BUILD YOUR OWN TILT-OVER TOWER

OR... What to do if you can't get 8 friends to help you out on a Saturday morning.

BY C. P. CABELL,* WA7EMM

BEAMS and towers are great to have, but there is one problem, things do go wrong sometimes, and somebody has to work on the antenna or the rotor, or maybe haul up other antennas and attach them. When we got ready to put up a tower last summer, the XYL insisted that it be some sort of a tilt-over, so that the old man could do his work on the ground, or pretty close to it. This was great with the OM, since he was not about to go climbing up around the top of a 40 foot tower anyhow.

Figure 1 shows the down position of our setup. We can get to the antenna easily from a stepladder. We should have been able to get the antenna to within half-boom length from the ground, but forgot about the row of evergreens in the way. This gives us point No. 1–figure out carefully what the thing will look like when the tower is down.

Figure 2 shows the general layout. The tower rotates at a point eleven feet above the ground. It's supported by a 1¼" galvanized pipe that goes into the house 10 feet and is bolted to the joists. The bottom end of the pipe is in four feet of concrete. The height of eleven feet to the tilt-over point is really not quite enough, it would be better to have about 15 to 17 feet but one works with what one has. This makes it possible for one lazy man to raise and lower the tower without having to have a big search for help from all his friends.

Figure 3 shows the main lifting mechanism. A 1600 pound boat hoist, double-locking, from Sears Roebuck is the major item. It costs about $15, and it is *double-locking,* in either the up or down position. Double locking is a vital safety feature. A 3/16" galvanized cable, a 750 pound pulley, and a 1/2 inch eyebolt in 4 feet of concrete (to hold the pulley) are the vital parts. The eyebolt is the weak link. I used an open type, and it started to open up under load. Se be sure to get a *closed* eyebolt.

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Fig. 1—Tower in the down position. The final height above ground depends on the antenna.

Fig. 2—In the down position the tower is nearly parallel to the roof eaves. The 1¼" support pipe extends 10' into the house and is bolted to the joists. The bottom of the pipe is 4' into concrete.

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Figure 4 shows the tilt-over mechanism itself. The tower tilts over the horizontal section of the 1¼" supporting pipe. Three muffler clamps are placed around this pipe. Then, another short section of 1¼" pipe is set above it, and the muffler clamps are bolted to the upper short section of pipe.

Now, how to get the upper section of pipe connected to the tower? Perhaps we could just drill holes in the tower legs and bolt the upper pipe to them, but the tower is in maximum stress at this point, and putting holes in it might very well break the tower in two. It's most discouraging when this happens!

We bolted the upper pipe to 1" support pipes to reinforce the tower legs. (See fig. 5). Then we clamped the 1" support pipes (3 feet long) to the tower legs, using husky U clamps from Lafayette (only known source). Figure 6 shows how the 1" reinforcing pipes are attached to the tower. Also, note that all wiring comes out through the main 1¼" pipe, and this makes a very neat installation.

A sketch of the anchor and cabling arrangement is shown in fig. 7. The cable, as shown, wraps around each leg at the base and is secured at the end by a closed type of hook with a safety catch (as illustrated). The method of securing the cable to the hook is shown in detail (B). The hook passes through the thimble to prevent chafing and the wire is secured, as indicated, by three clamps with the U-bolts bearing on the free or dead end.

The 1¼" support pipe, three tower legs and the eyebolt with bend to increase holding) are shown set in 3′ × 3′ × 4′ of concrete. The pulley fitting through the eyebolt must be closed with a metal plate that can be removed.

Safety Points

In fig. 8, the tower is shown in the up position. Note the safety bar bolted to the bottom of the tower. The point here is that when you get the tower into the up position, you would prefer that the tower *not* keep right on going, and fall over on its backside. The safety bar will hit against the main vertical support to prevent that. Along the same line of safety, the following points should be observed:

A. Before releasing the bolts at the bottom of the legs, attach a temporary safety cable from the eyebolt to the tower to keep it from falling over before you want it to move.

