RCA

UHF
Antennas

Manufactured by

RADIO CORPORATION OF AMERICA

ENGINEERING PRODUCTS DEPARTMENT

Camden, New Jersey, U. S. A.

UHF TELEVISION ANTENNA SYSTEMS

TFU-21BL, TFU-24BL, TFU-24BM, TFU-27BH

PRELIMINARY INSTRUCTION
MANUAL

Manufactured by
RADIO CORPORATION OF AMERICA
Engineering Products Department
Camden, New Jersey, U.S.A.

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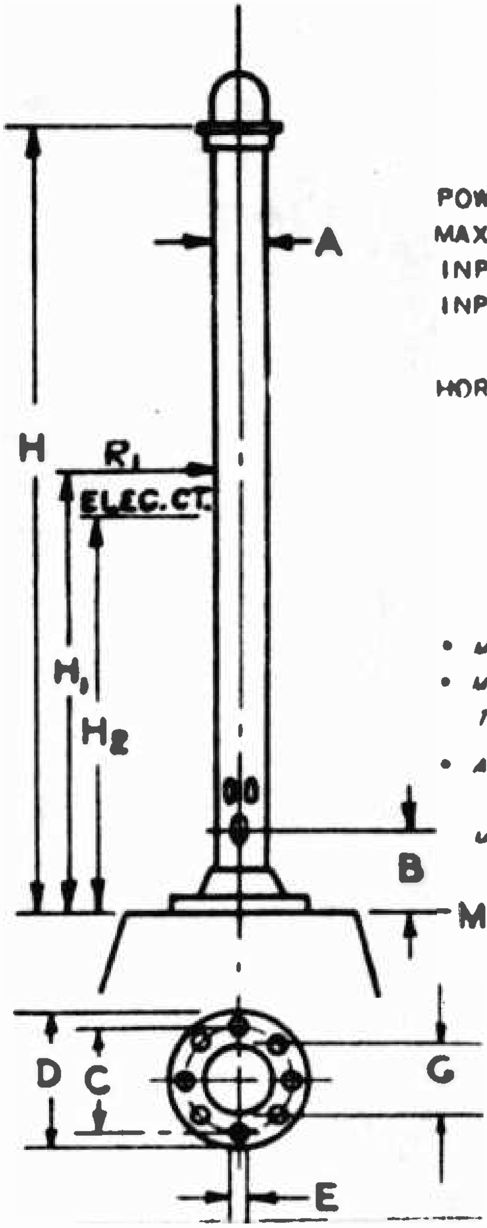


PRELIMINARY ENGINEERING DATA
UHF SLOTTED TELEVISION ANTENNAS

ELECTRICAL SPECIFICATIONS

POWER HANDLING	. 10 KW UP TO 5000'
MAXIMUM AMBIENT	. 45° C
INPUT IMPEDANCE	. 50 OHMS, V.S.W.R. LESS THAN 1.1/1
INPUT CONNECTION	. SINGLE 3-1/8 U.H.F. FLANGED COAXIAL LINE.
HOR. PATTERN CIRCULARITY	. ± 0.5 DB

MECHANICAL SPECIFICATIONS

DESIGN ASSUMPTIONS

- *Max. wind velocity (1/2" rad. ice) 95 mph.*
- *Max. wind velocity (no ice) 110 mph. (50/30 psf)*
  Tensile stress - below 20,000 psi
- *Actual wind velocity*

  Max. Stress on Bolts 18,000 psi

CHANNELS (Approx.)	14 to 30 incl.	14 to 30 incl.	31 to 50 incl.	51 to 83 incl.
TYPE NUMBER	TFU-21 BL	TFU-24 BL	TFU-24 BM	TFU-27 BH
MI NUMBER	MI-19195 D-*	MI-19195 A-*	MI-19195 B-*	MI-19195 C*
WEIGHT, POUNDS	Varies with channel — See Table I			
A, Inches (Diam.)	10-3/4	10-3/4	8-5/8	6-5/8
B, Inches	37 to 32	37 to 32	32 to 28	30 to 25
C, Inches (Bolt Circle)	15-1/4	15-1/4	13	10-5/8
D, Inches (Diam.)	17-9/16	17-9/16	15	12-1/2
E, Inches (Bolt Diam.)	1-1/8	1-1/8	1	7/8
F, Number of Holes	16	16	12	12
H, FEET	Varies with channel — See Table I			
H_1 (All)	$H_2 + 1$ Ft.			
H_2 (Elect. Ctr.)	Varies with channel — See Table I			
R_1 (50/30psf.) no ice	Varies with channel — See Table I			
M, Ft/Lbs (Moment) (30psf.)	Varies with channel — See Table I			
RELATIVE GAIN	21	24	24	27
G Top cap Hole (Diam.)	9-3/4"	9-3/4"	7-5/8"	5-3/4"

*Note: Suffix number added to MI number indicates channel number.

TABLE I

PRELIMINARY UHF ANTENNA DATA

WEIGHTS, HEIGHTS, AND MOMENTS FOR FILING

Channel No.	H_2 (Ft.)	H (Ft.)	Weight	R1 (Ft./Lbs.)	M (Ft./Lbs.)	
14	23.85	47.70	2880	1595	39790	
15	23.65	47.30	2855	1585	39460	
16	23.50	46.90	2835	1575	38930	
17	23.10	46.20	2800	1550	37680	
18	22.80	45.60	2760	1530	36740	
19	22.55	45.10	2740	1515	36000	
20	22.35	44.70	2710	1500	35370	
21	22.15	44.30	2690	1490	34840	TFU-21BL
22	21.80	43.60	2650	1485	33680	
23	21.60	43.20	2630	1455	33160	
24	21.40	42.80	2610	1440	32530	
25	21.20	42.40	2590	1425	31950	
26	20.95	41.90	2560	1415	31360	
27	20.75	41.50	2540	1400	30730	
28	20.55	41.10	2515	1485	30200	
29	20.30	40.60	2485	1370	29560	
30	20.15	40.30	2470	1360	29140	
14	27.023	54.167	3090	1820	51800	
15	26.668	53.334	3052	1795	50550	
16	26.417	52.834	3015	1775	49550	
17	26.083	52.167	2988	1755	49000	
18	25.750	51.500	2980	1735	48500	
19	25.417	50.835	2950	1720	47750	
20	25.167	50.334	2900	1695	44550	
21	24.917	49.834	2875	1680	43650	TFU-24BL
22	24.584	49.167	2850	1665	42850	
23	24.334	48.668	2820	1645	42000	
24	24.000	48.000	2800	1625	41250	
25	23.750	47.500	2770	1615	40450	
26	23.500	47.000	2750	1600	40000	
27	23.250	46.500	2720	1590	39250	
28	23.000	46.000	2690	1570	38800	
29	22.750	45.500	2660	1550	38300	
30	22.500	45.000	2630	1540	37750	
31	22.250	44.500	2440	1275	30750	
32	22.000	44.000	2400	1265	30300	
33	21.834	43.668	2340	1255	29750	
34	21.584	43.167	2320	1245	29300	
35	21.417	42.834	2300	1235	28750	TFU-24BM
36	21.167	42.334	2280	1225	28300	
37	20.917	41.834	2260	1215	27800	
38	20.750	41.500	2250	1205	27250	
39	20.584	41.167	2230	1195	26750	

TABLE I (Continued)

Channel No.	H_2 (Ft.)	H (Ft.)	Weight (Lbs.)	R_1 (Ft./Lbs.)	M (Ft./Lbs.)	
40	20.334	40.668	2210	1185	26350	TFU-24BM
41	20.167	40.334	2200	1175	25950	TFU-24BM
42	20.000	40.000	2180	1165	25450	TFU-24BM
43	19.834	39.668	2160	1155	25000	TFU-24BM
44	19.584	39.167	2150	1145	24700	TFU-24BM
45	19.417	38.834	2140	1135	24250	TFU-24BM
46	19.250	38.500	2120	1125	23900	TFU-24BM
47	19.000	38.000	2100	1110	23400	TFU-24BM
48	18.751	37.584	2090	1095	23000	TFU-24BM
49	18.584	37.250	2080	1085	22600	TFU-24BM
50	18.414	36.828	2070	1075	22300	TFU-24BM
51	20.584	41.167	1910	985	22600	TFU-27BH
52	20.417	40.834	1895	980	22500	TFU-27BH
53	20.250	40.500	1875	970	22000	TFU-27BH
54	20.083	40.167	1860	965	21780	TFU-27BH
55	19.917	39.834	1850	955	21350	TFU-27BH
56	19.750	39.500	1840	950	21000	TFU-27BH
57	19.584	39.167	1830	945	20800	TFU-27BH
58	19.417	38.834	1820	940	20450	TFU-27BH
59	19.250	38.500	1800	930	20100	TFU-27BH
60	19.083	38.167	1785	925	19950	TFU-27BH
61	18.917	37.834	1775	920	19650	TFU-27BH
62	18.750	37.500	1760	915	19250	TFU-27BH
63	18.584	37.167	1755	905	19000	TFU-27BH
64	18.500	36.917	1750	900	18850	TFU-27BH
65	18.334	36.668	1740	895	18550	TFU-27BH
66	18.167	36.334	1730	890	18200	TFU-27BH
67	18.000	36.000	1715	885	17990	TFU-27BH
68	17.917	35.834	1700	880	17800	TFU-27BH
69	17.834	35.584	1690	870	17500	TFU-27BH
70	17.668	35.334	1675	865	17100	TFU-27BH
71	17.500	35.000	1660	860	16990	TFU-27BH
72	17.417	34.834	1655	855	16840	TFU-27BH
73	17.250	34.500	1650	850	16460	TFU-27BH
74	17.083	34.250	1640	845	16240	TFU-27BH
75	17.000	34.000	1630	840	16000	TFU-27BH
76	16.917	33.834	1620	835	15850	TFU-27BH
77	16.751	33.584	1610	830	15600	TFU-27BH
78	16.668	33.334	1600	825	15400	TFU-27BH
79	16.584	33.167	1590	820	15100	TFU-27BH
80	16.417	33.000	1580	815	14950	TFU-27BH
81	16.334	32.584	1575	810	14750	TFU-27BH
82	16.167	32.334	1570	805	14500	TFU-27BH
83	16.083	32.167	1560	800	14350	TFU-27BH

EQUIPMENT

The UHF Television Antennas, MI-19195 A, B, C, and D are supplied completely assembled and adjusted for operation in any one of the UHF television channels from channel 14 to channel 83.

TABLE II

COMPARISON OF TFU - SERIES ANTENNAS

Antenna Type	Outside Diameter	Relative Power Gain	Number of Layers	Channels for which Supplied
TFU-21BL	10-3/4"	21	14	14 to 30
TFU-24BL*	10-3/4"	24	16	14 to 30
TFU-24BM	8-5/8"	24	16	31 to 50
TFU-27BH	6-5/8"	27	18	51 to 83

*Note: This antenna is supplied on special order only.

Note 2: Slotted-cylinder UHF pylon television antennas are available with fewer than 14 layers for all channels on special order, (such as TFU-12, TFU-9, TFU-6, and TFU-3).

DESCRIPTION

The RCA Type TFU-21BL, 24BL, 24BM, and 27BH Antennas (see Figure 1) are slotted-cylinder type radiators. Each radiating layer consists of three one-inch wide slots approximately 1.2 wavelengths long, parallel to the axis of the cylinder, and equally spaced around the circumference. Adjacent layers of slots are staggered 60 degrees to obtain maximum mechanical strength and a circular horizontal radiation pattern.

The R-F energy is fed to the layers of slots by means of a single coaxial line feeder system within the self-supporting, slotted-cylinder radiator. The inside surface of the slotted radiator serves as the outer conductor of the coaxial line, and a coaxial copper tube within the cylindrical radiator serves as the inner conductor. A coaxial line is installed within the inner conductor to obtain off-center feed, with the attendant benefits of adjustable vertical pattern tilt, symmetrical patterns for any frequency, and greater bandwidth than with an end-fed antenna.

Although some antennas were shipped with center feed to the inner conductor, antennas now being shipped are off-center fed to provide more uniform coverage of the service area close to the station (by minimizing nulls produced by the secondary lobes). The coupling to the slots below the feed point must be increased, under these conditions, to maintain the electrical balance of the feed system. Antennas which have the feed point offset in this manner have the suffix letter "S" added to their type number (as TFU-21BLS).

The slotted radiator is constructed of hot-dip galvanized, open-hearth structural steel to obtain a life which should exceed 50 years. Particular attention has been paid to all parts of the antenna to assure maximum durability. All the hardware and metal parts are made of corrosion-resistant metals. The physical dimensions of the antennas are listed in the Engineering Data. A comparison of the antennas is given in Table II.

