

3.5.3 Accuracy of Measurement

A 25 dB isolation figure will be measured to an accuracy of +0.5 dB.

3.6 SIDE LOBE AMPLITUDE BETWEEN AXES AND ANTENNA GAIN MEASUREMENTS

3.6.1 Specification

a. Side lobes. The near axis in both axes is to be measured at the satellite beacon frequency of 7299.5 MHz and the side lobes out to ±5° are to be at least 15 dB down.

b. Antenna gain. The antenna gain during transmission in dB is to be 59 dB at 8.4 GHz as measured at the transmit input port of the feed. During reception the gain is to be 58 dB at 7.25 GHz as measured at the receive output port of the feed.

3.6.2 Procedure

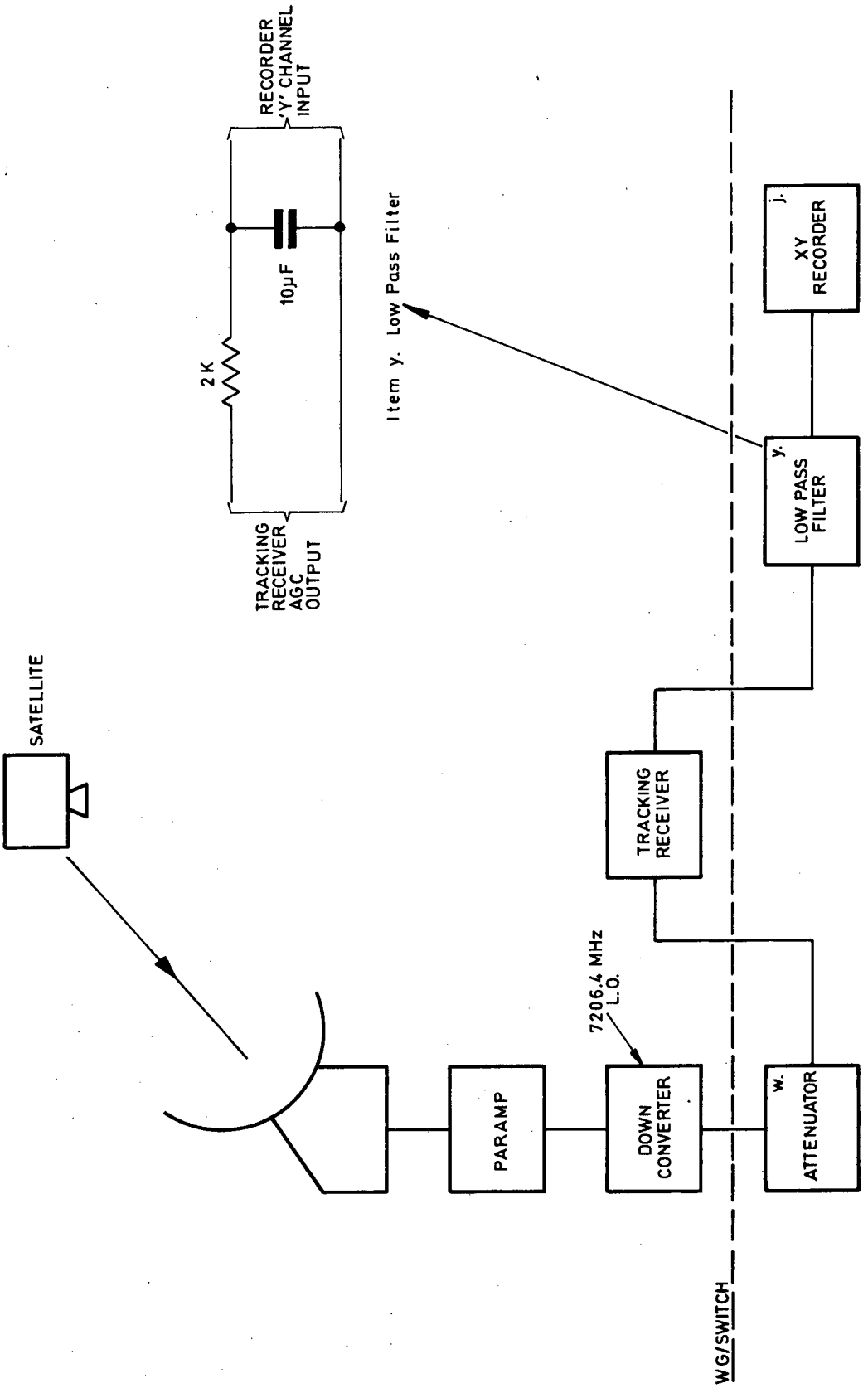
a. Set up the equipment shown in Figure 5.3-3 with one channel of the parametric amplifier system tuned to a 7276 MHz centre frequency. The attenuator (item w) is to be connected to the tracking output line located on the i.f. switch unit within the distribution amplifier rack.

NOTE: During this procedure the servos are driven between 0.03 and 0.04° per second in a clockwise direction in azimuth and upwards in elevation therefore a short practice session to determine the required setting of the rate controls is recommended.

b. Connect the Y channel of the XY recorder (item j) to the tracking receiver AGC output via the low pass filter (item y). Use AGC monitor point on Servo Rack 5, Card 1424, Test Point b3.

c. Set the tracking receiver synthesizer pre-selector and digital frequency selector to 93.1 MHz. Use phase lock tracking with a 200 Hz loop bandwidth, 10 kHz sweep width and 128.5 kHz beacon signature (NATO 1 satellite must be used for these tests as beacon ERP from other satellites is not sufficiently high).

d. Acquire the satellite beacon with the tracking receiver. Check that the acquisition is confirmed by illumination of the BEACON ACQUIRED lamp followed by the BEACON IDENTIFIED FREQ. CORRECT lamp on the control console panel. Locate the antenna beacon tip by fine adjustment of the antenna position in the manual mode until the tracking receiver beacon level (AGC) is maximized.



Antenna Pattern Using A Satellite Signal

e. Check that the tracking receiver elevation (ΔY) and azimuth (ΔY) meters give a reading of zero $\pm 0.01^{o}$.

f. Put the servos into standby. Break phase lock on the tracking receiver by detuning the 93.1 MHz digital frequency setting.

g. Set the tracking receiver sweep width to manual. Retune to 93.1 MHz and adjust the manual sweep vernier control to re-acquire the satellite beacon. Lock the vernier control at the acquisition setting.

h. The tracking receiver tuning should now ensure that acquisition of the satellite beacon occurs automatically with the sweep width control set to manual. Check this by breaking phase lock as defined in step f, then retune to 93.1 MHz.

j. Check that re-acquisition occurs; if it does not occur the fine tuning of the manual sweep vernier is not quite correct and steps g and h are to be repeated until re-acquisition occurs automatically.

k. Check that the satellite has not drifted away from the antenna beam tip. The tracking receiver elevation (ΔY) and azimuth (ΔX) error meters should still indicate zero $\pm 0.01^{o}$. If the indications on the meters are incorrect repeat steps d and e.

m. Set the XY recorder time base to 0.2 sec./cm, and the Y axis sensitivity so that the pen is at the top of the recording paper when the attenuator (item w) is set to 0 dB and at the base of the recording paper when the attenuator is set to 40 dB. The tracking receiver may momentarily lose lock during these changes of attenuation values, this is not important and occurs because the attenuator open circuits during the changing from one value to another.

n. Run calibration traces across the recording with the attenuator (item w) set in turn to values of 30 dB, 25 dB, 20 dB, 16 dB, 15 dB, 14 dB and 0 dB. These lines represent calibrations of antenna gain below the reference gain at beam tip. Leave the attenuator setting at 0 dB.

p. Check again that the satellite has not drifted away from the antenna beam tip. The Δ Y and Δ X error meter indications should still be zero $\pm 0.01^{\circ}$ steps d and e.

q. Drive the antenna away from the satellite position in azimuth. Set the azimuth rate control for clockwise rotation between 0.03° per second and 0.04° per second. Set the XY recorder time base to 5 seconds per cm.

r. Simultaneously start the XY recorder time sweep and the azimuth CW sweep in manual mode. The antenna beam should then traverse the satellite position. As the received satellite beacon signal level rises above the tracking receiver threshold, the tracking receiver should phase lock to the satellite beacon and trace out the antenna pattern. Stop the sweep after 3.5° to 4.5° of traverse.

s. Record the servo indicator readouts at the beginning and end of the sweep to obtain a base scale in degrees for the XY plot.

t. The peak of the traced pattern should be within 1 mm of the 0 dB calibration line. If these results are not obtained satellite drift or gain drift may have occurred within the receiver and steps n to s must be repeated. If the tracking receiver fails to lock to the satellite beacon this is probably due to the reasons given in step j and steps g to s must be repeated.

u. Repeat steps k to t for the elevation axis with exception of step q which for the elevation axis is as follows:

Drive the antenna 2.0° down from the satellite position in elevation. Set the elevation rate control for rotation between 0.03° per second and 0.04° per second UP. Set the XY recorder time base to 5 seconds per cm.

3.7 CHECK OF THE AIRTIGHTNESS OF THE WAVEGUIDE SYSTEM

3.7.1 Specification

The pressure in the sealed waveguide system should fall at a rate not greater than 100 mm on the Spinner pressure gauge in 5 minutes.

3.7.2 Procedure

a. Ensure that the waveguide system is completely assembled. (See Part One, Section Four, Constructional Details, sub-section 3 for instructions on re-use of gaskets.)

b. Switch off the pressurizing unit and note the indication.

c. After 5 minutes, again note the gauge indication and verify that the fall in pressure is less than 100 mm. Record the two indications.

d. Switch on the pressurizing unit.

3.8 FEED HEATER TESTS (Figure 2.3-6 Part 1, Figure 2.3-1 Part 3)

a. Connect the feed heater cable (4202) to SK1 of the Feed Heater Relay Assembly box, located in the elevation cabin. Remove the cover of the Feed Heater Relay Assembly and check for correct voltage strapping.

b. Connect cable 2218, from the console via the cable spiral, to PL2. Do NOT connect the mains cable (4201) from fuse box R2 at this stage.

c. Select the FEED HEATER switch on bay 4 of the console to ON. Verify the switch is illuminated.

d. At the Feed Heater Relay Assembly, check for continuity (with the multimeter) between PL1/A and TB1/7 (RL1.2 in circuit).

e. Check for a short circuit (at ambient temperatures below +60° C), between TB1/5 and /7. Check for 96 ohms ±8 ohms between TB1/5 and /4. (24 ohms ±2 ohms North America.) Note that each heater is 48 ohms ±4 ohms, but they are connected in series for 220 V operation and in parallel for 120 V operation.

f. Switch off the FEED HEATER at the console. Connect the mains cable 4201 to PL1.

g. Ensure that the automatic fuse circuit breaker for the feed heater in Fuse Box R2 is ON. Select FEED HEATER at the console.

h. With the multimeter on the 300 V a.c. range, verify that 220 V ±22 V a.c. (120 V ±12 V a.c. North America) appears on TB1/5 and /4. Observe the ELECTRICAL HAZARD WARNING given in the preliminary pages of this handbook.

j. When the ambient temperature reaches +60° C, the thermostat will operate and the 220 V a.c. (120 V a.c.) will be removed from TB1/5-/4. Note that the time required before the thermostat operates will depend on local site external temperatures.

k. Replace and secure the Relay Assembly cover. Switch off the FEED HEATER switch if the heater is not required.

