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Colin Hinson

In the village of Blunham, Bedfordshire.



**AP 116E-1757-1**

**January 1985**

**HF WIDEBAND  
FAN DIPOLE ANTENNAS  
(C&S TYPE WFA SERIES)  
GENERAL AND TECHNICAL INFORMATION**

**BY COMMAND OF THE DEFENCE COUNCIL**

*Miss Whitmore.*

**Ministry of Defence**

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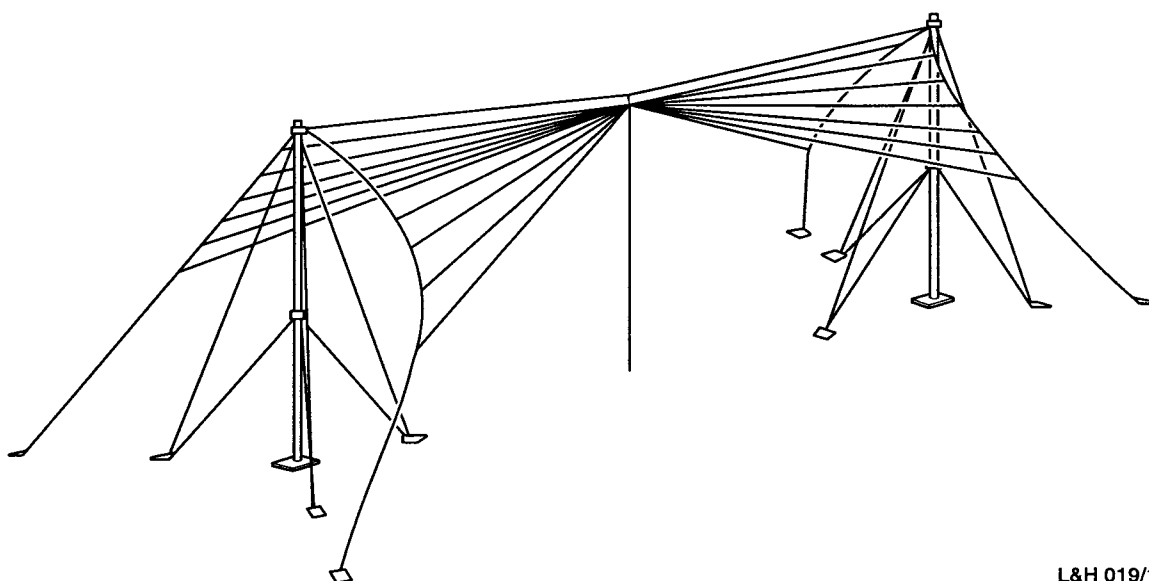
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AP 100B-01 Order 0504 (RAF)**

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Chapter 1LEADING PARTICULARS

L&amp;H 019/1

<u>Title</u>	HF wideband fan dipole antenna.
<u>Ref. No.</u>	WFA 230 (NATO Stock No. TBA)
<u>Purpose</u>	To provide omni-directional ground-to-air coverage in transmission and reception within the hf band 2 MHz to 30 MHz
<u>Brief description</u>	The radiating curtain consists of four sets of aerial wires (where each set has six wires of varying lengths), suspended from two masts. Each set of wires is attached between a side catenary (there are two side catenaries on each mast) and a bracket suspended halfway along a catenary between the masts. The catenaries are constructed of fibreglass.

Site requirements

An area of approximately 135.4 m (444.4 ft) by 59.6 m (195.6 ft) is required, flat and free from obstructions.

Physical characteristics

Height	36 m (118.2 ft)
Mast spacing	101.3 m (332.5 ft)
Stay radius	34.3 m (112.6 ft)
Weight	95 kg (209.5 lb), approx

Electrical characteristics

Impedance	300 ohms
Azimuth radiation pattern	Omni-directional
Polarisation	Horizontal
Maximum VSWR	Generally better than 2.5:1
Gain (minimum)	5 dBi (over good earth)
Power rating	20 kW
Frequency range	2 MHz to 30 MHz

Chapter 2TECHNICAL DESCRIPTION

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- 2 Electrical
- 4 Mechanical

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General

1 Antennas in the WFA series are fan dipoles, each consisting of a radiating curtain formed by four sets of six wires. The array is suspended by catenaries attached to two masts.

Electrical

2 The WFA series of antennas is designed for the transmission and reception of horizontally polarised electromagnetic waves, providing an omni-directional radiation pattern in the horizontal plane and low-angle coverage in the vertical plane.

2 The elevation radiation patterns shown in fig 1 demonstrate the required high elevation angles at lower frequencies (for short to medium range working) and the progressively lower angles at higher frequencies (for long range working). The azimuth characteristic is acceptably omni-directional up to 30 MHz.

3 Fig 2 shows a typical VSWR curve for the WFA series at frequencies of 2 MHz to 30 MHz.

Mechanical

4 Each of the four sets of cadmium copper wires that form the radiating curtain is attached between one of the two side catenaries connected to each mast, and a bracket suspended halfway along a central catenary between the masts. The catenaries are constructed of fibre glass.

5 The masts are each supported by three sets of stays on 120° radials. A lightning arrester is fitted at the base of each mast.