Slot antennas differ from other types in that there are no external feed lines or radiators. The signal is radiated directly from the surface of the cylinder, resulting in a very sturdy exterior. Each layer of slots acts as a radiating section. Thus a 14 layer slot antenna performs at UHF in a manner similar to a 14 section Superturnstile Antenna at VHF. The large number of layers confines the radiated signal to a horizontal direction for more effective coverage of the service area.

Due to the concentration of energy in the horizontal plane, the vertical radiation pattern shows a relatively narrow main beam. In order to utilize this beam to greatest advantage, both electrical and mechanical means of tilting the beam may be employed. Electrical beam-tilting is accomplished by moving the inner conductor (harness) up or down, which shifts the phasing of the signals radiated from the upper and lower halves of the antenna. The effect of this is to raise or lower the beam uniformly around the antenna, thus expanding or contracting the cone of radiated power, umbrella fashion.

Mechanical beam-tilting is effected by adjusting leveling plates between the antenna base and the tower mounting flange. The antenna is thus actually tilted physically. The result of this tilting is to raise the pattern on one side and lower it on the opposite side. A combination of electrical beam tilt and mechanical beam tilt may be desirable under terrain conditions existing at some UHF television antenna sites.

The feed system in the TFU series of antennas is extremely simple. Each layer of this type of antenna is fed by 3 small coupling loops (one in each slot) which pick up part of the energy in the cylinder and produce circulating currents on its outer surface. These circulating currents produce an R-F field which is radiated as the television signal.

The inner conductor of the antenna (or harness) is centered in the cylinder by several sets of three ceramic centering pins. The entire harness is designed to slide vertically for electrical beam-tilting purposes, once the shorting clamp at the lower end of the harness has been loosened. The bottom end of the harness is designed to connect directly to 3-1/8 inch, 50 ohm, UHF transmission line (RCA MI-19089). The upper end of the harness is equipped with a lifting ring which may be used to shift the harness for beam-tilting purposes.

In order to keep out rain, snow, birds, etc. the slots in the antenna are fitted with plastic slot covers. UNDER NO CIRCUMSTANCES SHOULD THESE COVERS BE PAINTED. Paint on these slot covers may seriously impair the performance of the antenna. The bottom of the antenna may be screened in if desired, although this is usually not necessary.

INSTALLATION

General

It is strongly recommended that RCA Service Co. personnel be present to advise in the installation of this antenna, and check it before and after hoisting. RCA Service Co. engineers have the specialized equipment necessaryk to make these tests and any adjustments that may be required due to possible damage in transit. The services of RCA Service Co. engineers are available at current rates.

Before starting on the antenna, two trestles should be constructed to support the antenna in a horizontal position at least eight feet above the ground. A detailed drawing of approved trestle construction is shown in Figure 2. The antenna should be supported on these trestles away from trees and buildings, so that it is well removed from the influence of the ground.

With the antenna supported on the trestles, inspect it for visible damage or looseness of any hardware.

If one of the centering pins in a set is loose, it may be tightened in the following manner:

(1) Loosen the locknut.

(2) Run the centering pin against the inner conductor hand tight only. (The inner conductor is very easily dented.)

(3) Tighten the locknut with a wrench, but go easy on it.

If two, or all three pins in a set are loose, an RCA Service Co. engineer should be called in to set them. The setting of these pins determines the centering of the harness. Lateral displacement of the harness may seriously affect the input impedance of the antenna.

If any of the coupling loops are loose, or appear to be damaged, an RCA Service Co. engineer should be called to correct this trouble. These loops are set at an exact distance from the center conductor with special gauges and should never be changed by station personnel.

Check the slot covers, to make certain that all the screws are tight. If any screws are missing, replace them with aluminum, stainless steel, or nickel-plated brass screws (not steel or plated steel). Do not use screws that will protrude on the inside of the cylinder, as this will alter the electrical characteristics of the antenna. (A length of 5/8 inch is recommended.) If it is necessary to remove a slot cover, loosen the screws (don't remove them), then pull the cover off. It is flexible enough to come off. The slot covers should be removed only at the direction of the Service Co. engineer or the responsible station engineer.

Inspect the harness for dents. The upper and lower parts of the harness are separated by a Teflon end-seal, at the feed point. The joint containing the Teflon end-seal should be tight, and there should be no space between the Teflon and the metal parts.

The flange assembly at the bottom of the harness, is actually a double flange (see Figure 4). The lower section is a lock flange which is tapped to receive the flange bolts. The flange bolts should be tightened first (if they are loose). This lower section supports the Teflon insulator which carries the harness inner conductor. The harness inner conductor, in turn, carries the impedance matching transformers which match the transmission line to the antenna. The positioning of the center conductor and the impedance matching transformers is extremely critical. FOR THIS REASON, THE HARNESS FLANGE ASSEMBLY SHOULD NEVER BE DISASSEMBLED BY STATION PERSONNEL.

The inner conductor of the harness, at this point, also contains a "bullet" for joining it to the inner conductor of the transmission line. The "bullet" is a spring-type connector plug which is locked to one of the sections to be joined, insuring good electrical contact between the inner conductors. (See Figures 3 and 4.)

If inspection of the harness shows it to be damaged in any way, call in an RCA Service Co. engineer.

> (Note: Broadcast station personnel should be certain that there has been no transportation damage. It is recommended that an RCA Service Co. engineer be engaged to check the antenna for transportation damage prior to its erection on the tower.)

The part of the harness protruding beyond the antenna flange should be protected during hoisting to prevent damage to the center conductor and insulator, and also to protect the harness from being pushed up into the antenna (thus changing the electrical beam tilt from its factory setting.)

> (Note: The antenna is shipped with a sheet metal protecting sleeve bolted to the antenna flange. This sleeve should remain in place during hoisting, and be removed just before the antenna is seated on the tower.)

After the antenna has been inspected, the lightning protector and beacon mounting assembly should be installed. The lightning protector is shipped knocked-down and must be assembled to the beacon mounting assembly. (See Figure 10.) Remove the nuts and lockwashers from three alternate bolts on the beacon mounting assembly. Slide the flattened end of a support assembly (item 5) on each of these bolts, then replace the lockwashers and nuts (Figure 10 view "A"), but do not tighten the nuts. Slide the three tie rods (item 6) over the ends of the support assemblies, then slide a sleeve (item 7) on each support assembly. Tighten the nuts holding the support assemblies to the beacon mounting assembly, then tighten the setscrews on the sleeves to hold the tie rods securely in place.

Mount the beacon mounting assembly (with attached lightning protector) on the top of the antenna and insert and tighten the three 5/8-11 x 1-1/4 inch set screws.

The beacon and beacon cable may now be installed. Cable clamps are supplied with the antenna for holding the beacon cable. The beacon and cable are available on separate order.

When all mechanical work has been completed, the antenna should be painted, in accordance with CAA regulations. DO NOT, UNDER ANY CIRCUMSTANCES, PAINT THE SLOT COVERS. Paint on the slot covers may seriously impair the performance of the antenna. (Note: The antenna may be painted after erection if so desired. Painting it on the ground, however, is easier and more economical than painting it after erection.)

On a new installation, the paint may not adhere readily to the antenna. It is suggested that the antenna be given a coat of "Bonderite" (which may be purchased locally) before applying the first coat of paint.

The antenna is now ready for electrical testing. This test, consisting of both DC and R-F tests, should be made by an RCA Service Co. engineer. (It is for the purposes of this pre-erection R-F test that the antenna is supported on trestles eight feet high.)

Mechanical Beam Tilt

A set of tapered leveling plates is provided, to align the antenna vertically if the tower top plate is not exactly level. These plates are also used to obtain mechanical beam tilting of the antenna. If mechanical beam tilting is desired, it should be done at the time of initial installation, since the services of riggers are required. The following method is used to adjust the mechanical beam tilt. (A spirit level and set of feeler gauges are required):

Examine the tower top plate for any surface irregularities. If any such irregularities exist (such as lumps of dried paint, or galvanizing coating, they should be removed, to insure proper seating of the leveling plates. If the tower top plate has not been hot-dip galvanized, it should be painted with red lead, zinc chromate, or a good rust-inhibiting primer. Corrosion protection of this area is very important, as water tends to run to this point. Lack of corrosion protection will result in corrosion of the tower. Allow the paint to dry before mounting the antenna or the leveling plates. (An additional coat of wet primer may be used as a sealing cement.)

Set up the equipment as shown in Figure 5 with the thickness of feeler gauge given by the station engineer for the particular length of level used. The feeler gauge thickness required is such that the angle between the top leveling plate and the spirit level is equal to the desired tilt of the antenna. The antenna tilt desired is determined by the station engineering consultant.

(Note: If the tower top plate is level, and if no mechanical beam tilting is contemplated, the leveling plates may be left out and the antenna bolted directly to the tower.)

Turn the top leveling plate a small amount, and rotate the level (together with the feeler gauge) to find the greatest slope. (The position of greatest slope will change, as the leveling plates are moved with respect to each other.) If this slope is too much or too little (as indicated by the level), the position of the leveling plates, with respect to each other, must be changed. When the position is found where the instrument is level on the greatest slope, turn both plates together so the top one slopes downward in the same direction the antenna is to be tilted. Recheck the slope in this position. (Just in case the tower top plate is not level.)

The leveling plates are provided with numerous holes for the antenna flange bolts. When the proper position of the leveling plates has been found, it may be necessary to rotate them slightly to align the holes in the leveling plates with the holes in the tower top plate. These holes should be kept in alignment while the antenna is being lowered into position. A convenient way of doing this, when the tower top plate is tapped for the flange bolts, is to screw two or three of the flange bolts through the tower top plate from the bottom. They will then serve to keep the leveling plates in position, and also act as a guide for the antenna. After the other antenna flange bolts have been secured, these bolts may be removed and inserted properly from the top. (Figures 7, 8, and 9 show details of antenna mounting on the tower top plate.)

If the holes in the tower top plate are not tapped, the holes in the leveling plates and antenna may be aligned with a spud wrench just before seating the antenna on the tower.

The antenna is provided with two hoisting lugs, but if they cannot be used, the antenna may be hoisted by means of a sling. IF A SLING IS USED, EXTREME CARE SHOULD BE EXERCISED SO THAT NEITHER THE SLOT COVERS NOR THE COUPLING LOOPS ARE DAMAGED. (Blocks of wood may be used to protect the slot covers and coupling loops during hoisting.)

When lowering the antenna into position, the weight of the antenna should be kept off the leveling plates until several of the flange bolts and nuts have been started, to permit slight adjustment of the antenna or level plates if necessary. (Note: Orientation of the standard antenna is not required due to the fact that its radiation pattern is very nearly circular. The adjustment referred to, is the slight adjustment necessary to align the holes.)

After positioning the antenna, it should be bolted securely to the tower, using the bolts supplied with the antenna.

> Caution: All spaces between the bodies of bolts and the holes of all hardware used to fasten the antenna to the tower should be caulked to prevent the entry of moisture. "Alumilastic, consistency C" or equivalent may be used. This caulking compound may be obtained from the Parr Paint and Color Company, 18312 Syracuse Avenue, Cleveland (10) Ohio.

If electrical beam tilting is to be employed, two of the antenna mounting bolts should be temporarily left out. (See Electrical Beam Tilt.)

Electrical Beam Tilt

On new installations, the beam tilt is adjusted at the factory, to the customer's specification. If a beam tilt angle is not specified, then the antenna is shipped with the harness set in the "no-beam tilt" position.

A hose clamp is fastened to the bottom of the harness, so that the top of the hose clamp is even with the bottom of the antenna flange, when the harness is in the position in which it was shipped from the factory. (ie: If the antenna was shipped adjusted for a beam tilt of 1/2 degree, then when the hose clamp is even with the bottom of the antenna flange, the harness is in the proper position for 1/2 degree of beam tilt.) THE HOSE CLAMP DOES NOT INDICATE "NO BEAM TILT" UNLESS THE ANTENNA WAS INITIALLY SHIPPED WITH THE HARNESS ADJUSTED FOR NO BEAM TILT.

As mentioned previously, electrical beam tilt is obtained by shifting the harness up or down. The following method, while not the only possible way, has proven to be a very satisfactory one in the field:

(1) Disconnect the first section of transmission line from the antenna. (The gas supply valve should be shut off, and the gas pressure in the line relieved first.)

(2) Remove two of the antenna flange bolts from opposite sides of the flange.

(3) Using two all-thread bolts 18 inches long (with nuts), a piece of angle iron, and a block of wood with a hole in the center to protect the harness, set up the equipment as shown in Figure 6A.

(Alternatively, if a support is available below the antenna, the method shown in Figure 6B using a suitable jack may be employed.)

CAUTION: DO NOT REMOVE THE HARNESS FLANGE BOLTS OR ATTEMPT TO OPEN THE DOUBLE FLANGE WHICH IS PART OF THE HARNESS.

Drill holes in the block of wood large enough to take the flange bolts. Any lifting force exerted on the harness should be applied to the outer flange only.

