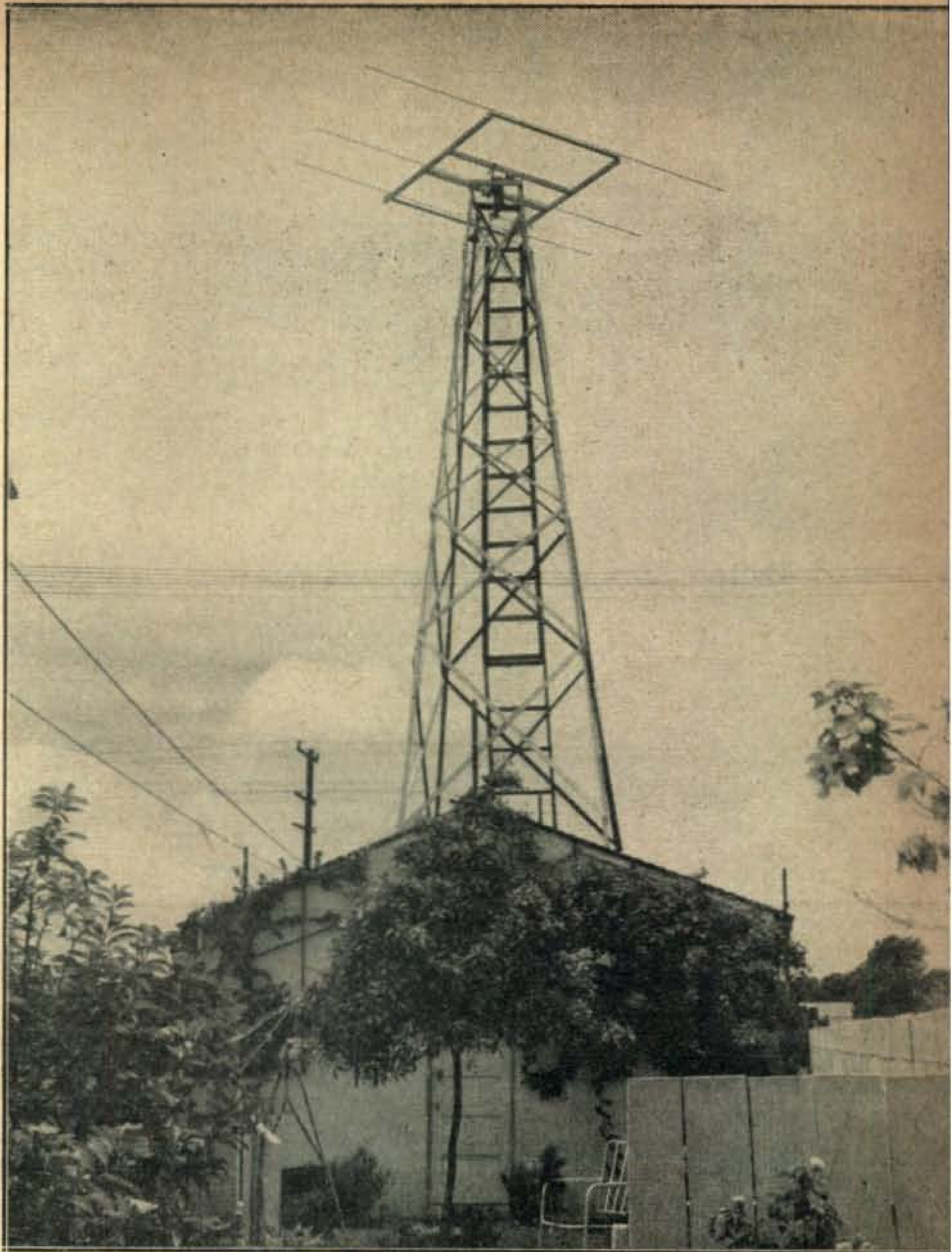
A. J. F. CLEMENT, W6KPC

Apt. 1, Bldg. 418, Palos Verdes Parkway, Redondo Beach, Calif.



Got a spare rooftop? Got a few spare hours and some lumber? Well then, add five or six men for a few minutes and you can throw up a tower just like this.

A 42-Foot Rooftop Tower

W6KPC describes a tower that should meet the requirements of many amateurs. Frank is an aircraft engineer, and his experience in solving wind-stress problems is evident in the tower's design—Editor.

The average suburbanite just cannot wheedle sufficient space away from the XYL for a decent antenna tower. Fortunately, the "wasted" space of a garage roof can support one. Furthermore, it will provide an average of twelve feet of height for nothing. *Figure 1* and the photograph depict a tower designed to meet these conditions. It has been widely duplicated in Southern California.

The tower itself is thirty feet high and is built of clear, knot-free Douglas Fir or Spruce. It is approximately eight feet square at the bottom and two feet square at the top. Each leg is anchored to the roof by means of a ⅜-inch, alloy-steel bolt through the roof joist. The spacing of the joists determines the exact dimensions of the base. Full-truss construction results in a tower that will withstand strong winds without guying. Finally, a ladder, plus the tower taper, makes it safe to climb, while being mounted on the roof discourages the neighborhood children from doing the climbing.

Construction

Figure 1 shows the overall construction of the tower and the materials required. *Figures 3* to *7* show detail.

Starting at the bottom, the angles for fastening the tower to the roof are detailed in *Fig. 3.* They are fastened to the legs with ¼-inch bolts fitted with washers under the bolt head and nut for increased surface area. The bolts through the leg at right angles to those fastening the angles reduce the possibility of the wood splitting.

Fasten the angle to the leg with only the center bolt at first. Later, when the tower is bolted in place on the roof, the remaining holes may be line drilled, and the other bolts inserted. This procedure allows a little leeway in truing up the tower.

