B GUYED TOWERS
ERECTION

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1. GENERAL

1.01 This section outlines the general considerations involved in erecting B Guyed Towers, and includes recommended procedures and precautions.

1.02 This section is reissued to add plumb, bow, and initial guy tension limit information. Since this issue covers a general revision, the arrows ordinarily used to indicate changes have been omitted.

1.03 Erection drawings are normally furnished with the tower, and provide information necessary for the field assembly of the tower, including the location and orientation of every piece and subassembly. All steel (except nuts, bolts, and washers) is identified by stencils, stamps, or metal tags which correspond to the markings shown on the erection drawings. The identifying mark of leg members is located on the outer face near the lower end. These drawings also show the number and type of bolts, nuts, and washers required to join the members. A more than adequate supply of each specified type of bolt, nut, and washer is furnished with the tower, but care must be exercised to ensure that the proper type and size of each is used for each joint, or a shortage of some types or sizes may develop.

2. PRE-ERECTION CONSIDERATIONS

2.01 Tower erection should not be started until all required permits have been obtained, as outlined in Section AG25.210.

2.02 The permit issued by the Federal Communications Commission (FCC) to construct and operate a radio system usually indicates whether or not lighting and painting to improve visibility are required. Where only receivers are to be installed and it has been determined that FCC permission is not required, the Federal Aviation Agency (FAA) will determine the necessity for markings to improve visibility. If lighting is required, arrangements must be made to assure the availability of electric power at the site, and the lighting facilities must be ordered and on hand at the tower site. Note that the standard lighting kit only provides the material ***which goes on the tower.*** Conduit and wire from the base of the tower to the lighting control panel in the building should be ordered locally. Methods of lighting and painting towers are described in Sections AG25.230 and AG25.300. Information on temporary warning lights is contained in Part 4 of this section.

2.03 Section AG25.210 provides information on foundations and anchors for B Guyed Towers. Steel erection should not be started until the results of concrete compression tests are known to be satisfactory. (See Section AG25.130 for a discussion of concrete.)

2.04 The grounding system at the anchors should be completed and the grounding connections at the foundation should be readily accessible. Installation of the grounding system is described in Section AG25.210.

2.05 All equipment to be installed on the tower should be available when required, and its mounting location on the tower should be specified to the contractor in order that hoisting equipment may be positioned to avoid conflict.

2.06 If aerial electric power facilities are in a location that may present a hazard to or interfere with temporary guys, hoisting equipment, tag lines, etc, arrangements should be made to have the power company relocate, de-energize, or insulate their facilities.

2.07 Foundations and anchors should be carefully checked to ensure that they are located correctly and are of the right size. This should include checking the azimuths of the anchors, which in turn fix the transmission blind spots referred to in Section AG25.200. Details of layout are covered in Section AG25.210.

2.08 Installation of a talking circuit on the tower to facilitate adjustment of antennas and reflectors during system lineup may be desirable. Information on this subject is contained in Section AG25.230. A physical circuit can be avoided by use of the "walkie-talkie" radio, if this equipment is available. This equipment may also prove of value in the erection of the tower itself.

3. INSTALLATION OF BASEPLATE ASSEMBLY

3.01 Both the foundation surface and the baseplate should be cleaned of mud, grime, and other foreign matter. The baseplate is then installed as illustrated in Fig. 1 by placing it on four tapered steel wedges located about midway between the anchor bolts. The plate is leveled by adjusting the wedges. Since the baseplate is symmetrical about the center, it may be installed without regard to its orientation on the pier.

3.02 After the baseplate is leveled, the anchor bolt nuts should be tightened. The wedges should provide a clearance of 3/4 to 1-1/4 inches between the baseplate and pier to allow for grout. The baseplate may be installed and "grouted in" at any time after the results of the compression tests on the concrete are known to be satisfactory.

3.03 The grout should consist of one part portland cement (Type I or III) to two parts sand (by volume). Portland cement is described

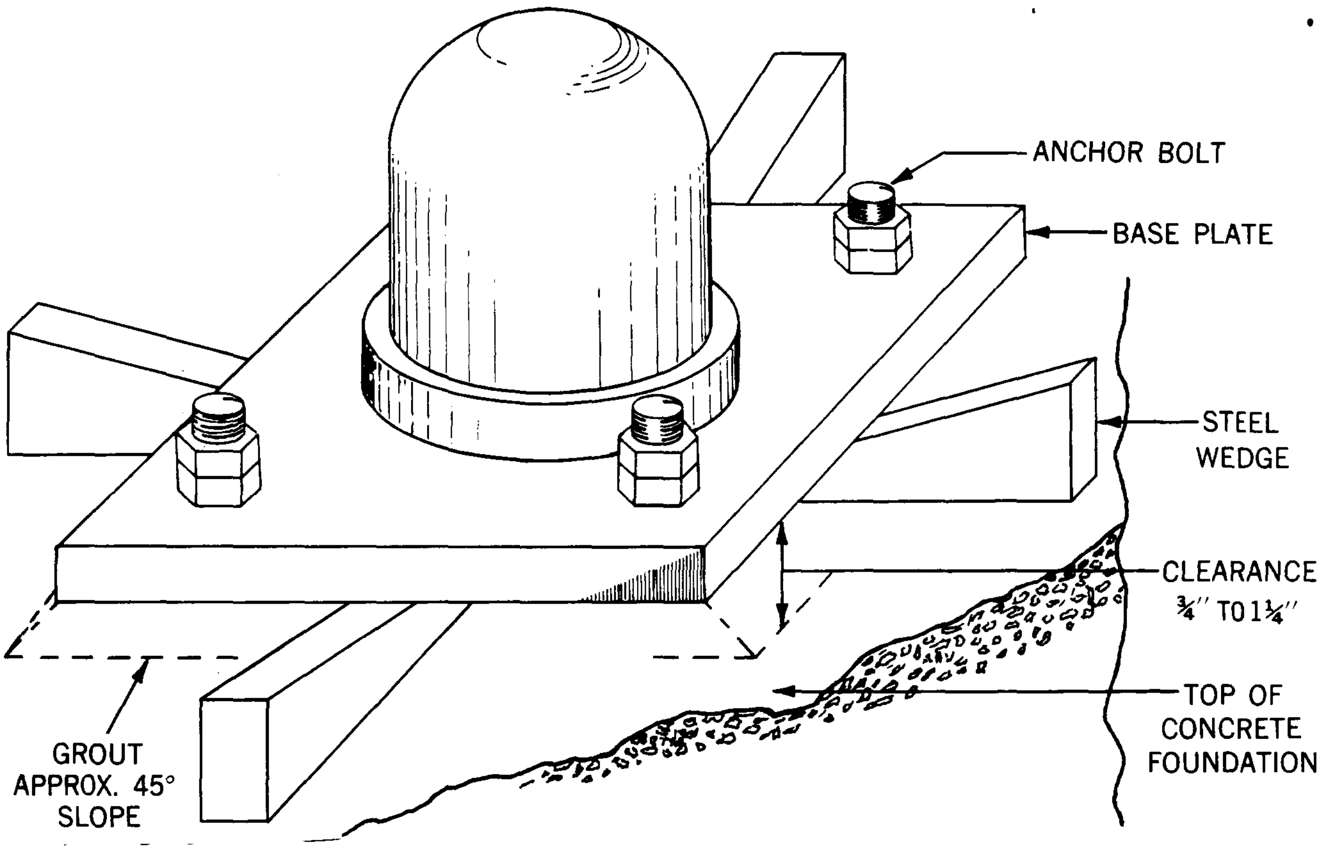


Fig. 1 – Baseplate

in Section AG25.130. Clean sand from a reliable supplier should be used in the grout. The water should be clean and potable.

3.04 The consistency of the grout must be very stiff. The sand and cement should be thoroughly mixed in a dry condition and then water should be added sparingly so that the mixture retains a granular appearance. Grout of the proper consistency will form a lump when squeezed in the hand, and the lump will crumble freely when disturbed.