PART ONE

SECTION SIX

OPERATING INSTRUCTIONS

1. GENERAL

Operating instructions for this equipment are located as follows:

Overall antenna control	:	Antenna Servo, Drive and Control Handbook No. 601
Transmission Line Dehydrator BN514606	:	Manufacturer's Handbook 909, Spinner
Feed heater	:	Control Console Handbook No. 700
Waveguide Switches	:	TLT - Handbook No. 703 LNR - Handbook No. 504 HPA - Handbook No. 503
Cooled Load	:	TLT Handbook No. 703

PART TWO

MAINTENANCE

LIST OF CONTENTS

SECTION ONE

FIRST LEVEL MAINTENANCE

PART TWO

SECTION ONE

FIRST LEVEL MAINTENANCE

1. GENERAL

The only preventive maintenance required is a periodic inspection for physical damage, fouling and/or deterioration of surface finishes of both the reflector and the horn radome. This finish should be cleaned and, if necessary, be renovated using the following materials:

Cleaning	:	Soap solution. Rinse and dry off after cleaning.
Reflecting Surface	:	Matt white epoxy resin paint (DTD 5555).
Rear Surfaces	:	Gloss white epoxy resin paint (DTD 5555).

Before painting, the surface should be etched and primed according to the paint manufacturer's instructions.

NOTE: Do not use spray application.

2. MAINTENANCE INTERVALS

At stations where a radome is fitted, carry out the visual inspections detailed above once every year.

At stations without a radome, these inspections should be carried out once every six months.

3. CORRECTIVE MAINTENANCE

Procedures describing the corrective maintenance required after partial or complete dismantling of the sub-system equipment are described in Part One, Section Five, sub-section 3.

4. WAVEGUIDE INSPECTION

Visually inspect the waveguide including flexibles and flanges for mechanical damage every three months.

5. FIXINGS

Every six months, inspect all rivets, nuts, bolts and washers for rust, corrosion and correct tightness.

If necessary, replace corroded nuts, bolts and washers. Secure to the specified torque (See Part One, Section Five) and then prime and repaint.

Corroded or loose rivets can only be replaced when a segment is replaced or the complete reflector removed.

6. WAVEGUIDE PRESSURIZATION

Carry out the procedures given in Part One, Section Five, sub-section 3.7.2 at three monthly intervals.

7. FEED HEATER

Every six months or when the heater is in use because of local climatic conditions check by using a clip-on ammeter or multimeter that the current being drawn by the heater is 2 amps (North American Stations 4 amps). If the values indicated by the ammeter or multimeter are incorrect carry out procedures given in Part Three, Section Two, sub-section 3.1.1 a. and b.

PART THREE

FAULT LOCATION

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PART THREE

SECTION ONE

FIRST LEVEL FAULT LOCATION

1. FAULTS COVERED

This section covers the possible faults of mechanical damage, heater failure and deterioration.

WARNING: ENSURE THAT THE SAFE TO TRANSMIT AND SAFE TO ROTATE KEYS ARE SWITCHED TO OFF AND REMOVED FROM THE CONSOLE BEFORE WORKING ON THE WAVEGUIDE RUNS OR THE REFLECTOR SURFACE. THE KEY SHOULD REMAIN IN THE POSSESSION OF THE TECHNICIAN UNTIL THE WORK IS COMPLETED.

2. FAULT LOCATION

2.1 POSSIBLE FAULTS

2.1.1 Reflector

a. Mechanical damage.

2.1.2 Feed

a. Mechanical damage, including radome cracks.

b. Feed heater or indication of failure.

c. Thermal cut-out operation.

d. Air leaks

2.1.3 Waveguide Runs

a. Mechanical damage.

b. Air leaks.

2.2 CAUSES OF FAULTS

2.2.1 Reflector

a. Mechanical impact.

2.2.2 Feed

a. Connections.

b. Open circuit heater windings or relay failure.

c. Open circuit thermal cut-out.

d. Mechanical impact.

e. Overpressure (internal).

2.2.3 Waveguide Runs

a. Mechanical impact/stress.

b. Faulty dismantling/re-assembly of flanges.

c. Faulty air hose connection

3. FAULT RECTIFICATION

3.1 REFLECTOR

3.1.1 Mechanical Impact Damage

If the damage is light, and has not distorted the precise contours of the reflector, repaint the damaged area using the appropriate paint. The paint types are specified in Part Two, Section One. Where panel contours have been distorted beyond acceptable limits, replace the damaged panel(s) with new item(s); align the new panel(s) with the edges of the surrounding panels. If the area affected is large, it may be necessary to replace complete segments as described in Part One, Section Five, sub-section 3.3. The need for replacement must be assessed following a close examination of the reflector surface.

3.2 FEED ASSEMBLY

3.2.1 Surface Finish

Light impact damage can be rectified by re-painting.

3.2.2 Electrical Connections

If an electrical fault in the feed heater circuit is suspected, use a multimeter in conjunction with Figure 2.3-6, Part One to localize the fault, as described in Section Two, Second Level Fault Location. If necessary, proceed with sub-section 3.2.3 below.

3.2.3 Other Faults

Rectify faults requiring dismantling of the feed assembly by following the dismantling and re-assembly procedures detailed in Section Two, Second Level Fault Location.

3.3 WAVEGUIDE RUNS

3.3.1 Mechanical Distortion

Faults of this nature must be rectified by replacement of the damaged waveguide section. Operational use of damaged waveguide sections can cause high VSWR's and other undesirable effects to the transmission and reception of signals.

3.3.2 Incorrect Assembly

Carry out the relevant tests in Part One, Section Five to localize the faulty equipment and carefully re-assemble as required.

3.3.3 Pressurizing Faults

Check all hose connections and joints for leaks as detailed in Section Two, Second Level Fault Location. If necessary, check the pressurizing unit as described in the Spinner Pressurization Equipment Handbook No. 909.

PART THREE

SECTION TWO

SECOND LEVEL FAULT LOCATION

1. GENERAL

The following procedures include dismantling and re-assembly when a defective item has to be replaced. Observe the WARNING given in Section One.

2. TEST EQUIPMENT

The following test equipment is required:

Multimeter	:	Philips Type PM2411
Foam fluid for detecting air leaks	:	e.g. 'SEARCH' Ch. Fischer No. 843-3000.

3. FAULT FINDING PROCEDURE

3.1 FEED

3.1.1 Feed heaters (Figures 2.3-6, Part One and Figure 2.3-1 Part Three)

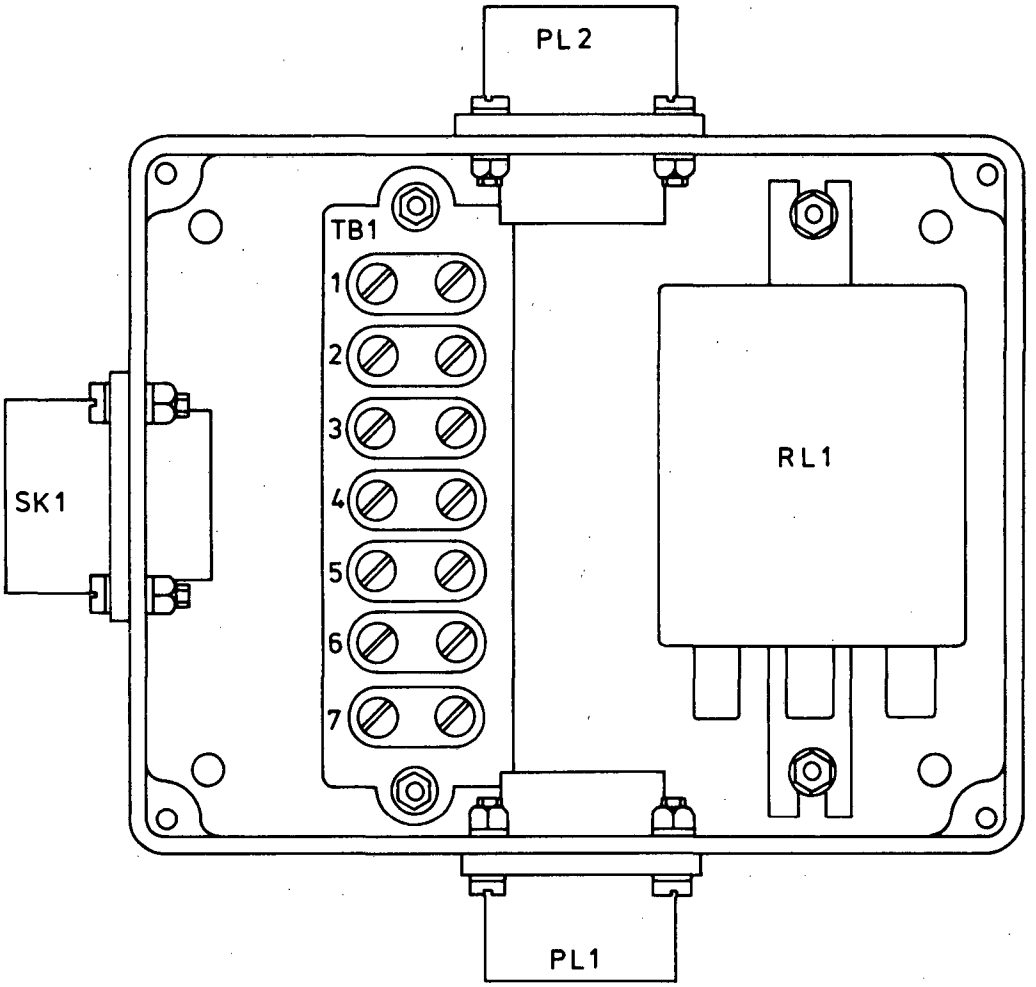
a. Check that the resistance of each heater is 48 ohms ±4 ohms in both cases.

b. Check that a short circuit exists at temperatures below +60° C between pins E and F of socket SK1 on the feed heater relay box.

c. In the event of a heater failure, first check the wiring, then the components, using the dismantling and re-assembly procedures detailed in sub-section 4.

3.1.2 Thermal Cut-Out

Check that a short circuit exists between pins F and G of plug PL1 on the cable between the feed heater



Note:
See circuit diagram (Figure 2.3-6 Part 1) for details of strapping required to suit a.c. mains voltage.

Feed Heater Relay Assembly, Component Layout

Fig. 2.3-1

relay box and the feed heater assembly. If an open-circuit is measured, the thermal cut-out must be replaced with a new unit. See sub-section 4 for assembly instructions.

3.1.3 Air Leaks

Paint a 'SEARCH' solution around all seals and joints to check that they are airtight. If a bubble appears at any point, reseal as detailed in the dismantling and re-assembly procedures in sub-section 4. Carefully dry off all traces of the solution after use.

3.1.4 Horn Radome

Rotate the antenna to the stow (Zenith) position. Set SAFE TO ROTATE to OFF afterwards. Use the ladder to gain access to the reflector surface via the hatch (see Part One, Section Five, sub-section 2.5 a.). Using a ladder, inspect the horn radome for damage and replace if necessary. (See sub-section 4.)

3.2 WAVEGUIDE INTERCONNECTIONS

3.2.1 Air Leaks (Figure 2.3-2)

Use the same procedure as given in sub-section 3.1.3.

3.2.2 Suspected Performance Deterioration

Carry out the relevant Commissioning Test Procedure.