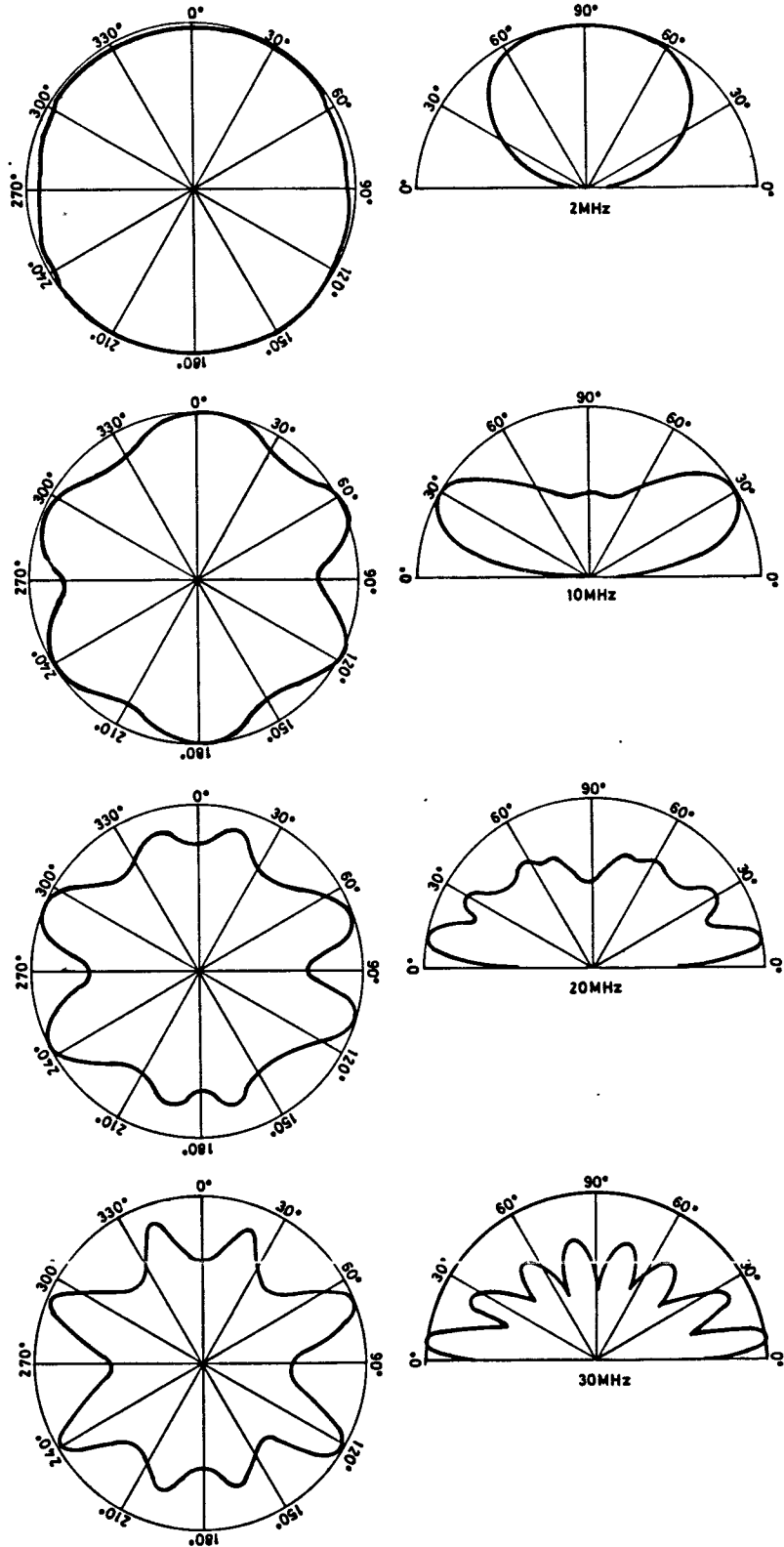


Fig 1 Radiation patterns

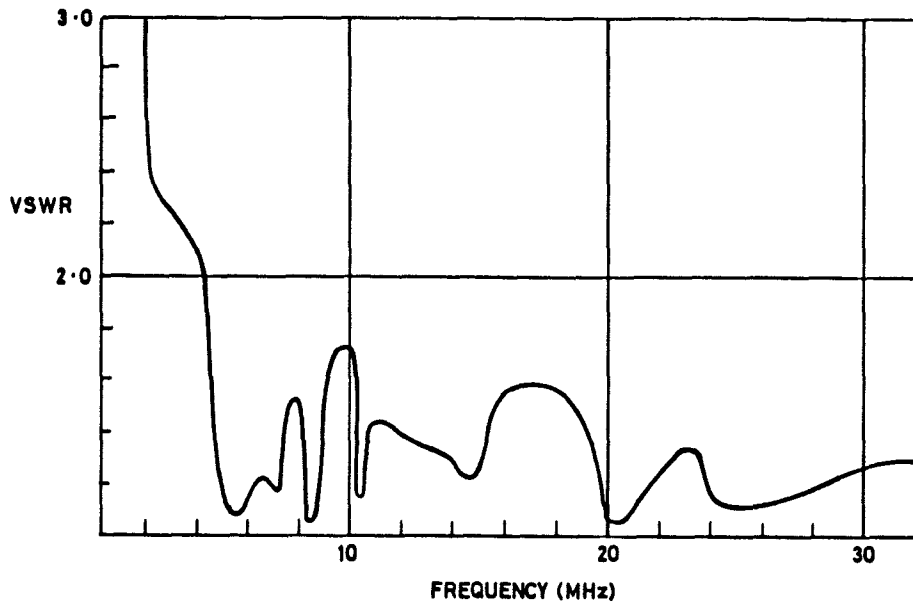


Fig 2 VSWR curve (2 MHz to 30 MHz)



## Chapter 3

### TAPERED LINE FEEDER

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1 Matching between the 300 ohms antenna impedance and the 600 ohms station output impedance is achieved by a tapered line feeder which effects the necessary transformation.

2 As shown in fig 1, the station feeder lines are taken to an adaptor plate on the termination beam. The transmission lines leave the termination beam at 9½ inch spacing, tapering off to 3 inch spacing at the intermediate headcap assembly (fig 2). This effectively matches the antenna impedance. Different spacings will effect different transformations where the WFA antenna impedance or the station output impedance varies from the figures quoted above.

3 The two double-stranded line outputs are fed, parallel to each other, to the adaptor plate on the feeder pole, where connection is made to the downlead assembly (fig 3).

4 Table 1 shows parts used in the tapered line feeder between termination beam and downlead assembly, where item numbers are those shown in fig 1, 2 and 3.

TABLE 1 TAPERED LINE FEEDER PARTS

Item No.	Drg/ref no.	Description	Qty
1	C&S 3/6857	Headcap assy., 9½" spacing	1
2	C&S 3/6856	Headcap assy., 3" spacing	1
3	C&S 2/4568	Transformer line, single stranded	1
4	C&S 1/4567	Transformer line, double stranded	1
5	C&S 4/4531	Insulator assy.	8
6	C&S 4/4565	Pulley block	2
7	-	Rigging screw 3/8" fork and eye, stock no. BP26	4
8	-	Line tap V15, stock no. P44	6
9	-	Cord-copper wire, 7/.048 x 4'6"	2
10	SEE/181507	Adaptor plate	1
11	SEE/181489	Adaptor feeder pole	1
12	SEE/181490	Adaptor plate	1
13	29A/1222785	Bolt, M10 x 120, hex hd., Zn plated	1
14	5310-99-1225297	Nut, M10 hex, steel, Zn plated	8
15	5310-99-1226476	Washer, M10 flat, steel, Zn plated	8
16	5310-99-1389228	Washer, M10 single, coil, st., Zn plated	8
17	29A/1222782	Bolt, M10 x 90, hex hd., Zn plated	4
18	29A/1222784	Bolt, M10 x 110, hex hd., Zn plated	2
19	-	Bolt, M10 x 130, hex hd., Zn plated to B.S. 3692	1

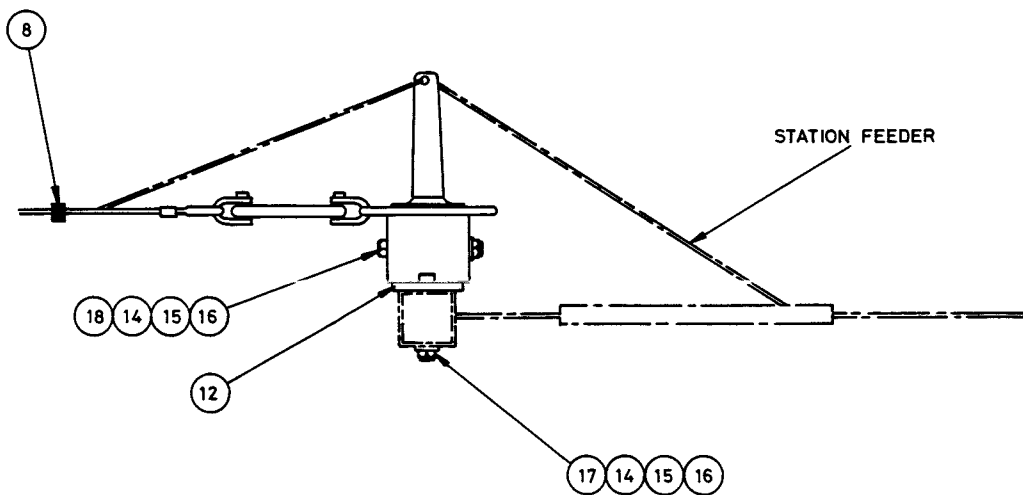
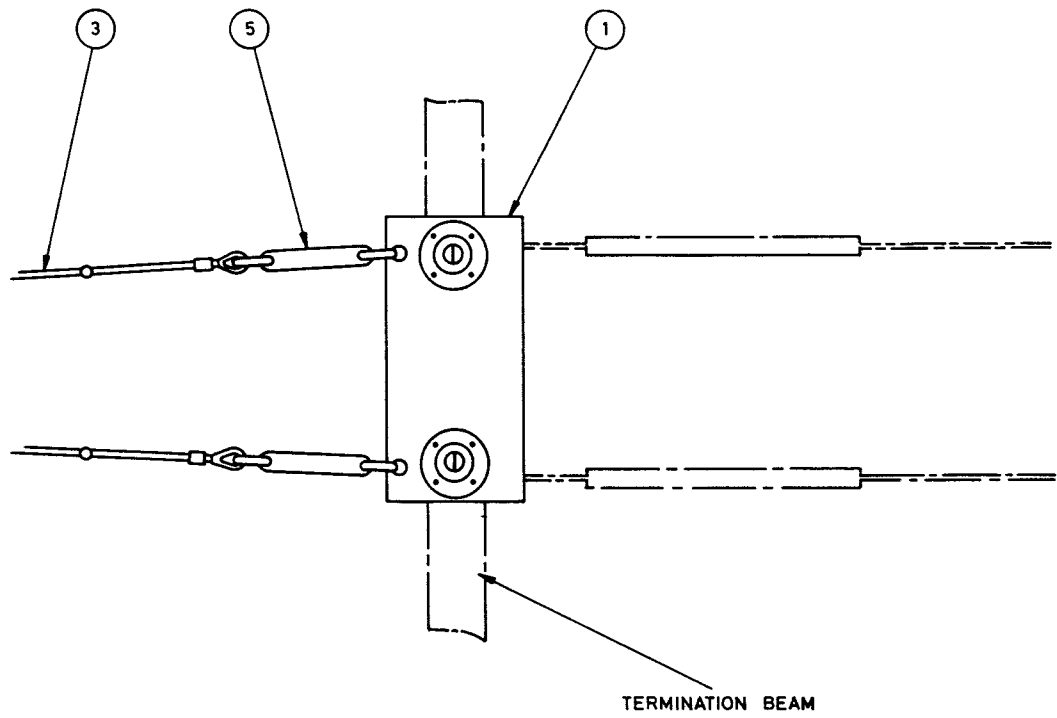