3.05 Grout should be forced under the baseplate from all sides, completely filling all voids. The wedges should then be removed, and the void left by removing the wedges should be filled immediately with additional grout. The grout should be beveled as illustrated in Fig. 1.

4. TEMPORARY WARNING LIGHTS

4.01 The rules of the FCC and FAA require that temporary warning lights be placed on any tower which is required to have permanent air obstruction warning lights. The number of sets (or levels) of temporary lights required will be the same as the number of levels of permanent lighting. Where two or three levels of permanent lights are required, only one temporary set of lights is required (at the top) until the level of the first permanent lights is exceeded. Temporary lights should then be installed at approximately the level of permanent lights and, in addition, a set of temporary lights is always required at the uppermost point of the structure. Even on towers requiring only one level of permanent lighting, a set of temporary lights is required at the top of the structure, and this applies even though only one section of the tower may have been erected by sunset.

4.02 Temporary lights are to burn steadily from sunset to sunrise. Top lights are to consist of two 100- or 111-watt lamps (#100 A21/TS or #111 A21/TS) enclosed in aviation red obstruction light globes. Two similar lights are required at each level where permanent lights would be installed. (Permanent lights may be used in lieu of temporary lights.) All side lights are to be positioned so that at least one of the two lights at each level will be visible from any angle of approach. Many contractors have temporary warning lights for use during erection, but it is advisable to notify them if temporary lighting will be required, and also whether it will be one-, two-, or three-level.

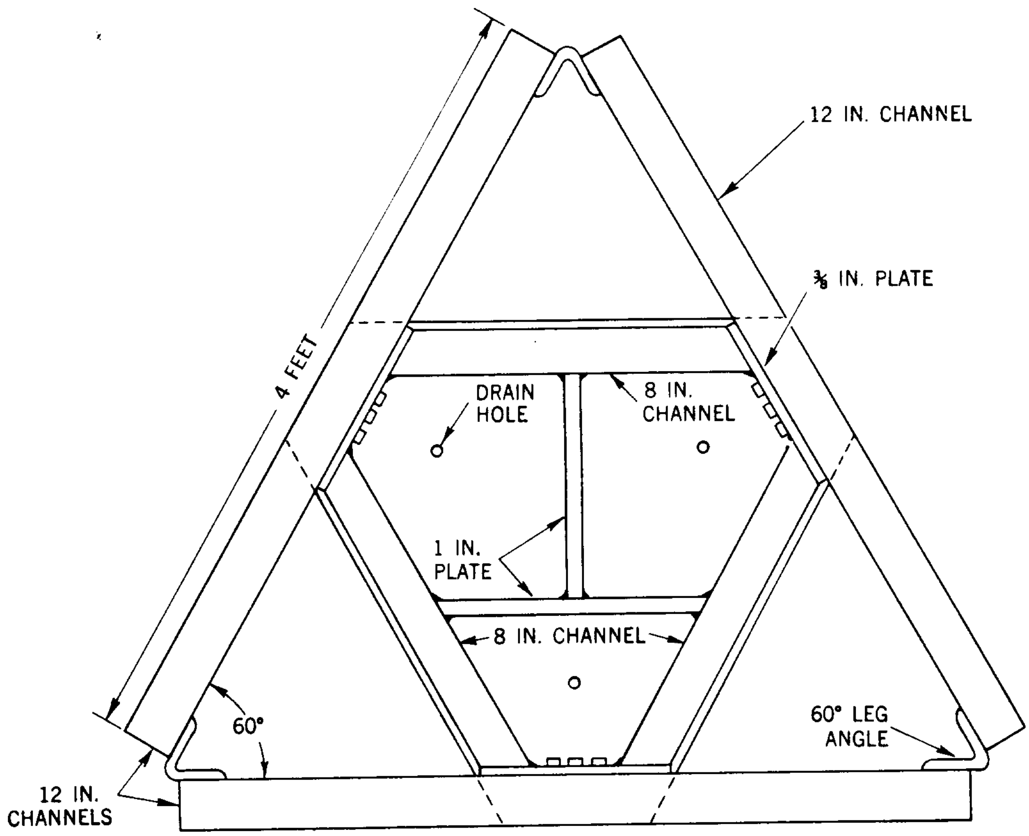
5. ERECTION CONSIDERATIONS

5.01 Erection of steel towers is usually performed by contractors rather than by telephone personnel. It should be noted that the contractor is responsible for the job and for the construction methods he chooses to use, and is presumably the best judge of the condition of his equipment and the loads which it can handle. The Telephone Company representative should, however, assure normal safeguards and require the contractor to correct any obviously dangerous items such as frayed winch lines and ropes.

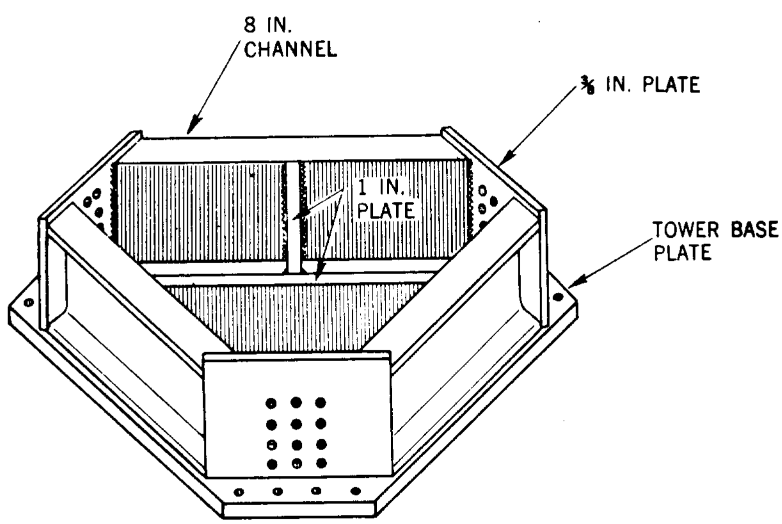
5.02 The general appearance of the base of the tower is shown in Fig. 2. Note the use of 12-inch channels in the base, and 8-inch channels for internal bracing. Four bolts connect the baseplate to the flange of each 12-inch channel. A washer is placed under the head of each bolt, in addition to the one used under the nut. (See Fig. 3.)

5.03 6-inch channels are employed in the top section of the tower to form the anchorage for the backstay azimuth arm on reflectors and on the 5-foot antenna. Washers should also be used under the heads of the bolts at these connections.

5.04 Most structural members of the tower are formed of angles. Legs are 60-degree angles; lacing and horizontal bracing are all 90-degree angles. Note that the legs are double-laced with 1-1/2″ x 1-1/2″ x 1/8″ angles (i.e, cross-braced) except for the top section. This is a tension-compression system and, to get the maximum strength out of these small angles, they are bolted together at the point where they cross. On a given face, since one set of lacing angles is bolted to the inside of the legs and the other is bolted to the outside, angles which cross each other are separated by the thickness of the leg members. As shown in Fig. 4, a spacer washer must be installed to avoid the bending of these angles which would otherwise result if they were bolted together without the spacer in place.