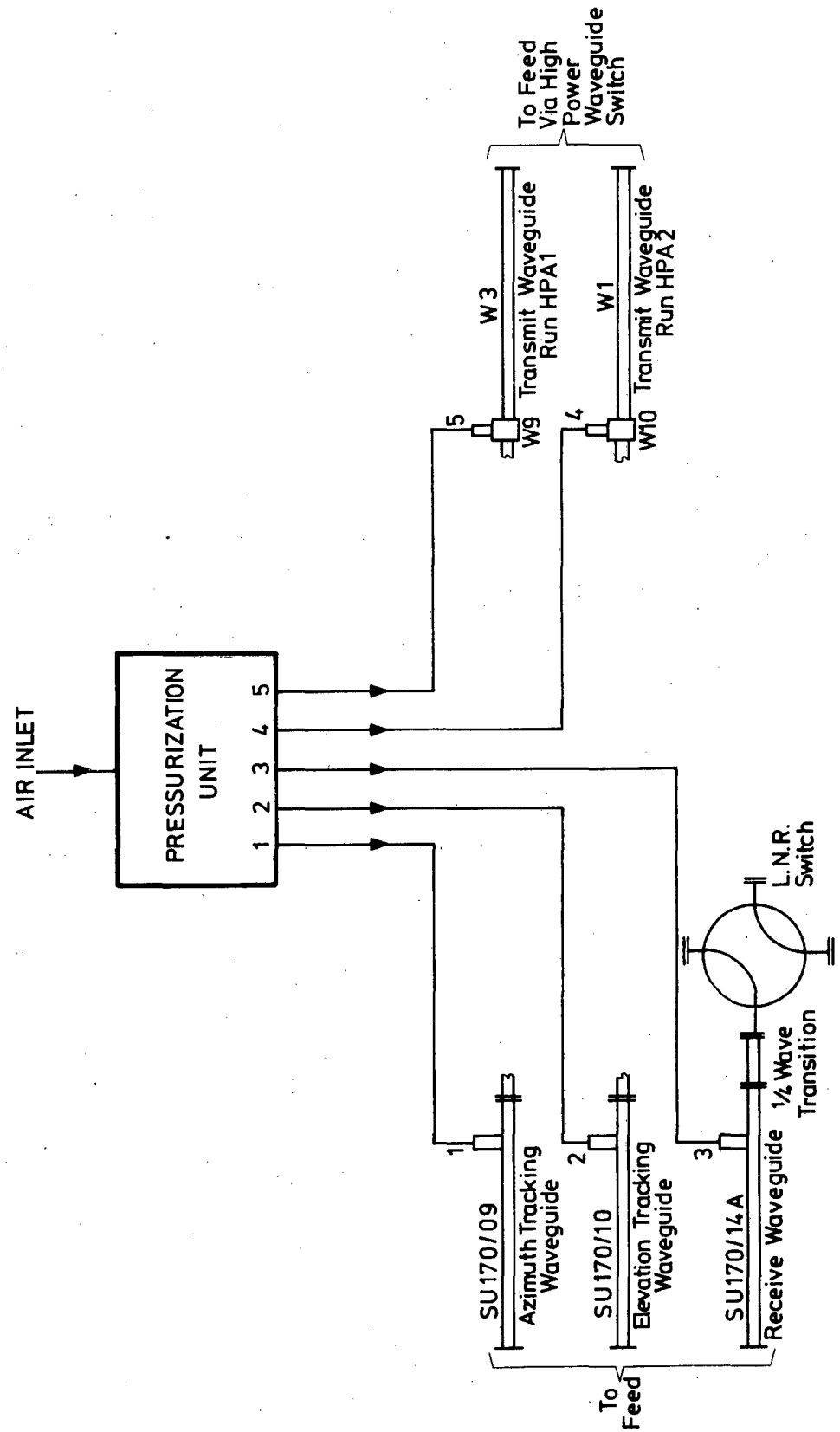
4. DISMANTLING AND RE-ASSEMBLY PROCEDURES

If the horn assembly or the waveguide system has to be separated from the interface plate, it is essential that they are subsequently resealed with the special sealing paint (AEI red glyptal) to prevent corrosion caused by the potential difference between dissimilar metals. Screws, nuts, bolts, washers, and ring seals that have been removed are to be carefully put aside in readiness for re-assembly.

4.1 DISMANTLING

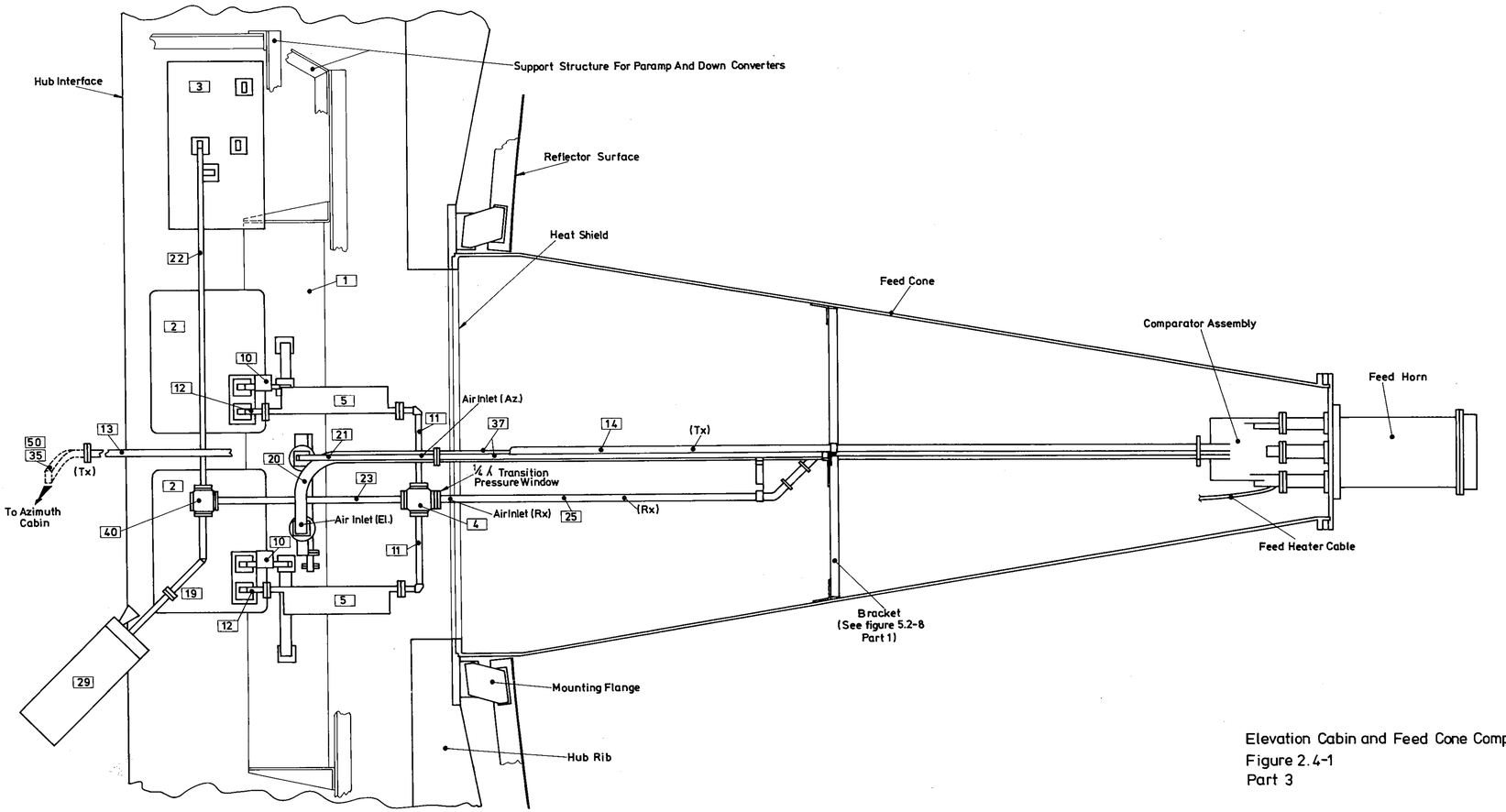
4.1.1 Radome-Horn Seal

Release the bolts around the radome horn seal flange and break the seal, using a knife if necessary.



Waveguide Pressurization-Block Diagram

Fig. 2.3-2



Elevation Cabin and Feed Cone Components
Figure 2.4-1
Part 3

Before re-assembly clean the surface with Wellseal gasket sealant on both sides of the rubber gasket.

4.1.2 Horn Assembly

a. Remove the bolts and dowel from the flange and break the seal between the horn assembly flange and the interface plate.

b. Disconnect the leads to the thermal cut-out, which is accessible from the horn side of the interface plate.

c. Remove the two retaining screws and withdraw the cut-out.

4.1.3 Polarizers and Comparator

a. Remove the feed cone cover plate.

b. Remove the plug from its socket.

c. Remove the metal straps which support the waveguide assembly from the wall of the cone.

d. Disconnect the lower end of the waveguide assembly at the mounting flanges, taking care that the shims are not lost during the process.

e. Release the four retaining screws on each polarizer flange which fix the polarizers to the interface plate. (Total of 20 screws.)

f. Break the paint seal between the flanges and interface plate.

g. Withdraw the polarizers and comparator network through the feed cone aperture by removal of the cover plate. Ensure that the rubber 'O' ring seals on the waveguide flanges are not lost during this process.

4.2 RE-ASSEMBLY

4.2.1 Procedures

a. The re-assembly procedures are the reverse of the dismantling procedures detailed in sub-section 4.1.

b. If the horn assembly and/or interface plate and waveguide assembly have been separated, the gap between them must be carefully resealed with the special paint (AEI red glyptal).

c. It may occasionally be necessary to replace the Dubo plastic retaining washers with new ones, a stock of spares being held for the purpose.

4.3 COMPONENT LOCATION

4.3.1 Antenna and Horn Assembly

Components are easily identifiable using the illustration contained in Part One, Section Two.

4.3.2 Elevation and Azimuth Cabins

Figures 2.4-1 of Part One, 2.4-1, 2.4-2 and 2.4-3 aid in the location and identification of waveguide components as well as providing information concerning w/g flanges, pressurizing points and pressure windows. The boxed numbers cross refer in all three diagrams, and are detailed in Table 2.4-1 below:

