B SELF-SUPPORTING TOWERS
ERECTION

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1. GENERAL

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

1.02 This section is reissued to add general information regarding tower erection methods. 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 assure 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 AG25.260.

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.

2.03 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.

2.04 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 tower erectors are equipped with temporary warning lights for use during erection but it is advisable to notify the erector if temporary lighting will be required, and also whether it will be one-, two-, or three-level.

2.05 Section AG25.260 provides information on foundations and anchors for B Self-Supporting 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.)

2.06 The grounding system of each pier should be completed and should be readily accessible. Installation of the grounding system is described in Section AG25.260.

2.07 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.

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

2.09 Foundations should be carefully checked to ensure they are located correctly, are of the right size, and include all specified reinforcing steel and anchor bolts. Details of layout are covered in Section AG25.260.

2.10 Installation of a talking circuit on the tower to facilitate adjustment of antennas or 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 "walkie-talkie" radio, if this equipment is available. This equipment may also be of value during tower erection.

2.11 If the Tower Ladder Safety Device is to be installed, the carrier rail and its associated rung clamps and studs should be on hand.

2.12 If the base shoes are leveled, and the tower is fabricated properly and erected in accordance with good practices, the tower will not vary from vertical to any appreciable degree. In any case, the tower should not deviate from vertical by more than its total height in feet divided by 720. Methods for observing vertical alignment are outlined in Section AG25.300.

3. INSTALLATION OF BASE SHOES

3.01 The base shoes must be oriented on their individual piers so that the intersection of the vertical wing plates is nearest the outside corner of the pier. The line formed by the junction of the two wing plates should slope slightly toward the center of the tower.

3.02 Both the foundation surface and the base shoe should be cleaned of mud, grime, and other foreign matter. The foundation may be damp, but standing puddles or pools of water on its surface should be eliminated.

3.03 As shown in Fig. 1, each base shoe should be set on four steel wedges located about midway between the anchor bolts. The four base shoes should be set so that they are level one with the other within 1/4-inch. If this is not done, the tower will be extremely difficult (if not impossible) to assemble.

Wedges should be positioned so that the base shoe is about one inch above the surface of the foundation. The shoe should be leveled in two directions with a spirit level, and the nuts on the anchor bolts tightened. Leveling should be checked after the nuts have been tightened, and if necessary the wedges should be adjusted to relevel the shoe. After the nuts are tightened, the wedges should provide a clearance of 3/4- to 1-1/4 inches for grout between the base shoe and the top of the pier.

3.04 The base shoes of the Self-Supporting Tower are grouted ***only after 30 feet or more of the tower has been erected.*** The grout should consist of one part portland cement (Type I or III) to two parts sand (by volume).

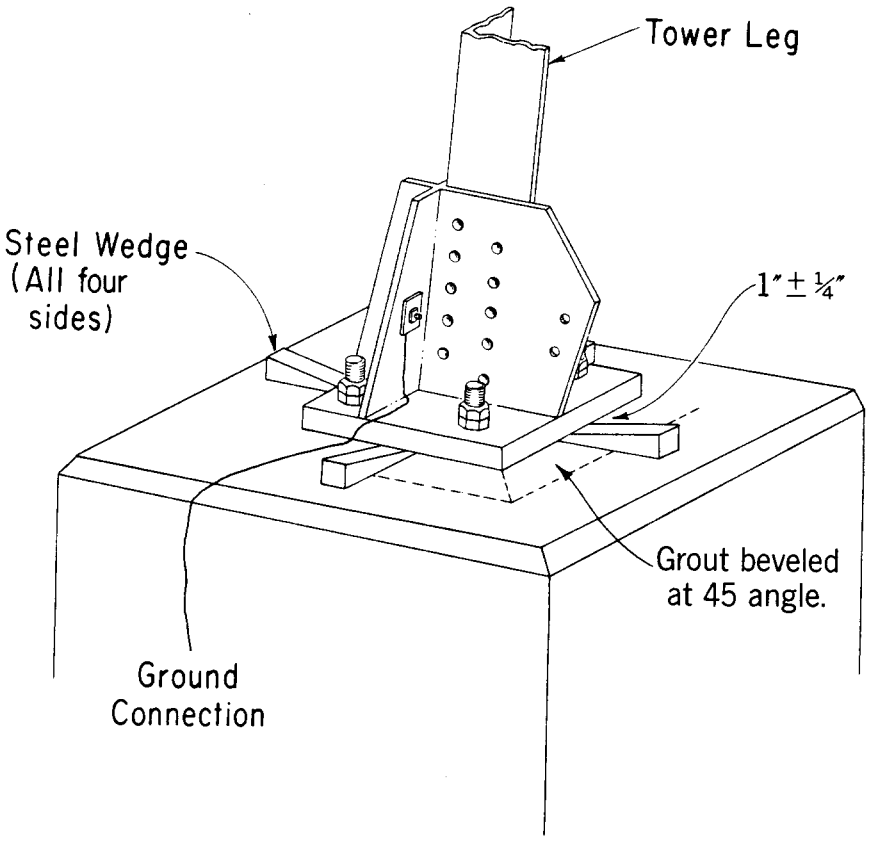

Fig. 1

Clean sand from a reliable supplier should be used. The sand and cement should be thoroughly mixed in a dry condition. Water should be added ***sparingly*** so that the mixture retains a granular appearance and shall not become so wet as to resemble plastic mortar. Water must be clear and fit for drinking. The final mixture shall form a lump when squeezed in the hand and upon being disturbed shall crumble freely. Water is deliberately kept to a minimum to obtain high compressive strength.

3.05 Grout should be forced under the shoe from all four sides, completely filling all voids. Next the nuts of the anchor bolts may be loosened and the wedges carefully withdrawn. The nuts should be carefully retightened and the voids left by the wedges filled. The grout should be beveled as illustrated in Fig. 1.

4. ERECTION CONSIDERATIONS

4.01 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, 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.