(4) Measure down from the top of the hose clamp, the distance it is necessary to raise the harness to secure the desired beam tilt. Scribe a mark at this point. (A method of calculating this distance is given at the end of this section.)

(5) Put another hose clamp on the harness so that the top of this hose clamp coincides with the scribe mark. Do not remove the original hose clamp as it serves as a reference point for beam tilt adjustments.

(6) Remove the two pipe plugs from the side of the antenna, and loosen the harness shorting clamp with a 7/32 inch, long-handled Allen wrench (two capscrews). (These pipe plugs are located between the lowest layer of slots and the base flange.)

(Note: On later production antennas, a different type of shorting clamp is used. This type of shorting clamp has <u>three</u> recessed-head lock screws, which are accessible through the bottom opening in the antenna. Using a 7/32-inch, long-handle Allen wrench, loosen all three lock screws about three or four turns each. Do not loosen the lock screws any more than necessary to permit movement of the harness.)

(7) Raise the harness until the top of the second hose clamp is exactly level with the bottom of the antenna flange.

(8) Tighten the clamp shorting setscrews and replace the pipe plugs.

(9) Remove the equipment used to raise the harness.

(10) Reconnect the transmission line. (Extreme care should be exercised so that the weight of the transmission line, will be supported by the fixed hanger mounted directly below the top flange of the first section of transmission line. IF THE HARNESS FLANGE NUTS ARE TIGHTENED AS A MEANS OF PULLING THE TRANSMISSION LINE INTO POSITION, THE RESULT MAY BE THAT THE HARNESS WILL SLIDE DOWNWARD, THUS CHANGING THE ANGLE OF BEAM TILT.)

(11) If the method shown in Figure 6A has been used, replace the antenna flange bolts.

(Note: (a) To lower the harness, the procedure is the same except that steps 4 and 7 are performed similarly, but in the opposite direction.

(b) On new installations the procedure is the same except: disregard step 1, and in place of step 10, follow the instructions under Transmission Line.

(c) The hose clamps may be left in position as they will not affect the operation of the antenna.)

The top of the harness, has a lifting ring attached, so the harness may be raised from this point if so desired. However, shifting the harness is more readily accomplished from the bottom.

The distance by which the harness is to be shifted may be calculated with the help of Figure 14. Locate the required beam tilt in degrees on the proper curve. Find the phase difference corresponding to this beam tilt. To obtain the physical shift in inches, 1/2 the phase difference indicated should be converted to inches at the visual carrier frequency, using the wavelength in free space.

The formula for finding this physical shift is:

$$\text{Shift in inches} = \frac{\delta}{360} \times \frac{11802}{f}$$

Where: δ = 1/2 the phase difference (from Figure 14)

f = visual carrier frequency in MC

The following example will illustrate the use of this formula:

Assume we have a TFU-24BM which is to operate on channel 40 (626 to 632MC). An electrical beam tilt of 0.5 degrees is desired.

The visual carrier frequency (1.25MC above the low end of the channel) = 627.25 MC.

Referring to Figure 14, we find that a beam tilt of 0.5 degrees is equal to a phase difference of 49.5 degrees. (For practical purposes this may be considered as 50 degrees.) Thus delta (δ), which is 1/2 this phase difference, will be = 25 degrees.

Substituting these values in the formula we have:

$$\text{physical shift} = \frac{\delta}{360} \times \frac{11802}{f} \qquad f = 627.25 \text{ MC.} \quad \delta = 25 \text{ degrees}$$

$$= \frac{25}{360} \times \frac{11802}{627.25}$$

$$= \frac{5}{72} \times \frac{11802}{627.25}$$

$$= \frac{5}{36} \times \frac{5901}{627.25}$$

$$= \frac{29505}{22581}$$

$$= 1.307 \text{ inches}$$

It is obvious that electrical beam tilting may be accomplished after the initial installation of the antenna. A change in beam tilt may be required after actual field strength measurements have been made, to improve the coverage of the service area. (Note from Figure 13 that the gain of the antenna decreases rapidly with beam tilt in excess of 1°.)

Two factors should be kept in mind when changing the beam tilt. One is the possibility of taking up the slack in the transmission line. If the shift in the harness position is small (about one inch or so), the shift can usually be accommodated by the slack in the line. If the shift is in the neighborhood of two inches or more, it may be necessary to insert a section of transmission line to handle this shift. This will be dependent upon the transmission line run at a particular installation.

The other factor to remember is to always gas the transmission line in accordance with the instructions under "Transmission Line", after all adjustments have been completed.

Transmission Line

The antennas described in this book are designed for RCA MI-19089 matched transmission line (3-1/8 inch diameter, 50 ohms impedance). This transmission line has an extremely low standing wave ratio, and may be cut at any point (except at an insulator). (See Figure 10 for MI-19089 fittings.)

This transmission line uses anchor insulators, and the weight of the inner conductor is carried by the insulator at the top of the line, during hoisting. If the line is tipped over, in hoisting, the inner conductor will fall out. As shipped from the factory, the lengths of transmission line have a cover disc on the bottom end and an anchor insulator at the upper end (held in place temporarily by a retaining disc).

The anchor insulator consists of a Teflon insulator disc centrally mounted on a "bullet". (See Figure 3). The "bullet" is a spring-type double-ended male connector, with an annular groove around either end. The upper end of the center conductor, in each section of line, has a dimple, which engages the groove in the bullet, thus locking the anchor insulator to the center conductor on this end. During assembly, the bullet extending from one section, slides into the next section, thus aligning and making contact with the center conductor of that section.

To remove the bullet from a section of line, insert a punch or nail through the hole next to the dimple, and depress the spring section of the bullet. This will disengage the groove in the bullet from the dimple, and the bullet may be pulled out.

The transmission line flanges are equipped with locating pins and holes. When joining two sections of line, make certain that the pin in one flange mates with the hole in the flange to which it is being joined.

At UHF frequencies, dents and bumps in the transmission line are much more serious than at VHF. Consequently, greater care should be exercised in handling and installation of this line. Only one length of transmission line should be hoisted at a time. Never hoist several sections bolted together, as this invites bending near the flange. The use of box-end wrenches is recommended for tightening the flange bolts to minimize the possibility of wrench dents.

The UHF miter elbows are the only ones suitable for bends. They are especially designed to be electrically smooth, and will not cause reflections in the lines as will the long sweep elbows at UHF.

(A detailed drawing should be made of the transmission line run before ordering the equipment, so that station personnel may determine their exact

requirements as to the number of sections of transmission line, number and types of elbows, number of gas stops, and whether any pieces of transmission line shorter than a full section are required. The local RCA Broadcast Equipment Sales Engineer will assist station personnel in determining their requirements. When planning the layout of the transmission line it should be remembered that the use of gas stops and swivel joints adds to the length of the line. A swivel joint adds 3/8 inch to the length of the line. (If the swivel joint is part of a line fitting, such as an elbow, then the dimensions given for the fitting itself may be used, since these dimensions include the swivel joint.) The insertion of a gas stop in the line adds 7/8 inch to the length of the run.)

Having mounted the antenna, and adjusted the beam tilt, the transmission line may now be connected.

The first section of transmission line should be hoisted to the top of the tower, keeping the cover disc, on the bottom of the section, in place. (It is necessary to keep this cover disc in place on the first section, since the bullet supports the center conductor. With the bullet removed (as is necessary for the first section) the inner conductor would fall through the line if the cover disc did not support it. Once the joint to the harness is completed, the bullet in the harness supports the center conductor, so the cover disc is no longer necessary. On the other sections of line, since the bullet is not removed, the center conductor will not fall out if the disc is removed. To prevent damage to the center conductor, however, it is good practice to leave the cover discs in place, until ready to connect the next section of line.)

Remove the bullet from the first section of line and join the first section to the harness. (Be certain that the "O" ring gasket is properly seated.) The bullet should be removed from the first section of line only, since the harness is already equipped with a bullet for this joint. On all other joints, the bullet should remain in the upper end of the section being attached, so that it can mate with the bottom end of the section previously installed.

The first section of line should be secured by tightening the nuts only. This procedure is necessary, because the harness flange assembly contains a lock flange. This lock flange is tapped, and the flange bolts have already been screwed into these tapped holes. (See Figure 4). The bolts should be held with a wrench to keep them from turning as the nuts are tightened.

> (Note: If mechanical beam tilting is employed, the first section of transmission line will have to be bent slightly. Allow the bend to occur naturally in the first section, as the nuts joining it to the harness are tightened. DO NOT, UNDER ANY CIRCUMSTANCES, BEND THE HARNESS.

Since the harness is designed to slide vertically, it will not support much weight without slipping. The first section of transmission line, therefore, must be supported by a fixed hanger directly below its upper flange.

After the first section of line is in place, and with the second section ready for connection, the wooden cover disc on the bottom of the first section may be removed.

The balance of the transmission line run may now be installed, and should be supported by spring hangers spaced 10 feet apart. When bolting the sections of line together, make certain that the "O" ring gaskets are properly inserted, to prevent their being pinched and thus destroying the gas seal. (Note: The spring hangers should be adjusted in accordance with the chart that accompanies them.)

If the transmission line run does not work out to an exact number of sections (it rarely does), a piece of line less than a full section must be used. There are three methods of obtaining this short section.

The first method is to order a section (or sections) of transmission line from RCA, specifying the length desired. (The size of this section of line may be determined from the plan of the transmission line run, and ordered when all the line is ordered. A better way is to install the transmission line as far as possible, then measure directly, the lengths of any short sections required and order them from RCA.) Special lengths of line should be ordered from RCA Engineering Products Department, Camden, N.J.

(Although special length sections of line are shipped by Air Express, usually within 24 hours of receipt of the order, circumstances beyond the control of RCA may cause a delay in delivery. For this reason, it is recommended that the line be cut and fitted on the job, using one of the two following methods.)

The second method of obtaining the short sections is for the installer to cut them himself (from full length sections of line), and fit them as needed. If this method is followed, enough additional flanges (MI-19089-11), connectors (MI-19089-10), "O" ring gaskets (MI-19113-10), and sections of transmission line should be ordered for these short lengths of line.

This second method is described in detail in the following paragraphs:

(1) Measure the exact length that will be required for the short section of line. (This length should be the finished length measured between the faces of the two end flanges.)

(2) Remove the inner conductor assembly from a spare section of transmission line. Measure the required length of line, less 1/4 inch, from the face of an end flange, and mark the outer conductor at this point. (Check to make certain that the point marked will be at least one inch away from an insulator on the center conductor when the center conductor is reinserted. If this condition cannot be met, the transmission line run should be modified slightly to permit it.)

(3) The outer conductor should be cut square at the point marked. Use a miter box and a hack saw. Do not use a tubing cutter. After cutting, remove all burrs and irregularities with a file.

(Note: A set of cutting sleeves may be used to facilitate cutting and squaring of the transmission line sections if desired. These sleeves are not supplied with the antenna or transmission line, but are available on separate order from RCA. The cutting sleeves are hardened steel sleeves that slide over the conductor being cut, and are clamped in place to serve as a cutting guide. Two are furnished to a set; one to fit the outer conductor, and one to fit the inner conductor.

(To use a cutting sleeve, slide it over the conductor to be cut, so that the end of the sleeve is in line with the point at which the cut is to be made. (If the end to be cut has a flange on it, then the conductor must be rough-sawed slightly longer than needed, to permit the sleeve to slide on the conductor. Remove any burrs on the outside of the conductor after rough-sawing, as the sleeve is a close fit.) Clamp the sleeve at the point marked. Using the sleeve as a guide, saw the conductor to size. The conductor should be filed, to remove any saw marks, with the cutting sleeve in place, as this will insure that the finished job will be square and correctly sized. After removing the sleeve, remove any burrs that remain on the conductor.)

(4) A flange (MI-19090-11) should now be soldered to the cut end of the outer conductor. Clean the outside of the outer conductor for a distance of 3/8 inch back from the edge. Make certain that the inside of the flange is clean. The inside of the flange has a small annular groove on the side that fits on the outer conductor. Insert a length of rosin core solder in this groove all the way around. Coat the mating surfaces of the flange and outer conductor sparingly with soldering paste, and insert the outer conductor into the flange.

(Note: The soldering paste used should be a non-corrosive type of paste, (Kester or equivalent). The recommended type of solder is rosin core, 1/8" diameter, wire solder of the tin-lead type. Either 40/60, 50/50 or 60/40 may be used. Do not use silver solder, since the higher heat required to melt silver solder may cause warping (or annealing with subsequent denting) of the outer conductor, which may in turn produce reflections in the transmission line).

Solder the flange to the outer conductor using a Pres-to-lite soldering torch directed on the outside of the joint. (If a Pres-to-lite torch is not available, a gasoline blowtorch may be used. Since the cone of heat from a gasoline blowtorch flame is not as concentrated or as hot as that from a Pres-to-lite torch, the outer conductor will be annealed in the region of the flame, and thus will be more subject to dents and bumps which may produce reflections in the line. Therefore, it is recommended that a gasoline blowtorch be used only as a last resort.) Additional solder may be fed into the joint (from the outside) if necessary, the object being to produce a mechanically strong, gas-tight joint. Remove any solder that has run inside the outer conductor. (Blobs of solder inside the line may cause reflections.)