Table 2.4-1

Identification of Waveguide Components

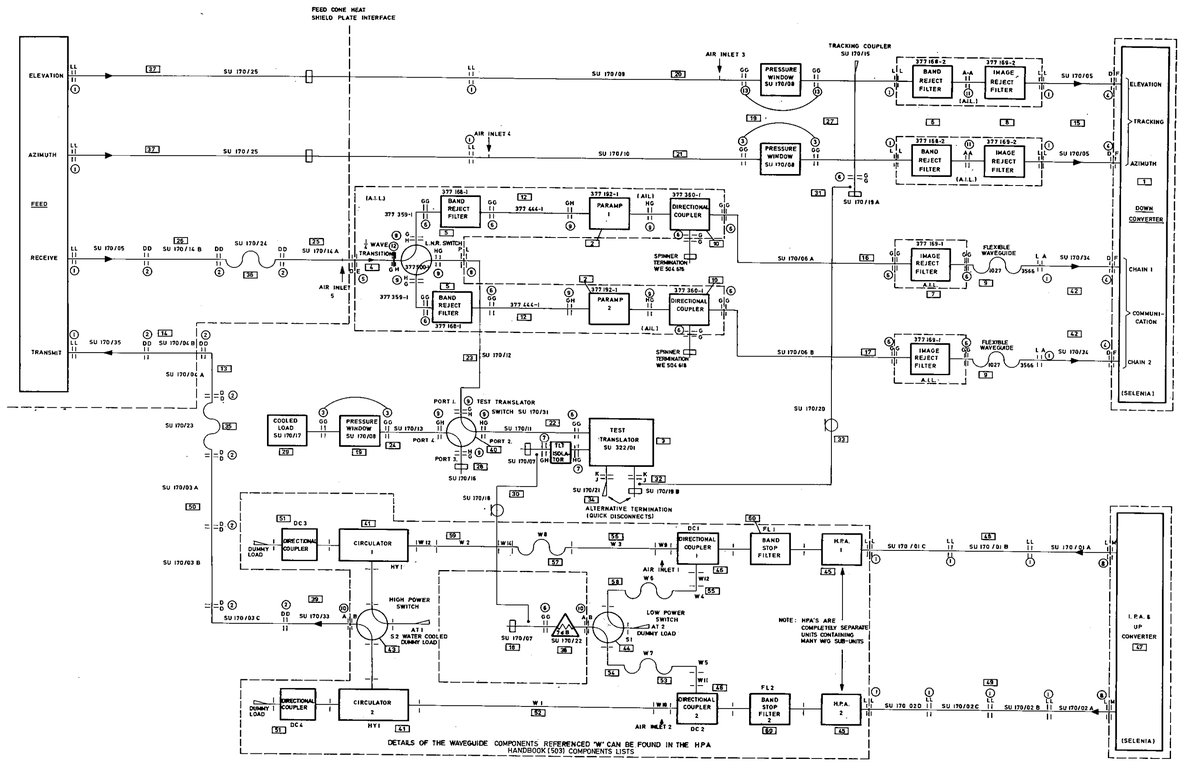
Figure Item No.	Description/Part No.
1	Down-Converter Rack - Selenia T139
2	Parametric Amplifier - AIL 377243
3	Test Loop Translator - GEC SU 322/01
4	Waveguide Switch - AIL 377500-1
5	Band Reject Filter, communication channel - AIL 377168-1
6	Band Reject Filter, tracking channel - AIL 377168-2
7	Image Reject Filter, communication channel - AIL 377169-1
8	Image Reject Filter, tracking channel - AIL 377169-2
9	Flexible Waveguide - SEL 1027 3566

Table 2.4-1 (Cont'd)

Figure Item No.	Description/Part No.
10	Waveguide Directional Coupler - AIL 377360-1
11	Waveguide Assembly - AIL 377359-1
12	Waveguide Assembly - AIL 377444-1
13	Waveguide Section - GEC SU 170/04A
14	Waveguide Section - GEC SU 170/04B
15	Transition WR137-WR112 140 mm - GEC SU 170/05
16	Waveguide Section - GEC SU 170/06A
17	Waveguide Section - GEC SU 170/06B
18	Waveguide to Coaxial Transition - GEC SU 170/07
19	Waveguide Pressure Window - GEC SU 170/08
20	Waveguide Section with air pressurizing fitting - GEC SU 170/09
21	Waveguide Section - GEC SU 170/10
22	Waveguide Section - GEC SU 170/11
23	Waveguide Section - GEC SU 170/12
24	Waveguide Section - GEC SU 170/13
25	Waveguide Section - GEC SU 170/14A
26	Waveguide Section - GEC SU 170/14B
27	Tracking Coupler - GEC SU 170/15
28	UG51 Flange Shorting Plate - GEC SU 170/16
29	Cooled Load Assy. - GEC SU 170/17
30	Coaxial Cable 5 metres - GEC SU 170/18
31	Coaxial to Waveguide Transition - GEC SU 170/19A
32	Coaxial to Waveguide Transition - GEC SU 170/19B
33	Coaxial Cable 1.8 metres - GEC SU 170/20
34	Waveguide Load Assy. - GEC SU 170/21
35	Flexible Waveguide 457.2 mm - GEC SU 170/23
36	Flexible Waveguide 76.2 mm - GEC SU 170/24
37	Waveguide Section - GEC SU 170/25 (EL and AZ)
38	Test Translator Attenuator Assy. - GEC SU 170/22
39	Transition WR137-WR112 140 mm - GEC SU 170/33
40	Test Translator Waveguide Switch - GEC SU 170/31
41	Circulator
42	Transition WR137-WR112 140 mm - GEC SU 170/34
43	High Power Waveguide Switch
44	Low Power Waveguide Switch
45	High Power Amplifier

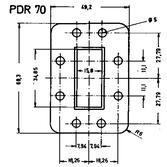
Table 2.4-1 (Cont'd)

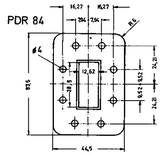
Figure Item No.	Description/Part No.
46	Directional Coupler
47	Second Up-Converter Rack - Selenia T138
48	Waveguide Sections - GEC SU 170/01 A,B,C
49	Waveguide Sections - GEC SU 170/02 A,B,C,D
50	Waveguide Sections - GEC SU 170/03 A,B,C
51	Power Monitor and Load Assy. - CAN-WEST HY1 and DC3/4
52	Waveguide Section - CAN-WEST W1
53	Waveguide Section - CAN-WEST W5
54	Flexible Waveguide - CAN-WEST W7
55	Waveguide Section - CAN-WEST W4
56	Waveguide Section - CAN-WEST W3
57	Flexible Waveguide - CAN-WEST W8
58	Flexible Waveguide - CAN-WEST W6
59	Waveguide Section - CAN-WEST W2
60	Band Stop Filter - CAN-WEST L1/L2

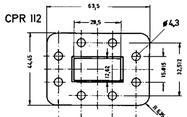


Iss.1

FLANGES:







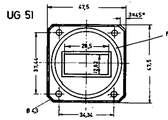


TABLE 'A'

DRAWING REF 'N'	NAME	QUANTITY	COLOUR CODE	GROUP	GASKET MATERIAL (ACCEPTABLE ALTERNATIVE)
1	8 U.N. FACING WASHER 8 U.N. CRINKLE WASHER M4 ORDINARY NUT GASKET - PDR 84 M4 BOLT 1.67"LONG)	8 8 8 1 8	RED	FLANGE TO FLANGE PDR 84	CHROMIUM (COPPER)
2	10 U.N. FACING WASHER 10 U.N. CRINKLE WASHER M5 ORDINARY NUT GASKET - PDR 70 M5 BOLT (1.06" LONG)	8 8 8 1 8	YELLOW	FLANGE TO FLANGE PDR 70	CHROMIUM (COPPER)
3	8 U.N. WASHER 8 U.N. CRINKLE WASHER 8 U.N.C. ORDINARY NUT GASKET-UG 51 8 U.N.C. BOLT (1.75"LONG)	4 4 4 2 4	BLUE	PRESSURE WINDOW (UG 51) COOLED LOAD & AZ TWG WG RUN	CHROMIUM (COPPER)
4	10 U.N. CRINKLE WASHER GASKET - PDR 70 M5 BOLT (1.85"LONG)	8 1 8	GREEN	PDR 70 TO DOWN CONVERTER	CHROMIUM (COPPER)
5	10 U.N. CRINKLE WASHER GASKET - PDR 70 M5 BOLT (1.70" LONG)	8 1 8	GREY	PDR 70 TO L.H.R. SWITCH	CHROMIUM (COPPER)
6	8 U.N. FACING WASHER 8 U.N. CRINKLE WASHER 8 U.N.C. ORDINARY NUT GASKET UG 51 8 U.N.C. BOLT (1.75" LONG) (ALL SCREW WITH ALLEN-STYLE HEAD ALSO EXISTS)	4 4 4 1 4	WHITE	FLANGE TO FLANGE UG 51	CHROMIUM (METEX, OR COPPER EXCEPT FOR ALL ITEMS)
7	8 U.N. CRINKLE WASHER 8 U.N.C BOLT (1.653" LONG) GASKET UG 51	4 4 1	BLACK	UG 51 TO TLT ISOLATOR (REFERENCE ECO 0093)	CHROMIUM (METEX)
8	8 U.N. CRINKLE WASHER GASKET - PDR 84 M4 BOLT 1.53" LONG)	8 1 8	DARK GREEN	PDR 84 TO LNR SWITCH OR LPA.	CHROMIUM (COPPER)
9	8 U.N. CRINKLE WASHER GASKET - UG 51 8 U.N.C. BOLT 1.53 "LONG) (ALL SCREW WITH ALLEN-STYLE HEAD ALSO EXISTS)	4 1 4	PINK	UG 51 TO TLT SWITCH OR PARAMP PORT OR LNR SWITCH	METEX
10	8 U.N. CRINKLE WASHER GASKET PDR 84. 8 U.N.C. SCREW 1.53" LONG)	8 1 8	ORANGE	CPR 112 TO H.P.A. SWITCH	CHROMIUM (COPPER)
11	8 U.N. FACING WASHER 8 U.N. CRINKLE WASHER 8 U.N.C. ORDINARY UNIT GASKET PDR 84. 8 U.N.C. SCREWS 1.0" LONG)	8 8 8 1 8	LIGHT BLUE	FLANGE TO FLANGE CPR 112	CHROMIUM (COPPER)
12	8 U.N.C. ALLEN-HEADED 4IL SCREW (0.53"LONG) GASKET UG 51 PRESSURE WINDOW (ECO 0701)	4 2 1	PINK	UG 51 TO QUARTER WAVE TRANSITION 11 NR SWITCH	METEX
13	8 U.N. WASHER 8 U.N. CRINKLE WASHER 8 U.N.C. ORDINARY NUT 8 U.N.C. BOLT (1.75"LONG) 8 U.N.C. STUDDING (2"LONG) GASKET UG51	6 6 6 2 2 2	BROWN	PRESSURE WINDOW (UG51) ELEVATION TRACKING RUN ONLY	CHROMIUM (COPPER)

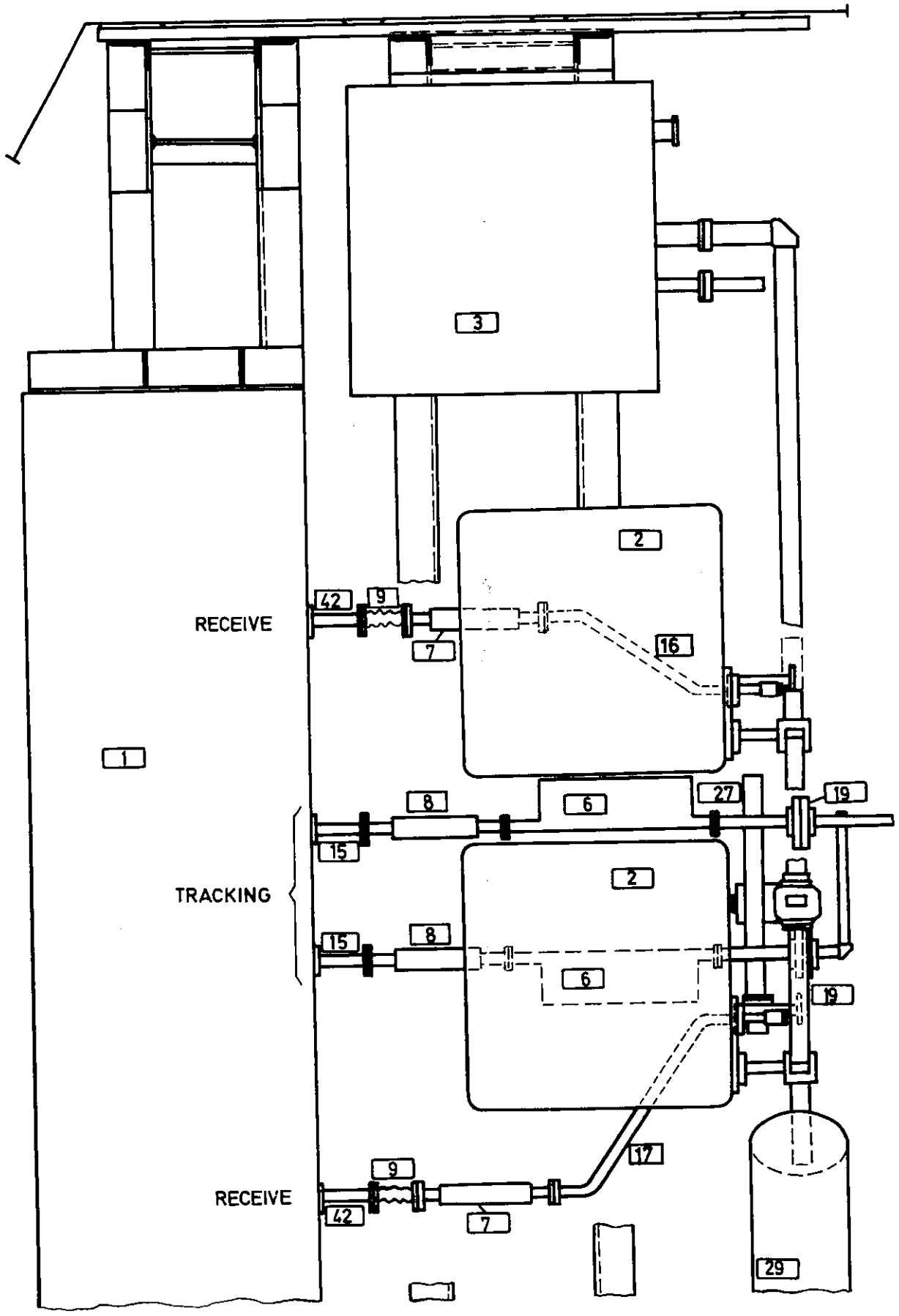
NOTE : Where a packing piece is used between flanges to take up tolerances, longer bolts (see Item 1 list) and an extra gasket must be used.