4.02 The particular procedure used in erecting towers will vary among contractors. Usually, after the base shoes have been leveled and the anchor nuts tightened, the four lower leg sections are installed. The associated horizontal and diagonal bracing is installed on two opposite

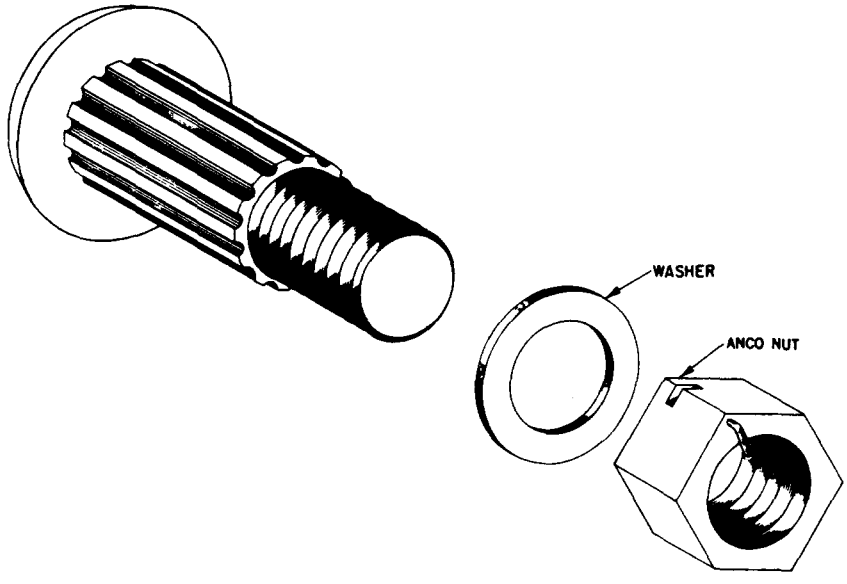

Fig. 2 – Structural Rib Bolt Assembly

faces of the tower (Fig. 3B, Faces A & C). The bracing in the other two faces (B & D) is not installed at this time, to avoid interference with the gin pole. The legs are held in place by a number of structural rib (drive) bolts. All rib bolts are to be equipped with flat washers and Anco Nuts (Fig. 2). Washers are employed to ensure that the nut can be turned up tightly without running into the ribbed part of the bolt, since some of the ribbed portion may extend out of the member. The ribs gouge into the sides of the hole into which they are driven, thus ensuring a snug fit and preventing rotation when the nuts are tightened. The underside of the bolt head should be in contact with the surface of the member involved. ***Care must be taken to avoid overdriving bolts.*** There should be no gap between the nut and the washer, or the washer and the adjacent surface of the member. All leg splices are to be made with structural rib bolts. ***Do not permit the use of machine or ordinary tower bolts or the reuse of rib bolts for this purpose.*** Some contractors may install bolts with the heads on the inside of the angle, so the nut will be exposed and more easily tightened.

4.03 A typical method of erecting self-supporting towers is illustrated in Fig. 3. Two cables are crossed on the ground, and their ends fastened to the foundation piers. The gin pole is laid through the center of the tower with its lower end resting on, and shackled to, the cables at their intersection (Fig. 3B). The use of the so-called "Black Diamond" (wooden) gin pole for erecting towers is not recommended.

4.04 The gin pole is set upright in the center of the tower, and temporarily guyed while the diagonal and horizontal bracing is installed on the remaining two faces of the tower. Four sets of blocks-and-tackles are employed to support the gin pole. One end of each set is fastened to the pole just above its center-point, with the other end fastened to a tower leg at the highest point at which all the bracing has been installed.

4.05 Components are usually laid out and assembled on two opposite sides of the tower. Two legs and their connecting bracing are assembled, and all bolts tightened. Splice plates are installed at the top of each leg, but the nuts and palnuts are not tightened at that time.

4.06 The associated bracing to complete the third and fourth faces of the tower are attached to each assembled panel, but the nuts are not tightened.

4.07 The gin pole is tipped to one face by adjusting the block-and-tackle on each leg. The assembled panel is hoisted into position and

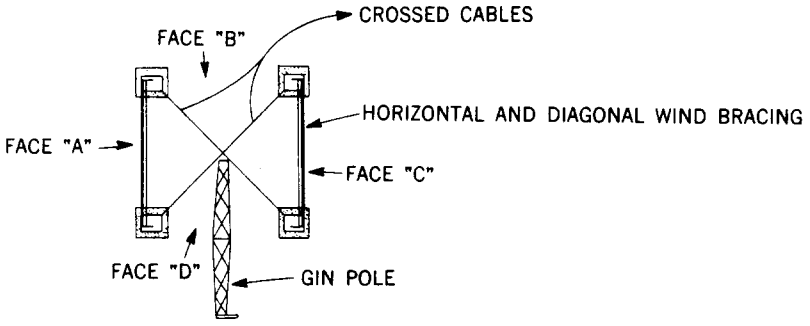

FIG. 3B PLAN VIEW

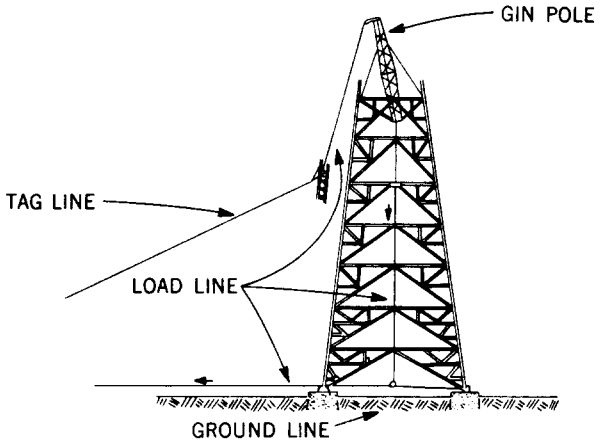

FIG. 3A
TYPICAL GIN POLE FOR HOISTING TOWER SECTIONS

Fig. 3 – Typical Construction Method

the splice plate nuts tightened. The gin pole is tipped to the opposite face, and the corresponding panel hoisted. The associated bracing for the remaining two faces is swung across, and bolted in position.

4.08 After all associated horizontal and diagonal bracing has been installed, and all nuts tightened, the gin pole is "jumped" to its next higher position. It is usually set so as to allow about 2 feet of "headroom" when sections are hoisted.

4.09 The lower end of the gin pole is cradled by (and shackled to) cables which are attached to diagonally opposite legs at a point where all bracing has been installed. It is common practice that as soon as the lower end of the gin pole clears a point at which interior bracing is required, that bracing is installed. The set of cables crossed on the ground is usually left in place, with the load line snatch block shackled to their intersection.

4.10 Unbraced legs or assembled panels ***should not be left "freestanding".*** If time will not allow all associated bracing to be installed, sections should not be hoisted into position on the structure.