(5) Replace the inner conductor and mark it slightly longer than the outer conductor. Remove the inner conductor and cut it off square at this point. Remove the burrs from the inner conductor.

(6) Replace the inner conductor, seating the anchor insulator on the flange at one end. Insert a connector (MI-19089-10) into the end just cut. Place a flange (MI-19089-11) on the Teflon insulator of this connector. Hold this temporary flange in place using bolts and nuts through both it and the flange on the outer conductor. Keeping the anchor insulator (at the other end of the section) properly seated, tighten the bolts holding the temporary flange and connector assembly, until the gap between the temporary flange and the flange on the outer conductor is even all around, and the center conductor is properly seated on the connector. Measure the gap between the face of the temporary flange and the outer conductor flange. This distance is the amount the center conductor must be shortened to obtain an exact fit. Cut the center conductor to size (squarely) remove the burrs, and the shortened section of line is complete.

The third method of obtaining the short section is by using a flanged to unflanged adapter (MI-19089-5). When using this adapter, the required length of the short section is determined as previously described. The outer conductor is cut 3/16 inch short of this length, and the inner conductor is cut 15/16 inch short. Remove all burrs from the inner and outer conductors. The adapter has a sleeve on one side that slides on the outer conductor just cut, and is tightened by means of a hose clamp. The inner conductor mates with a standard connector that is part of the adapter. The other side of the adapter consists of a standard flange that joins the next section of line in the usual way (using the bolts supplied with the adapter). This method of joining cut lengths of line, is the easiest and fastest. Be sure to order enough adapters (MI-19089-5) to cover your needs.

The previous methods of securing the necessary short sections of line are all for use where the transmission line is gassed. Where the line is ungassed, two sections of line without flanges (or two cut ends) may be joined by means of an ungassed coupling (MI-19113-8) which consists of a sleeve that joins the two outer conductors, and an inner conductor connector. The outer conductors are cut to the length required, and each inner conductor is cut 1/16 inch short of this length. The inner conductors are joined by a spring connector that has a series of tits (or lances) around it to keep it from sliding into either inner conductor too far.

When the transmission line run has been completed, it should be tested electrically. Since these tests require specialized equipment, they should be made by an RCA Service Co. engineer. After the tests have been completed, the transmission line should be connected to the filterplexer (RCA MI-19086).

(Note 1: The lower end of the MI-19089 transmission line should be terminated at a gas stop inside the station. The transmission line run between this point and the filterplexer should be left ungassed. Since the filterplexer is gassed, it is also equipped with a gas stop. This ungassed portion of line may be disconnected from

either the filterplexer or the line going to the antenna to permit tests on either the antenna or the transmitter, without the necessity of releasing the gas from either the transmission line (to the antenna) or the filterplexer. The ungassed portion of line should be connected to the gas-stopped joints through an adapter or a short piece of line, so that the gas-stopped joints will not be disturbed when opening the line for tests.)

(When a gas stop (MI-19089-4) is required, it is inserted between two sections of line, or between a section of line and an adapter, using the bolts supplied with the gas stop. The gas stop should be installed so that the bleeder plug is toward the gassed portion of line.)

(Note 2: The preceding discussion of transmission line assumes that MI-19089 line will be used. To obtain higher transmission efficiency, or on long transmission line runs, the 3-1/8 inch fitting on the antenna may be transformed to match RCA 6-1/8 inch line (MI-19387) or a UHF waveguide.)

The transmission line is now ready for gassing. A dry-nitrogen supply line should be connected to the gas stop at the bottom of the transmission line, and the line fed at 5 pounds pressure. Next, climb the tower to the bottom of the antenna. Open the pipe plug in the harness until the air bleeds slowly. Leave the plug open in this manner until the air in the line has been replaced by nitrogen. (The actual time required may be anywhere from four to eight hours, depending on the length of transmission line and the rate at which the air is escaping.) In connection with gassing it should be mentioned that the transmission line only, is gassed; the antenna itself is not gassed, although it is closed in.

An indication of the elimination of air from the line, is to hold a lighted match in the stream of escaping gas from the harness bleeder, that has been opened. If the flame is immediately extinguished, you may be reasonably certain that pure nitrogen is escaping from the line and hence, that the line is filled with nitrogen. On the other hand, if the match continues to burn in the stream of escaping gas, we may conclude that there is still a quantity of air in the line. The foregoing test although rather crude, has proven to be effective, for lines gassed with nitrogen.

A more positive indication of the elimination of moist air from the transmission line may be obtained by connecting a Megger across the bottom end of the transmission line. Let the bleeder plug (at the antenna) remain open until the shunt resistance of the line exceeds 200 megohms. (This indicates a very dry line.)

When the moist air has all been forced out of the line, the gas plug at the harness joint may be tightened. The gas pressure gauge should be checked, and the gas pressure-regulating valve adjusted if necessary, to maintain a pressure of 5 pounds in the transmission line.

A good test for the presence of leaks is to shut off the gas supply valve and note any gradual drop in line pressure over an eight hour period. If the pressure drops more than 20% it is advisable to check the line for leaks.

Connect the beacon wiring and see that the beacon is functioning properly. The antenna is now ready for operation.

OPERATION

The TFU series of antennas are adjusted at the factory to the channel for which they are ordered, and require no tuning or adjustment, other than beam tilt which has been covered under INSTALLATION.

When applying power to the antenna for the first time, it is suggested that the television transmitter be operated on reduced power to minimize the possibility of damage to the antenna and feeder system. If the power indications to the antenna are normal, full power may be applied. If the indications are abnormal, the transmitter tuning should be rechecked. If the transmitter tuning is correct and the indications are still abnormal, then an RCA Service Co. engineer should be called.

MAINTENANCE

Due to the sturdy construction of these antennas, it is anticipated that they will require little in the way of maintenance other than routine checkups and periodic painting.

The antenna and transmission line should be inspected twice a year. Check the antenna for any loose or missing hardware or slot covers. Examine it for any evidence of corrosion, particularly around the base flange. Inspect the transmission line for any signs of potential leaks or breaks, and for any loose or missing hardware. Check the transmission line also for any discolored areas (which indicate local heating, hence a potential fault.)

The beacon lamp will require occasional replacement. When replacing this lamp, an examination of the antenna and transmission line may be made at the same time.

Check the gas supply tanks periodically. If the pressure in the tanks drops too rapidly, it is an indication of a leak in the system which should be corrected. (A spare tank of nitrogen should be kept on hand at all times.)

The antenna should be painted regularly in accordance with CAA regulations. The intervals at which repainting will be required will be determined by local conditions (primarily the weather, and the smoke and fumes encountered in the area). In painting the antenna, note that some hardware items are galvanized

and paint may not adhere to these surfaces (on new installations), unless the surfaces are either chemically prepared or allowed to weather for a few months after installation. (A coat of Bonderite may be applied before the first coat of paint for this purpose.) Any standard brand of tower paint may be used, DO NOT, UNDER ANY CIRCUMSTANCES, PAINT THE SLOT COVERS.

If this maintenance schedule is adhered to, and small items replaced when necessary, the antenna will have a long and useful life, and station breakdowns due to the antenna will be held to a minimum.

REPLACEMENT PARTS

A replacement parts list is not available at the time of this writing. If any parts are needed for the antenna, they may be obtained through your nearest RCA Broadcast Equipment Sales Office.

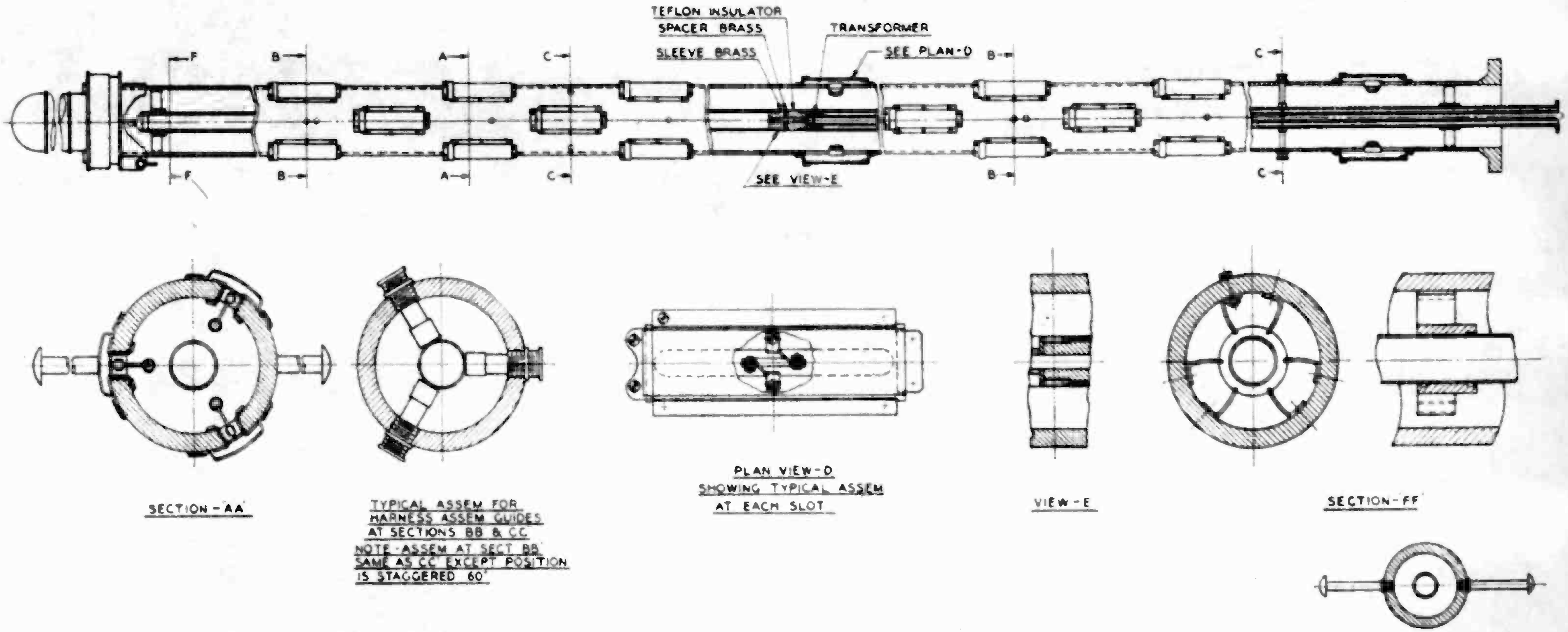


FIG. 1 Cross Section of TFU Antenna Assembly.

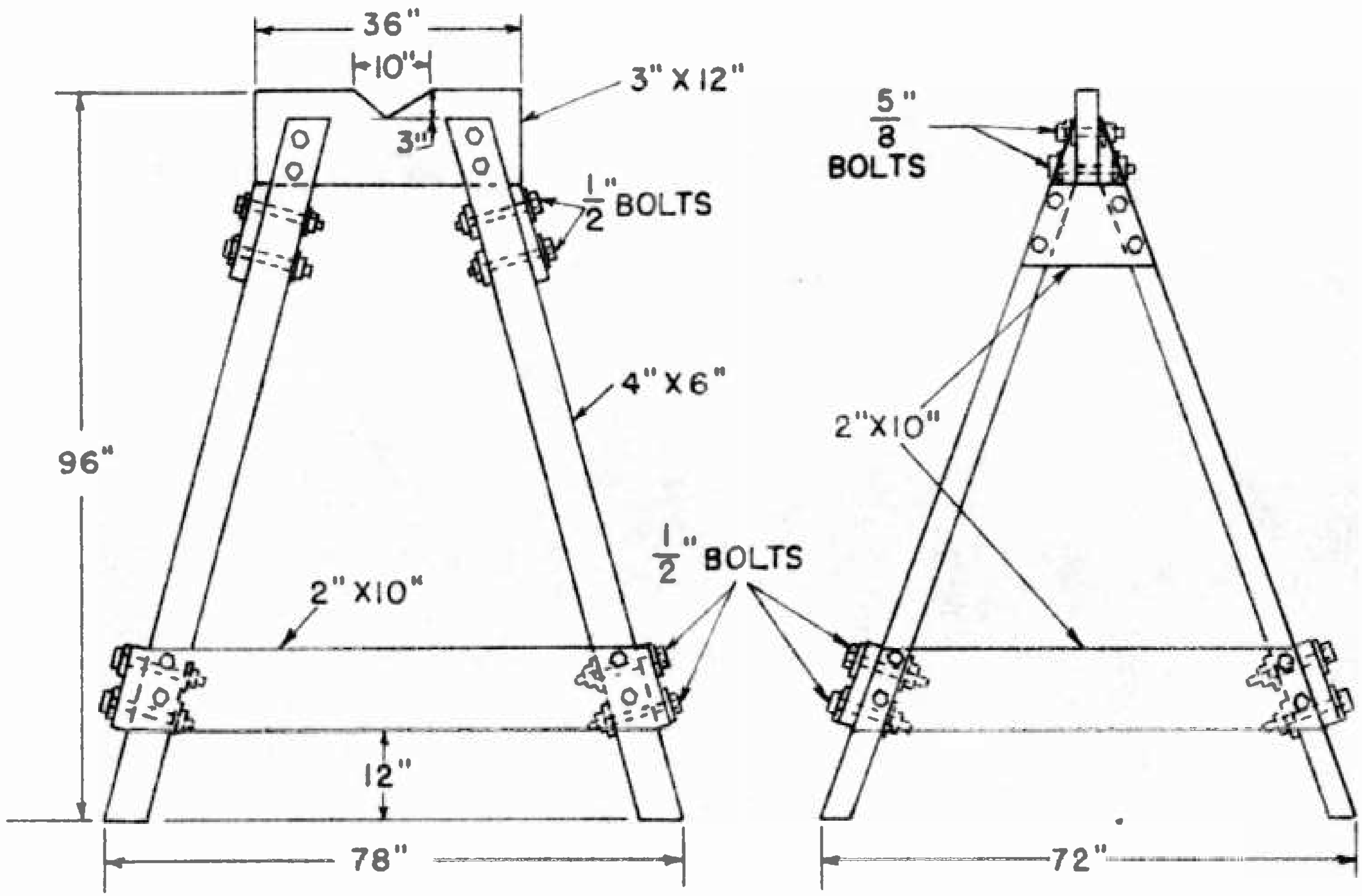


FIGURE 2. ANTENNA SUPPORT TRESTLE (462866)