WAVEGUIDE FLANGE CODE			
REF	TYPE	FACE	HOLE DATA
A	CPR 112	PLAIN	CLEARANCE
B	CPR 112	PLAIN	THREADED
C	CPR 112	PLAIN	CLEARANCE(EXTRA THICK FLANGE - WITHDRAWN)
D	PDR 70	PLAIN	CLEARANCE
E	PDR 70	PLAIN	THREADED
F	PDR 70	PLAIN	THREADED & DOWELLED
G	UG 51	PLAIN	CLEARANCE
H	UG 51	PLAIN	THREADED
J	UG 51	SEALING GROOVE	CLEARANCE QUICK RELEASE FLANGE
K	UG 51	SEALING GROOVE	THREADED QUICK RELEASE FLANGE
L	PDR 84	PLAIN	CLEARANCE
M	PDR 84	PLAIN	THREADED DOWELLED
N	UG 51	CHOKE	CLEARANCE
P	PDR 84	PLAIN	THREADED

NOTES:-
1. PRESSURE WINDOWS COMPONENT REF SU 170/08 HAVE THROUGH CLEARANCE HOLES.
2. WAVEGUIDE SIZES:- TRACKING RUN WR 112 THROUGHOUT.
RECEIVE AND TRANSMIT RUN WR137 FROM FEED TO COMPONENT INTERFACE THENCE WR112.
UP CONVERTER PORTS WR112 DOWN CONVERTER PORTS WR 137.

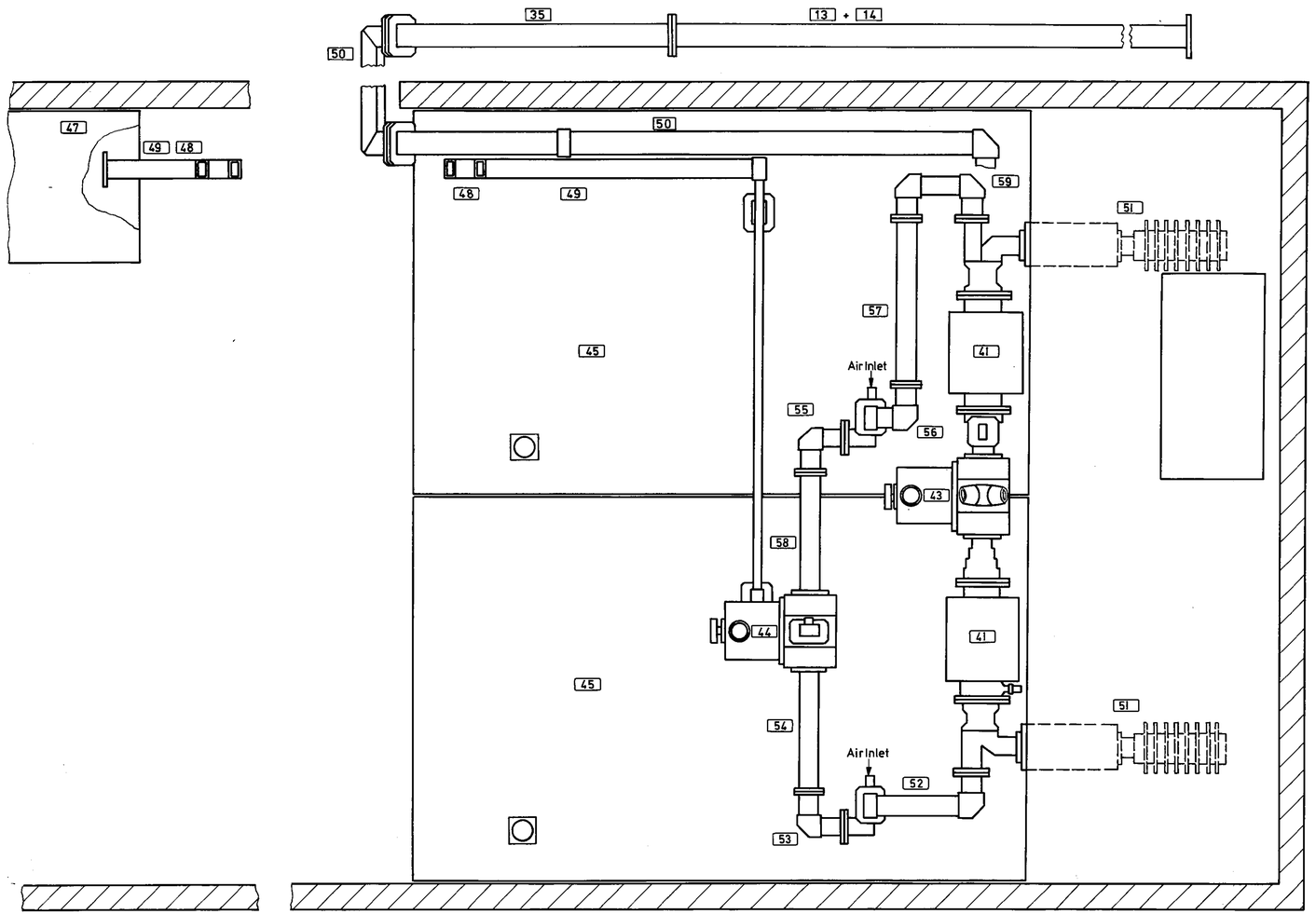
LEGEND:-
NUMBERS IN ○ SEE TABLE 'A' ON THIS FIGURE.
NUMBERS IN □ SEE FIGURES 2.4-1, 2.4-2 AND 2.4-3 OF PART 3.