Fig 1 Station feeder line connections

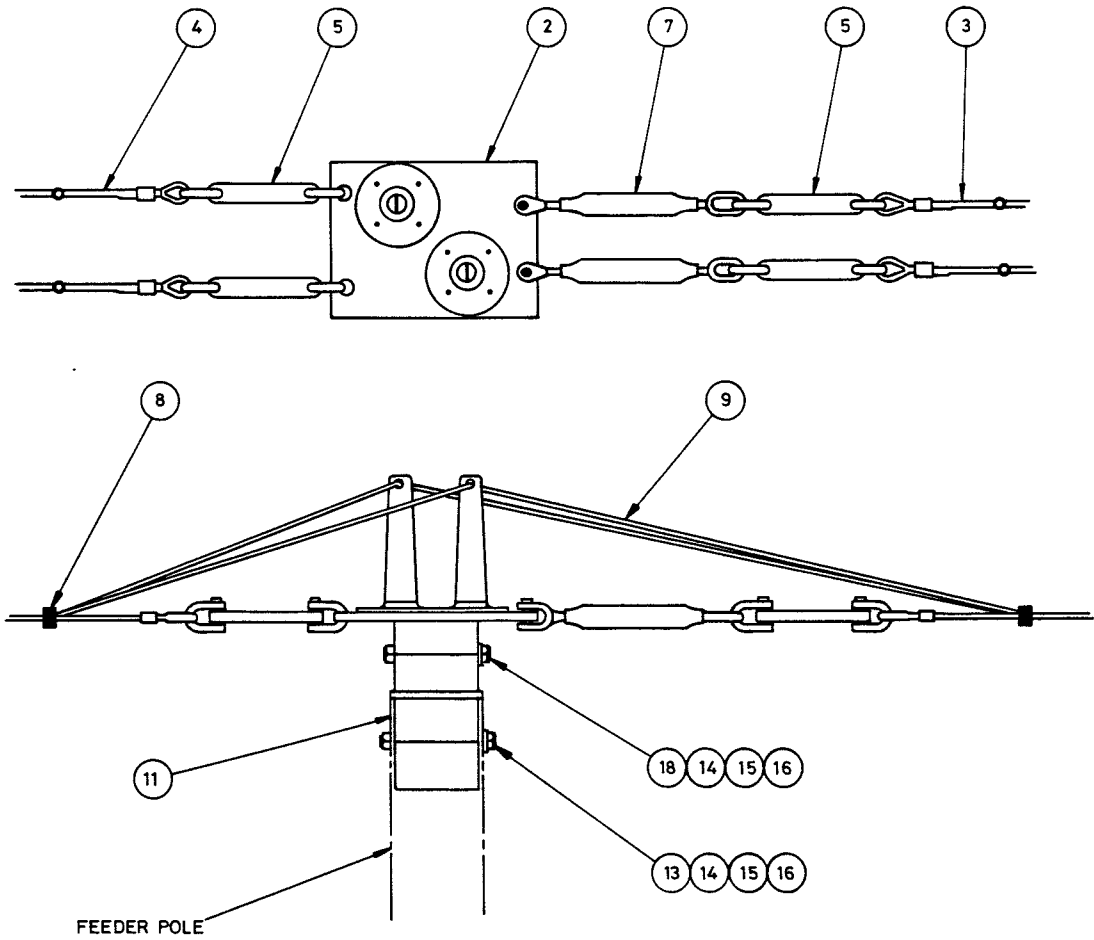


Fig 2 Intermediate headcap assembly connections

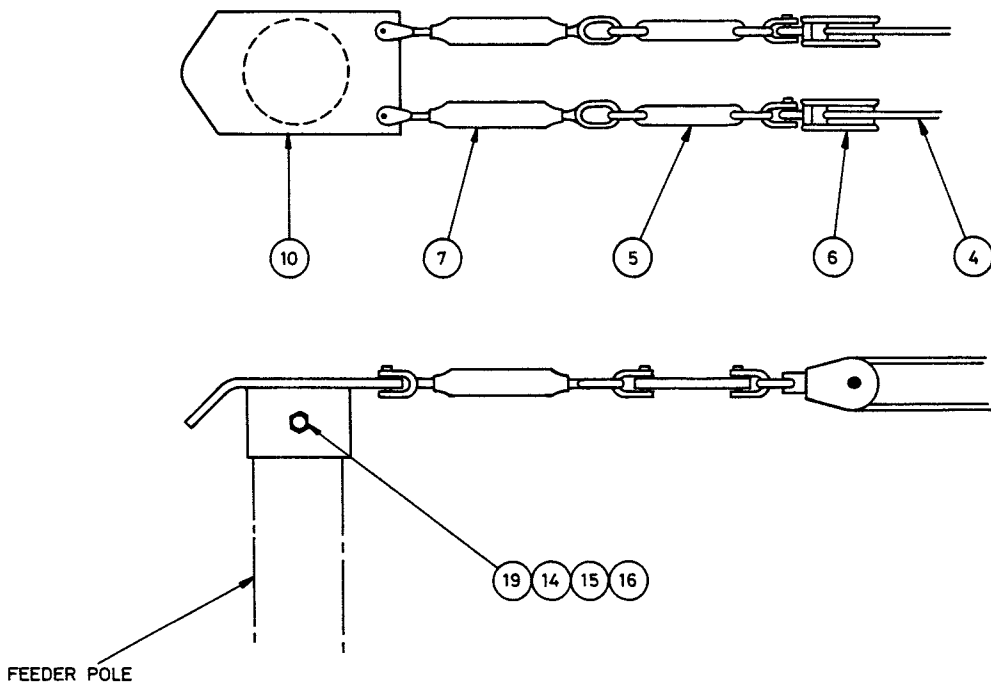


Fig 3 Last line feeder pole connections

Chapter 4WFA 230 ERECTING AND DISMANTLING  
INSTRUCTIONS

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DRAWINGS AND ASSOCIATED PUBLICATIONS

1 These erecting and dismantling instructions are to be read in conjunction with the following drawings and publications:

- |                  |   |
|------------------|---|
| AP 119K-0001-5F  | Lifting tackle : general information and servicing schedules. |
| AP 119K-0001-1   | Lifting tackle : standards and practices                      |
| AP 119K-0304-15F | Safety suspension chair.                                      |
| AP 119K-0614-16A | Tirfor winch W13.   |
| AP 119A-1101-5F  | Safety harness and associated equipment.                      |
| AP 119A-1101-1   | Safety anchors and harnesses.                                 |

2 Parts to be used during the erecting and dismantling of the WFA 230 antenna are listed in Table 1. Special tools required to carry out these tasks are listed in Table 2. All reference drawings are collated at the end of this chapter.

### SAFETY PRECAUTIONS

3 All relevant safety precautions are to be taken during erection and lowering of the antenna, and these must not be compromised in any way.

3.1 The instructions listed in para 1 are to be read carefully and understood before leaving for the site.

3.2 Care must be taken when handling items weighing more than 5 kg.

3.3 If an electrical storm or a windspeed of 10 knots or over is forecast, no erection or lowering of the antenna is to take place until local weather conditions have improved.

3.4 Check that the antenna foundation blocks have been provided in accordance with the appropriate works service drawing.

### PSA (DOE) RESPONSIBILITIES

4 These erection instructions assume that the masts have been erected previously by PSA. The masts and their stays remain the responsibility of PSA, and are not to be adjusted.

### MANPOWER

► 5 A supervisor (senior NCO) and six men are required to assemble and erect the antenna. Similarly, a supervisor and six men are required to lower the antenna.

Note ...

A man being lifted or lowered in a safety suspension chair must be hauled up or lowered by a team of six men and a supervisor, as described in AP 119K-0304-15F.

### ASSEMBLY OF ANTENNA CURTAIN

6 To assemble the antenna curtain (fig 1) proceed as follows, where item numbers in brackets refer to both Table 1 and figures 1, 2, 4, 5 and 11:

6.1 Lay out the top catenary approximately one and a half metres to one side of the centre line between masts, and attach a halyard (25) to each end of the top catenary as shown in fig 2.

6.2 Lay out the side catenaries (16) in the positions indicated in fig 3 and attach them to the top-catenary chains, using the 'D' shackle (23) as shown in fig 2.

Note ...

It may later be necessary to adjust the position of the shackles on the chains. Para 16 refers.

6.3 As shown in fig 4, assemble the downlead support assembly. This should be attached mid-way along the top catenary, within a tolerance of  $\pm 50$  mm.

6.4 Lay out four complete sets of aerial wires (17) between the top and side catenaries. The wires are numbered in sets of six, as shown in fig 1.