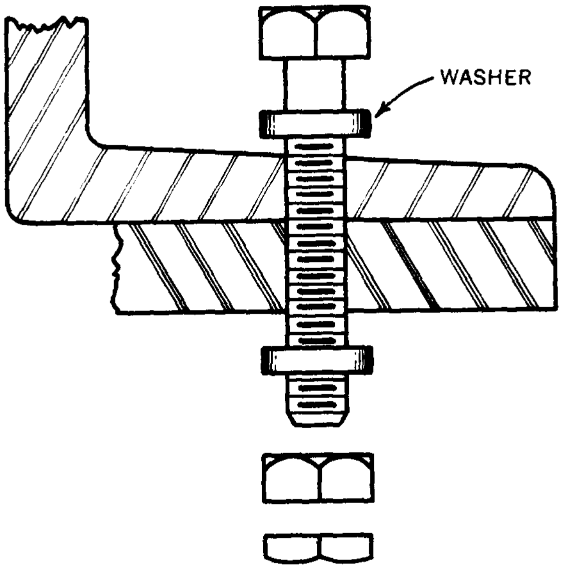


COMPLETE BASE OF TOWER



INTERNAL BRACING OF TOWER BASE

Fig. 2 – Tower Base



SECTIONAL VIEW
BEVELED AND FLAT SURFACES
BOLTED TOGETHER

Fig. 3 – Use of Washer

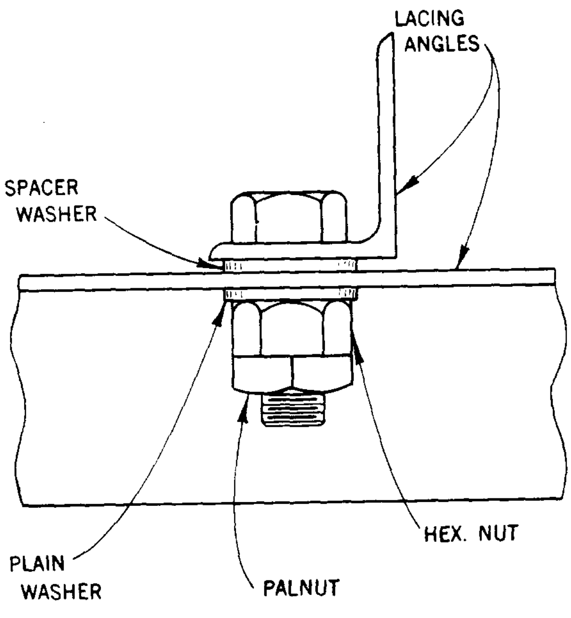


Fig. 4 – Use of Spacer Washers

5.05 It is general practice for contractors to assemble the tower sections on the ground, with the associated splice plates attached loosely at the top of each leg. The lower diagonals are usually left loose to facilitate lining up holes when the section is put in place. The sections should be inspected for such items as correct assembly, spacer washers, tightness of bolts, etc. All bolts should be equipped with a plain washer, hex nut, and palnut.

5.06 Contractors will vary in the exact manner in which they assemble the tower. Usually the bottom section, and sometimes the two bottom sections are bolted together on the ground and lifted onto the baseplate. Because of the ball and socket type of connection to the base pier, it is necessary to use temporary guys to prevent the tower from overturning. Selection of the size and type of temporary guys is the responsibility of the erection contractor. Temporary guys are to be moved up with the tower so that there is never more than one section (20 feet) extending above the level of the temporary guys. Guy strand intended for permanent guys should not be used for temporary guys.

5.07 As soon as the first section (or sections) is in place and stabilized with temporary guys, the grounding connections should be established. Each of the three 12-inch channels in the base of the tower has two 9/16-inch holes for a 1/2-inch machine bolt. Only one hole in two of the three faces is used. The ground wire is secured under a grooved washer held in place by the 1/2-inch machine bolt. Since the wire is copper and the baseplate is galvanized, the presence of water in the joint will cause an electrolytic action between the dissimilar metals. The bolt should be drawn up tightly and painted with hot pitch or other waterproofing material. Information on the grounding system is contained in Section AG25.210.

5.08 Permanent guys should be installed at their appropriate level and correct tension as soon as the tower reaches the height at which they are required. The structure should be made plumb before adding any more sections. Guy strand is furnished in quantities sufficient to make up all guys with each anchor on a minus 6-degree (ground) slope (i.e.. a drop of about

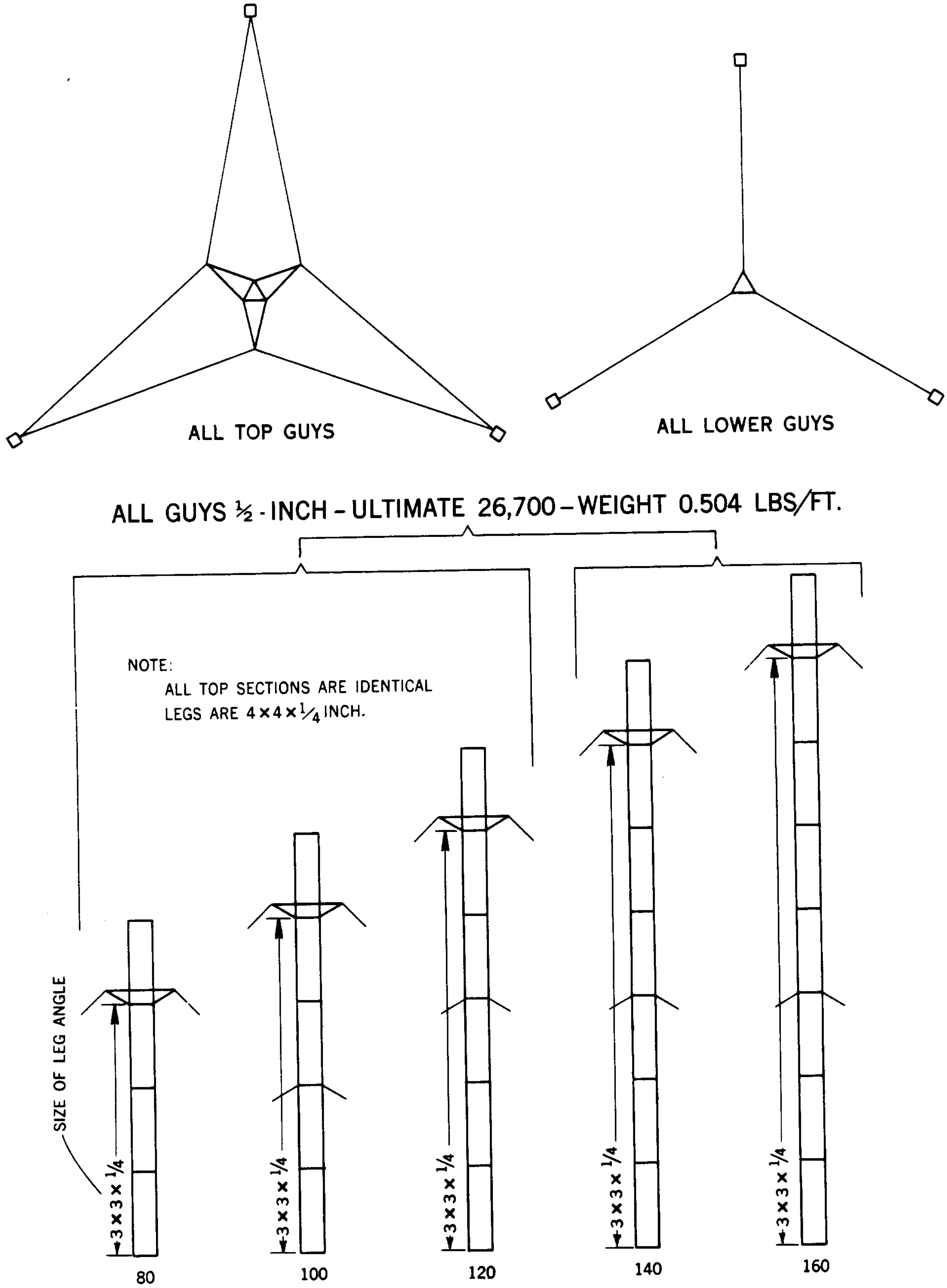


Fig. 5 – 160-foot and Smaller Towers

ALL GUYS 9/16-INCH - ULTIMATE 33,700 - WEIGHT 0.637 LBS/FT.