Waveguide Interconnections: Block Diagram
Figure 2.4-1
Part 1

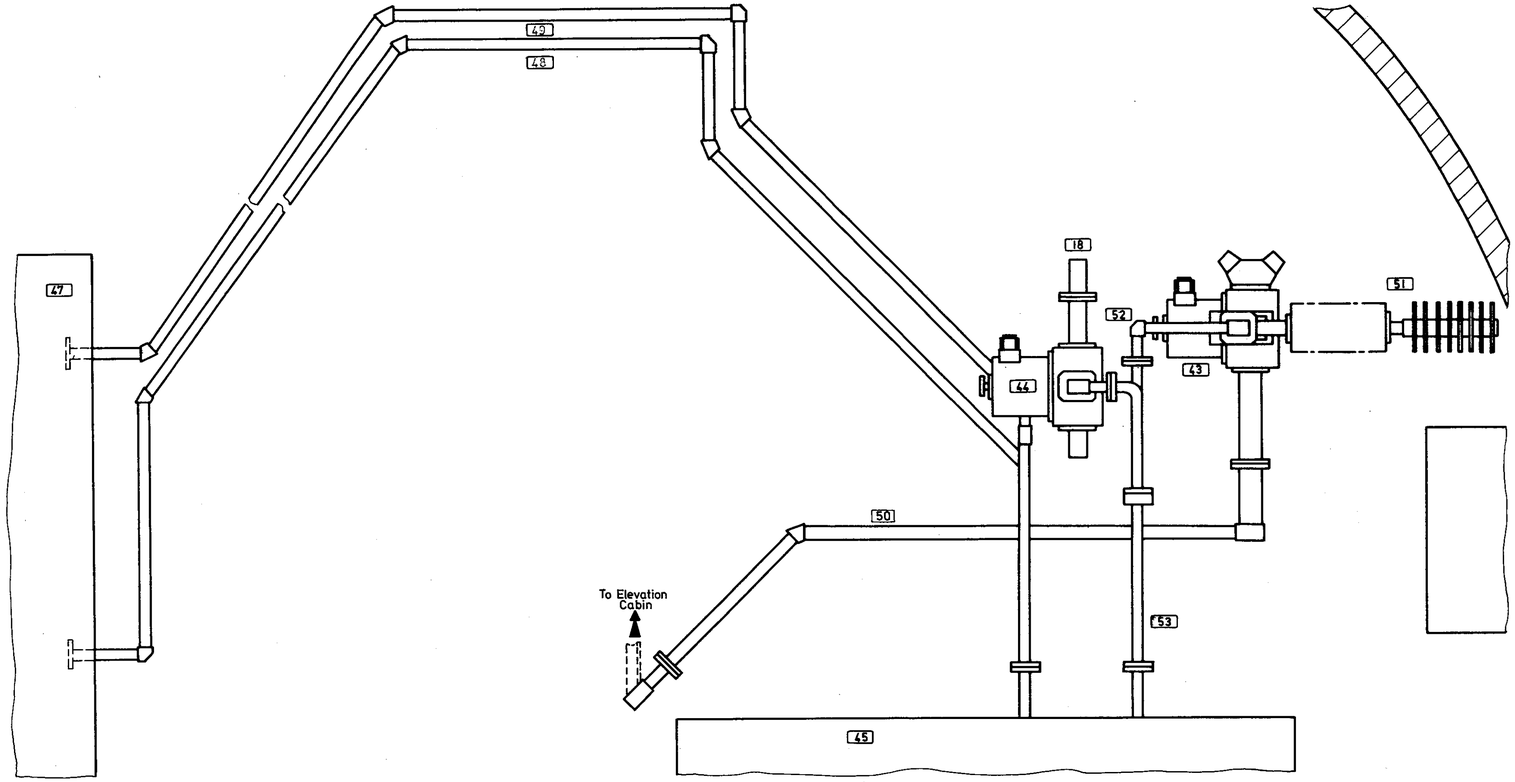


Elevation Cabin Components

Fig. 2. 4-2

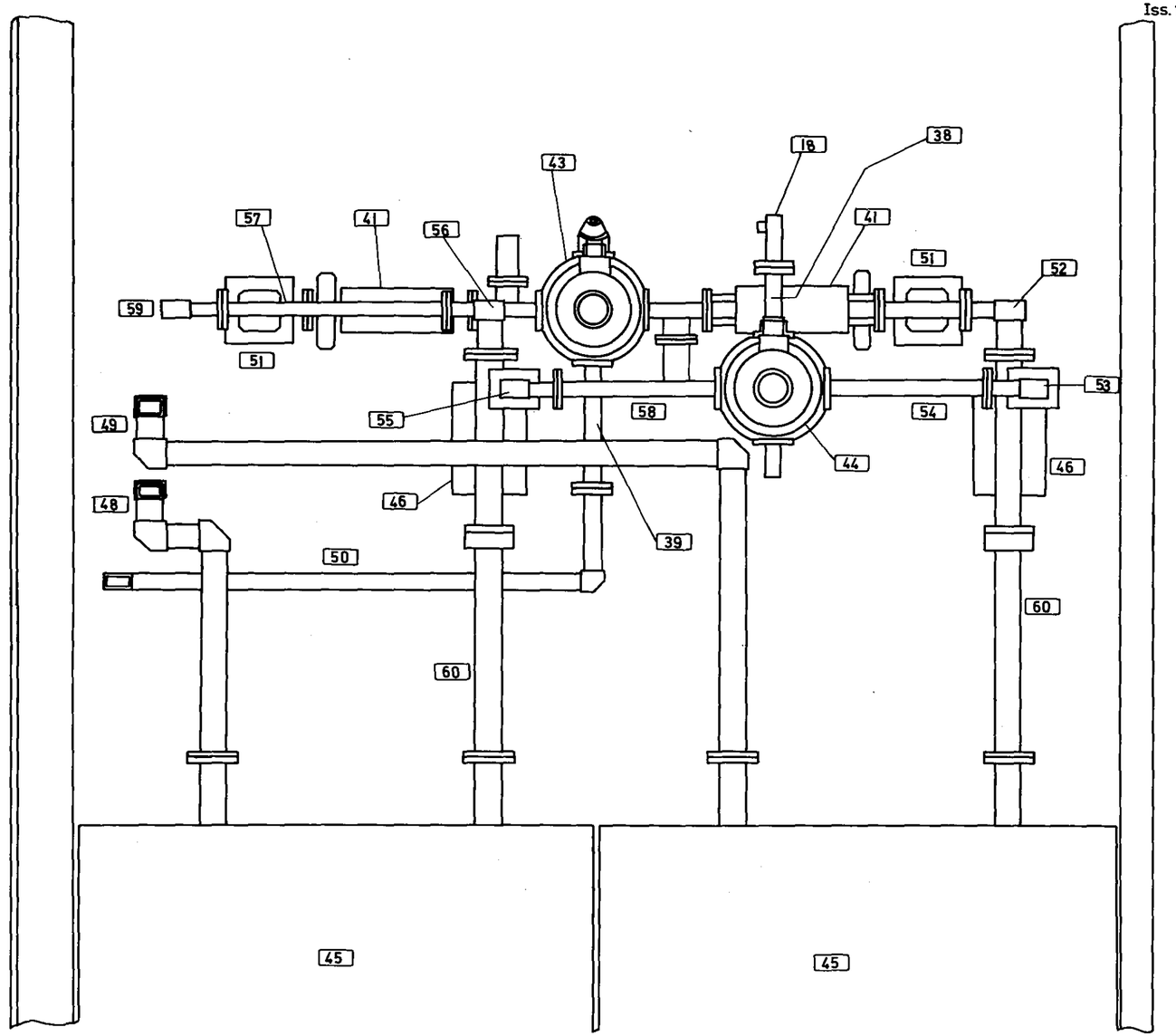


Azimuth Cabin Components
Figure 2.4-3 Sheet 1 of 3
Part 3



Azimuth Cabin Components
Figure 2.4-3 Sheet 2 of 3
Part 3

Iss. 1



Azimuth Cabin Components
Figure 2.4-3 Sheet 3 of 3
Part 3

PART FOUR

COMPONENTS LIST

LIST OF CONTENTS

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: REFLECTOR (Figure 4.1-1 to 4.1-4 Part 1)

Item	Value	Description	Qty	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
		Inner reflector panel			GEC-AEI	W3014831 col. a	
		Outer reflector panel			GEC-AEI	W3014874 col. a	
		Outer reflector panel			GEC-AEI	W3014874 col. b	
		Middle reflector panel			GEC-AEI	W3014875 col. a	
		Outer reflector panel (modified)			GEC-AEI	W3014930 col. a	
		Outer reflector panel (modified)			GEC-AEI	W3014930 col. b	
		Middle reflector panel (modified)			GEC-AEI	W3014933 col. a	
		Middle reflector panel (modified)			GEC-AEI	W3014933 col. b	
		Hatch reflector panel			GEC-AEI	W3017364 col. a	
		Outer reflector panel			GEC-AEI	W3014874 col. a	
		Sub-reflector			GEC-AEI	W3015032 col. a	√
		Sub-reflector support			GEC-AEI	W3015034	
		Tetrapod arm			GEC-AEI	W3015122	
		Tetrapod support			GEC-AEI	Y3015061	
		Backing structure			GEC-AEI	W3014792 cols. a and b	
		Hardware (refer to pages 20 to 25 for itemized list of hardware)			GEC-AEI	W3015145 and W3015146	

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: REFLECTOR INSTALLATION EQUIPMENT (Part One, Section 5)

Item	Value	Description	Qty	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
		Lifting supports	6		GEC-AEI	Y3017461	
		Sling	1		GEC-AEI	Y3018282	
		Lifting straps	4		GEC-AEI	Y3018283	
		Lifting beam assembly	1		GEC-AEI	W3018308	
		Lifting straps	2		GEC-AEI	X3018311	
		Drift pins	As req'd		GEC-AEI	M3018318	
		Pins	6		GEC-AEI	M3018316	
		Pivot pins	2		GEC-AEI	M3018317	
		Sling (endless)	1		GEC-AEI	M3018312	
		Bolts, steel; to BS3692-8.8 M20 x 65 mm long, plated to BS3382 part 2	4		GEC-AEI	ND	
		Nuts, steel; to BS3692-8 M20, plated to BS3382 part 2	4		GEC-AEI	ND	
		Tetrapod handling equipment	1 set		GEC-AEI	W3018305	

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM
WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: FEED ASSEMBLY
(Figure 4.1-5, 4.2-1 to 4.2-6 Part 1)

Item	Value	Description	Qty	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
1		Feed cone assembly	1		GEC-AEI	W3017146 col. a	
2		Septum polarizer assembly	5		GEC-AEI	Y3017177 col. a	
3		Feed mounting plate assembly	1		GEC-AEI	W3017137 col. a	
4		Comparator assembly	1		GEC-AEI	W3017350 col. a	
5		Strap assembly	1		GEC-AEI	M3017330 col. a	
6		Strap assembly	1		GEC-AEI	M3017330 col. b	
7		Horn seal assembly	1		GEC-AEI	Y3017176 col. a	
11		Horn	1		GEC-AEI	W3015060	
12		Spacing ring between items 3 and 1	1		GEC-AEI	X3017138	
13		Strap in item 5	1		GEC-AEI	M3017335-1	
14		Strap in item 6	1		GEC-AEI	M3017335-2	
15		Spacer in items 5 and 6	2		GEC-AEI	M3017336	
16		Packing in items 5 and 6	8		GEC-AEI	M3017337	
17		Bracket in horn assembly	1		GEC-AEI	M3017338	
18		Insulating spacer in item 17	1		GEC-AEI	M3017339	
19		Dowel in item 11	2		GEC-AEI	M3017340-1	
20		Dowel in item 3	2		GEC-AEI	M3017340-2	
21		'0' ring seal: 0.139 in. diameter, 126 in. long approx. Item 3 (46.5 in.), item 11 (33.00 in.), item 1 (46.5 in.)	1		GEC-AEI	M2840038-3	
22		De-icing element: tubular, mineral-filled, 110 V, 250 W, in horn assembly	2		AEI (Heating) Ltd	Y3017154	
23		Insulating knob on item 22 (2 on each)	4			M3017459	

EQUIPMENT: REFLECTOR FEED AND SYSTEM
WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: FEED ASSEMBLY (Cont'd)
(Figure 4.1-5, 4.2-1 to 4.2-6 Part 1)

Item	Value	Description	Qty	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
24		'O' ring seal: 1 11/16 in. outside diameter, 1 in each item 2	5		Dowty	GEC-AEI Y2340374-56	
25		'O' ring seal: 2 in. outside diameter, 0.07 in. diameter, 1 in each item 2 (5) and in item 4 (5)	10		Dowty	GEC-AEI Y2340374-65	
26		Bolt fitting 8 UNC, 4 on each item 2 (20)	20				
27		Cable clip on interface plate	1		GEC-AEI	SK2479059-2	
28		Bolt fitting 8 UNC on item 4	20		GEC-AEI	M2275636-3	
29		Nyloc nut 8 UNC on item 4	20		GEC-AEI	Y2275641-45	
30		Waveguide blanking flanges	4		GEC-AEI	M3017455	
31		Gasket on item 7	1		GEC-AEI	Y3017460	
32		Cable cradle and tie on item 2	1		GEC-AEI	Y2911944-4	
34		Thermal cut-out in horn assembly	1		A.F. Bulgin	FS20/188	
35		Cartridge thermostat in horn assembly	1		Ether Ltd	314H	
36		Terminal blocks on interface plate	1		Ward Brooke	WS/UN/1118/S/E/200EP	
37		Cover on item 36	1		Ward Brooke	WB/UN/118/B/2	
38		Cable connecting plug	1		Cannon Electric Ltd	CVGE16SIP A30	
39		Faston contact on item 34	2		Aircraft Marine Products Ltd	250 Series List No. 41772	

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM
WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: FEED ASSEMBLY (Cont'd)
(Figure 4.1-5, 4.2-1 to 4.2-6 Part 1)

Item	Value	Description	Qty	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
40		Wire (pink) on item 38: 37/0.0076 P.T.F.E.	30 ft		GEC-AEI	Y2756312-5	
41		Spiral tubing on item 38: nylon 1/4 in. outside diameter	As req'd		Spiralon	2N Style S338159	
42		Terminal (ring tongue) on 2 feed heaters	4		Aircraft Marine Products Ltd	List No. 34k42 (4BA)	
43		Terminal (ring tongue) on item 36	5		Aircraft Marine Products Ltd	List No. 34146	
44		Retaining ring ('Dubo') on item 11 0.250 in.	20		Fan Disc Ltd		
80		Loctite dowel sealant	-		Douglas Kane (Sealants) Ltd	GEC-AEI M2858054-7	
81		Special purpose paint (red glyptal)	-		GEC-AEI	SK834Y	
82		Paint: matt white, glossy white and matt black	-		Titanine Ltd	GEC-AEI M3015161	
83		Adhesive on item 1: ICI Deltaflex 345 with curing agent Supersec G	-		ICI	GEC-AEI M2858066	

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: FEED HEATER RELAY ASSEMBLY 470490/A2: 470491/A2 (Figure 2.3-6 Part 1)

Iss. 1

Cct. Ref.	Value	Description	Rating	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
RL1/2		Relay	24 V		Potter & Bloomfield	KUP14B55	
SK1		Socket connector	7 pole		Smart & Brown	MS.3102E.16S-1-S	
PL1		Plug connector	3 pole		Smart & Brown	MS.3102E-16S-5-P	
PL2		Plug connector	5 pole		Smart & Brown	MS.3102E-16S-8-P	
TB1		Terminal block	7 pole		Camblock	80/10/0207/00	