B. In addition to the main hoist cable, attach a safety cable to the bottom of the tower, and attach it firmly to the eyebolt or leg of the tower, for safety, in case the hoist should slip.

C. Always use thimbles where the cable goes around small objects.

D. Use three cable clamps. Be sure the screw end presses against the live side of the cable (the side where the load is.)

E. Keep small children, pets, and people out from under the tower at all times when it is in the up position.

Fig. 3—A 1600 pound double locking boat hoist from Sears Roebuck does the job, along with 3/16" galvanized cable, a 750 lb. pulley, and a 1/2" eyebolt in 4 feet of concrete.

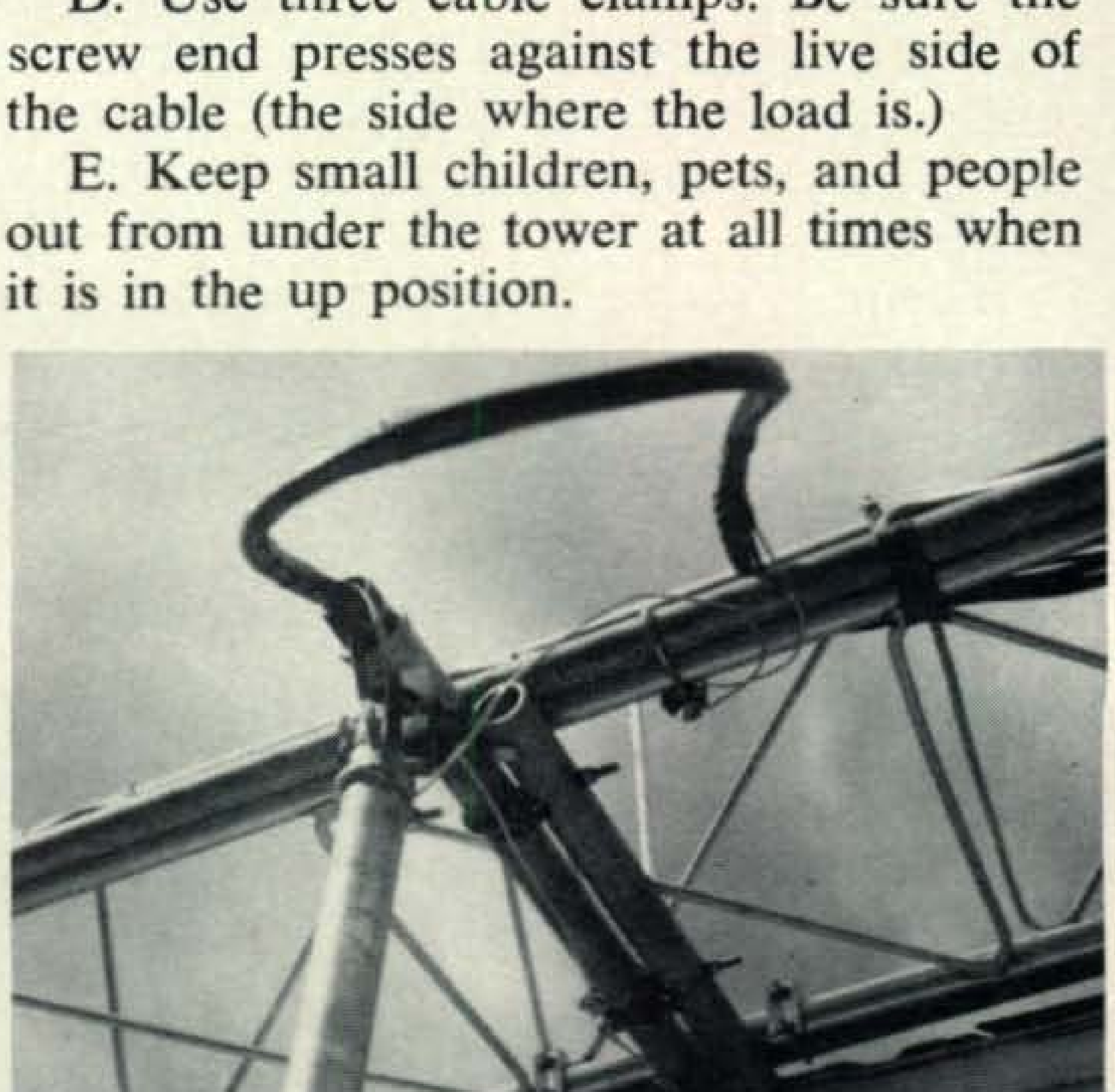

Fig. 4—The tilt-over mechanism is based on 3 muffler clamps which rotate around the horizontal part of the 1¼" pipe. These are attached to another piece of 1¼" pipe. This latter piece is attached to 1" reinforcing pipes (see fig. 6) attached to the tower.