4.11 There are, of course, other satisfactory construction methods, 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.

4.12 All bolted connections in the tower, except leg splices, are made with 5/8-inch high-strength tower bolts. The number of bolts in each

connection is indicated on the erection drawings. A typical bolt assembly is shown in Fig. 4. Bolt heads should be drawn snugly against the surface of the member they pass through. Bolts of lower strength than specified should not be substituted ***under any conditions.*** The plain washer shown ensures that the service nut can be fully tightened without running into the unthreaded part of the bolt. The service nut should be installed with the chamfered side against the washer, not against the palnut. The palnut is provided as insurance against vibration loosening the service nut. Tower bolts are usually installed with the head on the inner side of vertical members, and on the lower side of horizontal members.

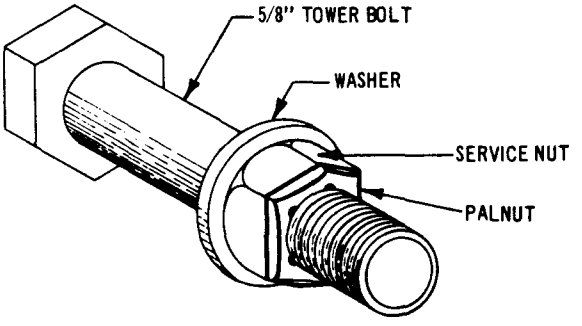

Fig. 4 – Typical Bolt Assembly

4.13 Installation of the first level of internal bracing provides a check on both the accuracy of fabrication and alignment of the foundation piers and anchor bolts. Figs. 5 and 6 illustrate three types of internal bracing which are used in the B Self-Supporting Tower. Internal bracing in the horizontal plane is all that is required to determine whether the tower can be trued up. Erectors vary somewhat in their procedure as to just when they start installing internal bracing. In general, it seems desirable to install the first level of internal bracing as soon as possible.

4.14 For either type of bracing shown in Fig. 5, some difficulty will usually be experienced in installing the second diagonal or completing the square formed by joining the midpoints of the sides. The tower cross section tends to "parallelogram" until the internal bracing is installed to square it up. Some forcing is to be expected, but deformation of members (buckling or bending) should not be permitted. Usually the square or the "x" can be completed without too much difficulty by adjusting the position of the steel wedges under the base shoes.

4.15 Errors in fabrication are rare, but they do occur. Sometimes such errors can be detected by comparing measurements of similar pieces (i.e., one leg vs an adjacent leg). These measurements should be checked against the fabrication drawings, which are included in the specification covering the manufacture of the tower. Each piece of steel (except nuts, bolts, etc) may be identified by its mark number.

4.16 Incorrect spacing of the foundation piers or differences in heights of piers can make it virtually impossible to erect the tower. These dimensions should be checked carefully before any tower components are modified or replaced because they cannot be installed without bending, reaming, etc.

4.17 Fig. 7 shows a butt leg splice where there is no change of size of the leg angles. Note that the ends of leg members are not required to bear against each other. Some difficulty is occasionally experienced in making up these joints due to irregularities in galvanizing, or because of slight misalignment of holes. Another possible source of difficulty is insufficient chamfer of the outside corner at the splice angle. The reason for the chamfer is to provide clearance for the fillet on the inside of the leg angle. (Outside corners have an extremely small radius — perhaps 1/16-inch — see Fig. 8). Leg angles with an unusually generous fillet will, of course, produce the same effect as too little chamfer. The remedy is to grind the splice angle to obtain a greater chamfer. Occasionally, it will be found that holes do not line up closely enough to permit full bolting without drifting of holes. There is no objection to removing excess zinc (galvanizing) which may unduly reduce hole size, but generally, ***reaming of holes is undesirable.*** Members which cannot be joined without further field fabrication should not be installed without checking dimensions against shop drawings 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***