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM
WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: WAVEGUIDE ASSEMBLY
(Figure 2.4-1 Part 1)

Cct. Ref.	Value	Description	Rating	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
SU 170/01A		Waveguide section. 835.66 mm straight section, plus 68° swept bend 63.5 mm radius, plus 35.5 mm straight section. WR112. PDR84 flanges.			GEC-AEI	W.G. Assembly S.U.121/0170/01A	
SU 170/01B		Waveguide section. 513.08 mm straight section with 68° swept bend 63.5 mm radius at one end and 58° swept bend 63.5 mm radius at the other. WR112 PDR84 flanges			GEC-AEI	W.G. Assembly S.U.121/0170/01B	
SU 170/01C		Waveguide section. 848.36 mm straight section plus 32° swept bend 63.5 mm radius plus 85.4 mm straight section. Run contains a 15° joggle 76 mm radius. WR112 PDR84 flange one end and CPR112 the other.			GEC-AEI	W.G. Assembly S.U.121/0170/01C	
SU 170/02A		Waveguide section. 420 mm long plus 60° swept bend 63.5 mm radius plus 89.916 mm straight section. WR112. PDR84 flanges.			GEC-AEI	W.G. Assembly S.U.121/0170/02A	
SU 170/02B		Waveguide section. 594.36 mm straight section plus 50° swept bend plus 76.2 mm straight section at one end and a 60° 63.5 mm radius bend and 56.6 mm straight section at the other.			GEC-AEI	W.G. Assembly S.U.121/0170/02B	

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM
WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: WAVEGUIDE ASSEMBLY (Cont'd)
(Figure 2.4-1 Part 1)

Cct. Ref.	Value	Description	Rating	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
SU 170/02C		Waveguide section. 609.6 mm long with 40° swept bend 63.5 mm radius plus 50.8 mm straight section. WR112. PDR84 flanges.			GEC-AEI	W.G. Assembly S.U.121/0170/ 02C	
SU 170/02D		Waveguide section. 574.04 mm long, plus a 90° swept bend 76.2 mm radius at one end and a 90° 76.2 mm radius swept bend and 189.9 mm straight section at the other. WR112. PDR84 flanges.			GEC-AEI	W.G. Assembly S.U.121/0170/ 02D	
SU 170/03		Waveguide section. 365.76 mm straight section plus 90° swept bend 31.75 mm radius at either end. WR137. PDR70 flanges.			GEC-AEI	W.G. Assembly S.U.121/0170/ 03A	
SU 170/03B		Waveguide section. 660.4 mm straight section with a 90° 31.75 mm radius swept bend at one end, and a 45° 46.7 mm swept bend and 249.9 mm straight section at the other. WR137. PDR70 flanges.			GEC-AEI	W.G. Assembly S.U.121/0170/ 03B	
SU 170/03C		Waveguide section. 424.18 mm straight section plus 90° 46.7 mm radius swept bend plus 124.4 mm straight section. WR137. PDR70 flanges.			GEC-AEI	W.G. Assembly S.U.121/0170/ 03C	

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM
WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: WAVEGUIDE ASSEMBLY (Cont'd)
(Figure 2.4-1 Part 1)

Cct. Ref.	Value	Description	Rating	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
SU 170/04A		Waveguide section. 1584.9 mm straight section. WR137. PDR70 flanges.			GEC-AEI	W.G. Assembly S.U.121/0170/ 04A	
SU 170/04B		Waveguide section. 1884.2 mm straight section. WR137. PDR70 flanges.			GEC-AEI	W.G. Assembly S.U.121/0170/ 04B	
SU 170/05		Transition WR137 - WR112, PDR70 flange PDR84 flange. 140 mm			GEC-AEI	W.G. Taper Transition S.U.121/0170/ 05	
SU 170/06A		Waveguide section. 63.5 mm straight section 34° swept bend, 330.0 mm straight section and 34° swept bend plus 63.5 mm straight section UG51 flanges. WR112.			GEC-AEI	W.G. Assembly S.U.121/0170/ 06A	
SU 170/06B		Waveguide section. 63.5 mm straight section 64° swept bend, 330.0 mm straight section and 64° swept bend plus 63.5 mm straight section. UG51 flanges. WR112.			GEC-AEI	W.G. Assembly S.U.121/0170/ 06B	
SU 170/07		Waveguide component. Waveguide to Coax transition UG51 flange. Type N Coax connector.			GEC-AEI	Transition Assembly W.G. To Coax S.U.121/0170/ 07	

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM
WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: WAVEGUIDE ASSEMBLY (Cont'd)
(Figure 2.4-1 Part 1)

Cct. Ref.	Value	Description	Rating	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
SU 170/08		Waveguide component. Waveguide window. Machined assembly. UG51 flanges. Plus window. 76 mm diameter 25.4 mm thick.			GEC-AEI	Pressure window S.U.121/0170/08	
SU 170/09		Waveguide section. 360.68 mm straight section plus 90° swept bend, plus 192.58 mm straight section plus 90° swept bend plus 40.6 mm straight section. Air pressurising fitting on this section. WR112. PDR84 flanges.			GEC-AEI	W.G. Assembly S.U.121/0170/09	
SU 170/10		Waveguide section. 360.68 mm straight section plus 90° swept bend plus 160.02 mm straight section. WR112. PDR84 flanges.			GEC-AEI	W.G. Assembly S.U.121/0170/10	
SU 170/11		Waveguide section. 942.34 mm straight section plus 90° swept bend plus 115.06 mm straight section. WR112. UG51 flanges.			GEC-AEI	W.G. Assembly S.U.121/0170/11	
SU 170/12		Waveguide section. 513.08 mm long. WR112. PDR84 flanges.			GEC-AEI	W.G. Assembly S.U.121/0170/12	
SU 170/13		Waveguide section 95.6 mm straight section plus 45° swept bend, 76 mm radius plus 95.6 mm straight section. WR112. UG51 flanges.			GEC-AEI	W.G. Assembly S.U.121/0170/13	

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM
WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: WAVEGUIDE ASSEMBLY (Cont'd)
(Figure 2.4-1 Part 1)

Cct. Ref.	Value	Description	Rating	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
SU 170/14A		Waveguide section. 885.98 mm straight section plus 45° swept bend. WR112 air pressuring section fitted on this run. WR137. PDR70 flanges.			GEC-AEI	W.G. Assembly S.U.121/0170/ 14A	
SU 170/14B		Waveguide section. 985.52 mm long straight section plus 45° swept bend. 46.7 mm radius. WR137. PDR70 flanges.			GEC-AEI	W.G. Assembly S.U.121/0170/ 14B	
SU 170/15		Waveguide component. Coupler assembly. Twin waveguide cross coupler, including matched load. UG51 and PDR84 flanges.				Tracking Coupler S.U.121/0170/15	
SU 170/16		Waveguide component. UG51 flange shorting plate.			GEC-AEI	Shorting Plate S.U.121/0170/16	
SU 170/17		Cooled load assembly. Refer to Handbook 703, Appendix D for details.			GEC-AEI	Cooled Load Assembly S.U.121/0170/17	
SU 170/18		Cable assembly. RG214. Type N connectors. 5000 mm long			GEC-AEI	Cable Assembly S.U.121/0170/18	
SU 170/19A		Transition assembly. Waveguide Component. UG51 flange. Type N Coax connector, matched component.			GEC-AEI	Transition Assembly W.G. To Coax S.U.121/0170/ 19A	

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM
WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: WAVEGUIDE ASSEMBLY (Cont'd)
(Figure 2.4-1 Part 1)

Cct. Ref.	Value	Description	Rating	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
SU 170/19B		Transition assembly. Waveguide component UG51 flange. Type N Coax connector, matched component.			GEC-AEI	Transition Assembly W.G. To Coax S.U.121/0170/ 19B	
SU 170/20		Cable assembly. RG214/U cable 1800 mm long, Type N connectors.			GEC-AEI	Cable Assembly S.U.121/0170/20	
SU 170/21		T.L.T. load assembly, waveguide component. 57.15 mm long, UG51 flange and containing matched load, WR112.			GEC-AEI	Load Assembly S.U.121/0170/21	
SU 170/22		T.L.T. attenuator assembly. 127 mm long. WR112. UG51 flanges. Waveguide component. 7dB attenuator.			GEC-AEI	Attenuator Assembly S.U.121/0170/22	
SU 170/23		Waveguide component. Flexible section 457.2 mm long. Special convoluted copper cross section. PDR70 flanges.			GEC-AEI	Waveguide. Flexible TX S.U.121/0170/23	
SU 170/24		Waveguide component. Flexible section 76.2 mm long. Special convoluted copper cross section. PDR70 flanges.			GEC-AEI	Waveguide. Flexible RX S.U.121/0170/24	

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM
WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: WAVEGUIDE ASSEMBLY (Cont'd)
(Figure 2.4-1 Part 1)

Cct. Ref.	Value	Description	Rating	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
SU 170/25		Waveguide section. 2024.38 mm long. Straight section WR112. PDR84 flanges.			GEC-AEI	W.G. Assembly S.U.121/0170/25	
SU 170/28		WG15. PDR84 soft copper gaskets.			GEC-AEI	Gasket WG15 PDR84 S.U.121/0170/28	
SU 170/29		WG14. PDR70 soft copper gaskets.			GEC-AEI	Gasket WG14 PDR70 S.U.121/0170/29	
SU 170/30A/30B		Feed heater relay assembly. Manufactured unit. Two types: 1 version strapped for 220 volts and the other strapped for 120 volts.			GEC-AEI	Feed Heater Relay Assembly (120 V) S.U. 121/0170/30B	
SU 170/31		T.L.T. waveguide switch. Decca UG51 flanges.			GEC-AEI	Waveguide Switch (T.L.T.) S.U.121/0170/31	
SU 170/32		UG51. WR112. Soft copper gaskets.			GEC-AEI	Gasket WG15 UG51 S.U.121/0170/32	
		UG51 Plastic/Mesh gaskets			Metex		

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: WAVEGUIDE ASSEMBLY (Cont'd) (Figure 2.4-1 Part 1)

Cct. Ref.	Value	Description	Rating	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
SU 170/33		WR137-WR112 transition. PDR70 flange one end and CPR112 flange the other. 140 mm long. Waveguide component.			GEC-AEI	W.G. Taper Transition S.U.121/0170/33	
SU 170/34		WR137-WR112 transition. PDR70 flange one end and CPR112 flange the other. 140 mm long. Waveguide component.			GEC-AEI	W.G. Taper Transition S.U.121/0170/34	
SU 170/35		WR137-WR112 transition. PDR70 flange one end and PDR84 flange the other. 140 mm long. Waveguide component.			GEC-AEI	W.G. Taper Transition S.U.121/0170/35	
SU 170/36A		Packing piece PDR84			GEC-AEI	Packing Piece PDR84 (.064) S.U.121/0170/ 36A	
SU 170/36B		Packing piece PDR84			GEC-AEI	Packing Piece PDR84 (.128) S.U.121/0170/ 36B	
SU 170/37A		Packing piece PDR70			GEC-AEI	Packing Piece PDR70 (.064) S.U.121/0170/ 37A	

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM
WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: WAVEGUIDE ASSEMBLY (Cont'd)
(Figure 2.4-1 Part 1)