Figure 4 shows the method of joining 2 X 4s and the 2 X 2s, to form the tower legs. Cut a slot, nine inches long, in one end of the 2 X 4's, wide enough to accommodate the ends of the 2 X 2s. Nail the 2 X 2s in place from each side. Next, bolt the steel reinforcing straps on the other sides, using four, ¼-inch bolts.

Figure 5 shows the construction of the structural angles, formed of 1 X 2s and used for the two lower X's in the tower. Two of them, back to back, form each X. The upper X's are simply 1 X 2s cut to length.

In *Fig. 6* we see the top construction, and have a birds-eye view of the method of anchoring the lower end of the beam drive shaft. (See *Fig. 7.*) The top of the tower is framed with 2 X 4s and covered with lengths of flat board nailed across them. In addition to pieces *J* and *K*, two lengths of 1 X 4 are nailed across the top beside the *K* pieces.

Figure 7 shows the rotating bearing system used here. Its main expedient is that it requires a minimum of machined parts. The outer housing is a piece of 1½ inch, galvanized, water pipe, about a foot long (exact length not important), with standard pipe flanges screwed on each end. Four holes, to accommodate ¼-inch bolts, are drilled equi-distant around the flanges. They are used to bolt the flanges to the top of the tower and to the metal straps that center the lower end of the bearing. These straps are lengths of 1 X $\frac{3}{16}$-inch steel that gives a ninety-degree twist, drilled, and bolted into position.

The drive shaft is a length of 1½-inch shafting, threaded on each end and fitted with standard semi-thrust ball bearings. The threads may be cut on a lathe or with an adjustable die.

These are the detail drawings for the construction of the rooftop tower. Figure 1 shows the side view and the bill of materials. Figure 3 shows the footing angles bent of 1 X ¼-inch steel. The bolts are ¼-inch in diameter. Figure 4 shows the method of joining 2 X 4's to 2 X 2's for the tower legs. Figure 5 shows the L pieces that are constructed for additional lower X bracing. Figure 6 and Figure 7 shows the details of the top of the tower and the top bearing. The bracket in Figure 7 shown by the dashed line is to support the selsyn motor, a part of the direction indicator.

A $\frac{3}{16}$-inch, stranded steel cable, running over a spring-loaded idler wheel and around a 3½-inch pulley on the drive shaft, turns the beam. Tension on the idler wheel is proportioned so that the beam slips under heavy wind gusts, in order to reduce the strain on the motor gears.

Erecting The Tower

My first plan was to construct the tower on the ground and hoist it into place on the garage roof. This plan was quickly abandoned upon ascertaining the cost of renting the services of a crane and an operator. Considerable further thought developed the following plan.

Two sides of the tower were fabricated on the ground. They were then rested on the eaves of the garage, as sketched in *Fig. 2.* Next, the tops were joined loosely together, exactly two feet apart, by means of two pieces of 1 X 4 and 10-32 bolts. Four men stationed on the roof, one at each tower leg, then lifted the tower sides, hand-over-hand to the roof and walked them to the pre-drilled holes in the roof.

Each man dropped a ⅜-inch, alloy-steel bolt through the holes in the mounting angles and the