6.5 Attach each aerial wire to its associated side catenary with M6 nuts and bolts, as shown in fig 5.

6.6 Attach each aerial wire to the downlead support assembly as shown in fig 4, where three pairs of wires are connected to each side of both terminal plates (5).

6.7 Attach the downlead assembly (15) to the downlead support assembly, as shown in fig 4, and lay the downlead assembly away from the top catenary, as shown in fig 3.

#### Positioning of mast bands

7 Before the antenna curtain can be erected, it is necessary for a man to climb each mast and position the mast bands. For each mast, proceed as follows:

7.1 Ascend the mast, either by climbing or by safety suspension chair (depending upon mast type), always adhering to the relevant safety precautions.

7.2 Adjust the height of the mast bands as specified on the rigging chart on the station installation drawing. Clamp the bands into position.

7.3 Attach a shackle (29) and pulley block (26) to the band.

7.4 Descend the mast.

#### ERECTION OF ANTENNA CURTAIN

8 A man must first ascend each mast to attach the antenna halyards. For each mast, proceed as follows:

8.1 Ascend the mast, taking the antenna halyard (25).

8.2 Reeve the halyard through the pulley block (26), as shown in fig 2.

8.3 Descend the mast, bringing the loose end of the halyard.

Note ...

The correct machinery must be used if the weight block should require moving.

9 Position the weight block (see works service drawing) at the base of one of the masts at a position two metres from the mast and one metre off the centre line between masts.

CAUTIONS ...

- (1) Take care when raising the antenna curtain to avoid the side catenaries and aerial wires twisting or fouling on the mast stays.
- (2) Treat the ceramic insulator with care (e.g. do not drag them over stones, etc)

10 Haul both halyards simultaneously to raise the antenna curtain to a height of approximately 25 metres or to a height which is practicable by hand. Tie off the halyards to the halyard blocks, as shown in fig 8.

11 Attach a weighting assembly (30) (guys) to the weight block previously positioned (para 9). Position the strops of the weighting assembly as shown in fig 7.

12 A man must now ascend each mast. For each mast, proceed as follows:

12.1 Ascend the mast, taking a guy grip dead end (circumference 1.25 in) and a length of T13 Tirfor wire. See Table 2 for details.

12.2 Attach the guy grip dead end to the antenna halyard (with the eye facing downwards) at a position approximately 25 metres above the ground.

12.3 Place the hook on the Tirfor rope through the eye of the guy grip dead end.

12.4 Descend the mast, bringing the loose end of the Tirfor wire.

13 Attach a 1.25 in thimble (27) on the bow of a 'D' shackle (29), and attach this assembly to the top eye in the weight block, as shown in fig 8.

14 Attach a 1.25 in thimble (27) on the bow of a 'D' shackle (29), and attach this assembly to the eye in the halyard block at the other mast. The pin of the shackle should pass through the eyes.

15 Using the two T13 Tirfor winches, proceed as follows:

15.1 Attach the hook of one winch to the top eye on the weight block, as shown in fig 9. Leave the shackle free.

15.2 Attach the hook of the other winch to the eye of the halyard block at the other mast. Leave the shackle free.

15.3 Reeve both winches with their respective Tirfor wires.

15.4 Operate both winches simultaneously, but using irregular strokes so as not to induce bounce into the mast and catenaries.

Note ...

As the wire enters the winch, ensure that it is clean and well lubricated.

15.5 At the mast without the weight block, operate the winch until the end swage on the halyard is approximately 150 mm (6 in) from the pulley block. Reeve a guy grip dead end (28) over the thimble on the loose shackle attached to the eye of the halyard block. Pull the halyard tight, and wrap the guy grip around the halyard. Operate the winch to release the tension from the Tirfor wire.



- 15.6 At the mast with the weight block, operate the winch until the weight block has lifted approximately one metre clear of the ground. Carefully release the halyard from the block and tie it off to the weight block.
- 16 At this point, it may become apparent that the top catenary needs shortening. In this case proceed as follows:
- 16.1 Lower the antenna curtain (refer to para 23 to 33).
- 16.2 Shorten the catenary by adjusting the chains (see fig 2). If chain adjustment is insufficient, cut the top catenary (by no more than 150mm at each end), ensuring that the degree of adjustment is equal at both ends.
- 16.3 Once correct rigging has been satisfactorily achieved, cut away any loose chain.
- 16.4 Raise the antenna curtain (refer to para 10 to 15).
- 17 Reeve a guy grip dead end (28) over the thimble on the loose shackle attached to the eye of the weight block. Pull the halyard tight and wrap the guy grip around the halyard.
- 18 Operate the winch to release the tension from the Tirfor wire. Unreeve the Tirfor wires from their winches and disconnect the winches.
- 19 A man must now ascend each mast, disconnect the Tirfor wires from the guy grip, and remove the guy grip from the halyards. The man should bring these items when he descends the mast.
- 20 Leave the loose halyard coiled at the base of each mast.
- 21 Connect the downleads to the end of the terminating resistance at the feeder pole, as shown in fig 10.

### Antenna servicing

- 22 After 28 days following erection of the antenna, reset the rigging as follows, to compensate for initial stretching of the terylene rope:
- 22.6 Reset the distance between the end swage on the halyard and the pulley block (see para 15.5).
- 22.7 Reset the distance above ground of the weight block to 150mm (6in.).

### LOWERING OF ANTENNA

- 23 Disconnect the downleads from the terminating resistance at the feeder pole.
- 24 Attach a guy grip dead end to each halyard, approximately two metres above its lower attachment, with the eye of the guy grip facing downwards. Attach a Tirfor rope to each of the guy grips.
- 25 Attach a T13 Tirfor winch to the top eye in the weight block, and reeve the winch with the appropriate Tirfor wire. Operate the winch to release the tension from the halyard at the weight block. Disconnect the halyard from the weight block.
- 26 Attach a T13 Tirfor winch to the eye in the halyard block at the other mast, and reeve the winch with the appropriate Tirfor wire. Operate the winch to release the tension from the halyard at the halyard block. Disconnect the halyard from the halyard block.

### CAUTIONS

- (1) **Take care when lowering the antenna curtain to avoid the side catenaries and aerial wires twisting or fouling on the mast stays.**
- (2) **Treat the ceramic insulators with care (eg. do not drag them over stones, etc)**

**NOTE**

**As the wire enters the winch, ensure that it is clean and well lubricated.**

- 27 Operate both winches simultaneously to lower the antenna curtain, using irregular strokes so as not to induce bounce into the mast and catenaries.
- 28 Once the tension has been released from the side catenaries, disconnect them from their respective anchor blocks.
- ▶ 29 As the curtain is lowered, on man placed at the end of each side catenary, to pull the antenna around the front top mast guys, this will alleviate any risk of chaffing of the side catenary or chain on the guys. See fig. 3. ◀
- 30 Lower the curtain to the point where it is practicable to finish the job by hand. Tie off both halyards to their respective blocks.
- 31 Unreeve the wires from the winches and disconnect the wires from the halyard and weight blocks.
- 32 A man must now ascend each mast, disconnect the Tirfor wires from the guy grip dead end and remove the guy grips from the halyard. The man should bring these items when he descends the mast.
- 33 Untie both halyard and continue lowering the curtain to the ground, keeping the side catenaries in tension.
- 34 Pack and store all lifting equipment in accordance with the appropriate Air Publication.

TABLE 1 WFA 230 PARTS LIST

Item No.	Drawing no.	Description	Qty
1	-	Top catenary GRP rod, 9.5 dia., 102 m	1
2	-	Preformed dead end	2
3	C&S 4/7397	Thimble	2
4	C&S 4/4701	Side wire clamp	2
5	C&S 4/25782	Terminal plate	2
6	-	Strain insulator	1
7	C&S 4/2301	Link plate	4
8	-	Bolt, hex hd, st.st., M6 x 30	6
9	-	Washer, plain, st.st., M6	31
10	-	Nut, aero, st.st., M6	23
11	-	Screw, hex hd, st.st., M6 x 20	7
12	-	Screw, hex hd, st.st., M6 x 25	10
13	-	Nut, full, st.st., M6	2
14	C&S 4/25783	Downlead bracket	1
15	C&S 4/25778	Downlead assembly	1
16	SEE 188883	Side catenary	4
17	C&S 3/23197/1	Aerial wires	4 sets
18	-	Bow shackle, 5/8 x 3/4, galv.st.	2
19	-	Chain, 1/2" x 4', galv.st.	2
20	-	'D' shackle, 1/2 x 1/2, galv.st.	2
21	-	Chain, 3/8" x 4', galv.st.	4
22	-	Rigging screw, 3/8 fork and eye, galv.st.	4
23	-	'D' shackle, 3/8 x 3/8, galv.st.	8
24	-	'D' shackle, 1/4 x 1/4, galv st.	8
25	SEE 191382	Halyard assy.	2
26	SCSHQ 154165	Swivel block, 10B 933/574	2
27	-	Thimble, 1 1/4 circ., 29H 9156642	2
28	90G 109807/10	Guy grip dead end, 10B 9331568	2
29	-	Large 'D' shackle, 3/4 pin, galv., BS 3072 SWL 1 1/2T	4
30	SCSHQ 159885	Weighting assy. for halyards	1
31	-	Sleeve, rubber, 5K 9107069	2