Cct. Ref.	Value	Description	Rating	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
SU 170/37B		Packing piece PDR70			GEC-AEI	Packing Piece PDR70 (.128) S.U.121/0170/ 37B	
SU 170/38		CPR112 flange soft copper gaskets			GEC-AEI	Gasket WG15 CPR112 S.U.121/0170/38	
SU 170/39		WG112 Neoprene grommets.			GEC-AEI	Grommet WG15 S.U.121/0170/39	
SU 170/40		WR137 Neoprene grommets. High temperature.			GEC-AEI	Grommet WG14 S.U.121/0170/40	
SU 170/41		WR137 Neoprene grommets. Low temperature.			GEC-AEI	Grommet WG14 S.U.121/0170/41	
SU 170/42		Waveguide support brackets.			GEC-AEI	W.G. Support S.U.121/0170/42	
SU 170/43		Feed cone heat shield upper section 495.3 mm radius manufactured aluminium plate. Half section complete with rubber inserts and fixing screws.			GEC-AEI	Feed Cone Heat Shield, upper S.U.121/0170/44	

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM
WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: WAVEGUIDE ASSEMBLY (Cont'd)
(Figure 2.4-1 Part 1)

Cct. Ref.	Value	Description	Rating	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
SU 170/44		Feed cone heat shield, lower section. 495.3 mm radius manufactured aluminium plate. Half section complete with rubber inserts and fixing screws.			GEC-AEI	Feed Cone Heat Shield, lower S.U.121/0170/44	
SU 170/45		Feed cone waveguide support structure. Manufactured U section support structure for internal waveguide runs in feed cone.			GEC-AEI	Feed Cone WG Support Assembly S.U.121/0170/45	
		Test Translator Connector Assembly.			GEC-AEI	470234 A1	
		Seal, Rubber, Round Section			GEC-AEI		NSN5985-99-083-0035
		8 UN Crinkle Washer			GEC-AEI		
		10 UN Crinkle Washer			GEC-AEI		
		8 UN Washer, facing			GEC-AEI		
		10 UN Washer, facing			GEC-AEI		
		8 UNC Nuts Ordinary			GEC-AEI		
		M4 Nuts			GEC-AEI		
		M5 Nuts			GEC-AEI		
		8 UNC Bolt (1.72 LG)			GEC-AEI	470034 A4/2	
		8 UNC Bolt (0.97 LG)			GEC-AEI	470034 A4/3	
		8 UNC Bolt (0.75 LG)					NSN5985-99-083-9010

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM
WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: WAVEGUIDE ASSEMBLY (Cont'd)
(Figure 2.4-1 Part 1)

Cct. Ref.	Value	Description	Rating	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
		8 UNC Bolt (0.5 LG)			GEC-AEI	470034 A4/4	
		M4 Bolt (0.855 LG)			GEC-AEI	470039 A4/1	
		M4 Bolt (1.05 LG)			GEC-AEI	470034 A4/2	
		M4 Bolt (0.735 LG)			GEC-AEI	470034 A4/3	
		M5 Bolt (1.045 LG)			GEC-AEI	470038 A4/1	
		M5 Bolt (1.235 LG)			GEC-AEI	470038 A4/2	
		M5 Bolt (0.835 LG)			GEC-AEI	470038 A4/3	
		M5 Bolt (0.685 LG)			GEC-AEI	470038 A4/3	

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: REFLECTOR HARDWARE (W3015145)

Item	Value	Description	Qty	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
12		Rod, screwed	3		GEC-AEI	M3017312	
22		Washer, convex, concave	12		GEC-AEI	Y2632663-9	
23		Spacer	8 approx		GEC-AEI	M3015062-1	
24		Spacer	4 approx		GEC-AEI	M3015062-2	
25		Spacer	4 approx		GEC-AEI	M3015062-3	
28		Bolt, fitting, M16	4		GEC-AEI	Y3015147-1	
29		Bolt, fitting, M16	8		GEC-AEI	Y3015147-2	
33		Bolt, M16 x 80 mm long	16		GEC-AEI	ND	
36		Bolt, M14 x 55 mm long	16		GEC-AEI	ND	
38		Bolt, M12 x 55 mm long	16		GEC-AEI	ND	
		Items 33, 36, 38 are steel to BS3692-88, plated to BS3382 part 2					
45		Nut, thin, hex. to BS3692-6, plated to BS3382 part 2, M24	24		GEC-AEI	ND	
49		Nut, hex. self-locking, 'Nyloc', M16	28		Firth Cleveland Ltd	PP/Y166	
50		Nut, hex. self-locking, 'Nyloc', M14	16		Firth Cleveland Ltd	PP/Y146	
51		Nut, hex. self-locking, 'Nyloc', M12	16		Firth Cleveland Ltd	PP/Y126	
52		Nut, hex, self-locking, 'Nyloc', M8	2		Firth Cleveland Ltd	PP/Y086	

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM
WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: REFLECTOR HARDWARE
(W3015145) (Cont'd)

Item	Value	Description	Qty	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
		Items 49 to 52 are zinc plated to BS3382 part 2					
54		Washer, plain, steel, M14 (Normal)	32		GEC-AEI	Y3015179-5	
55		Washer, plain, steel, M16 (Normal)	32		GEC-AEI	Y3015179-6	
56		Washer, plain, steel, M12 (Normal)	32		GEC-AEI	Y3015179-4	
57		Washer, plain, steel, M8 (Normal)	2		GEC-AEI	Y3015179-2	
58		Washer, plain, steel, M16 (Large)	24		GEC-AEI	Y3015179-19	
63		Pin, dowel, 4 mm	8		GEC-AEI	Y3017299-1	
64		Pin, dowel, 10 mm	1		GEC-AEI	M3018432-1	
67		Pin, dowel	1		GEC-AEI	M3018432-2	
74		Screw, slotted csk. hd. steel to BS3155, zinc plated to BS3382 part 2. 4-40, UNC-2A x 1 in. long	16		GEC-AEI	ND	
79		Nut, hex. steel to BS3155, zinc plated to BS3382 part 2. 4-40 UNC	16		GEC-AEI	ND	
83		Araldite	As req'd		GEC-AEI	M2777558	
85		Loctite	As req'd		GEC-AEI	M2858054-9	
87		Spherical bearing 0.75 in. bore	4		Glacier Metal	Cat. No. SE/24/DU3	

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM
WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: REFLECTOR HARDWARE
(W3015145) (Cont'd)

Item	Value	Description	Qty	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
92		'0' ring seal 0.139 in. dia. x 132 in. long approx	1		GEC-AEI	M2840038	
93		Adhesive, oil-resistant rubbers	As req'd		GEC-AEI	M2858066	

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: REFLECTOR HARDWARE (W3015146)

Item	Value	Description	Qty	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
8		Cover	1		GEC-AEI	Y3018116-1	
10		Cover	1		GEC-AEI	Y3017190	
11		Cover	4		GEC-AEI	Y3014886-4	
12		Label	1		GEC-AEI	Y3015167	
13		Support bracket	256		GEC-AEI	Y3015026-1	
14		Support bracket	64		GEC-AEI	Y3015026-2	
15		Connector plate	206		GEC-AEI	Y3015027-1	
16		Connector plate	30		GEC-AEI	Y3015027-2	
17		Connector plate	80		GEC-AEI	Y3015027-3	
18		Cover	2		GEC-AEI	Y3014886-1	
19		Cover	4		GEC-AEI	Y3014886-2	
20		Cover	4		GEC-AEI	Y3014886-3	
22		Gasket	4		GEC-AEI	Y3014893-2	
25		Bolt, fitting, M10	632		GEC-AEI	Y3015147-10	
26		Bolt, fitting, M14	160		GEC-AEI	Y3015147-13	
28		Bolt, fitting, M16	32		GEC-AEI	Y3015147-4	
29		Bolt, fitting, M20	64		GEC-AEI	Y3015147-7	
30		Gasket	1		GEC-AEI	X3017188-1	
31		Gasket	4		GEC-AEI	X3017188-2	
33		Screw, M10 x 28 mm long	320		GEC-AEI	ND	
35		Screw, M8 x 30 mm long	104		GEC-AEI	ND	
37		Screw, M6 x 20 mm long	224		GEC-AEI	ND	
39		Screw, M4 x 20 mm long	32		GEC-AEI	ND	
		Items 33, 35, 37, 39 to BS3692-88, plated to BS3382 part 2.					

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM
WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: REFLECTOR HARDWARE
(W3015146) (Cont'd)

Item	Value	Description	Qty	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
43		Shim	10		GEC-AEI	M3019557-1	
44		Shim	20		GEC-AEI	M3019557-2	
45		Insulation, slab, 1 in. thick	1 roll		Cape Insulation Ltd	AF20	
46		Adhesive	As req'd		Idenden Adhesives Ltd	ST-27	
47		Sealing tape	As req'd		Idenden Adhesives Ltd	T-78 S/A	
50		Nut, hex. self-locking, 'Nyloc', M10	952		Firth Cleveland Ltd	PT/Y106	
51		Nut, hex. self-locking, 'Nyloc', M14	160		Firth Cleveland Ltd	PP/Y146	
52		Nut, hex. self-locking, 'Nyloc', M16	32		Firth Cleveland Ltd	PP/Y166	
53		Nut, hex. self-locking, 'Nyloc', M20	64		Firth Cleveland Ltd	PP/Y206	
		Items 50 to 53 are zinc plated and passivate to BS3382 part 2.					
55		Washer, plain, steel, M6	224		GEC-AEI	Y3015179-1	
56		Washer, plain, steel, M8	104		GEC-AEI	Y3015179-2	
57		Washer, plain, steel, M10	632		GEC-AEI	Y3015179-3	
58		Washer, plain, steel, M12	632		GEC-AEI	Y3015179-4	
59		Washer, plain, steel, M14	160		GEC-AEI	Y3015179-5	

COMPONENTS LIST

EQUIPMENT: REFLECTOR FEED AND SYSTEM
WAVEGUIDE INTERCONNECTIONS

ASSEMBLY: REFLECTOR HARDWARE
(W3015146) (Cont'd)

Item	Value	Description	Qty	Tol.	Manufacturer	Manufac. Type or Drawing Nos.	NATO Stock No.
60		Washer, plain, steel, M16	40		GEC-AEI	M3018431	
61		Washer, plain, steel, M16	150		GEC-AEI	Y3015179-6	
62		Washer, plain, steel, M18	75		GEC-AEI	Y3015179-7	
63		Washer, plain, steel, M20	64		GEC-AEI	Y3015179-8	
64		Washer, plain, steel, M22	64		GEC-AEI	Y3015179-9	
65		Washer, plain, steel, M4	32		GEC-AEI	Y3015179-11	
66		Washer, plain, steel, M10 (Large)	640		GEC-AEI	Y3015179-16	
71		Araldite AV100	As req'd		GEC-AEI	M2777558	
73		Loctite nut lock (blue)	As req'd		GEC-AEI	M2858054-2	
75		Rivet, 0.187 in. dia. x 0.594 in. long, snap hd.	128		Avdel Ltd	1221-0619	
76		Rivet, 0.25 in. dia. x 0.594 in. long, snap hd.	520		Avdel Ltd	1221-0819	
84		Rivet, 0.156 in. dia. x 0.375 in. long, snap hd.	4		Avdel Ltd	1221-0512	
85		Pin, sealing (for item 75)	128		Avdel Ltd	1283-0619	
86		Pin, sealing (for item 76)	520		Avdel Ltd	1283-0819	
94		Al. angle, BS1476, HE30 WP to BS1161 (1.50 x 1.50 x 0.125 thk. x 37.38 in. long)	2			ND	
96		Shim material, BS1470 SK 0.032 in. and 0.002 in. thick laminations	As req'd			ND	