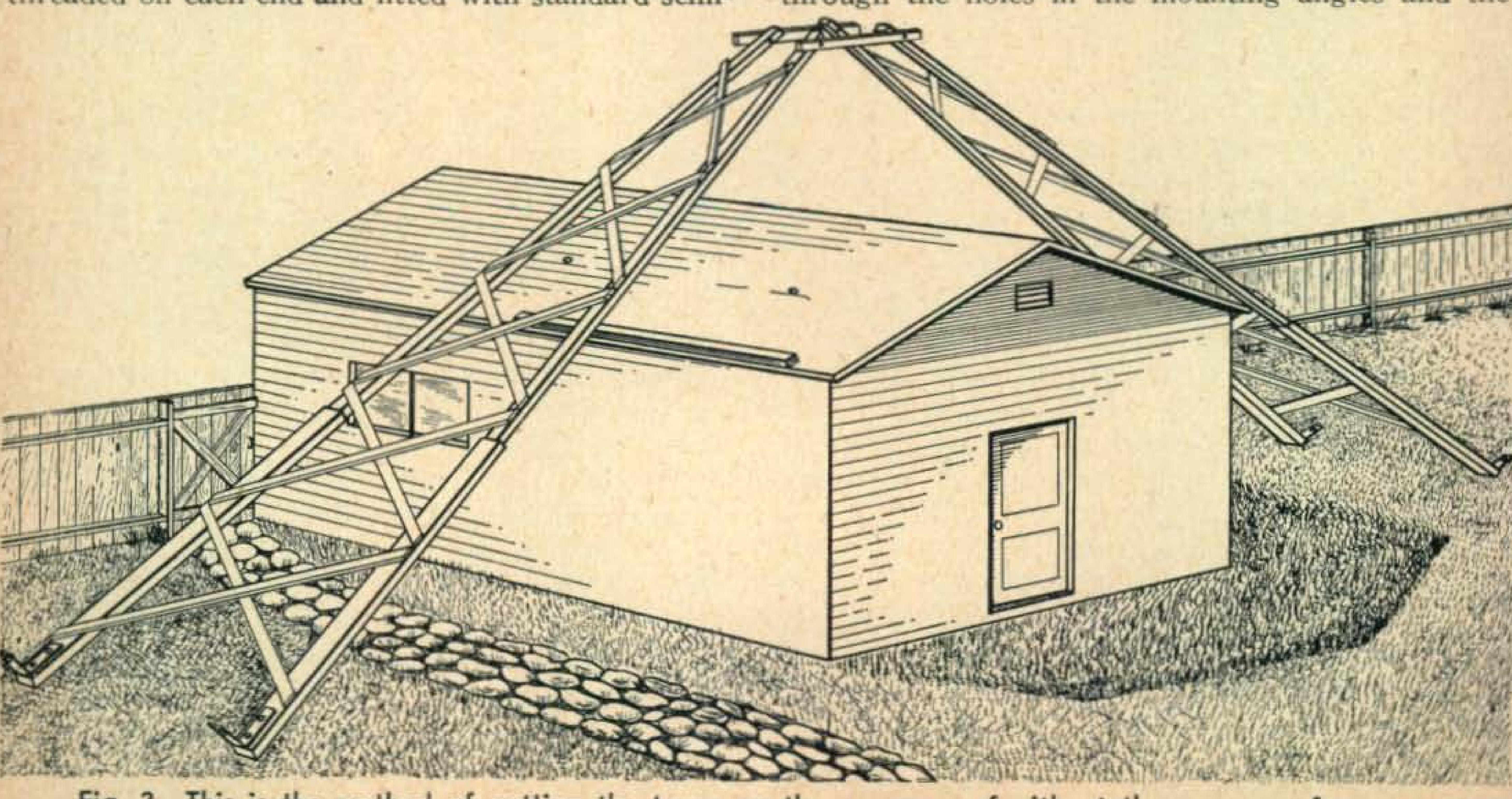


Fig. 2. This is the method of getting the tower on the garage roof without the expense of a crane operator. Have men stationed on the roof at each of the legs. They then hand-over-hand raise the tower and "walk" it into position where the bolts may be dropped into pre-drilled holes.