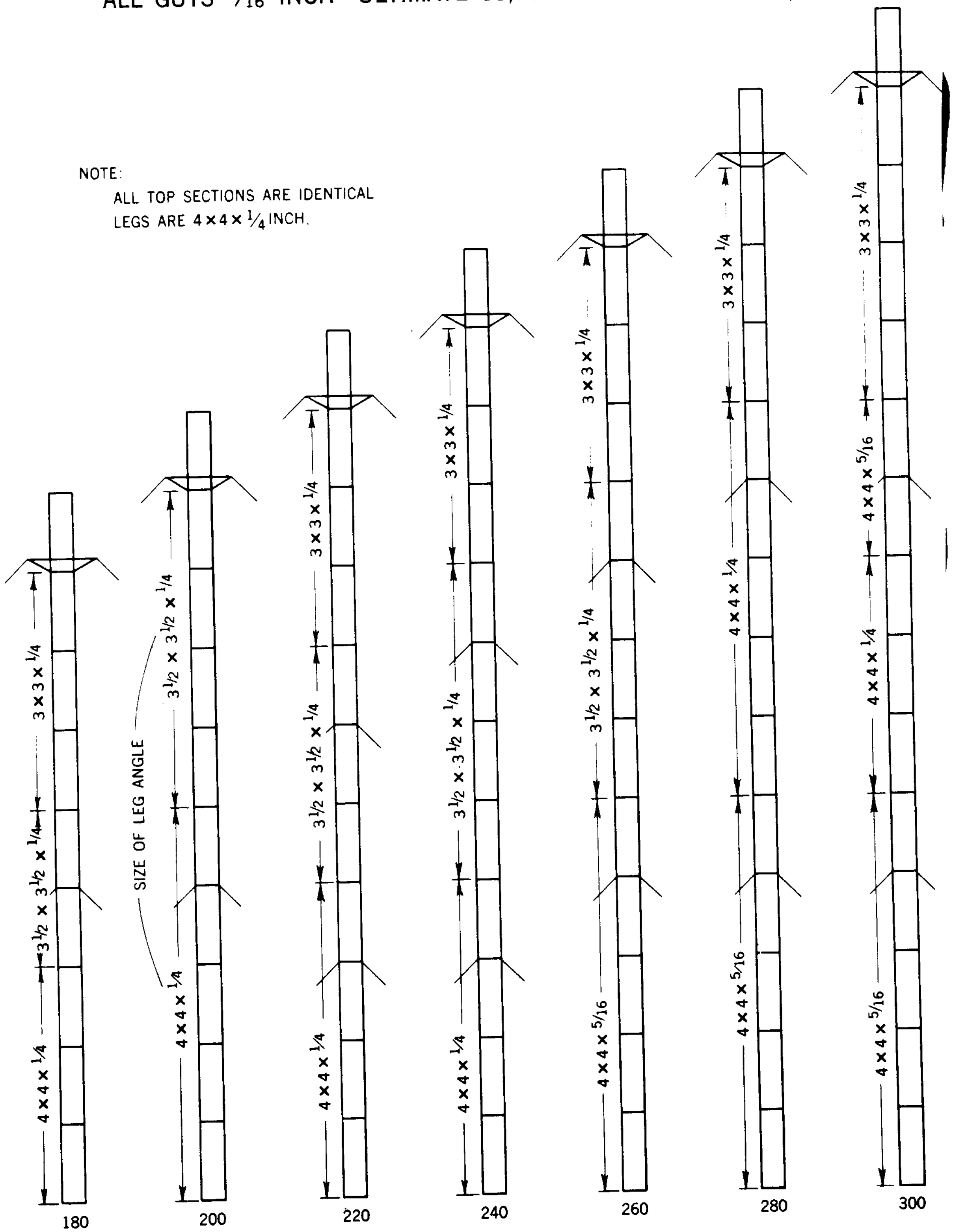


Fig. 6 – 180- to 300-foot Towers

10-1/2 feet per hundred feet). All towers of 160-foot and lesser heights employ 1/2-inch diameter 19 wire strand having an ultimate strength of 26,700 lbs. Larger towers employ 9/16-inch diameter strand with an ultimate strength of 33,700 lbs. Figs. 5 and 6 show the size, weight per foot, and placement of guys. Information on the method of measuring guy tension is contained in Part 6 of this section.

5.09 A typical set-up for erecting guyed towers is shown in Fig. 7. The gin pole is mounted on one face of the tower, fastened at two points. The use of the so-called "Black Diamond" (wooden) gin pole for erecting towers is not recommended. The bottom of the pole is usually hung by two short lengths of cable, shackled to each leg (Fig. 7A). The lower cables support the dead load of the gin pole plus the loads imposed by hoisting. The upper set of shackles (Fig. 7B) serve to support the gin pole in a vertical position Normally, the lengths of both sets of shackling cables are calculated so that the pole will not deviate from a vertical plane by more than 10 degrees. This restricts the bending moment imposed on the tower.

5.10 The gin pole used normally extends about two feet higher than the total length of the hoisted section. This is to provide headroom when a section is hoisted and set in position.

5.11 The top of the gin pole is equipped with a pivoted "rooster-head". When a section is being hoisted, the top of the gin pole will lean out to the limit of its top shackles. When the section reaches the upper block, hoisting is halted, and the section is pivoted (Fig. 7, Sec. A-A) around the pole. With this transfer of weight, the top of the pole will "kick-in", and the bottom will "kick-out". This action will put the center of the hoisted section near the center of the tower, and it can be lowered into place and bolted. It is recommended that all bolts be installed and tightened before progressing.

5.12 The gin pole is then "jumped" to the next highest position, and the next section installed. Normally, antennas or reflectors are hoisted only after the tower is completely erected, all permanent guys have been installed at their proper tension, and the tower plumbed.

5.13 The gin pole method, when properly used, is capable of hoisting any single assembled tower section, or System Standard antenna or reflector, (or comparable weights) without exceeding the design criteria of the tower. There are, of course, other satisfactory construction methods used, such as boom cranes, which are used quite frequently. Some contractors erect supplementary portable towers on the site for use in hoisting tower sections and equipment items.

5.14 The ends of guys are made up with five strand clips and thimbles (Fig. 8). The end of the strand should be served with a 2-inch wrapping of 22-gauge galvanized steel wire to prevent unraveling. Strand clips are made so that no difference in holding power can be introduced by incorrect orientation of the clip with respect to the strand. Holding power is primarily affected by the torque applied to tighten the clip. About 50 to 60 foot-pounds is adequate for these clips. Avoid overtightening.

5.15 The tower is erected by joining abutting leg angles using bolts and splice plates. In order to effect economies in fabrication, only two sizes of splice plates are used. One is 1-1/2 inches wider than the other, and has an extra hole for a step bolt. Both plates are the same length and each provides two groups of seven bolt holes. Fig. 9 shows the standard plate used at all leg splice locations where step bolts do not occur.

5.16 Bolt requirements at leg splices are as follows:

LEG SIZE	NO. OF BOLTS AT EACH END
4 x 4 x 5/16	7
4 x 4 x 1/4	6
3-1/2 x 3-1/2 x 1/4	5
3 x 3 x 1/4	4

Note that only the largest size leg members use all fourteen bolt holes, while the smallest size legs are spliced with only eight bolts, thus leaving six unused holes in the splice plate. ***All holes***