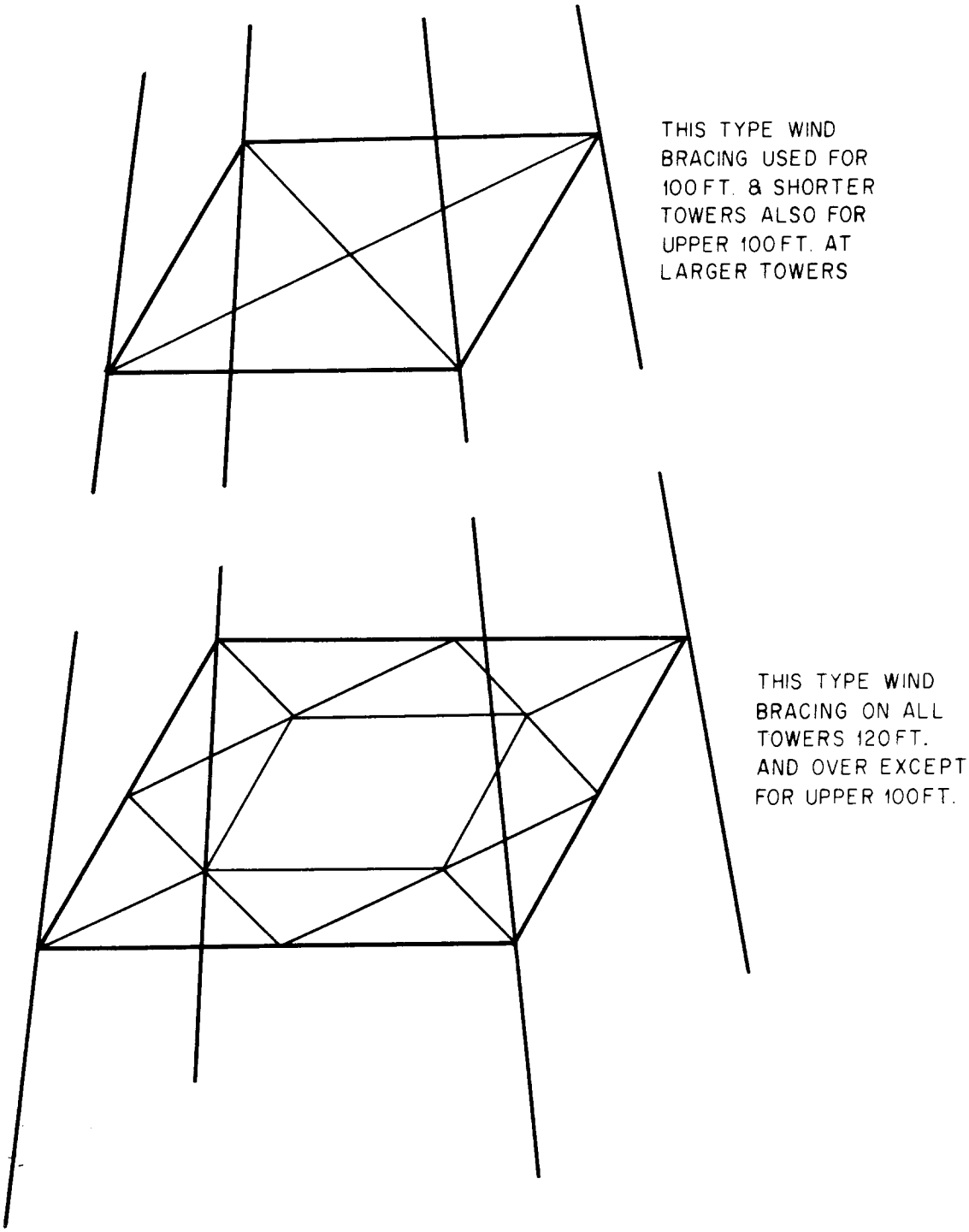

Fig. 5 – Types of Internal Bracing

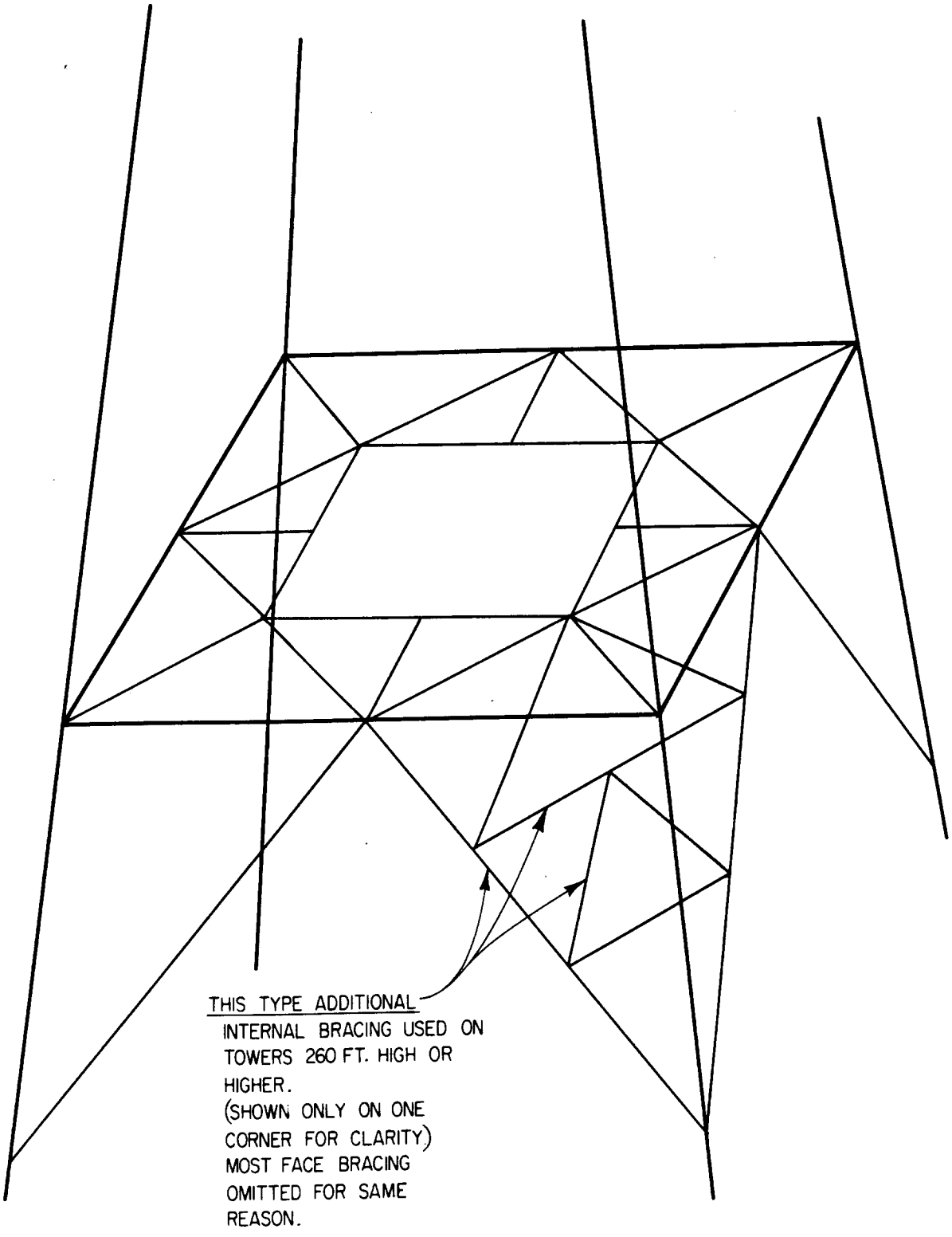

Fig. 6 – Types of Internal Bracing

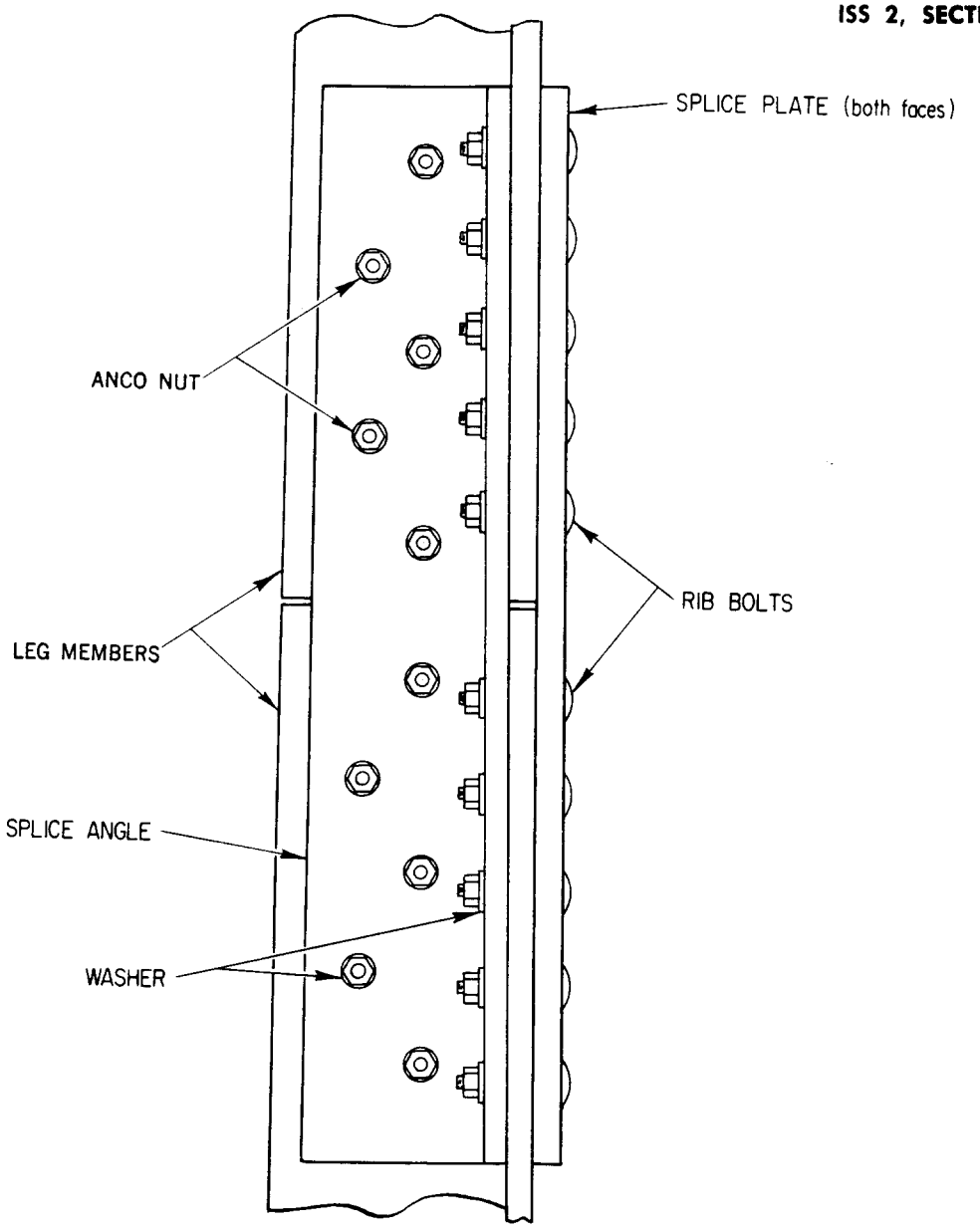

Fig. 7 – Typical Butt Splice

will be correct after cutting. Grinding may be permitted in lieu of cutting; ***cutting by a torch should not be allowed.***

4.18 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 have a coverage rate not exceeding 350 sq. ft/gallon. If this type of paint is not available, zinc oxide — zinc dust paint is an acceptable substitute. It must be applied over clean dry metal and should conform to Federal Specification TT P 641Type I or Type II.

4.19 To obtain economies in fabrication and erection, leg angle sizes are gradually decreased in size from bottom to top. Changes in

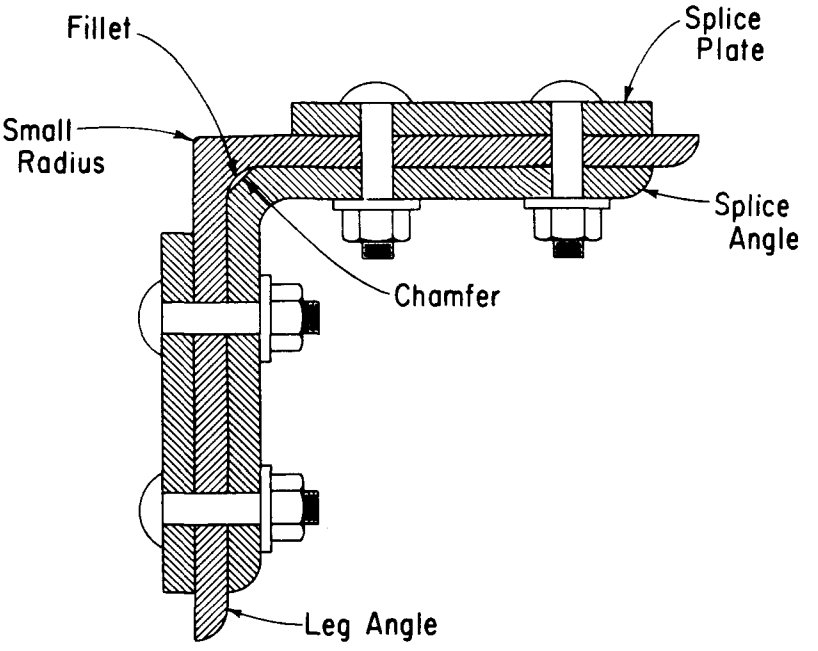

Fig. 8

leg sizes affect both width and thickness. The latter produces a problem at splices which is solved by the use of filler plates (Fig. 9). Note that the filler plate is fastened to the thinner angle by one bolt which does not pass through the splice plate and angle.

4.20 Not all splices are butt splices, however. All towers over 180 feet high contain one set of lap splices which occur approximately 180 feet down from the top of the tower. At this point the leg size changes from 6- by 6- by 5/8-in. to 8- by 8- by ½-in. The lap splice puts the smaller angle inside the larger, and the outside of the smaller angle is chamfered for the same reason as the splice angles used at butt splices.

4.21 Details of hoisting are, in general, best left to the contractor. However, it may be worthwhile to caution the contractor on one possibility, in the event he has not erected a B Self-Supporting Tower previously. All sizes of towers employ X bracing on the faces; towers over 120 feet high also employ K bracing. Both types of bracing are illustrated in Fig. 10. K bracing, of course, becomes fairly elaborate as the distance between leg members becomes greater. Caution must be exercised, to avoid buckling of the bracing during hoisting (Fig. 11). There are methods other than the one shown in Fig. 11 which are equally satisfactory, but the erector should be cautioned against using a single hitch around the top X brace, as this will cause buckling. ***MEMBERS WHICH HAVE BEEN BENT OR BUCKLED SHOULD BE REPLACED.***

4.22 The top section of the tower is considerably narrower than the other sections. Because of this, and the short length of the top level of X bracing, objectionable bending would occur at the point of crossover where these opposing braces are bolted together. One brace is bolted to the outside of the legs; the other must be bolted to the inside. At the point of crossing, the two are separated by the thickness of the legs (3/8-inch), so a 3/8-inch ring fill must be inserted between the two braces to prevent bending which would otherwise occur. All X braces must be bolted together at the point of crossover.