TABLE 2 TOOLS LIST

Item	Ref/Drg no.	Description	Qty
* 1	4L 4253400 (AP 119K-0304-15F6)	Safety suspension chair	1
2	10AR 5197422	Snatch block (used with item 1)	1
3	-	Small 'D' shackle, $\frac{1}{2}$ x $\frac{5}{8}$ , BS 3032, galv. (used with item 1)	1
4	42B 6337642	Denso tape rolls	2
5	-	Spanners	
	IC 9106287	M6 x M7, open jaw	4
	IC 1275368	M5 x M6, ring	1
6	IC 9105746	Hacksaw	1
7	10B 9331568	Guy grip dead end 1 1/4 circumference	12
8	4GB 2048346	Tirfor winch, T13	2
9	4GB 5238374	Tirfor wire, T13, 100 ft	2

\* Depending upon mast type, fall-arrestor equipment may be used in place of items 1, 2 and 3. See AP 119A-1101-5F and AP 119K-0304-15F.

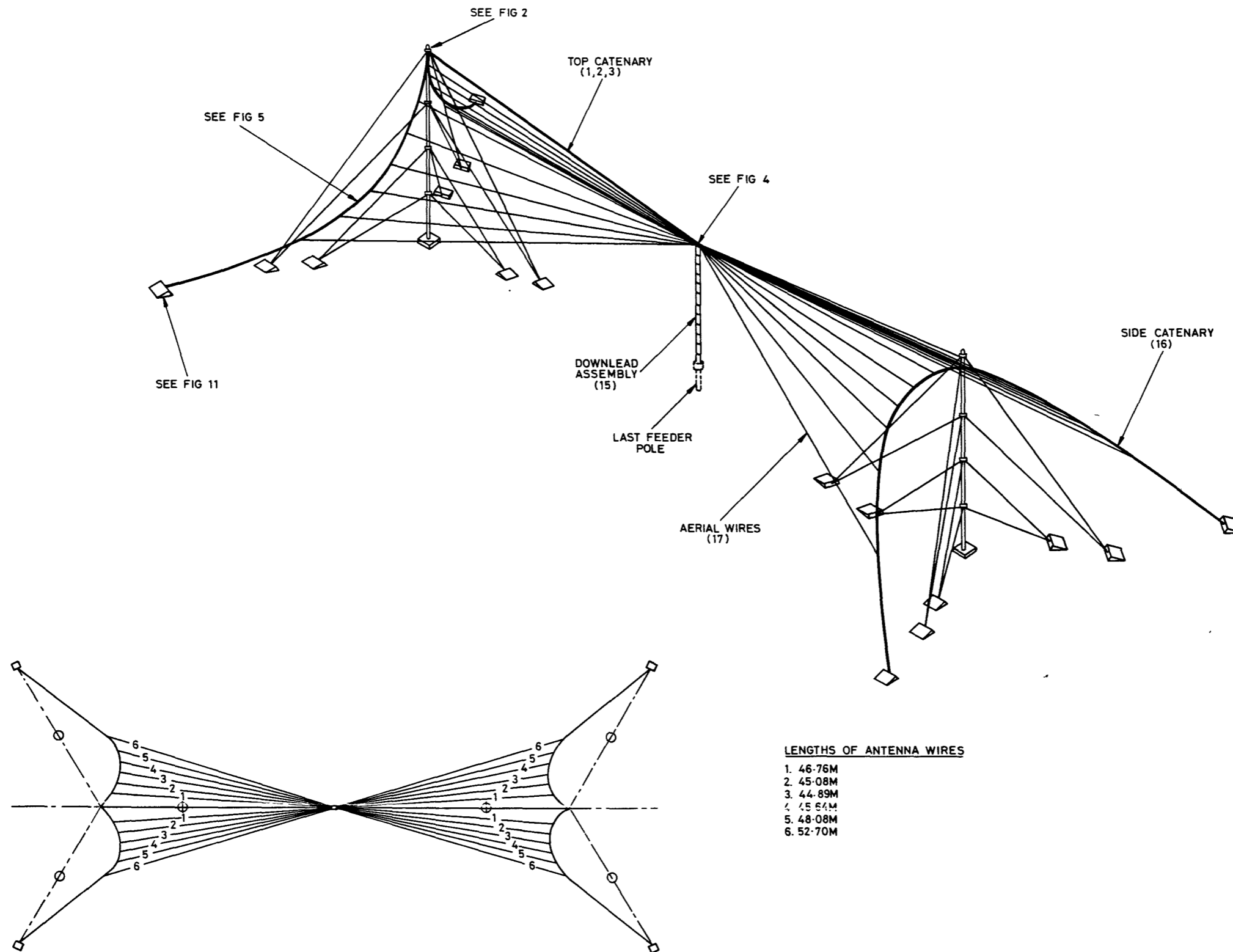


Fig 1

WFA 230 antenna

Fig 1

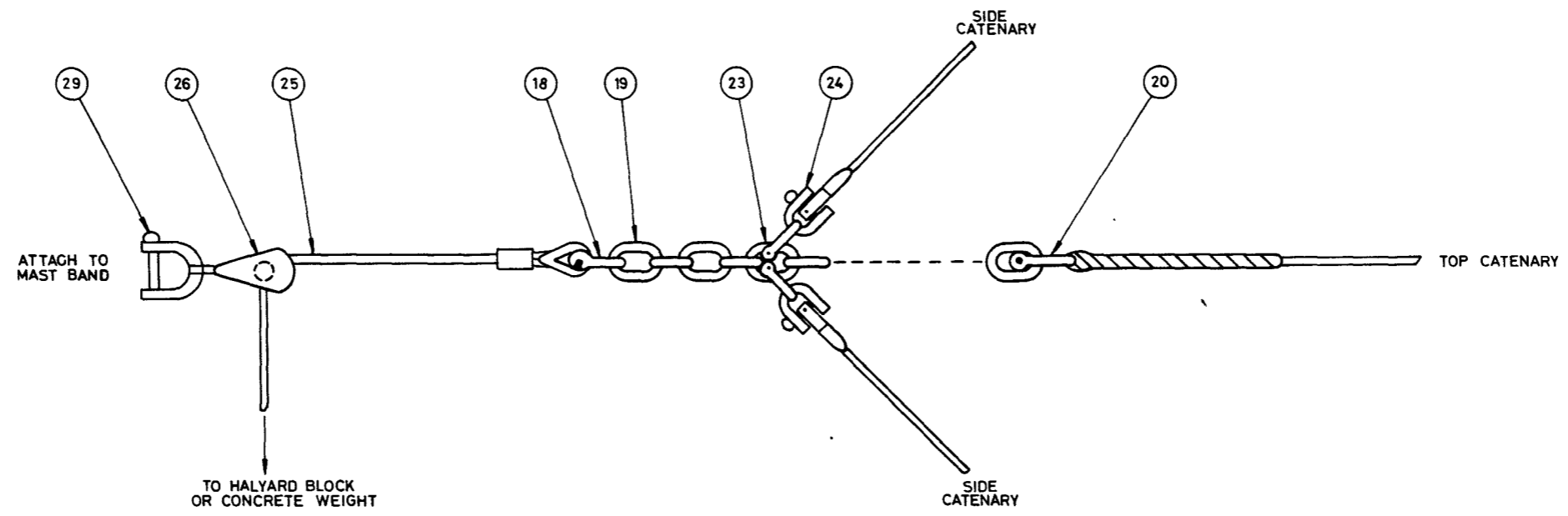