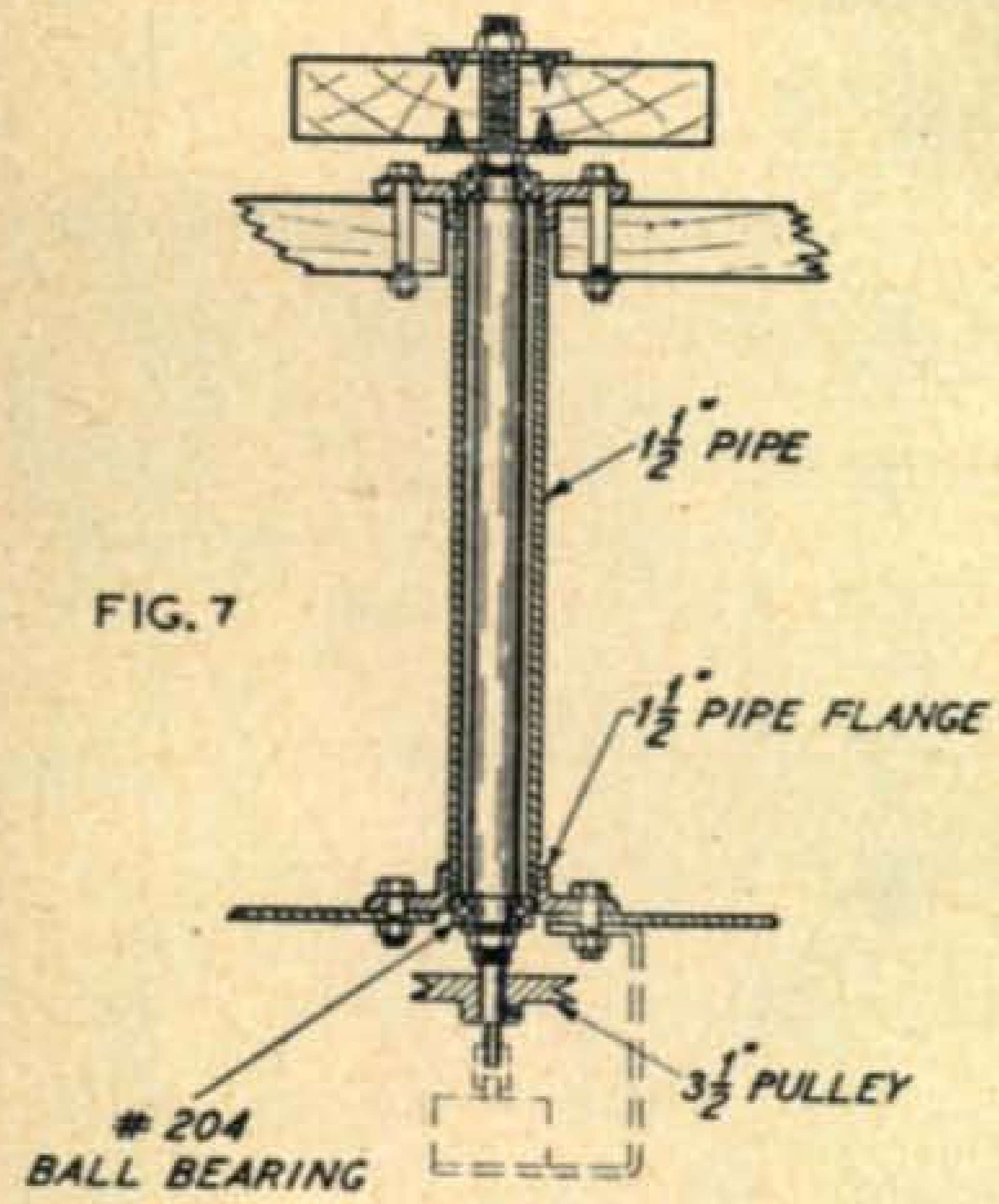


FIG. 7

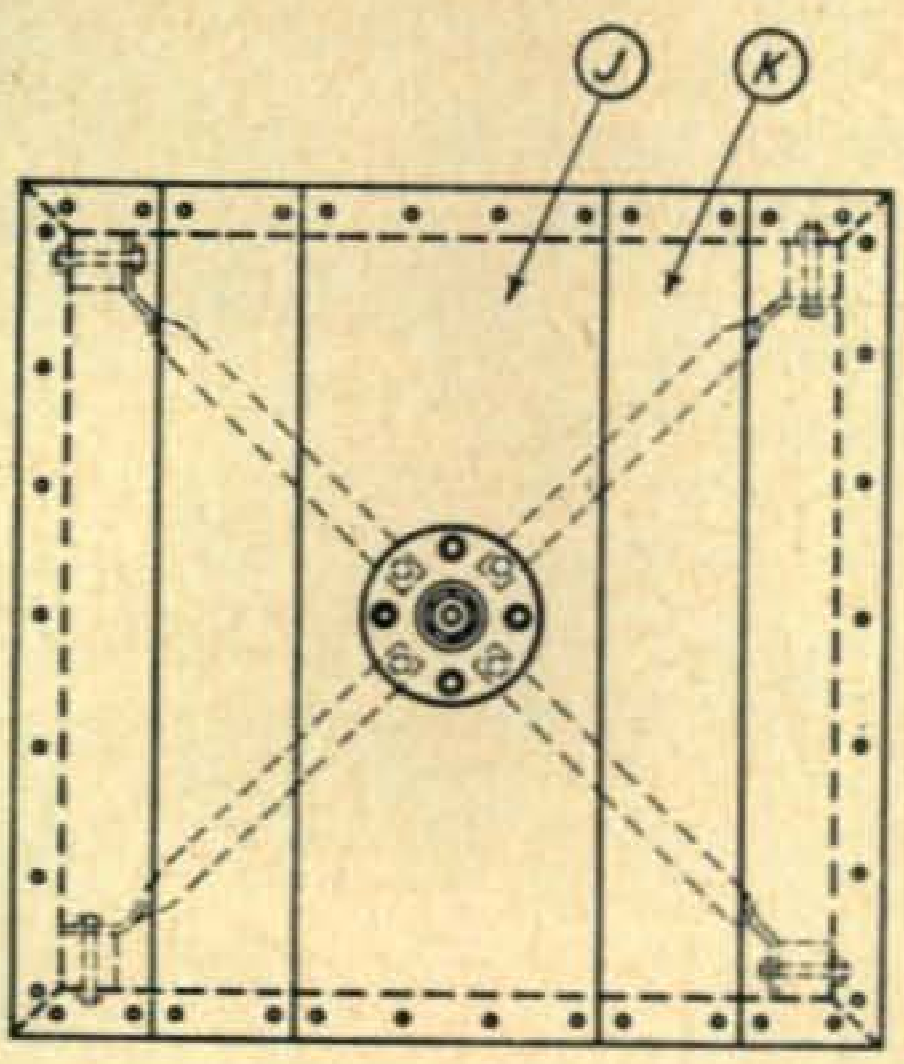


FIG. 6

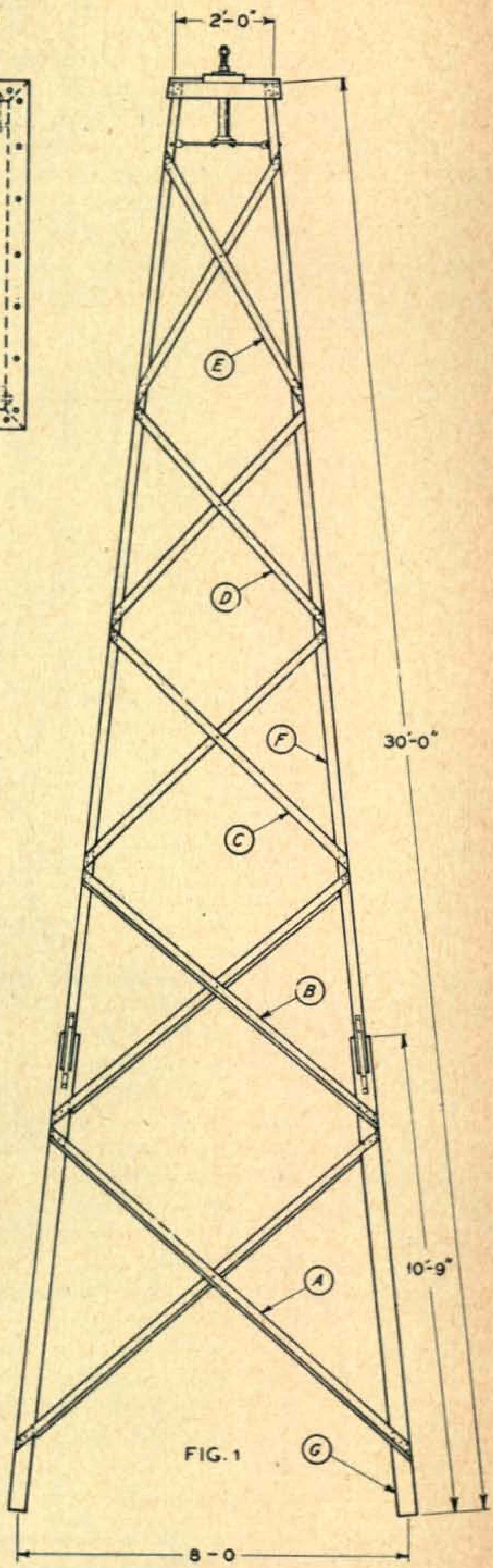


FIG. 1

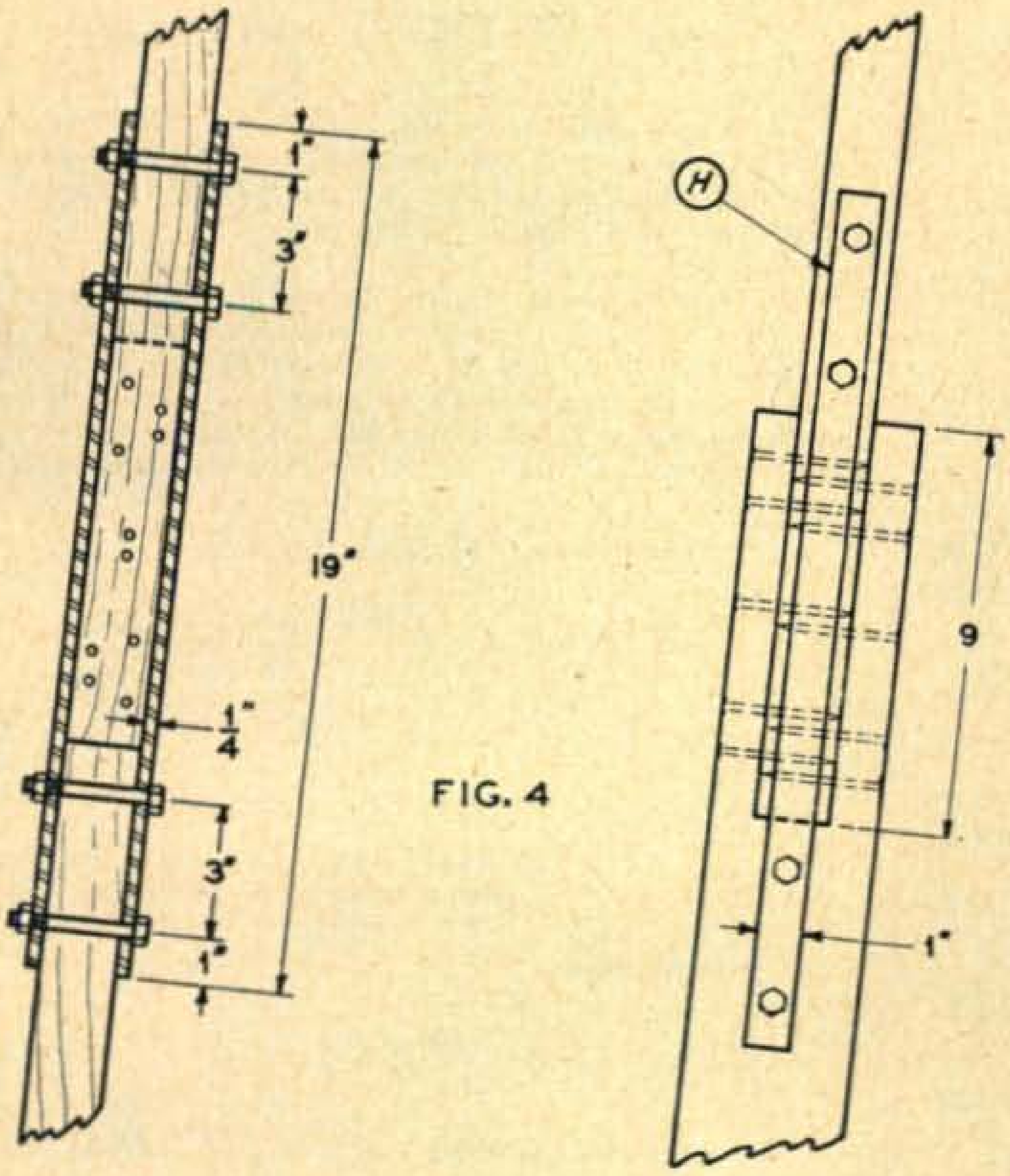


FIG. 4

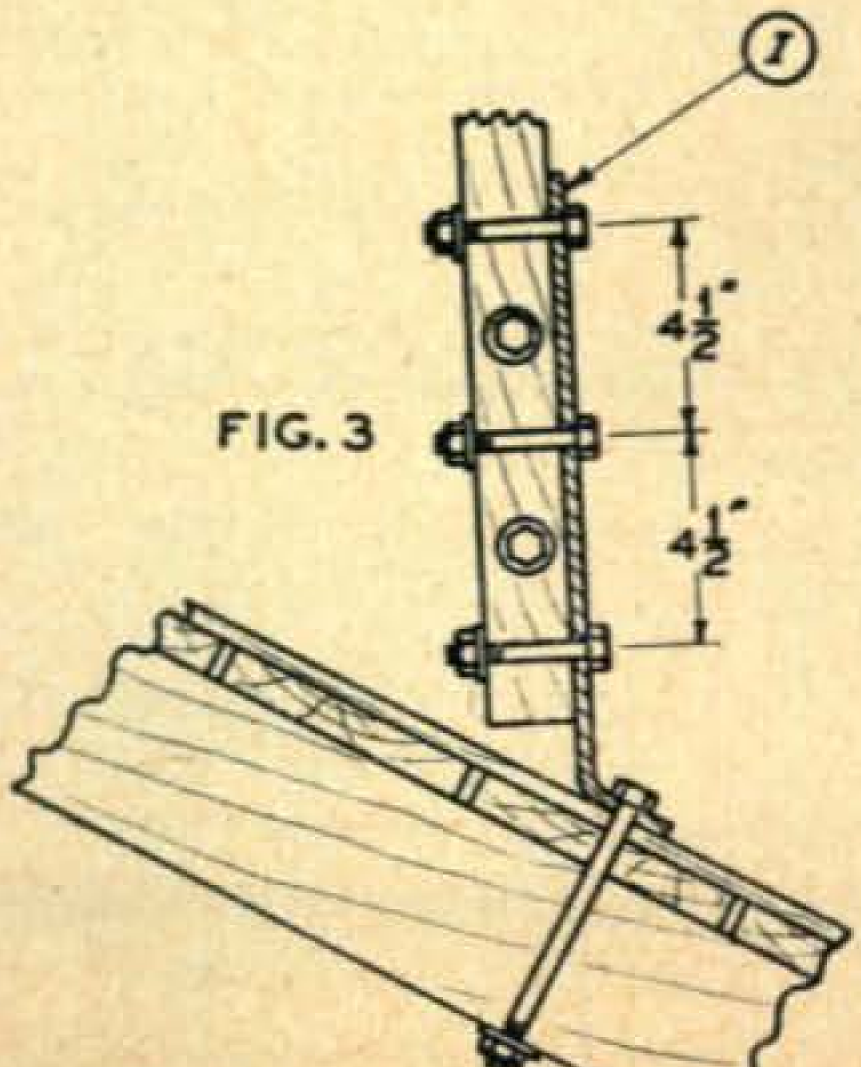


FIG. 3

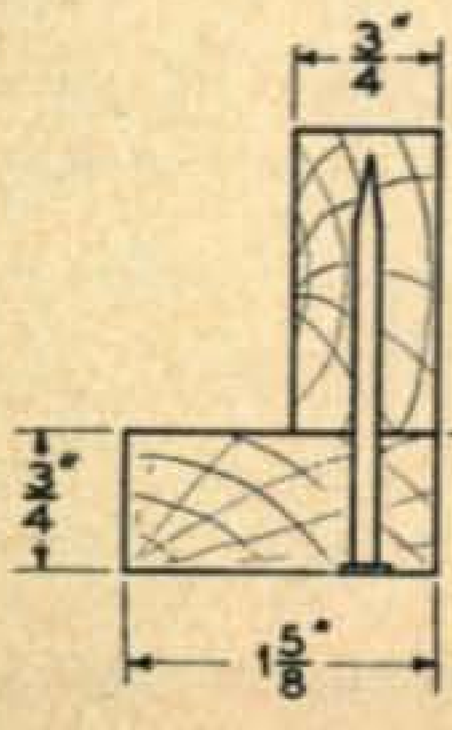


FIG. 5

BILL OF MATERIALS-SEE TEXT	
A	WOOD STRUCTURAL ANGLE 10'-0" LONG
B	WOOD STRUCTURAL ANGLE 8'-0" LONG
C	TIE BRACE 1" × 2", 7'-0" LONG
D	TIE BRACE 1" × 2", 6'-0" LONG