4.23 Access to the tower is provided by step bolts, each of which is designed to support 500 lbs. (Fig. 12). This step bolt is attached to the tower leg by a single 5/8-inch bolt. Rota-

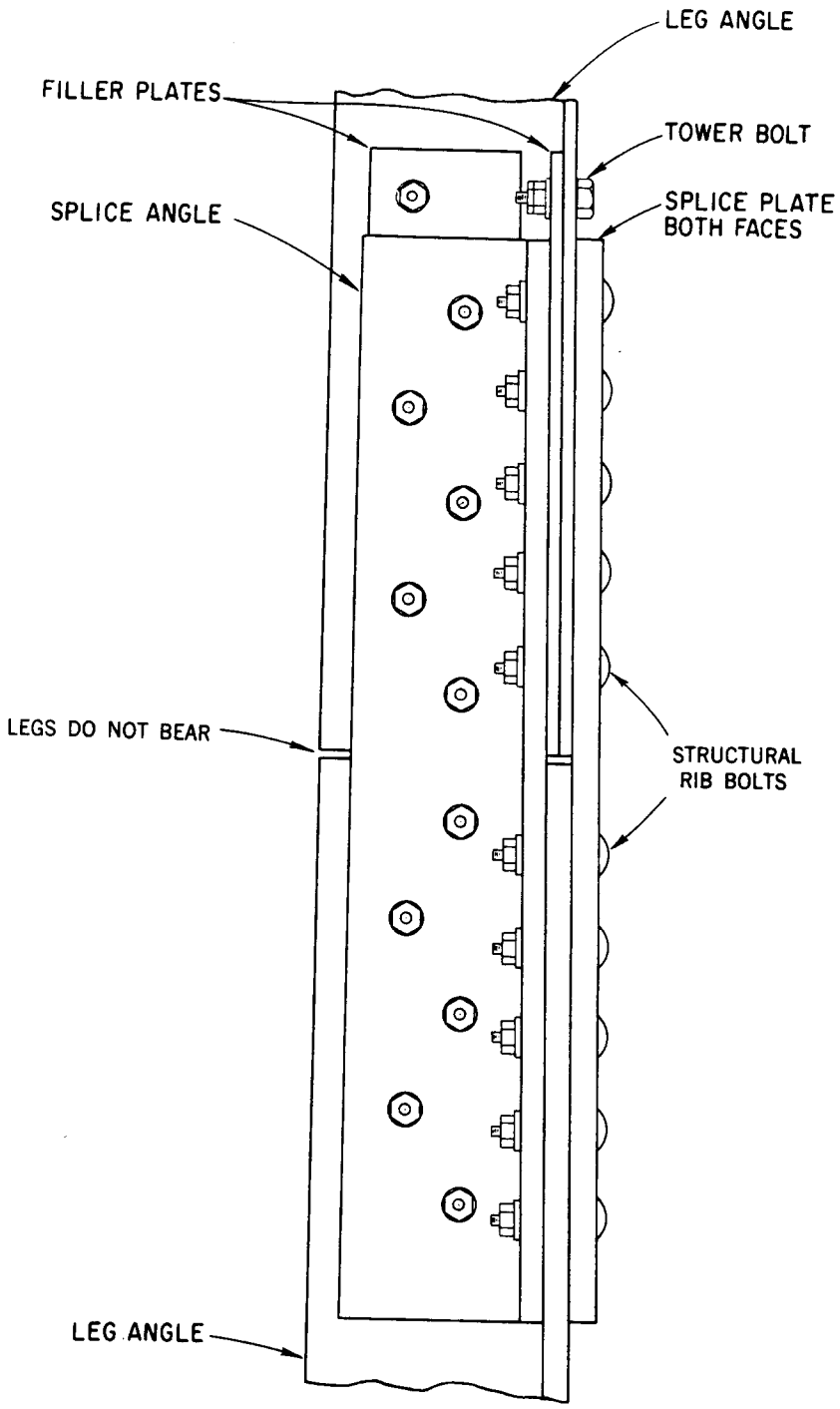
LEG ANGLE
FILLER PLATES
TOWER BOLT
SPLICE ANGLE
SPLICE PLATE
BOTH FACES
LEGS DO NOT BEAR
STRUCTURAL
RIB BOLTS
LEG ANGLE