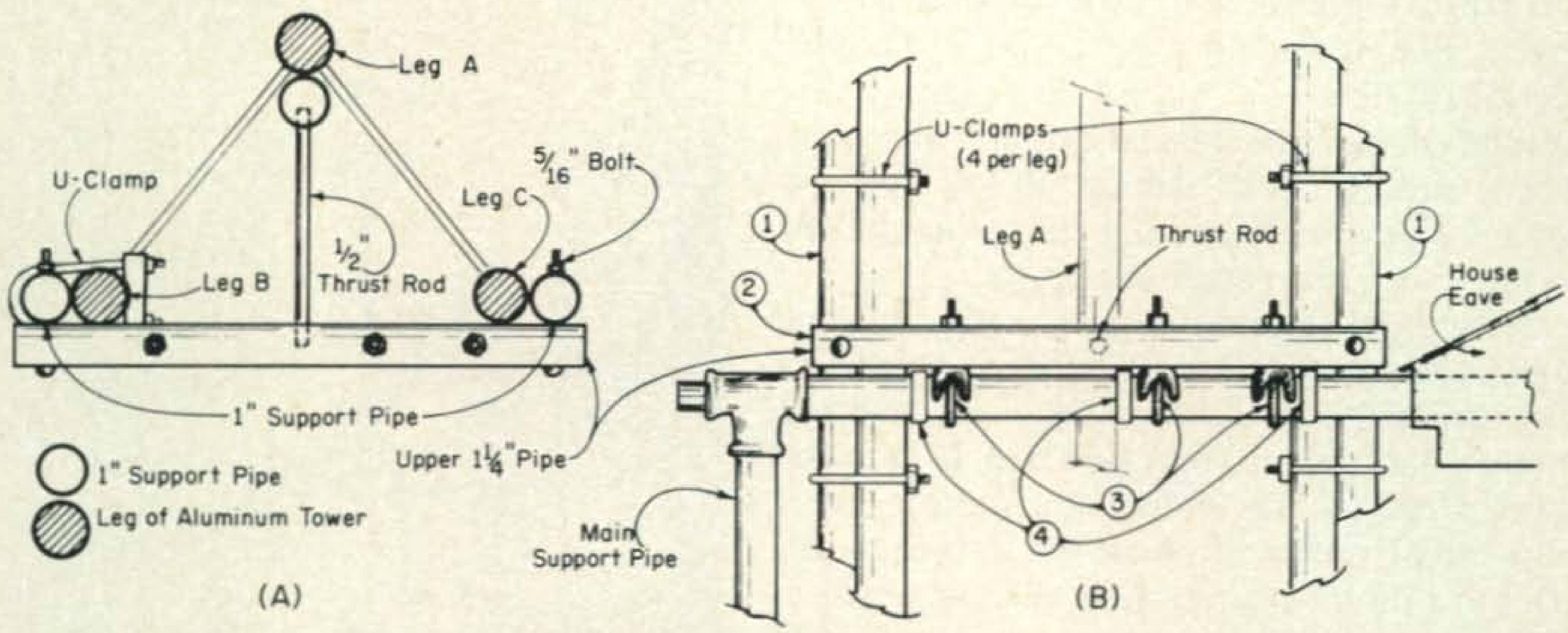

Fig. 5—Rotating mechanism described in the text. (A) Top view of the tower shows the location of the three steel reinforcing pipes and the 1/2" steel thrust rod that wedge fits into holes in the 1" and 1¼" steel pipe to enable leg A of the tower to support its share of the load. All steel 1" support pipes are held to the tower legs by four heavy duty U clamps. (B) Side view of the tilt-over fulcrum. The 1" steel support pipes (1) are bolted to the 1¼" upper pipe (2) which is held to the horizontal main support by three muffler clamps (3). These clamps are made up loosely and rotate around the horizontal main support pipe. Hose clamps (4) keep the muffler clamps from sliding on the 1¼" pipe. The heavy duty muffler clamps are available from Western Auto Co. or any similar supply outfit.

Loading Diagram

To make this a safe, operable setup, you have to do some figuring. Now, I believe that radio amateurs can easily handle simple structural problems, so figs. 9 and 10 show how it is done. The idea is to *avoid* breaking the tower in two at the tilt point. We do this by *not* exceeding the allowable "moment of restraint."

Figure 9 shows a loading diagram for a 40-foot Midway aluminum tower. The same general approach can be used with the Rohn #25 or the Spire tower. I don't think that this tilt-over approach would be practical for a tower much over 40 feet, maybe 48, but that would probably be the limit.