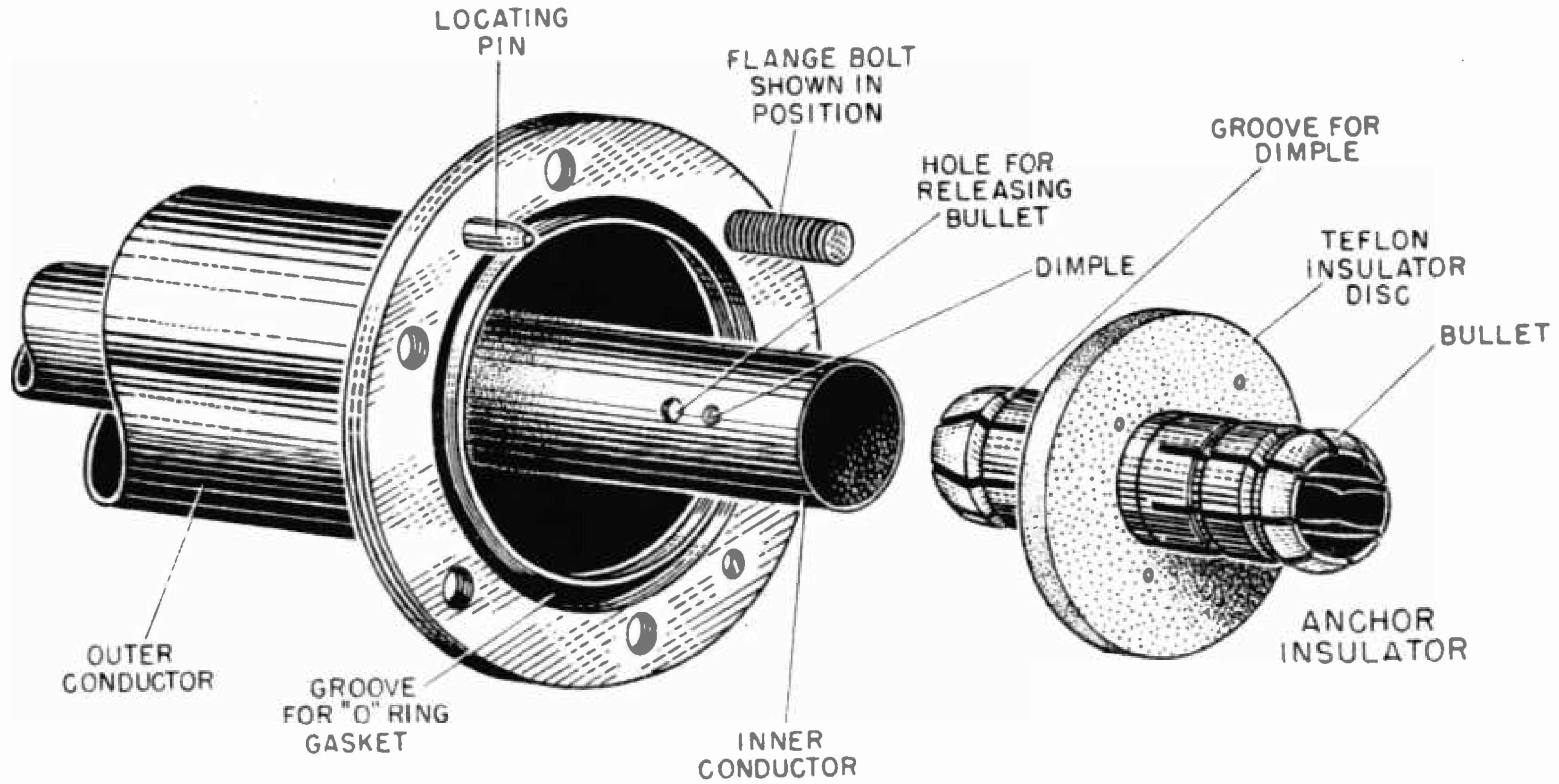


FIGURE 3. TRANSMISSION LINE MI-19089. UPPER FLANGE ASSEMBLY

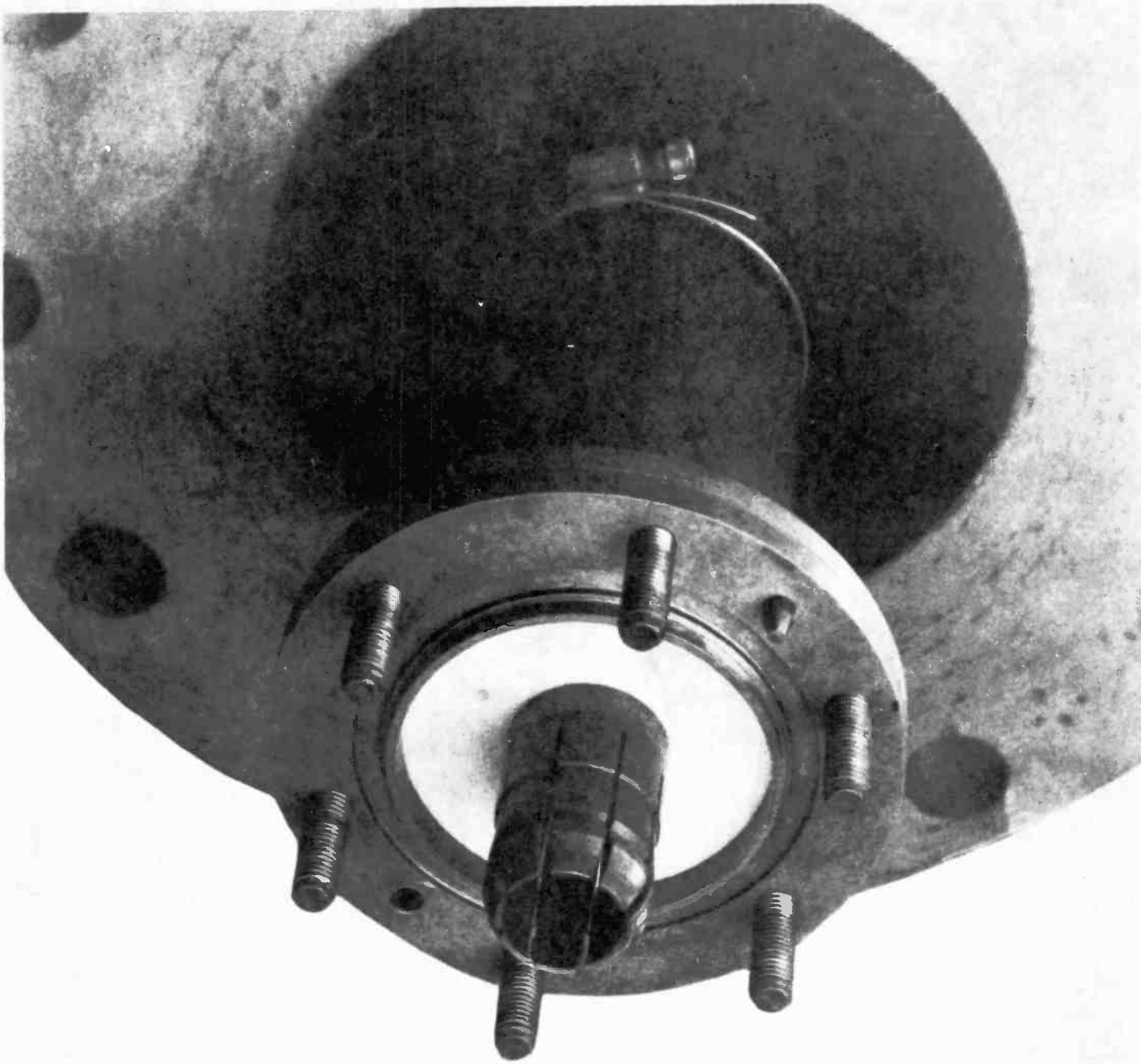


FIGURE 4. HARNESS FLANGE ASSEMBLY

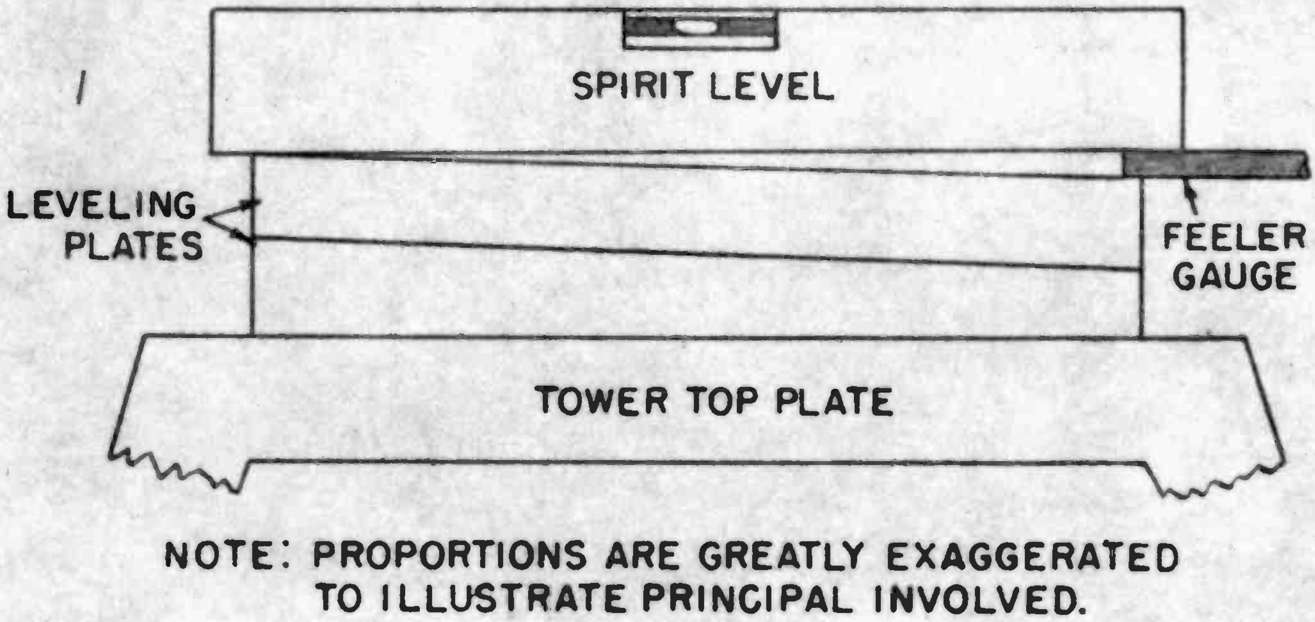


FIGURE 5. ADJUSTING MECHANICAL BEAM TILT (462865)