Fig. 9

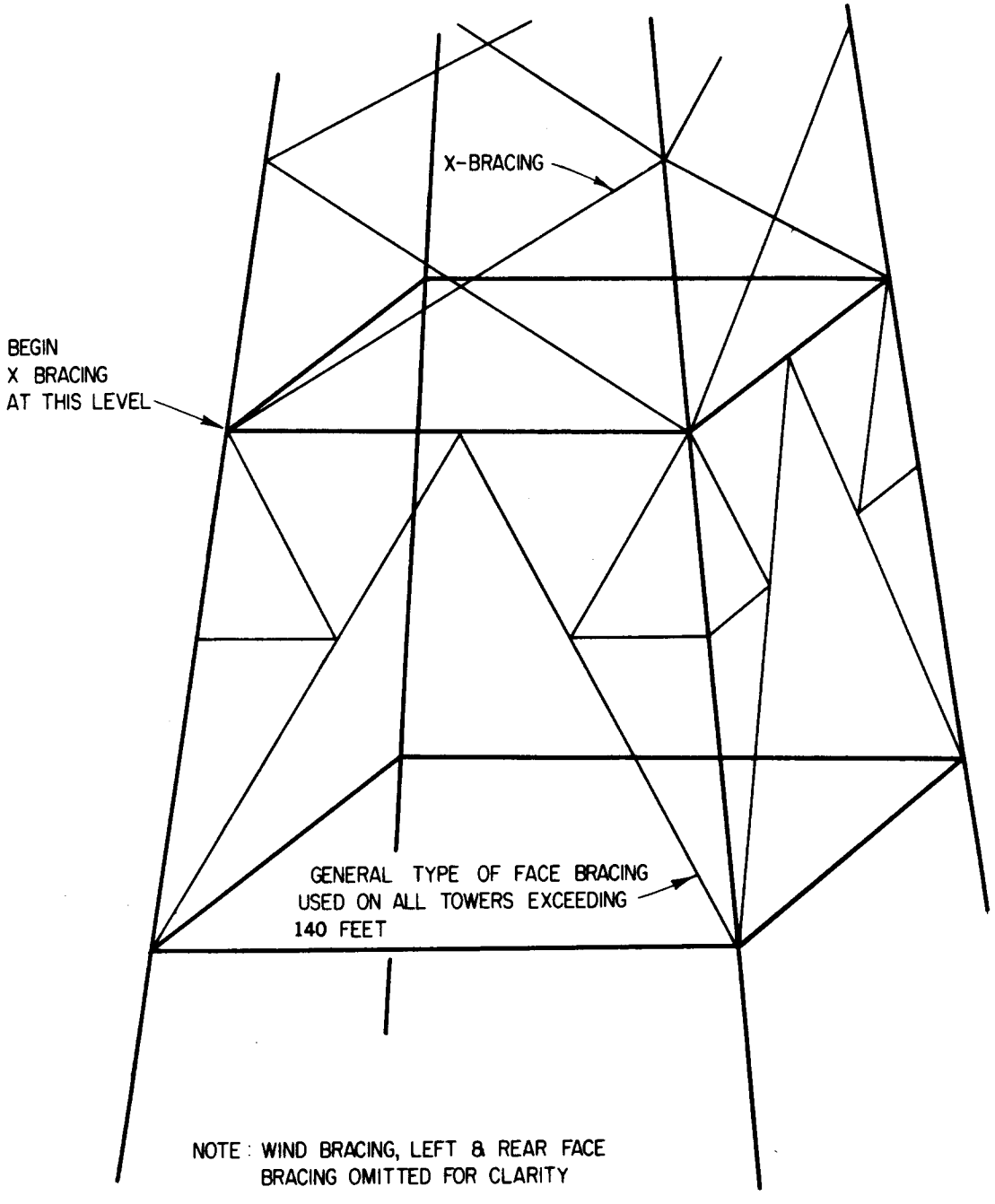

Fig. 10 – Types of Face Bracing

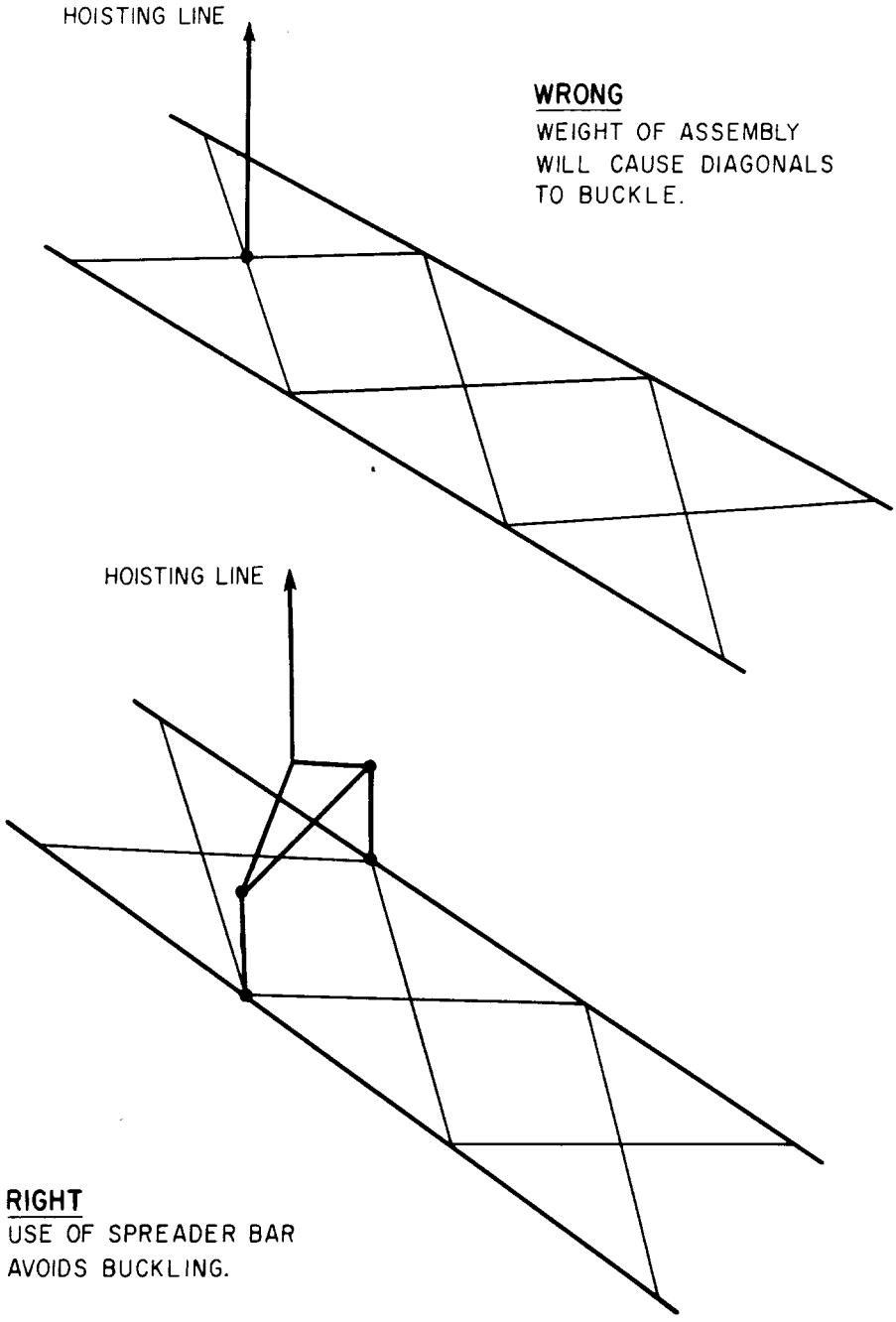
HOISTING LINE
WRONG
WEIGHT OF ASSEMBLY WILL CAUSE DIAGONALS TO BUCKLE.
HOISTING LINE
RIGHT
USE OF SPREADER BAR AVOIDS BUCKLING.