Fig 2

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Top catenary connection

Fig 2

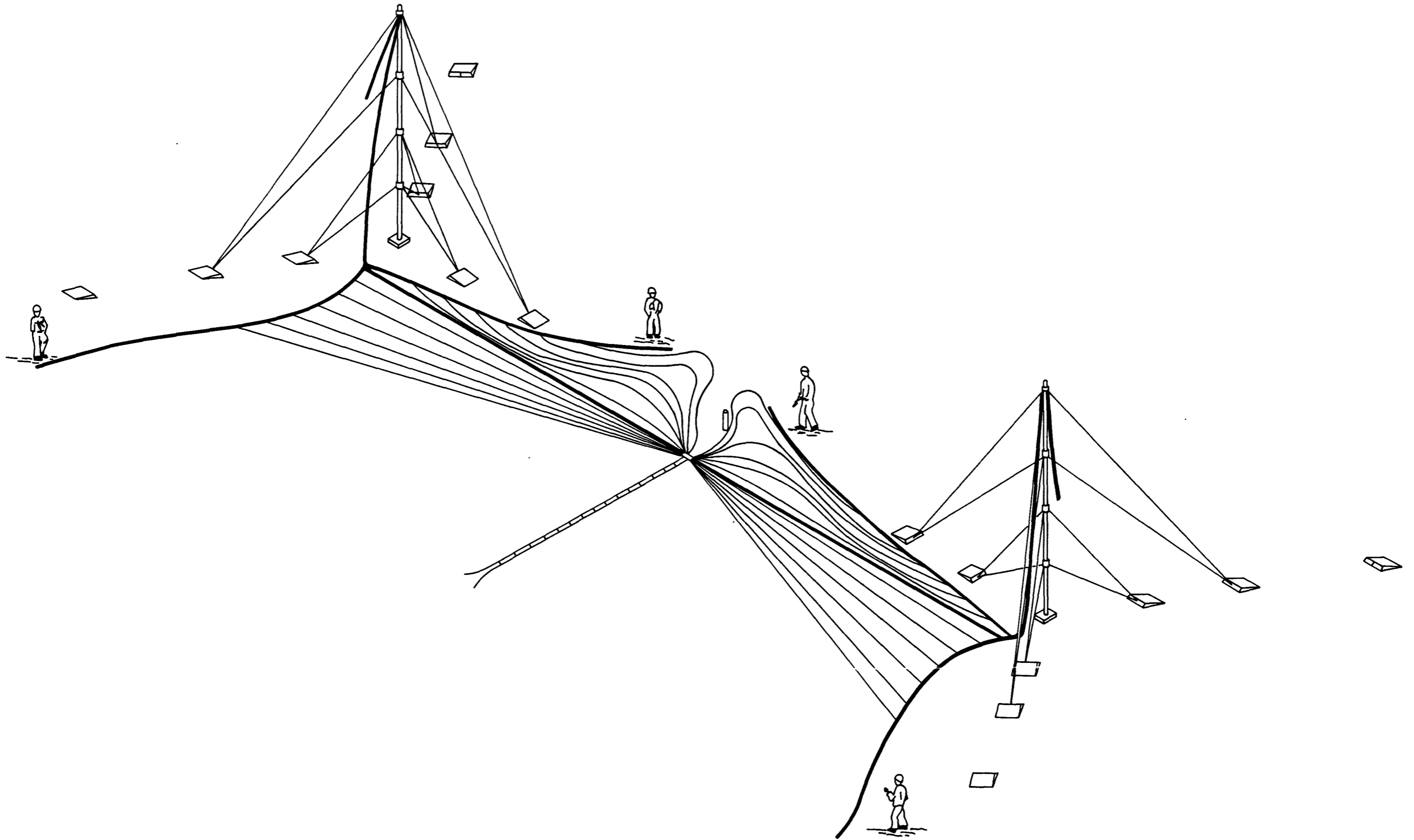


Fig 3

Antenna assembled on the ground

Fig 3





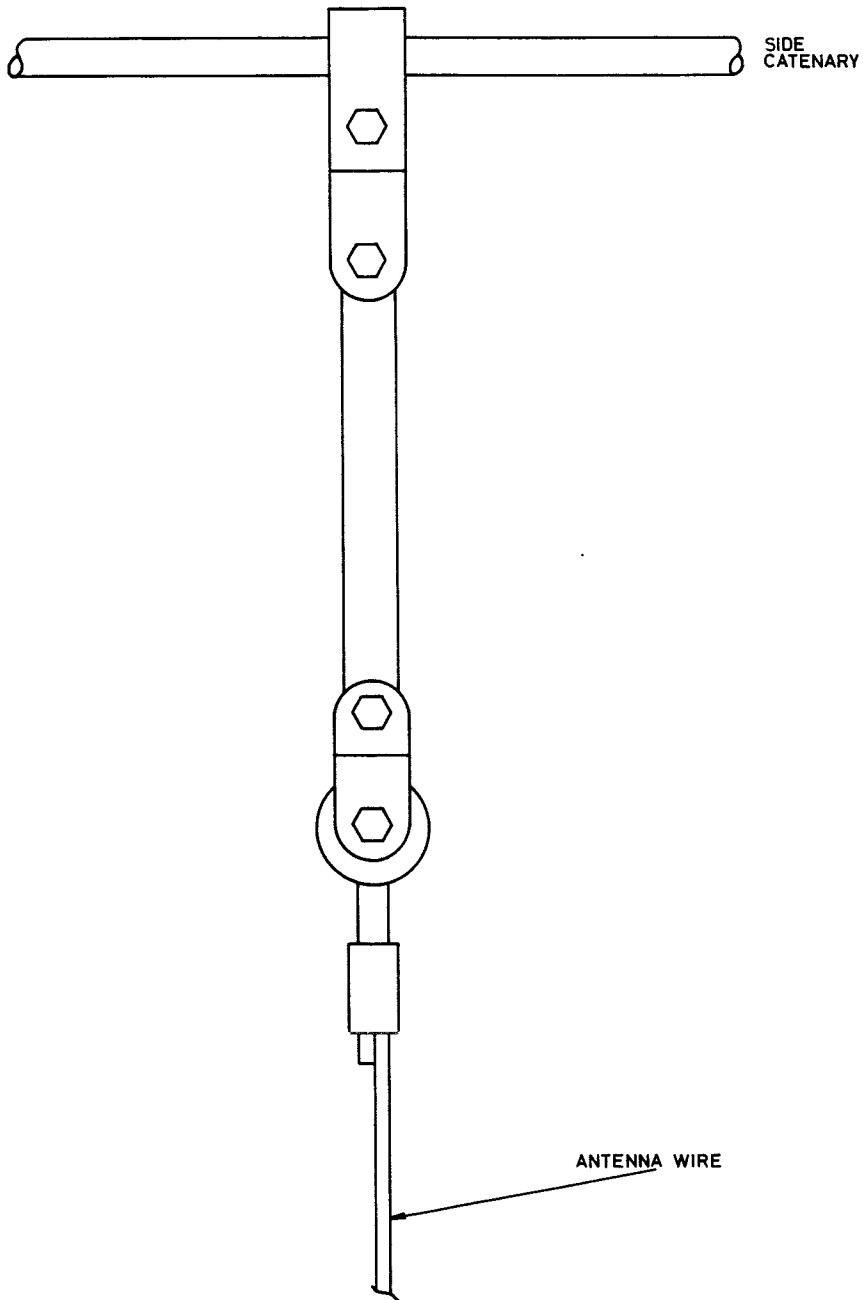


Fig 5 Wire connection to side catenary

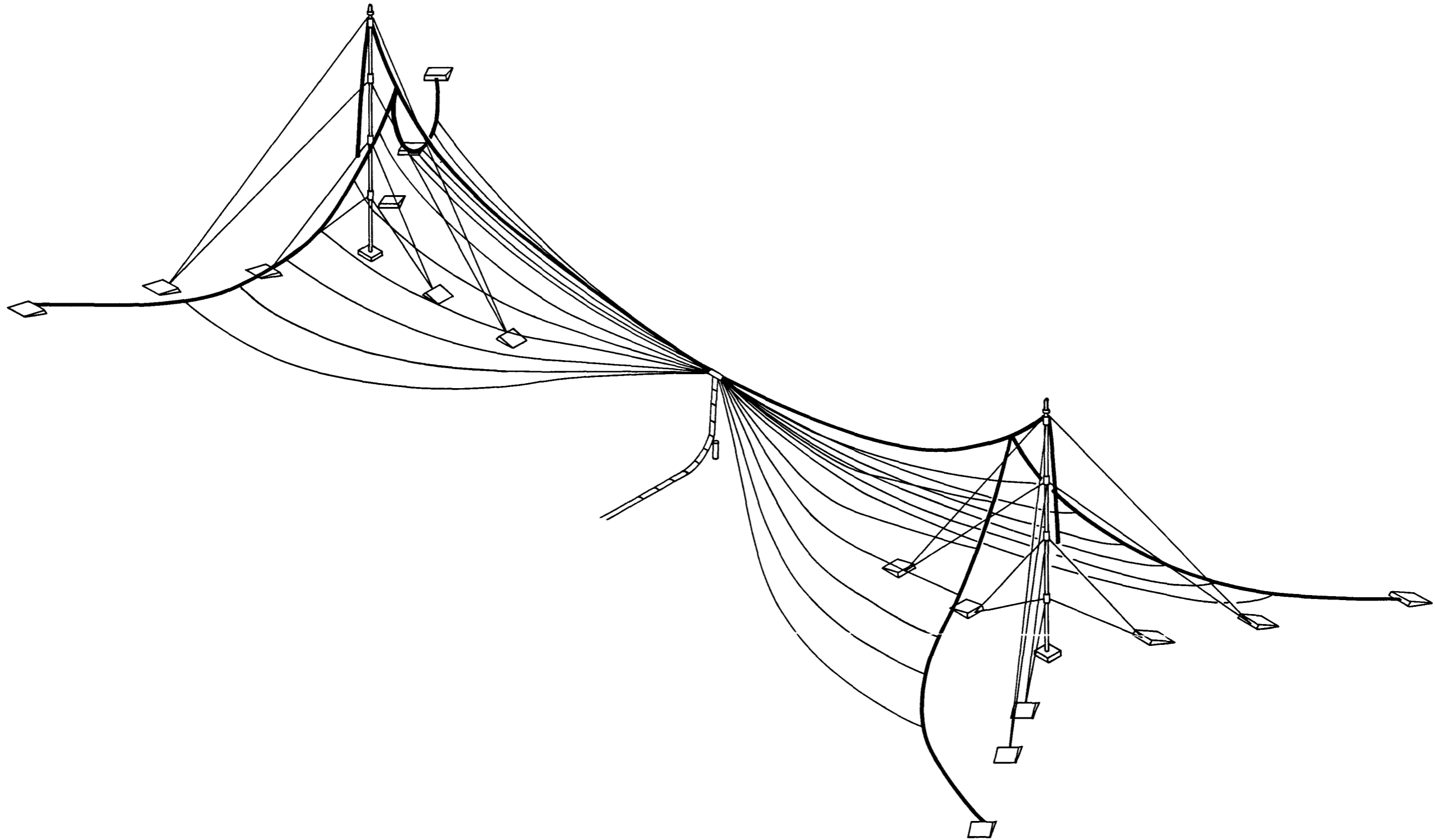
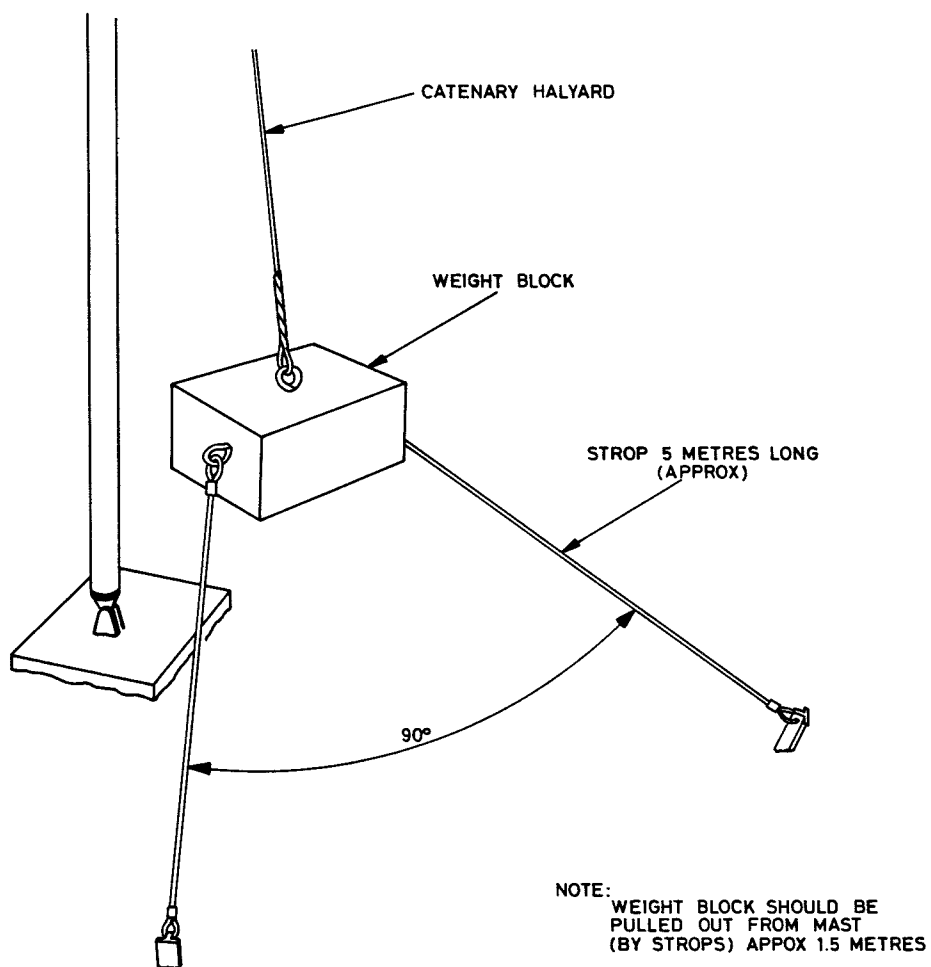