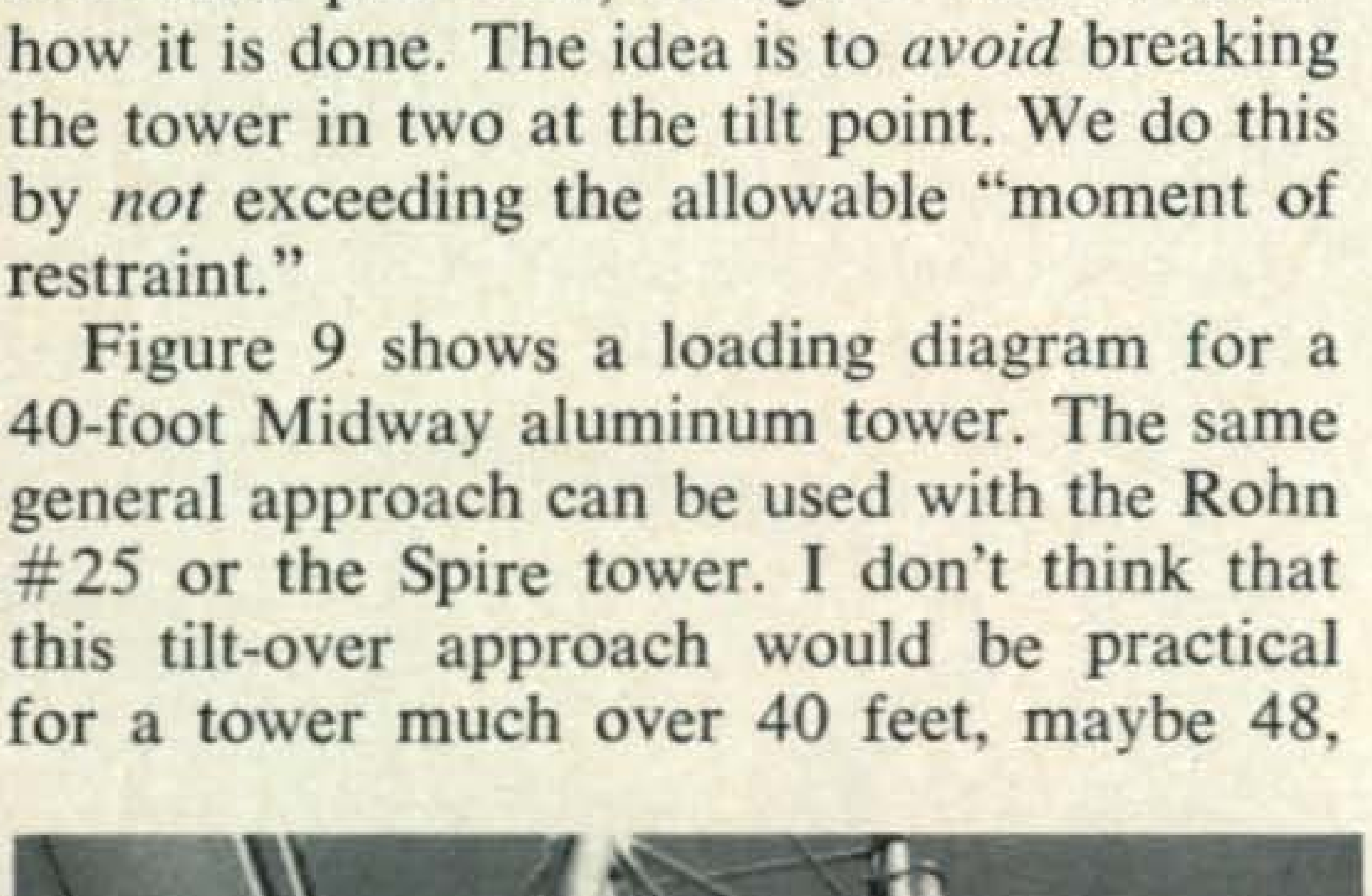

Fig. 6—How the 1" reinforcing pipes are attached to the tower. Also note that all wiring runs from the house through the 1¼" pipe, and through a tee at the top.

Let's begin on the left side. Assume the tower weighs 2 pounds per foot. (Four pounds a foot for a Rohn #25.) Total weight on the left side is 11 feet times 2 pounds a foot, or 22 pounds. Assume the weight is concentrated at the midpoint, or 5.5 feet out. So, the "moment" down is 120 foot pounds. (5.5 × 22).

Now, let's go to the right side. We have 29 feet of tower, equal to 58 pounds. The midpoint is 14.5 feet, so the "moment" from the tower is 841 foot pounds. (14.5 × 58). The Alliance rotor and the mast and post weigh a total of 20 pounds. This is located 30 feet from the tilt-over point, so the moment from these pieces is 600 foot pounds. For the TA-33 beam, the weight is 40 pounds, the distance is 31 feet, and the moment is 1240 foot pounds. This gives a grand total of 2681 foot pounds, which is OK for the tower model we have. (You will have to check with your tower manufacture if you have any questions on the allowable moment of restraint.) This same setup, with the Rohn #25, shows 3520 foot pounds, which is OK for the Rohn #25 (Moment of restraint of 4210 foot pounds is allowable by the Rohn Company). Remember we are not allowed to exceed the moment of restraint.

You can see from the diagram of fig. 9 that if the height at the tilt-over point were