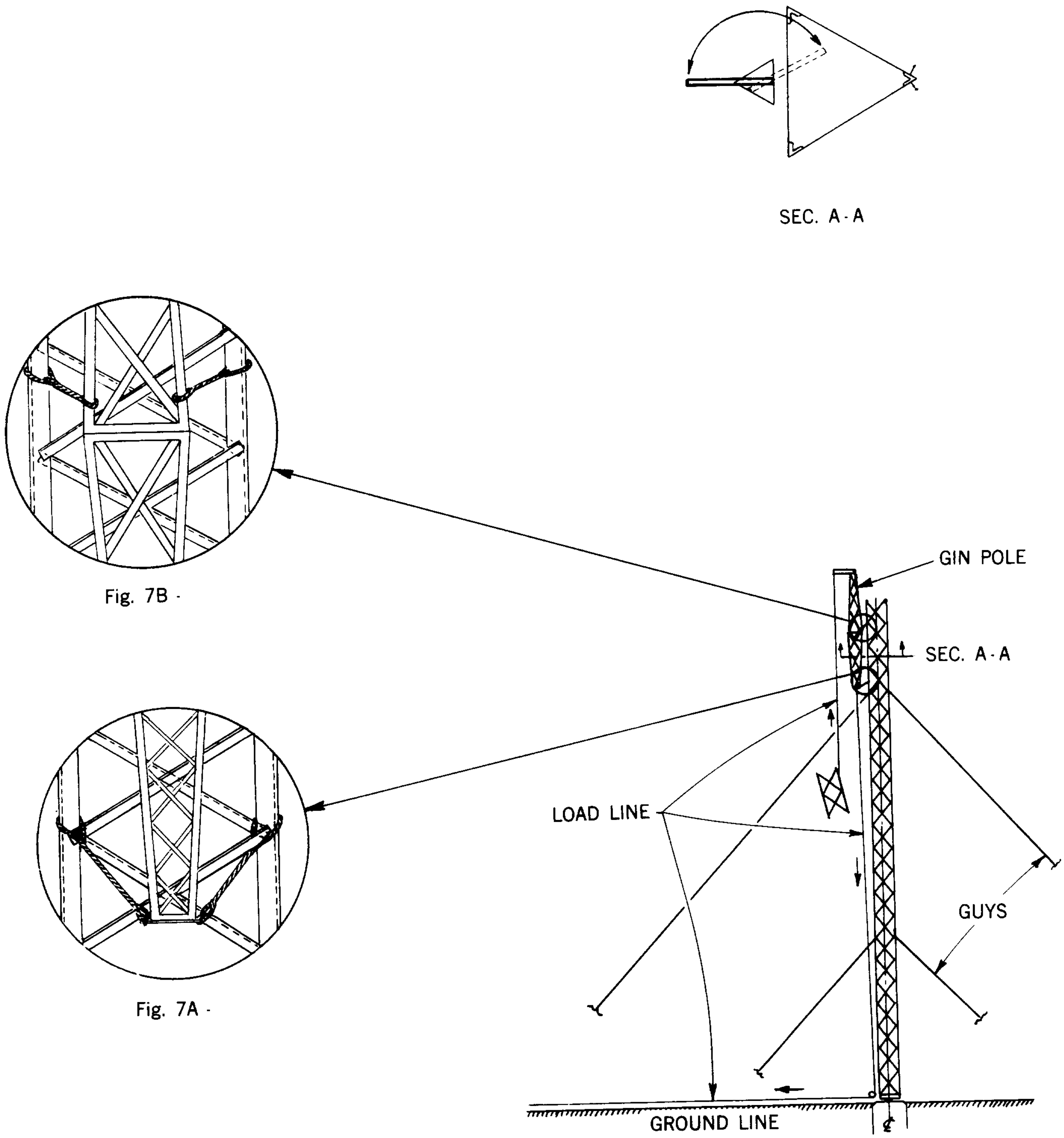


Fig. 7 – Typical Gin Pole Set-up for Hoisting Tower Sections

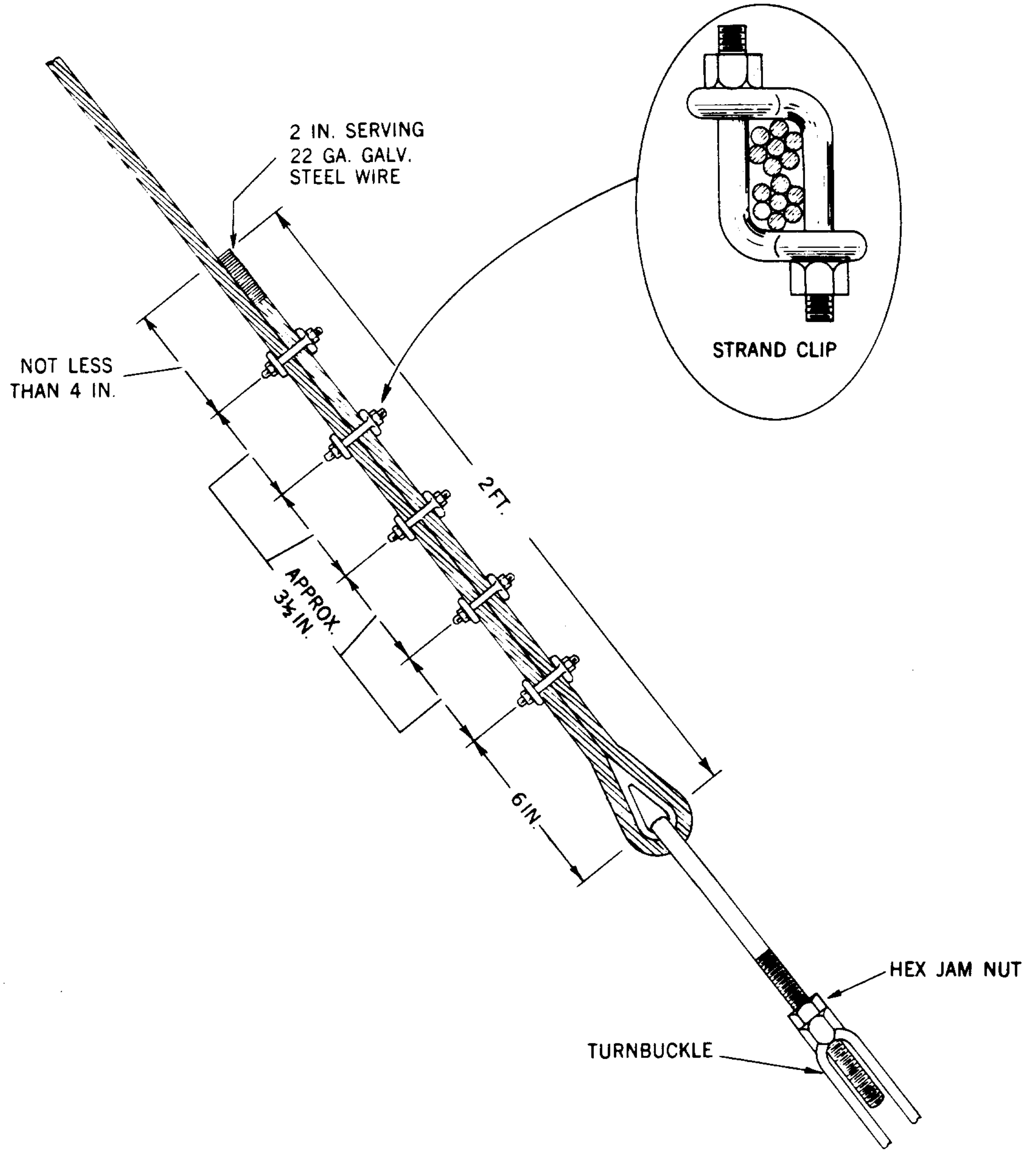


Fig. 8 – Lower End of Guy

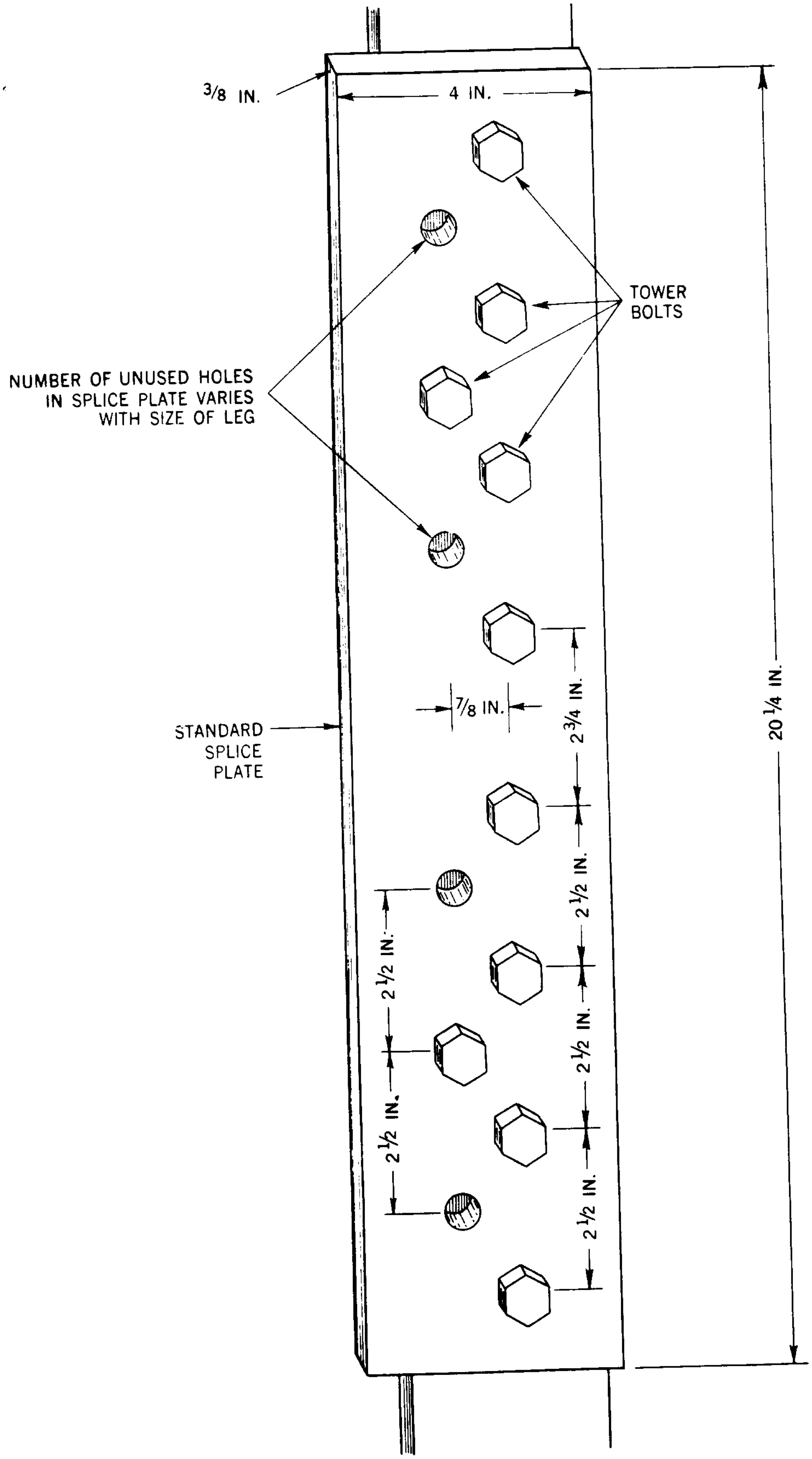


Fig. 9 – Standard Splice Plate

in leg members must contain bolts at splices. All top sections are made with 4 by 4 by 1/4-inch angles regardless of tower height. Details as to size of leg members in other parts of these towers are shown in Figs. 5 and 6.

5.17 Members which have been bent or buckled should be replaced. Occasionally it will be found that holes do not line up closely enough to permit bolting without drifting of holes. There is no objection to removing excess zinc (galvanizing) which may have unduly reduced hole size. Members which cannot be joined without further field fabrication should not be installed without checking dimensions to determine the nature of the mistake in fabrication. Members which are merely too long may be cut to proper length, ***provided distances between bolt holes are correct and edge distances will be correct after cutting.*** Grinding may be permitted in lieu of cutting; ***cutting by torch should not be allowed.***

5.18 Freshly cut surfaces, or any surface where galvanizing has been damaged should be painted immediately. The best protection is probably provided by the "Zinc-rich" type of paint. These paints are 90 per cent (or more) powdered zinc and will provide some galvanic protection in the same fashion as galvanizing. They also have the property of preventing rust creep under the paint film. They should not be applied to steel which is damp or wet, or coated with mud, oil, grease, mill scale, bird droppings, etc. Paint of this kind, to be effective, should not have a spreading rate exceeding 350 sq. ft./gallon. If this type of paint is not available, zinc oxide — zinc dust paint is an acceptable substitute. It should be applied over clean, dry metal and should conform to Federal Specification TT-P-641 Type I or Type II.