E	TIE BRACE 1" × 2" 6'-0" LONG
F	LEG 2" × 2", 20'-0" LONG
G	LEG 2" × 4", 10'-9" LONG
H	TENSION STRAP 1/4 × 1", 19" LONG - STEEL
I	LEG SUPPORT 1/4 × 1½", 14" LONG-STEEL
J	FLOOR BOARD 2" × 10", 2'-3½" LONG
K	FLOOR BOARD 1" × 6", 2'-3½" LONG

roof, and another man inside the garage slipped the washers and nuts on them. Elastic stop nuts are recommended. The entire procedure was supervised by the man handling a rope tied to the up-wind side of the tower, to help hold it upright.

The sides of the tower are quite limber; therefore care must be exercised in handling them. Also, no time should be wasted in lacing up the open sides, after they are in place on the roof. You can start breathing easily as soon as the lower Xs are in place. They can be installed while standing on the garage roof.

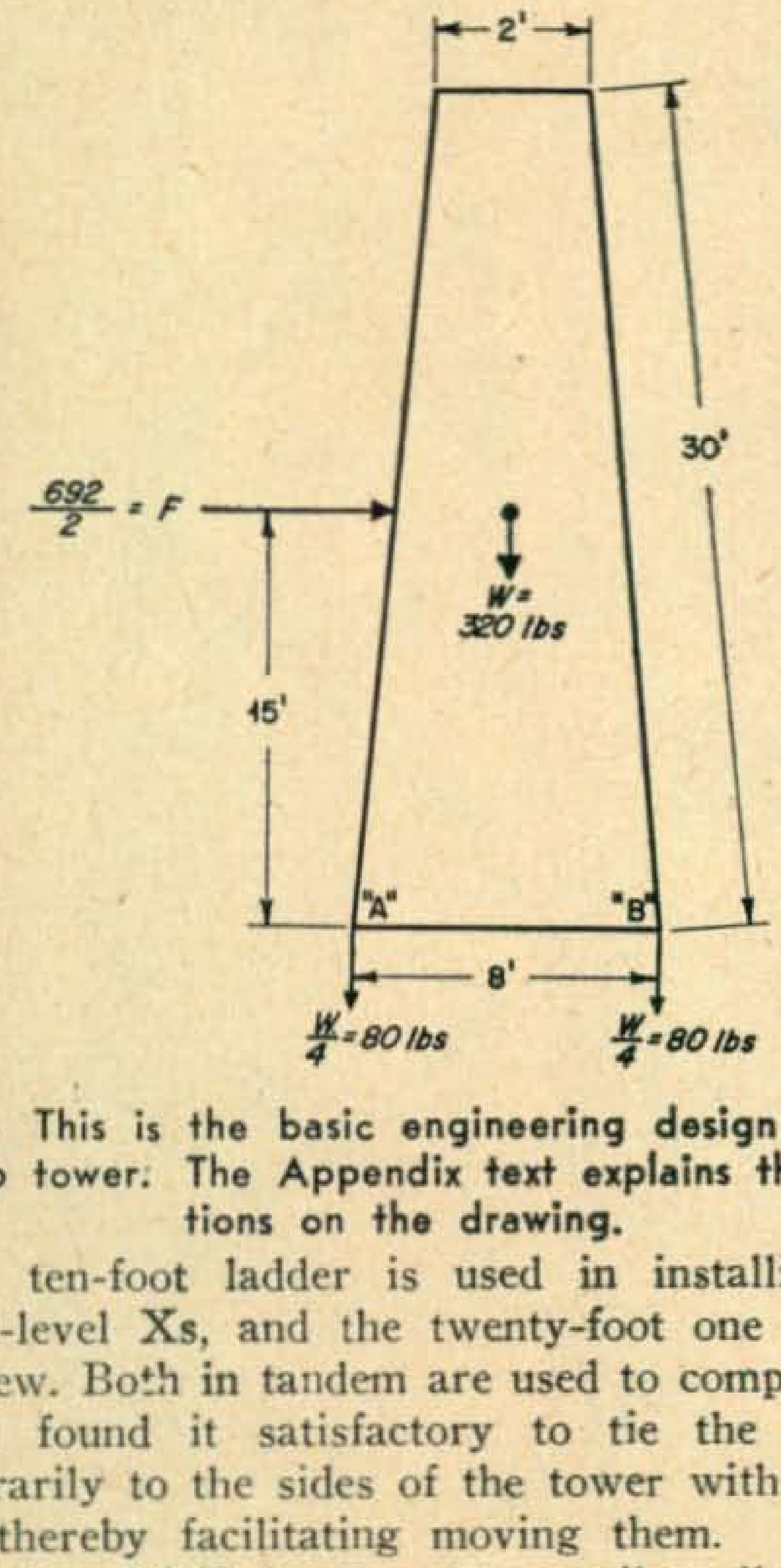


Fig. 8. This is the basic engineering design on the rooftop tower. The Appendix text explains the notations on the drawing.