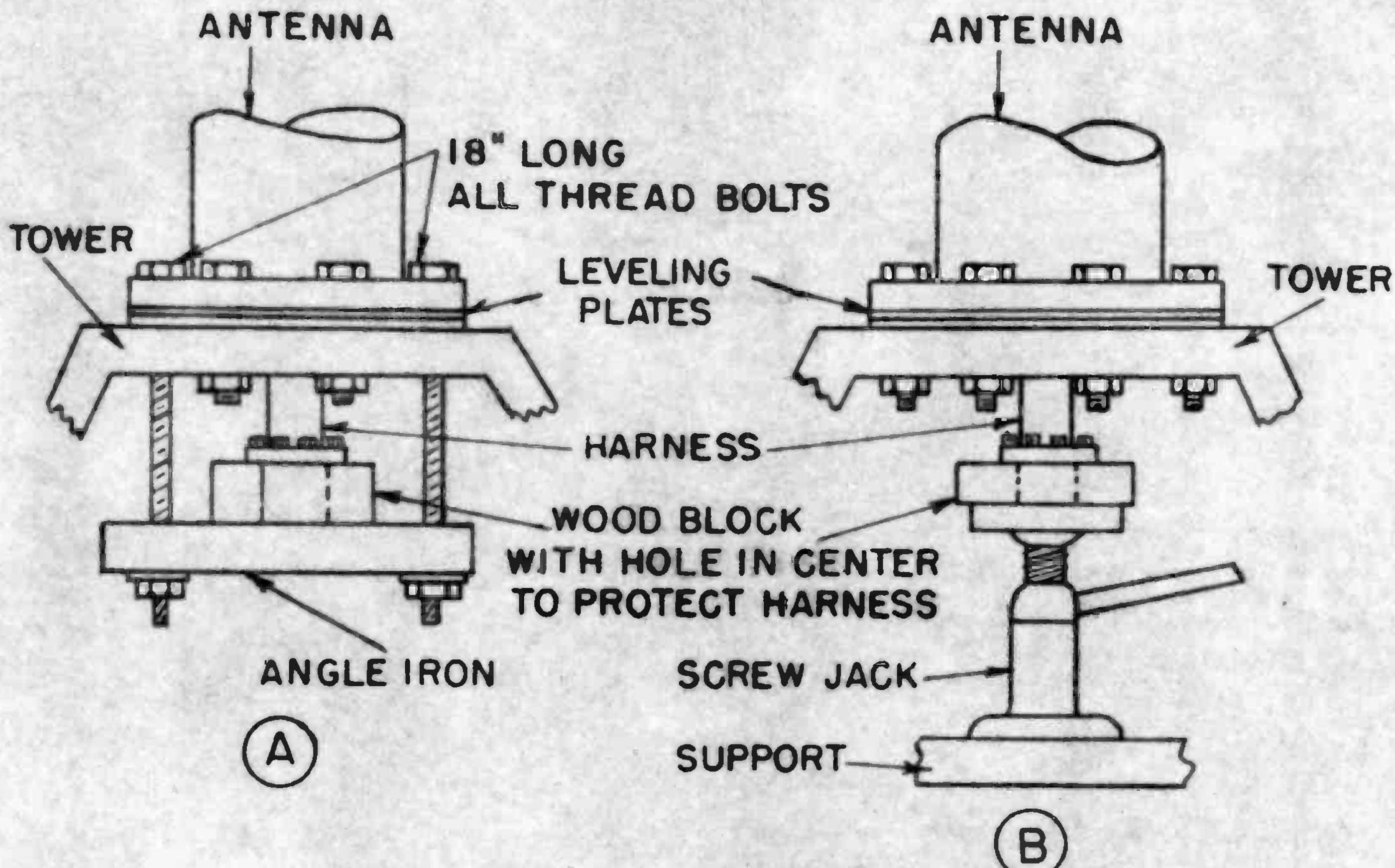


FIGURE 6. ADJUSTING ELECTRICAL BEAM TILT (462865)

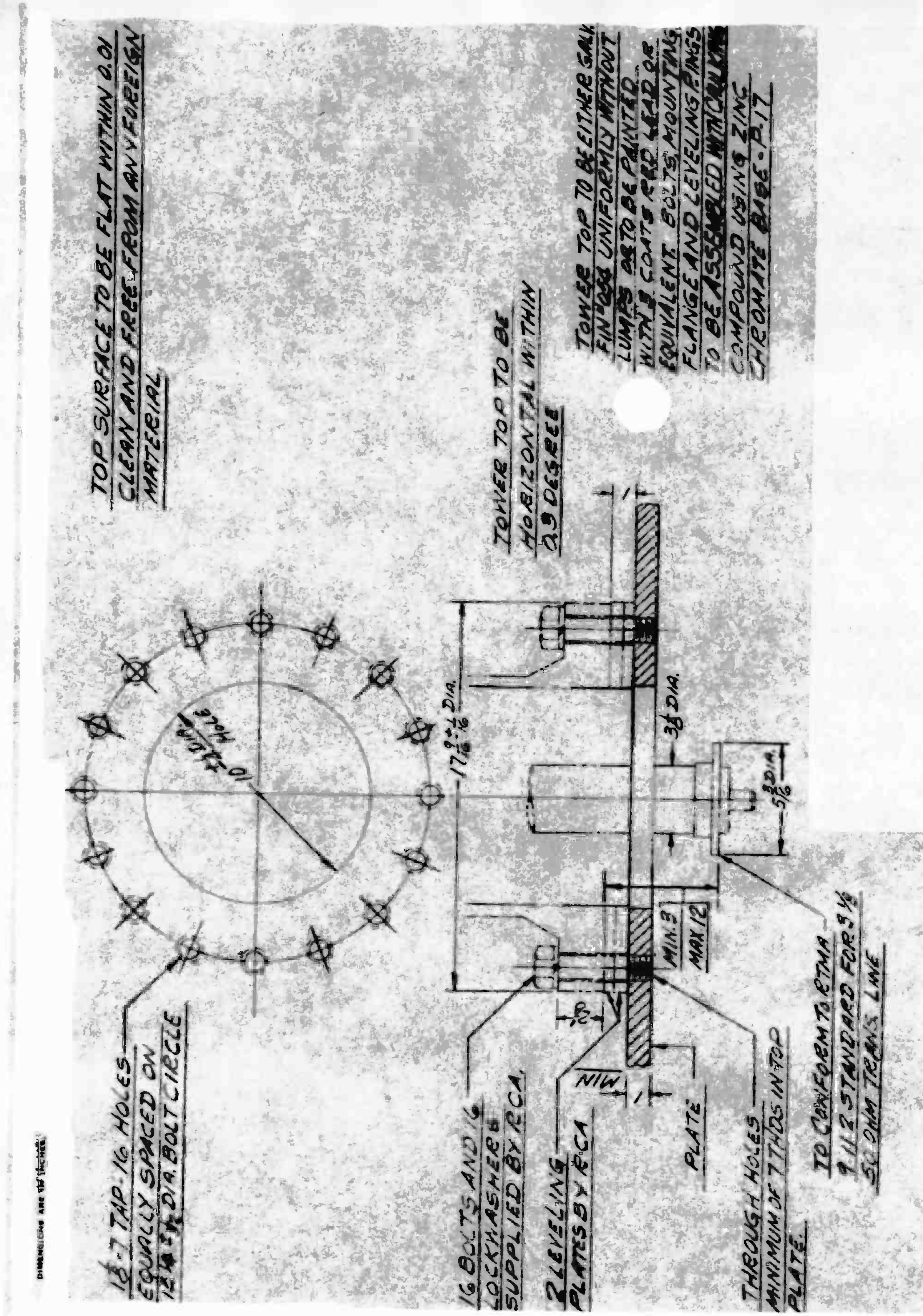


Figure 7. Mounting details, TFU-21BL and TFU-24BL Antennas (466357)

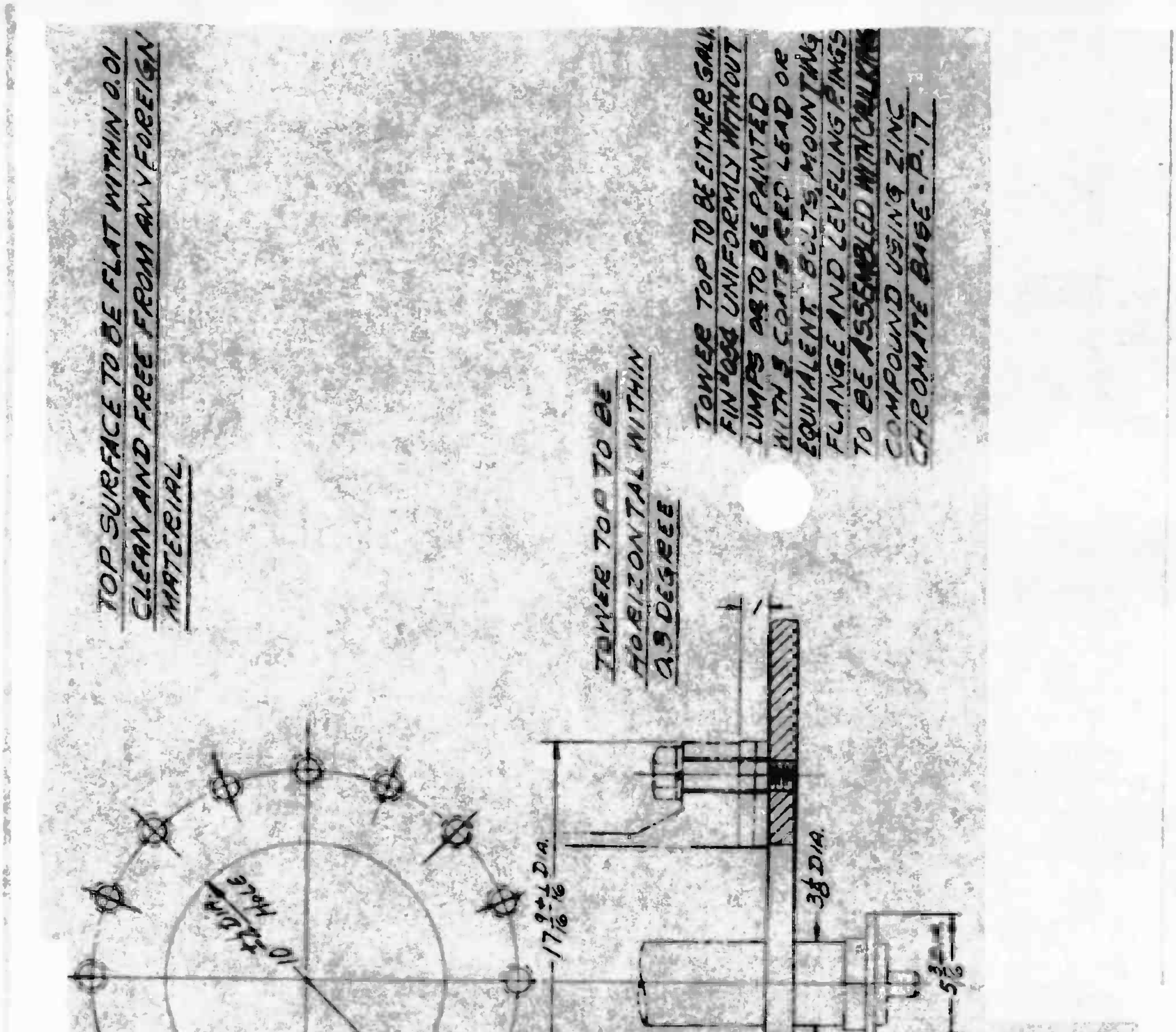


Figure 7. Mounting details, TFU-21BL and TFU-24BL Antennas (466357)