5.19 The tower has a series of 9/16-inch holes spaced 15 inches apart on alternate sides of one leg to accommodate step bolts, which provide access to the structure. All step bolts are to be installed with a plain washer, a hexagonal nut, and a palnut. Step bolts usually extend from the bottom of the tower to a point five feet above the grating platform in the top section, although they may be omitted in the bottom 8 feet to discourage unauthorized climbing. This precaution is, of course, unnecessary if the tower base is surrounded by a fence with a locked gate.

5.20 Each leg member has also been punched with three 9/16-inch holes in the same flange. Facing the tower, these holes will always be on the right-hand leg of the tower face, and are located 3 feet, 13 feet, and 18 feet, respectively, above horizontal bracing members of each panel, and have been provided to accommodate waveguide restrainers. These holes will normally be left unfilled unless waveguide is to be installed on the tower.

5.21 An extra hole is provided in each leg of the tower to accommodate a 6M safety strand (see Section 081-725-200). These holes are located 4 feet above the horizontal bracing members in all but the top panel. The strand is ordinarily used only at the level having side obstruction lights, and is intended to provide protection for workmen who may have occasion to service those lights.

5.22 A platform consisting of three pieces of steel grating (16" x 32") is provided at the lower end of the top section in all towers. Each piece of grating is fastened in place by four grating clips equipped with 3/8- by 1-3/4 inch bolts with nuts, washers, and palnuts. The general appearance of the platform is shown in Fig. 10.

5.23 Reflector backstays attach to an equilateral triangle formed by three 6-inch ship channels, each about 5 feet 8 inches long. They are joined together by means of six splice plates as shown in Fig. 11. The channels are fastened to the horizontal 5" by 3-1/2" by 3/8" angles (just above the last pair of diagonal braces) by six clip angles. Straight washers are required under the head of each bolt passing through the channel flanges.

6. GUY TENSIONS

6.01 Measurement of guy tensions should be undertaken only under relatively calm or windless conditions. Since ambient temperatures