The ten-foot ladder is used in installing the second-level Xs, and the twenty-foot one for the next few. Both in tandem are used to complete the top. I found it satisfactory to tie the ladders temporarily to the sides of the tower with bits of rope, thereby facilitating moving them.

Lengths of 2 X 4s were temporarily nailed along the roof eaves before resting the sides of the tower against them. This prevented damaging the roof while pulling the tower on the roof.

Although the tower is partially assembled on the roof, have all the pieces ready beforehand; so that only a minimum of work is necessary there. Do not forget to give the lumber a couple of coats of good paint.

Appendix

The drag in pounds on a flat plate area, whose surface is normal to the direction of the air flow is:

$$D = Cd \times 1/2 \times P \times V^2 \times S$$

where:

- D = drag in pounds
- Cd = 1.5 the scalar drag eoefficient
- P = air density in slugs per cubic foot
- V = wind velocity in feet per second
- S = flat plate area in square feet. (To compute it, find the total frontal area of all the members on one side of the tower and multiply it by two, giving the total area of the two opposite sides) or:

$$\frac{2 \times 3.625 \times 10.75}{12} = 6.5 \text{ sq. ft.}$$

$$\frac{2 \times 1.625 \times 20}{12} = 5.42 \text{ sq. ft.}$$

Corner post total = 11.92

$$\frac{2 \times 2.375 \times 7.25}{12} = 2.82 \text{ sq. ft.}$$

$$\frac{2 \times 2.375 \times 9}{12} = 3.56 \text{ sq. ft.}$$

$$\frac{2 \times 1.625 \times 6.5}{12} = 1.76 \text{ sq. ft.}$$

$$\frac{2 \times 1.625 \times 5.25}{12} = 1.43 \text{ sq. ft.}$$

$$\frac{2 \times 1.625 \times 5}{12} = 1.38 \text{ sq. ft.}$$

X member total = 10.95

Misc. (beam, etc.) = 2.00

GRAND TOTAL <u>24.87 sq. ft.</u>

therefore: $S = 2 \times 24.87 =$ approx. 50 sq. ft.

During a wind of 60 miles per hour (88 feet per second) the total drag becomes:

$$1.5 \times \frac{0.002378}{2} \times 88^2 \times 50 = 692 \text{ pounds}$$

To calculate the stress on the footing bolts we assume the tower to weigh about 245 pounds by allowing 2.56 pounds per board foot for Douglas Fir. To this we add 75 pounds for the beam and beam rotating mechanism.

Figure 8 shows how the various forces and stresses react through the tower. The wind pressure is assumed to be centered fifteen feet from the base of the tower. This is a conservative assumption because the tower has more area below its midpoint than it does above. Since the sketch shows only two legs, we will calculate the stresses on the same basis.

$$\text{Tension at A} = \frac{(F \times 15) - (w/4 \times 8)}{8}$$

$$\text{Compression at B} = \frac{(F \times 15)\ \ (w/4 \times 8)}{8}$$

where:

w/4 is 80 pounds the weight on each leg

F the wind pressure divided by 2, or 346 pounds at sixty miles per hour

substituting:

$$\text{Tension at A} = \frac{(346 \times 15) - (80 \times 8)}{8} = 569 \text{ pounds}$$

$$\text{Compression at B} = \frac{(346 \times 15) + (80 \times 8)}{8} = 729 \text{ pounds}$$

The strength of the footing bolts may be computed on the following basis. The root area of a 3/8-inch bolt is:

$$\frac{\pi \times 0.3263}{4} = \text{sq. in., or } 0.0836 \text{ sq. in.}$$

At a permissible stress of 16,000 pounds per square inch (mild steel), the maximum permissible stress on the bolts will be:

$$16,000 \times 0.0836 = 1.335 \text{ pounds}$$

Thus, as the stress analysis indicates, in a sixty mile-per-hour wind, the recommended bolting method offers over a 100 percent safety factor, even if mild-steel bolts are used instead of the preferred alloy-steel ones. This seems satisfactory. *(The average, three element, 14-mc array*

(Continued on page 55)

parallel with the series capacity of *C4* and *C5*. Do not attempt to reduce this effect by using "low-capacity" cable for the standard RG-58/U or RG-59/U cable. It is less ruggedly built than conventional cable, and as a result, moving it or stepping on it could result in a shift of frequency. This effect is completely negligible with the cable specified.

In addition to adding capacity to the circuit, lengthening the connecting cable lowers the Q of the tuned circuit. This is because the cable is part of the tuned circuit. Despite this fact, lengths up to thirty feet have been used with no observable ill effects.

Using The VFO

Putting the outboard VFO into operation is simple. Adjust the slug in *L1* (and the number of turns, if necessary) to place the lowest frequency to be tuned near the low-capacity end of *C1*. Any of the conventional methods of calibration may be used. The regular transmitter crystals may be pressed into service to establish calibration points. Spot their frequencies on the receiver dial. Then plug in the remote VFO, and zero beat it to each crystal frequency.

It is difficult to predict just how far the frequency of a transmitter can be shifted by tuning the VFO without necessitating the retuning of the rest of the transmitter. In a 75-meter mobile installation with a very-high-Q antenna, less than ten kilocycles either side of the center frequency might be possible. On ten meters, on the other hand, a variation of several hundred kilocycles is frequently possible.