Fig. 11

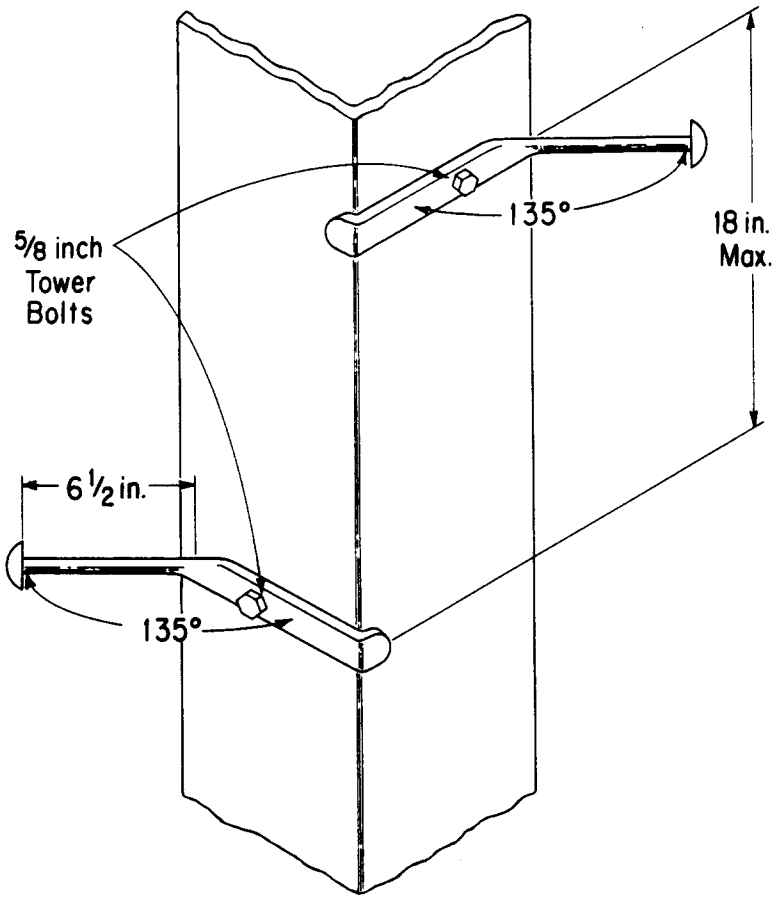

Fig. 12

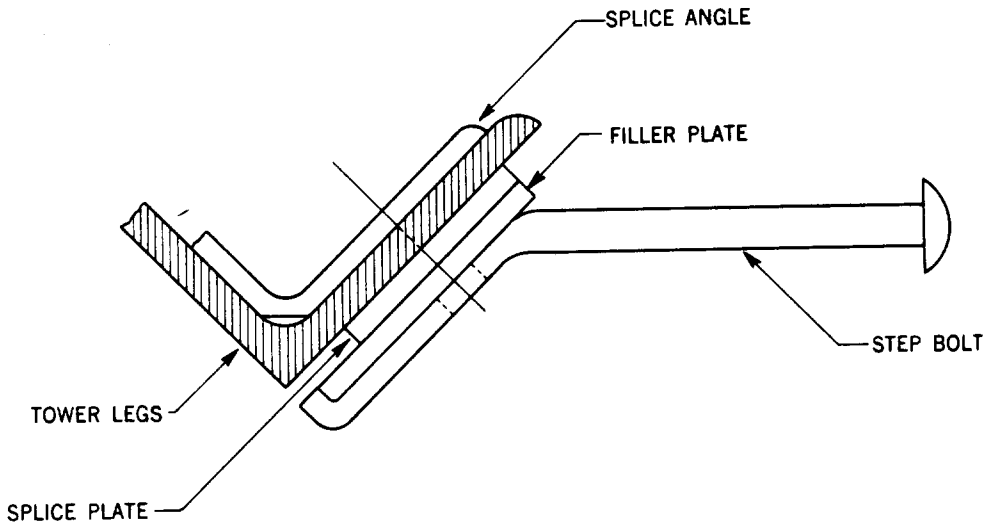

Fig. 13 – Typical Step Bolt at Leg Splice

tion is prevented by the right-angle bend which engages the outer corner of the leg angle. The 135-degree bend in the step results in alternate steps being in the same plane when mounted on a 90-degree angle iron, as opposed to the conventional straight steps, which would be at right angles. Occasionally, a step falls at a leg splice, and since a splice plate is not of sufficient size to provide restraint for the step, a filler plate must be placed on the outside of the splice plate at these points. The filler plate shall be attached by not less than two splice bolts. Filler plates and extra length bolts are provided as required. (Fig. 13). There are no holes for step bolts in the lower 8 feet of the tower, to provide some deterrent against unauthorized climbing.

4.24 Except for the lower 8 feet, step bolts are located on one leg of the tower in all but the upper 25 feet of the top section. The presence of the rings for mounting antennas and reflectors (as well as the antennas themselves) makes it impractical to continue the step bolts on the tower leg, so a ladder angle has been provided inside the tower to allow access to the top. The ladder angle is equipped with the same type of step bolts, and extends to the top of the tower. It is attached to the tower by means of clip angles at the top, middle, and bottom. A grating platform is provided at the bottom of the ladder angle to facilitate transferring from the ladder angle to the stepped leg, and vice versa. In recent production, a vertical handrail has been provided on the right side of the tower leg above the platform. This handrail replaces the two step bolts formerly provided which caused some interference in transferring at the platform. Since it is not practical to step over to the platform from the left side of the leg, the step bolts on that side of the tower should be left in place.

4.25 All 160 foot and higher towers may be equipped with a safety strand at the level of the side obstruction lights (assuming two-level lighting). The strand may be standard 6M, such as is used in pole line work. It should have a tension of about 500-600 lbs. (not critical). Towers of 160, 180 and 200 feet have three holes provided for attaching the strand to the stepped leg and the two adjacent legs. These holes are located 4 feet above the first (lowest) horizontal brace in the X braced part of the tower (about 90 feet from the top). For 220- and 240-foot towers, this location is 30 feet lower, or 4 feet above the horizontal brace at the top of the K braced part of the tower. For 260- to 300-foot towers, this location is 4 feet above the next lower horizontal brace. Section 081-725-200 provides instructions as to the manner of using the safety strand.