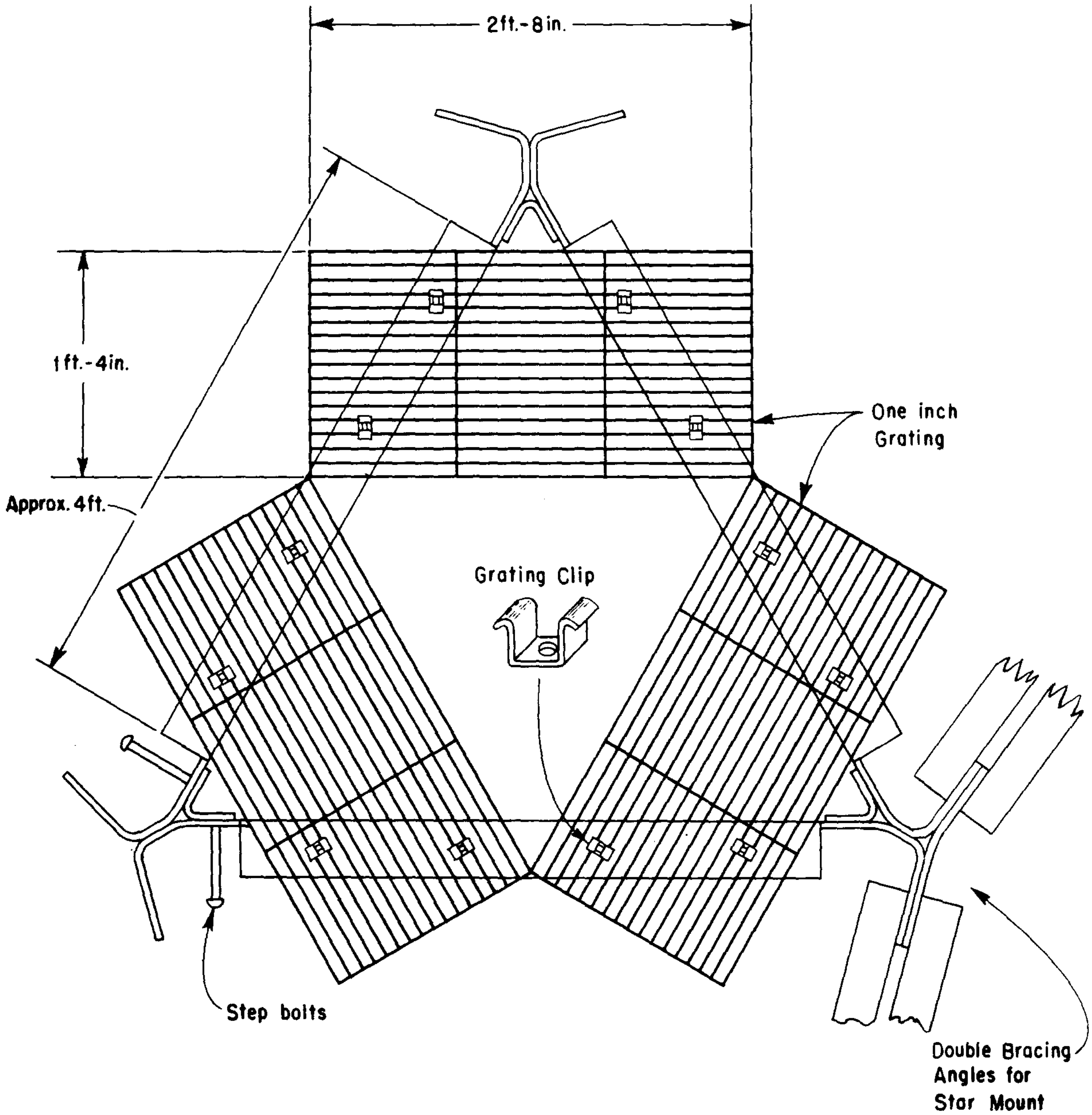


Fig. 10 – Tower Platform

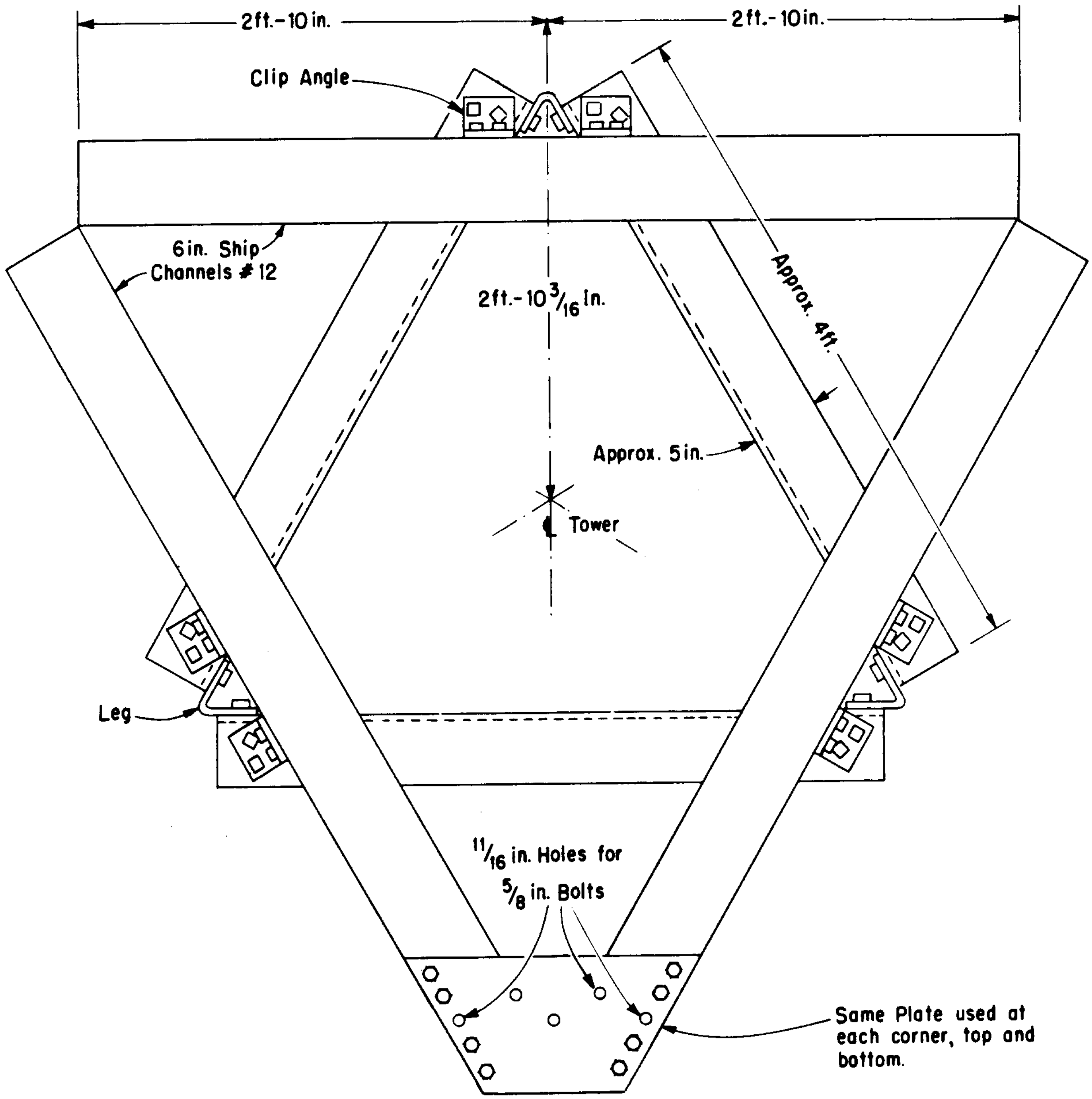


Fig. 11 – Triangular Brace for Attachment of Reflector Backstays

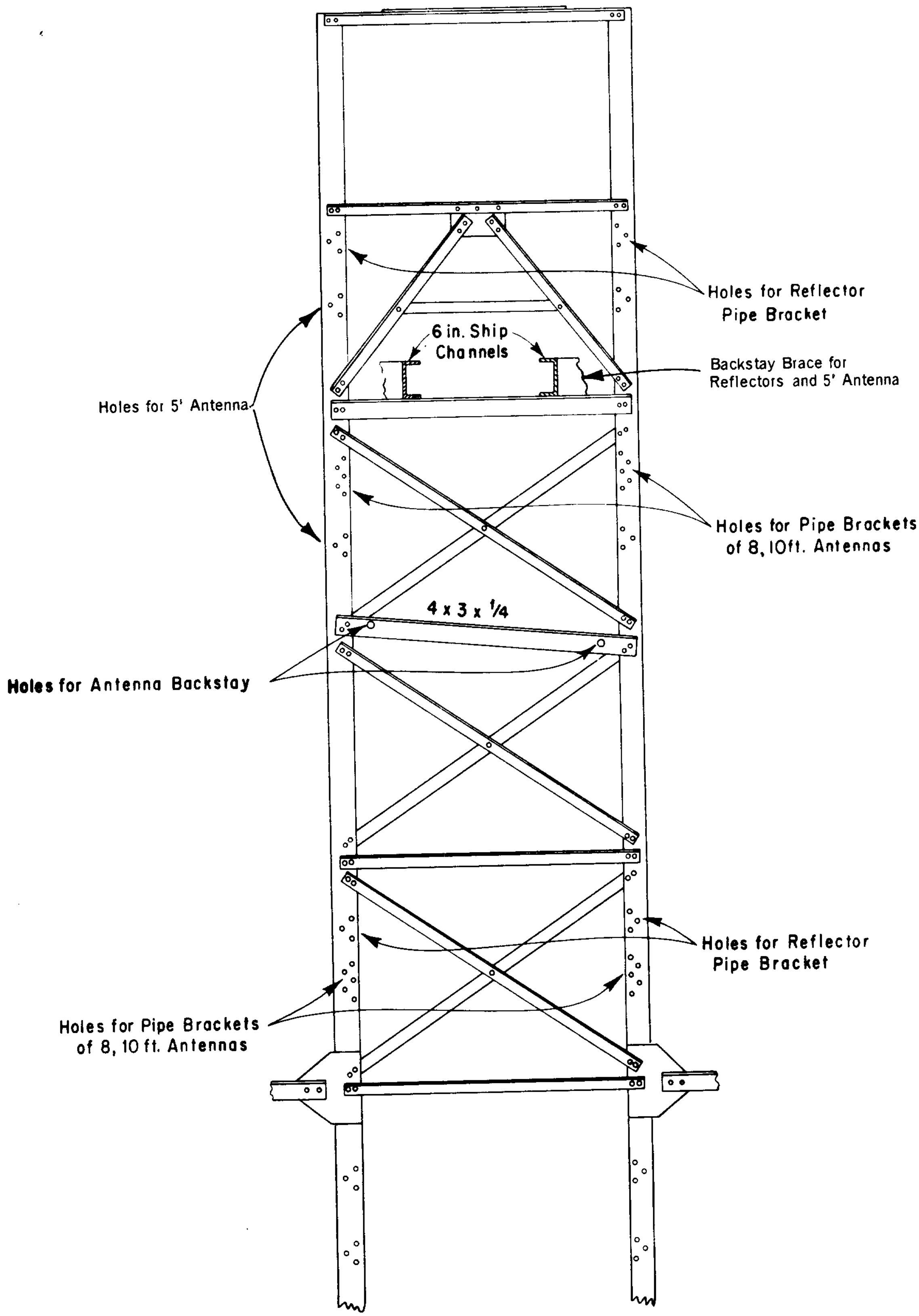


Fig. 12 – Locations for Antenna and Reflector Pipe Brackets

have an effect on tension, Tables 1 and 2 show the correct tension (T), and the corresponding time (S) for 20 oscillations at different temperatures for the 2 sizes of guys. Tensions should be set within ±5% of the specified values.

6.02 It may be desirable to use a greater number of oscillations to improve the accuracy of measurements. This may be done by adjusting the indicated time in proportion to the oscillations (e.g., time for 30 oscillations would be 1-1/2 times the value for 20 oscillations).

6.03 The formula for determining the elapsed time for any number of oscillations for any length of guy of any material at any tension is:

$S = 0.352\ NL\sqrt{W/T}$

in which

S = time in seconds

N = number of oscillations

L = length of guy in feet

W = weight of guy in pounds per foot

T = tension of guy in pounds

Since the design tension is given, the formula for the time for a predetermined number of oscillations will reduce to:

$S = K\ L$

in which

S = time in seconds

K = a constant, $(0.352\ N\sqrt{W/T})$

L = length of guy in feet

Tables 1 and 2 also show the values of "K" for the specified tension at each temperature range. Table 3 shows the length of the oscillating section of the guy for each height of tower on level ground.

TABLE 1
TIME FOR 20 OSCILLATIONS IN SECONDS
9/16-INCH GUYS

			TOWER HEIGHT (FT.)							
TEMP	**T**	**GUYS**	**300**	**280**	**260**	**240**	**220**	**200**	**180**	**K**
Below −10F	6300	Upper	28.5	26.5	24.5	22.5	20.5	18.5	16.5	.0707
		Middle	18.0	18.0	16.0	14.0	12.0	–	–	
		Lower	13.6	13.6	12.4	10.5	9.2	14.1	12.8	
−10° to +10F	5900	Upper	29.4	27.4	25.3	23.2	21.2	19.1	17.0	.0731
		Middle	18.6	18.6	16.6	14.5	12.4	–	–	
		Lower	14.1	14.1	12.8	10.8	9.5	14.5	13.2	
+10° to 30F	5500	Upper	30.5	28.3	26.2	24.1	22.0	19.8	17.6	.0757
		Middle	19.3	19.3	17.2	15.0	12.9	–	–	
		Lower	14.6	14.6	13.2	11.2	9.8	15.0	13.7	
30° to 50F	5100	Upper	31.7	29.5	27.2	25.0	22.8	20.6	18.3	.0787
		Middle	20.1	20.1	17.8	15.6	13.4	–	–	
		Lower	15.2	15.2	13.8	11.6	10.2	15.7	14.2	
50° to 70F	4700	Upper	33.0	30.7	28.3	26.0	23.7	21.4	19.1	.0819
		Middle	21.0	21.0	18.6	16.2	13.9	–	–	
		Lower	15.8	15.8	14.3	12.1	10.6	16.3	14.8	
70° to 90F	4300	Upper	34.5	32.1	29.7	27.3	24.9	22.5	20.0	.0857
		Middle	21.8	21.8	19.5	17.0	14.6	–	–	
		Lower	16.5	16.5	15.0	12.7	11.1	17.0	15.5	
Above 90F	3900	Upper	36.2	33.7	31.1	28.6	26.0	23.6	20.9	.0899
		Middle	23.0	23.0	20.4	17.8	15.3	–	–	
		Lower	17.3	17.3	15.7	13.3	11.7	17.9	16.2	

TABLE 2

TIME FOR 20 OSCILLATIONS IN SECONDS

1/2-INCH GUYS

			TOWER HEIGHT (FT.)							
TEMP	**T**	**GUYS**	**160**	**140**	**K**	**T**	**120**	**100**	**80**	**K**