ROOF TOP TOWER

(from page 52)

has an area up to eight square feet and will increase the above calculated stresses about twenty per cent. Icing—not a factor in Southern California—will also increase both the weight and the surface presented to the wind. An extra bolt in the roof at each corner might be a wise precaution in sections of the country where icing is a problem. Also, check the garage to be sure that its roof joists are firmly joined to the vertical framing. —Editor)

Vale Don McCaskrell, W9OCA

The VHF gang were shocked to hear of the untimely accidental death of Don, W9OCA (ex-W9NJT) in early September. Don was killed at the Edgerton American Legion Speedway when a racing car went out of control and crashed into the pits where Don was standing.

Don is well remembered as an outstanding enthusiast of the 6-meter band and was one of the few to make WAS on 50mc. Don was also a RASO/USAF Certificate recipient for his 6-meter work.

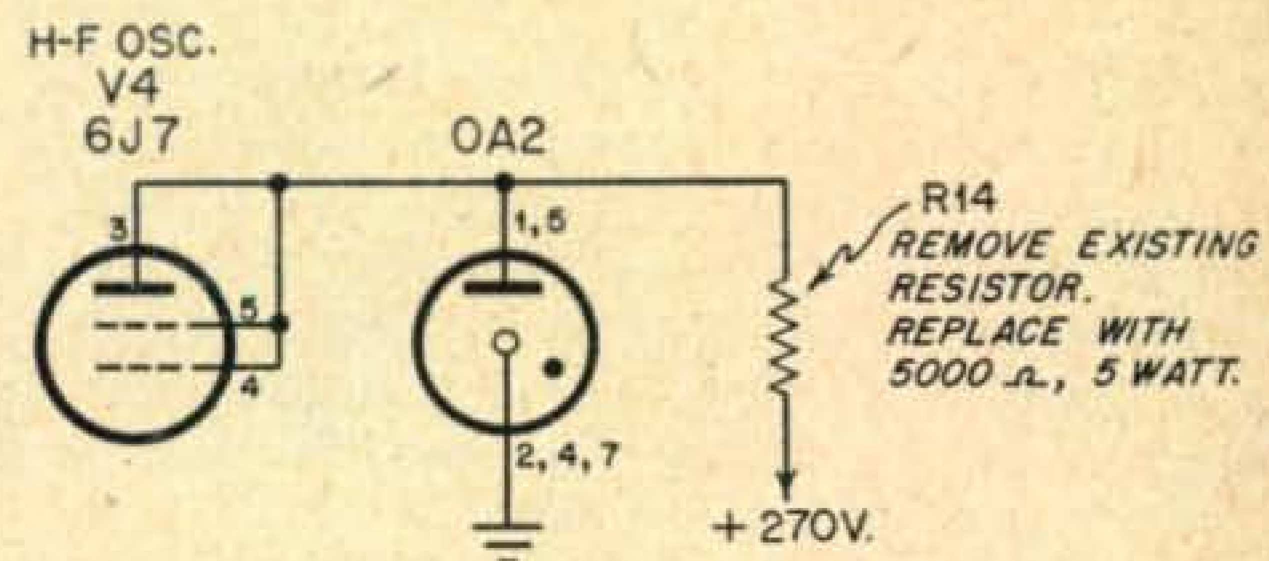
Two Meter Openings Terrific In Late August, Early September

The two-meter band went wild in late August and early September and produced many astounding first contacts. Preliminary reports from W9WOK, W2NLY, W9ZHL, W5JTI, WØTKX, WØMNQ and VE3BPB indicate these "firsts"—WØEMS, Iowa, to W1RFU, Massachusetts; VE3BPB, Ontario, to WØEMS, Iowa; W1PBB, Connecticut, to WØEMS, Iowa; W9FAN, Wisconsin, to W2NLY, New Jersey; WØKYF, Missouri, to W2NLY, New Jersey; WØEMS, Iowa, to W2NLY, New Jersey; W4HHK, Tennessee, to WØOAC, Minnesota; W4AO, Virginia, to WØMNQ, Missouri, (?). These QSOs occurred on the nights of September 7, 8, and 9. Jim Switzer, WØMNQ, states that the opening was produced by the high-pressure air mass centered over Boston and provided an inversion layer at about 5,000 ft., or less, above mean sea level.

In late August, a less extensive opening produced the first Minnesota to Mississippi 2-meter contact between WØIFS and W5RCI on the 23rd. WØIFS was using a 20 element beam and 75 watts input. WØJHS caught WØMNQ for Missouri to Minnesota as did WØIFS, and then they worked a Kansas station believed to be WØELL/9, Prairie Village.

Please send your reports, gang, so we can make a comprehensive write-up, and also correct any errors which may have occurred in the rush to get this into the column. —73, Bill McNatt, W9NFK/5, VHF Editor.

Inside the Shack and Workshop



Improving Stability of H-F Oscillator In The BC-779 Receiver

(The following idea for greatly improving the oscillator stability of war surplus BC-779 receivers is reprinted from the "Philco TechRep Division Bulletin" of April, 1952.)

Although the following modification is a simple and obvious method for improving oscillator stability, it provided such a great improvement that the writer believes it worthy of being brought to the attention of others who also use this equipment. The parts listed below are required for this modification.

Quantity	Description
1	Resistor, carbon, 5000 ohms, 5 watts
1	Tube, miniature, type OA-2
1	Socket, miniature, 710

The socket, with the tube inserted, was suspended, under the chasses, adjacent to the high frequency oscillator tube, V4 by means of the connecting leads. Solid insulated wire was used to provide greater mechanical resilience. Resistor R14 was removed, and the 5000 ohm resistor substituted. Pin 1 or pin 5 of the miniature socket is then connected to pin 3 of the oscillator tube socket V4. Pin 2 of the miniature socket is connected directly to ground.

L. W. Stockton—Philco Engineer