Fig 6

Erection at stage one

Fig 6



REFERENCE DRG. SCSHQ 159885

Fig 7 Positioning of weight block strops

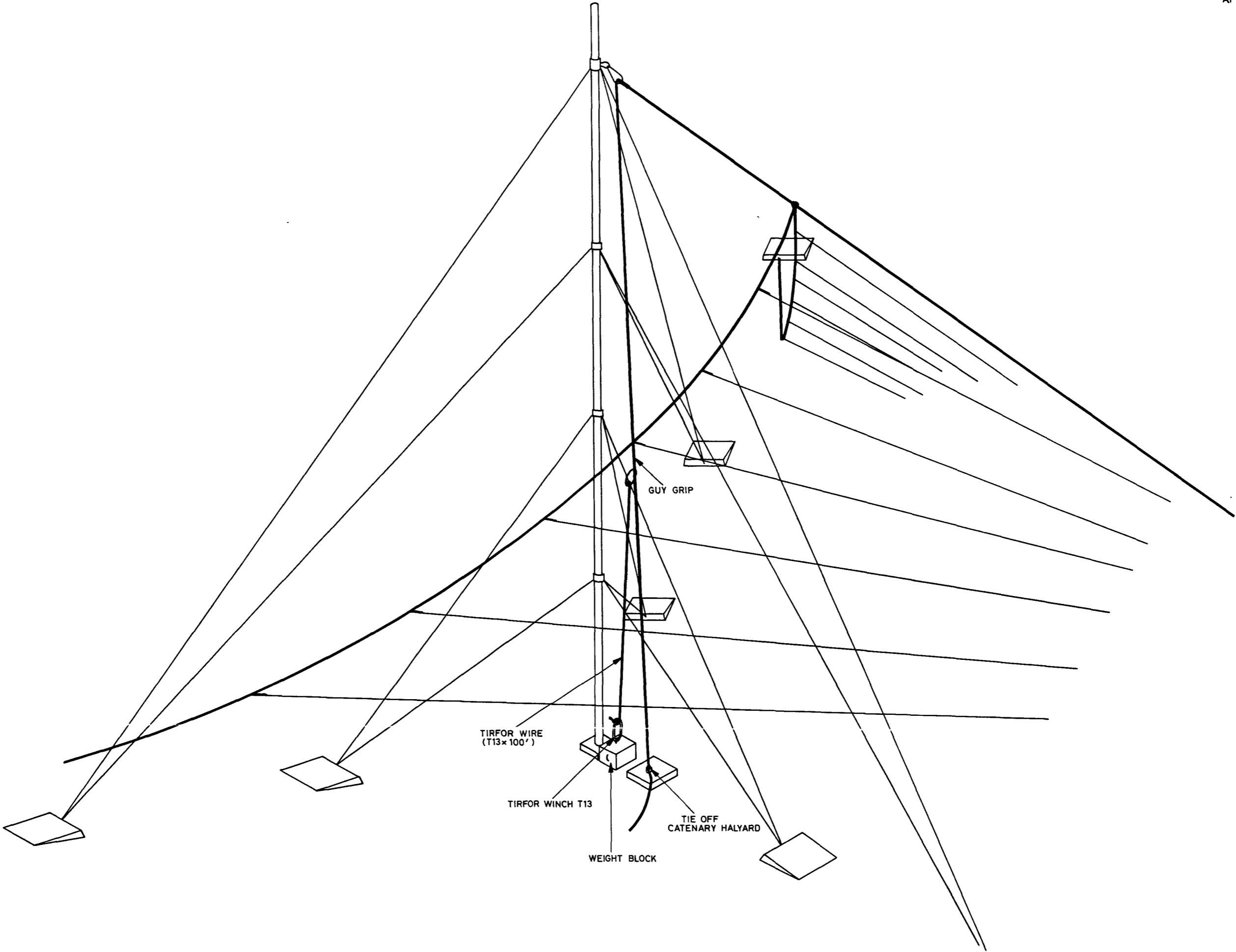


Fig 8

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Tensioning a halyard

Fig 8

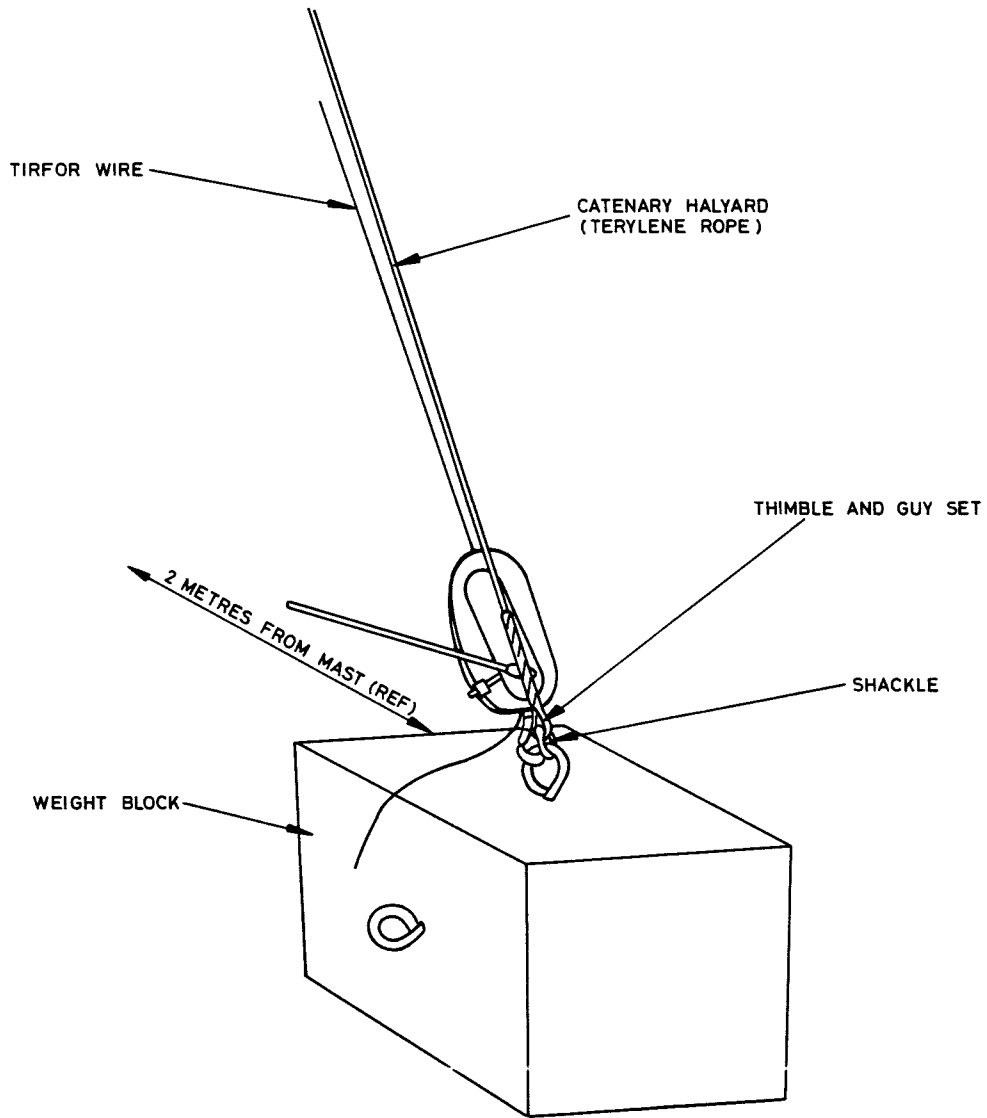


Fig 9 Tirfor winch operation (detail)

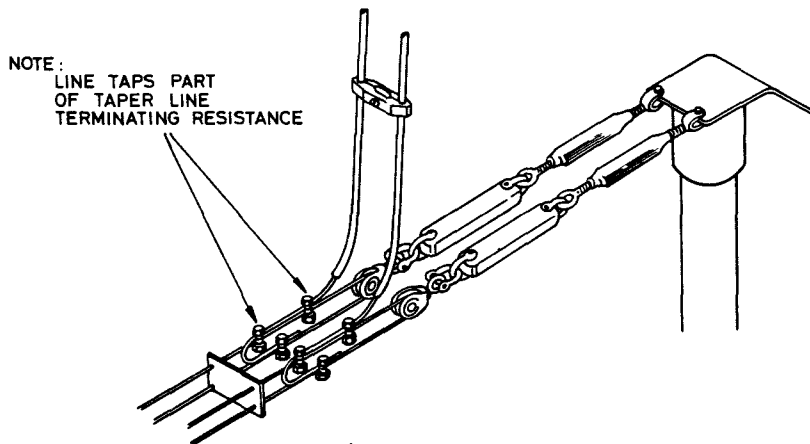


Fig10 Downlead connection to terminating resistance

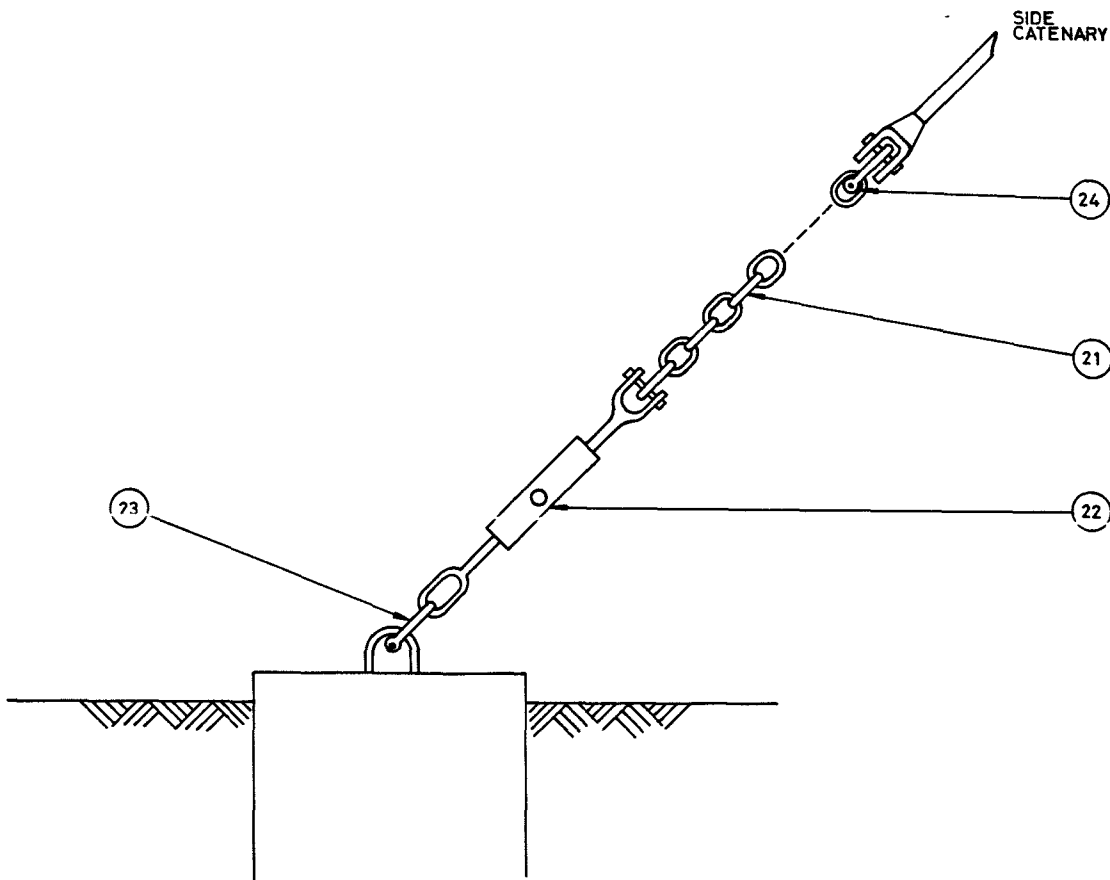


Fig 11 Side catenary ground-fixing