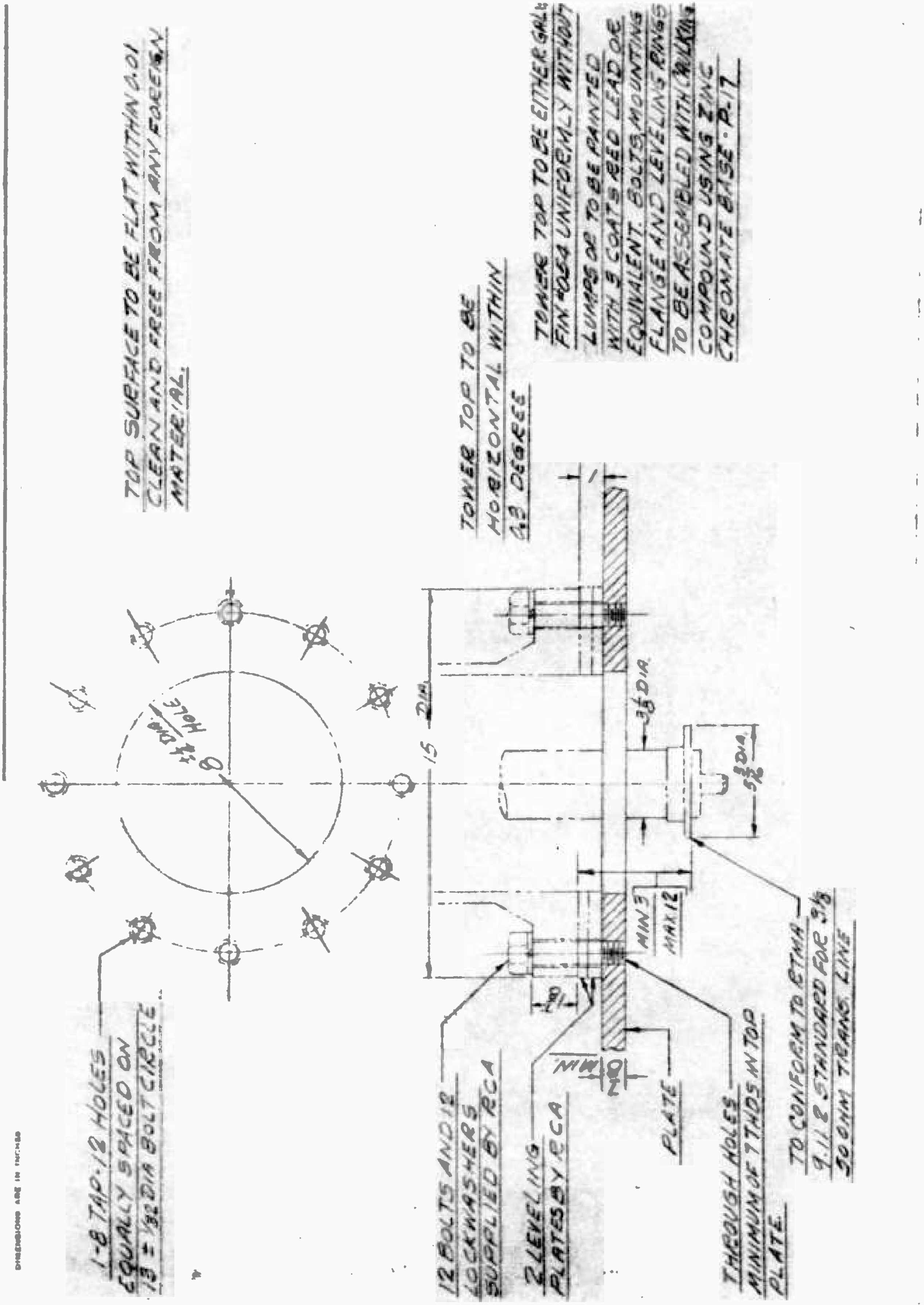


Figure 8. Mounting details, TFU-24BM Antenna (466358)

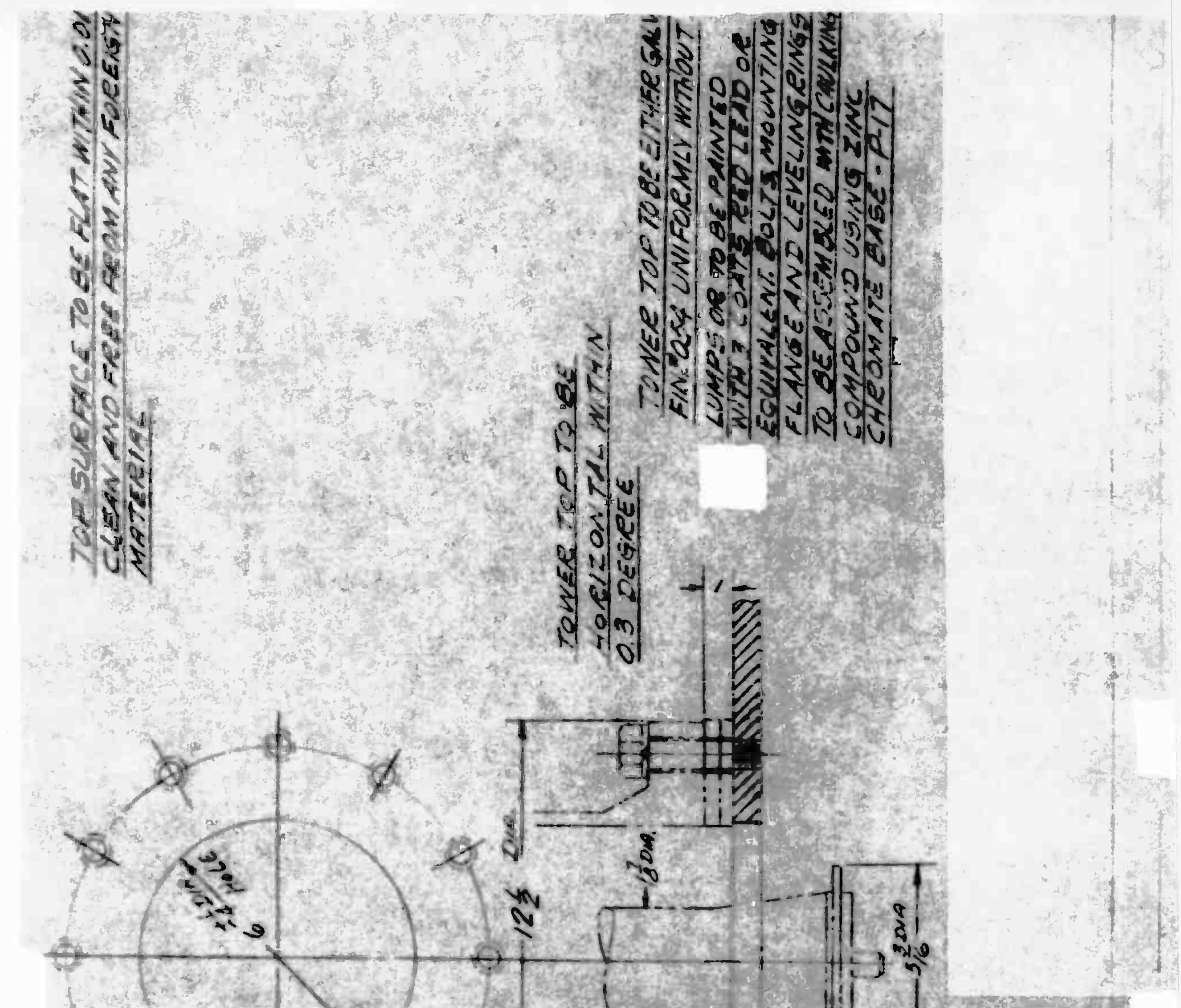


Figure 9. Mounting details, TFU-27BH Antenna (466359)

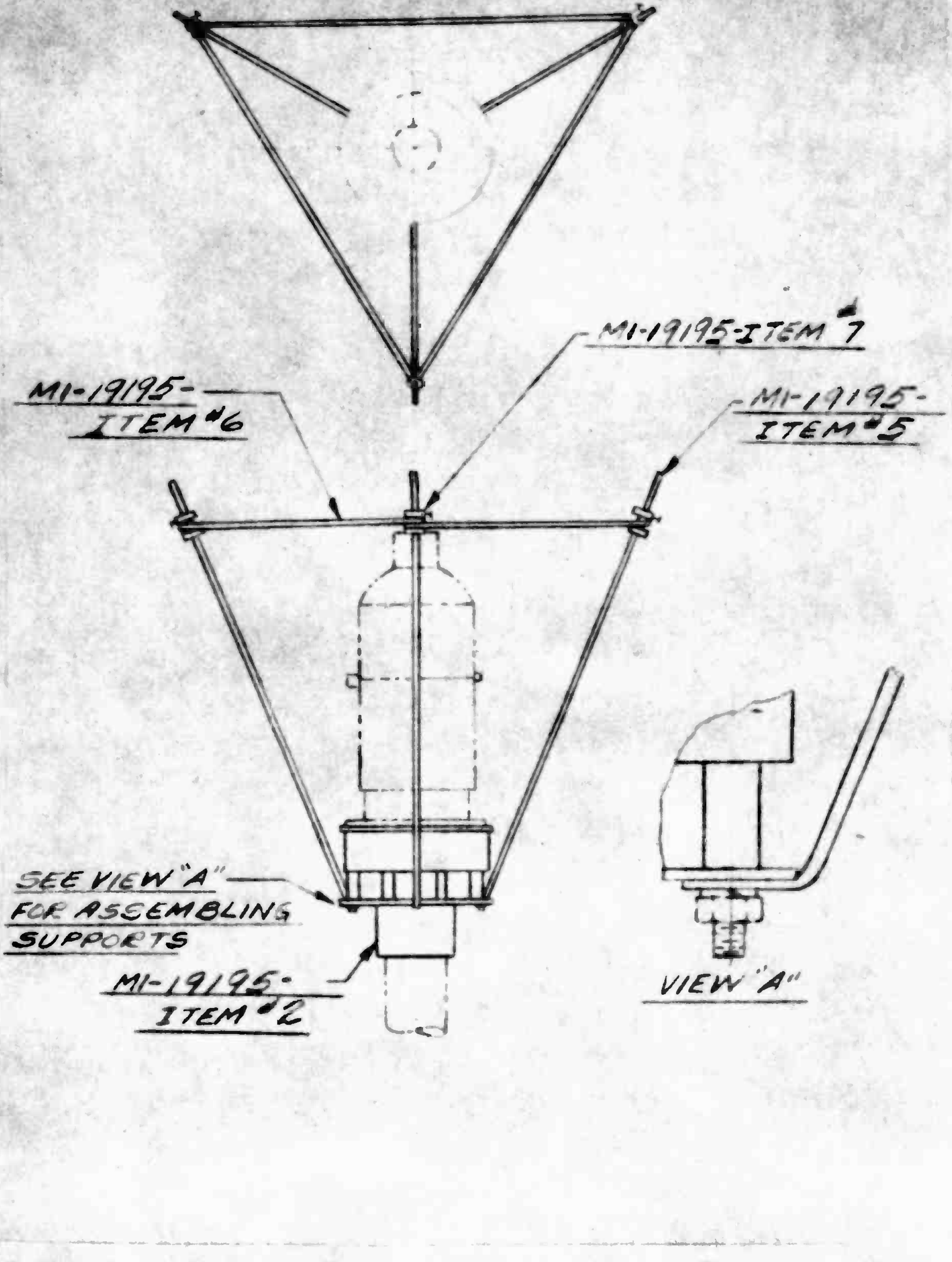


Figure 10. Lightning Protector, Installation Details (8827151)