Below −10F	4060	Upper Middle Lower	16.0 – 12.1	13.8 – 10.7	.0784	3560	12.4 – 10.0	10.0 – 7.7	7.7 – –	.0837
−10° to +10F	3740	Upper Middle Lower	16.7 – 12.6	14.4 – 11.2	.0816	3240	13.1 – 10.4	10.5 – 8.1	8.1 – –	.0878
+10° to 30F	3420	Upper Middle Lower	17.5 – 13.2	15.1 – 11.7	.0855	2920	13.8 – 11.0	11.1 – 8.5	8.5 – –	.0925
30° to 50F	3100	Upper Middle Lower	18.4 – 13.9	15.9 – 12.3	.0898	2600	14.6 – 11.7	11.7 – 9.0	9.0 – –	.0980
50° to 70F	2780	Upper Middle Lower	19.4 – 14.7	16.7 – 12.9	.0947	2280	15.6 – 12.4	12.6 – 9.6	9.6 – –	.1046
70° to 90F	2460	Upper Middle Lower	20.6 – 15.6	17.8 – 13.8	.1007	1960	16.8 – 13.4	13.5 – 10.4	10.4 – –	.1128
Above 90F	2140	Upper Middle Lower	22.1 – 16.7	19.1 – 14.7	.1077	1640	18.3 – 14.7	14.8 – 11.3	11.3 – –	.1234

TABLE 3

APPROXIMATE LENGTH OF GUY IN OSCILLATION — LEVEL GROUND

TOWER HEIGHT (ft)	TOP GUYS (ft)	BOTTOM GUYS (ft)	MIDDLE GUYS (ft)
80	92	–	–
100	120	92	–
120	149	119	–
140	177	137	–
160	205	155	–
180	233	181	–
200	262	199	–
220	290	130	170
240	318	148	198
260	346	175	227
280	375	193	255
300	403	193	255

6.04 If there is a difference in ground elevation between the location of the pier and the anchors, the length of the oscillating section will be different than the values shown in Table 3, and the periods shown in Tables 1 and 2 will not apply. In the case of top and middle guys, each foot of elevation difference will cause a difference of 1.41 feet in the length of the guy. In the case of bottom guys, each foot of difference in elevation will cause approximately 1.1-foot difference in the length of guy. The lengths shown in Table 3 should be increased if the ground line at the anchor location is lower than the ground line at the base pier, and decreased if the ground line at the anchor is located above the ground line at the base pier. The length of oscillating section, as adjusted for difference in elevation, should then be multiplied by the "K" factor (corresponding to the height of tower and temperature involved) to obtain the time "S" for 20 oscillations.

6.05 The tower should be checked to see that it is plumb after the correct guy tensions have been reached. Observations for plumbness should preferably be made with the aid of a transit. The tower should not deviate from vertical by more than its total height divided by 720. The maximum allowable deviation between guy points is obtained by dividing the distance between the two guy points by 720. Section AG25.300 discusses procedures for observing tower plumb and bow.

6.06 After the tower has been plumbed and the correct guy tensions have been set, the jam nuts of the turnbuckles should be tightened. As a further means of discouraging tampering, turnbuckles at any anchor may be locked together by a loop of strand. This precaution may be omitted if the anchors are enclosed by fences with locked gates.