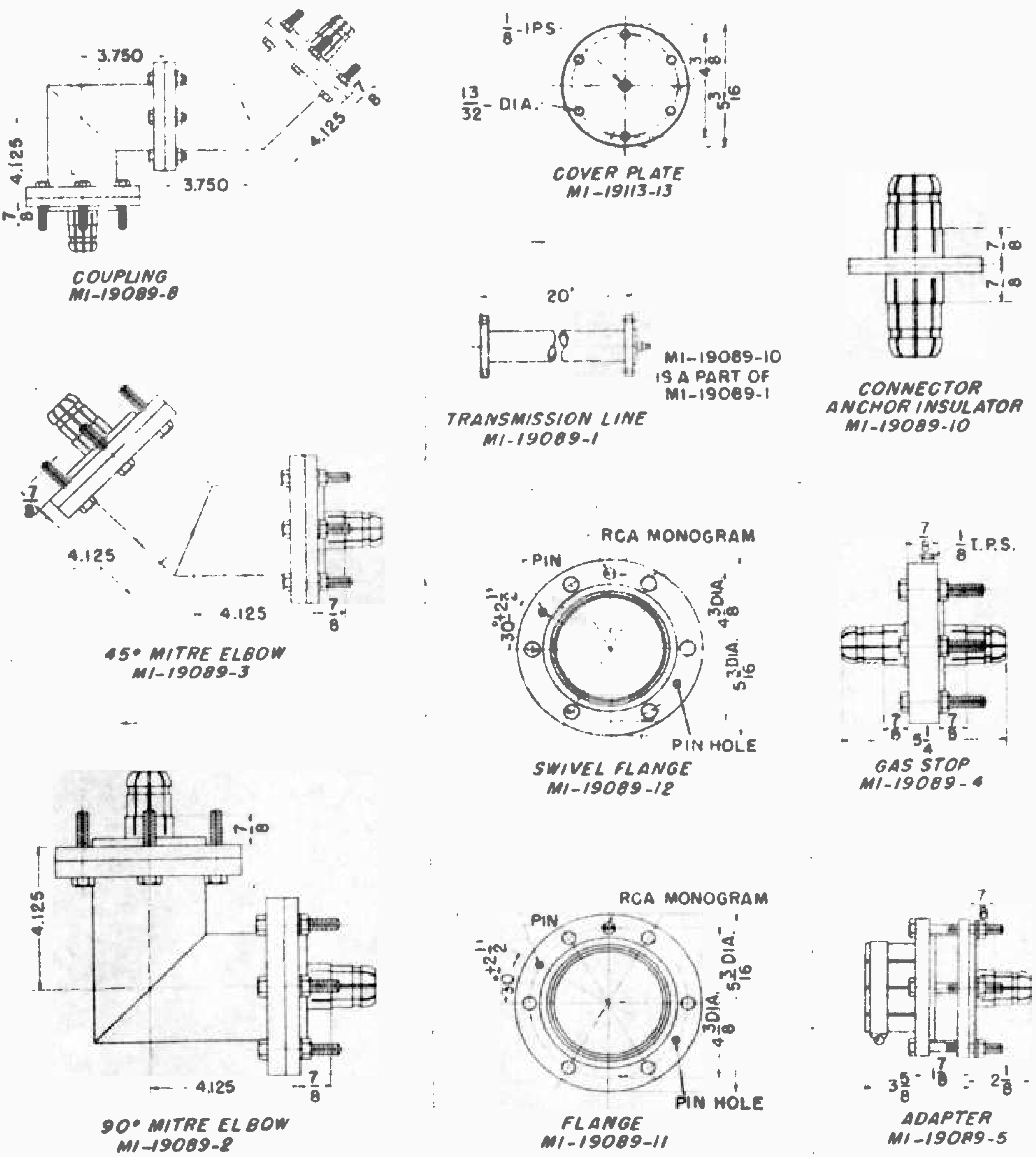
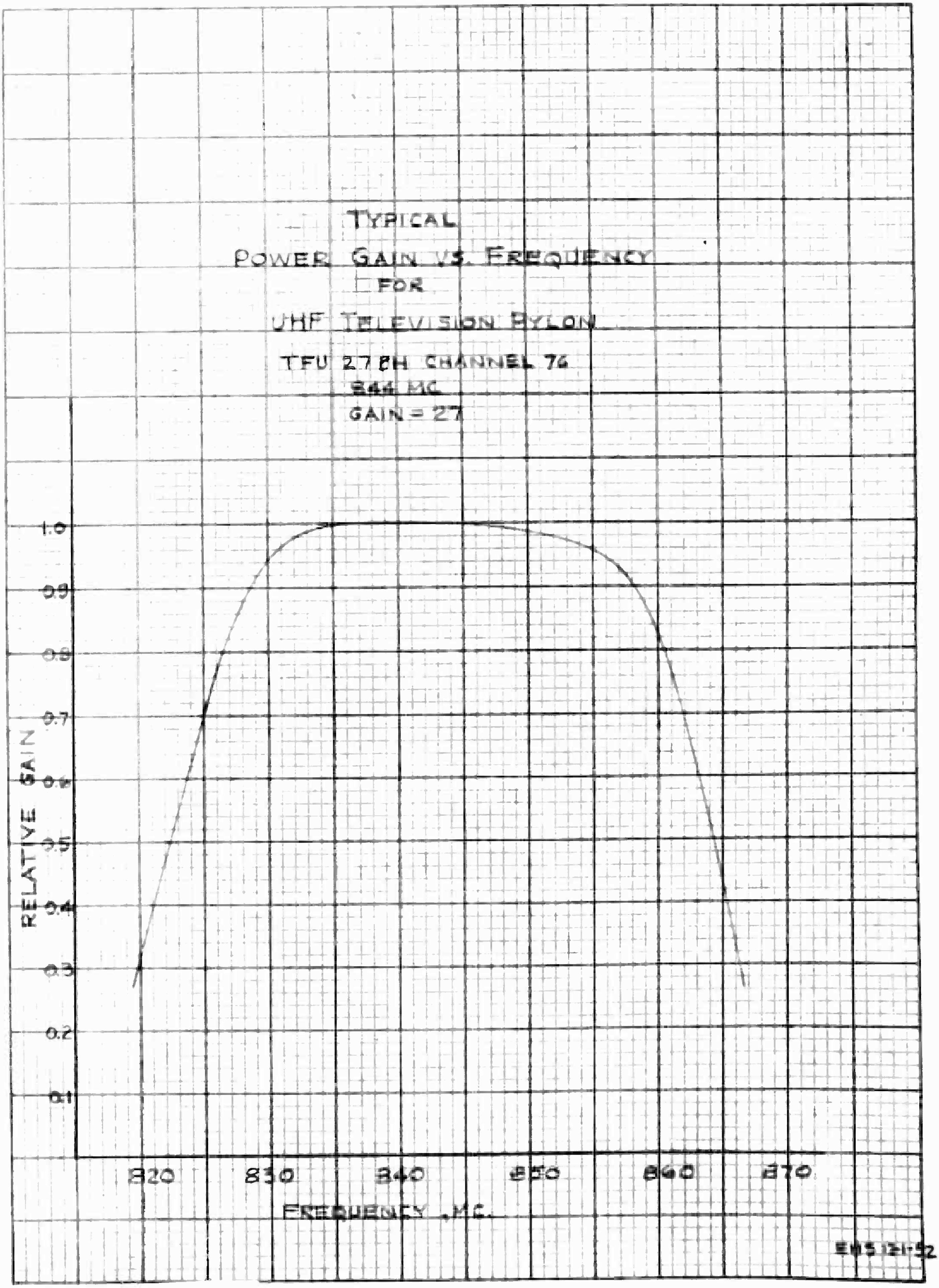


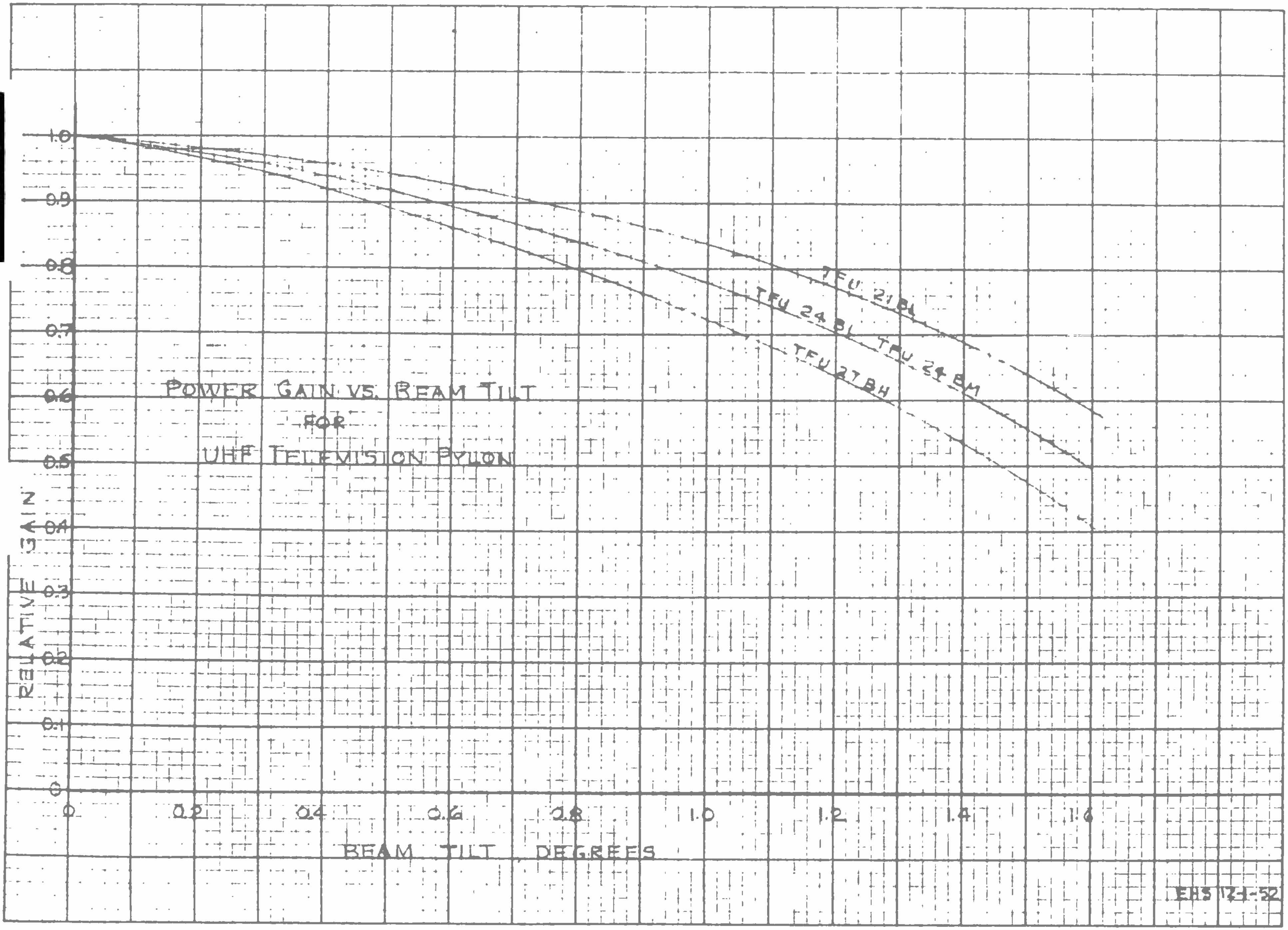
Figure [redacted] Dimensions, Transmission Line Fittings, 3 1/8", 50 Ohms



[redacted]

[redacted]

[redacted]



POWER GAIN VS. BEAM TILT
FOR
UHF TELEVISION PYLON
RELATIVE GAIN
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
BEAM TILT, DEGREES
TFU 21 BL
TFU 24 BL
TFU 24 BM
TFU 27 BH
EHS 12-1-52

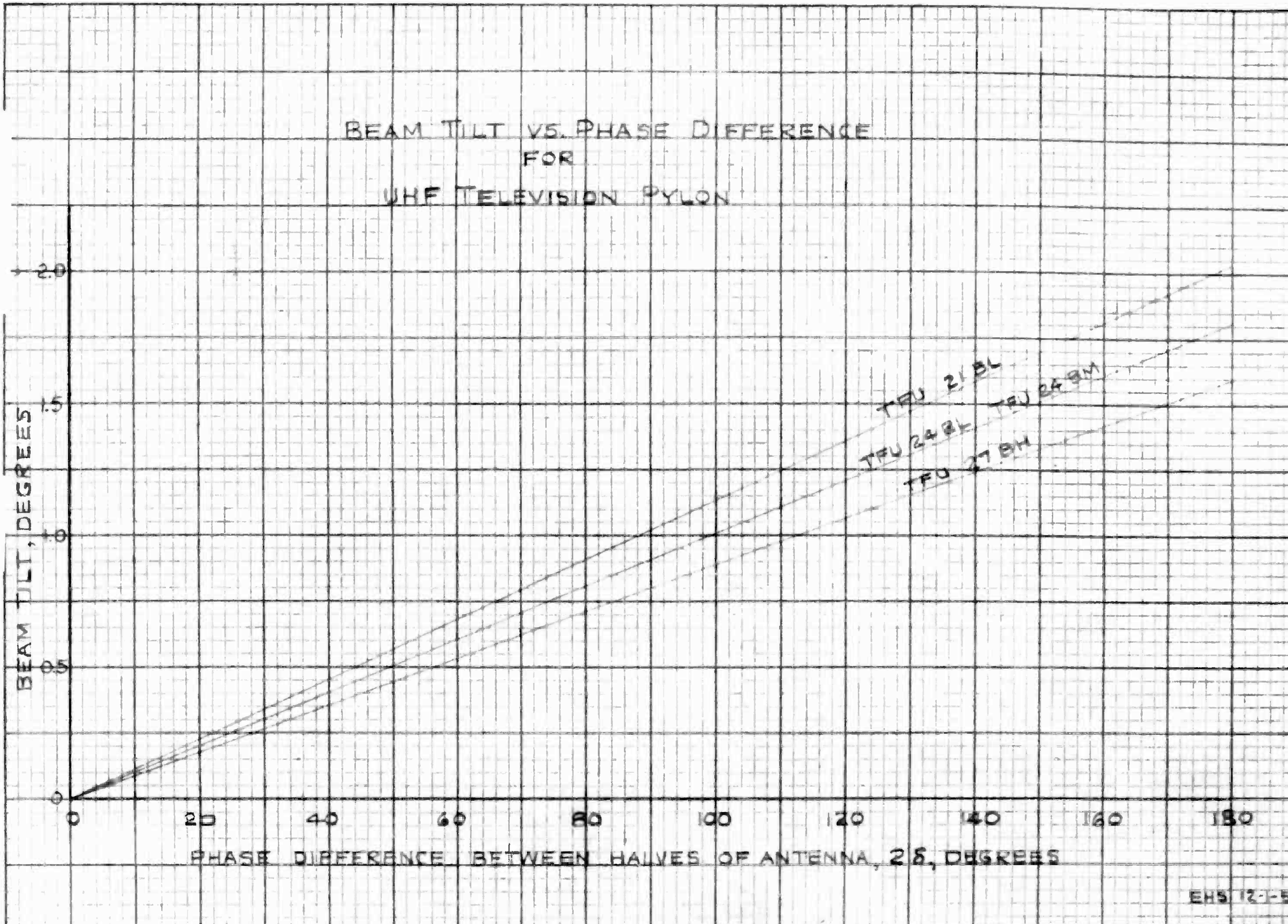


Figure 14

[redacted]