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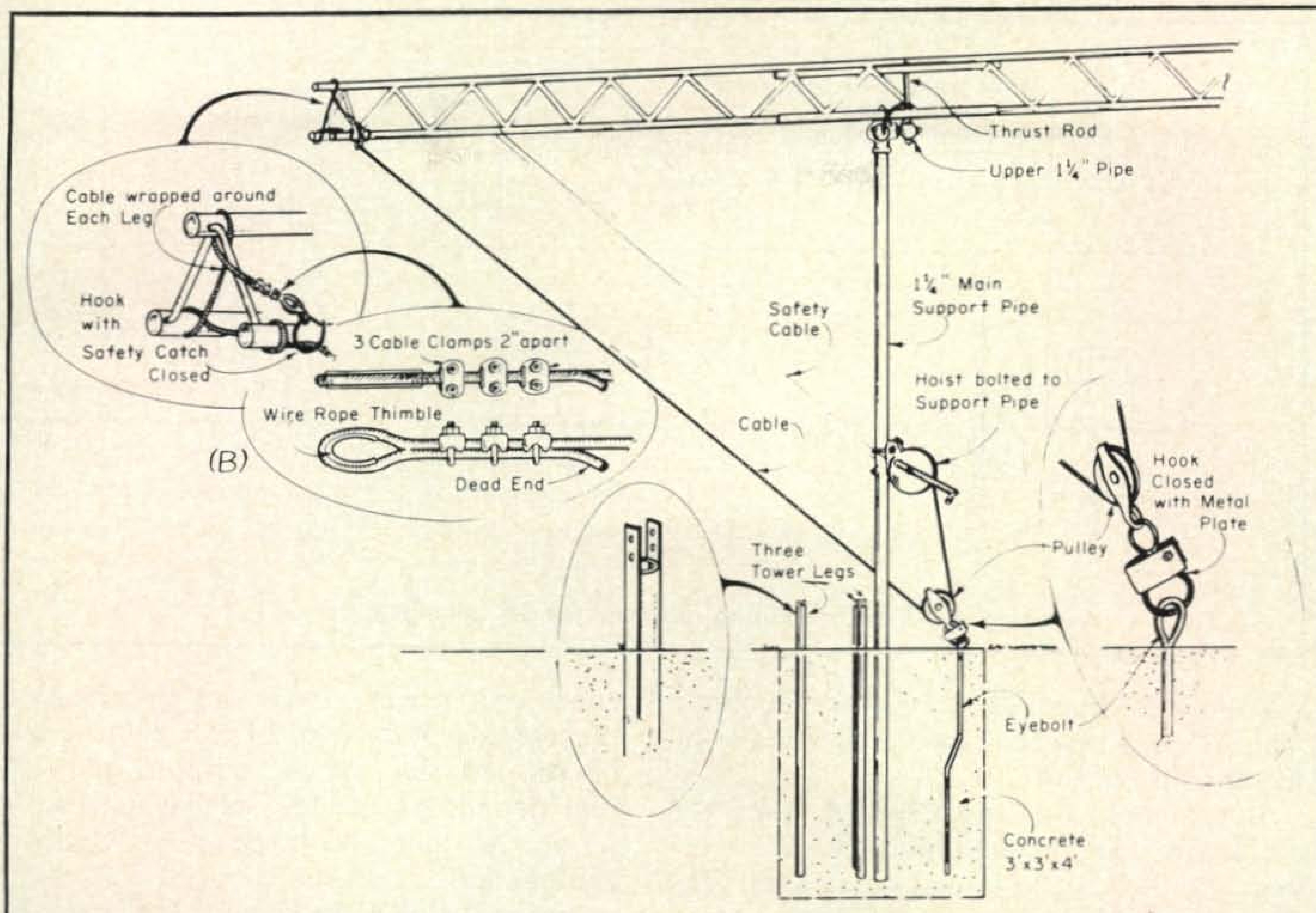

Fig 7(A)—Layout for the cable, hoist and concrete anchor described in the text. (B) Method of attaching the cable to the thimble and clamping the dead end.

increased, the loading would go down. Also, if the weight of the antenna and rotor and mast were increased, the loading would go up.

One way to check out what your tower will do is to refer to the manufacturer's ratings on wind loading. Use the following figures, for the wind velocities shown in Table I.

(These figures are based on the so-called conventional formula used by antenna manufacturers for normal antenna installations by amateurs).

The allowable moment of restraint of your tower can be estimated by multiplying the allowed *unguyed* length of your tower times the appropriate pounds per square foot, shown in Table I, times the antenna area. For example, say your tower manufacturer gives you six square feet of antenna, at 100 miles an hour, for a tower of 30 feet *unguyed* length.

At 100 miles an hour we have 30 pounds per square foot. The 30 pounds per square foot times 6 square feet is 180 pounds. The

m.p.h.	lbs. per sq. ft. of ant
60	11
70	15
80	20
90	25
100	30

Table I—Wind load versus wind velocity.

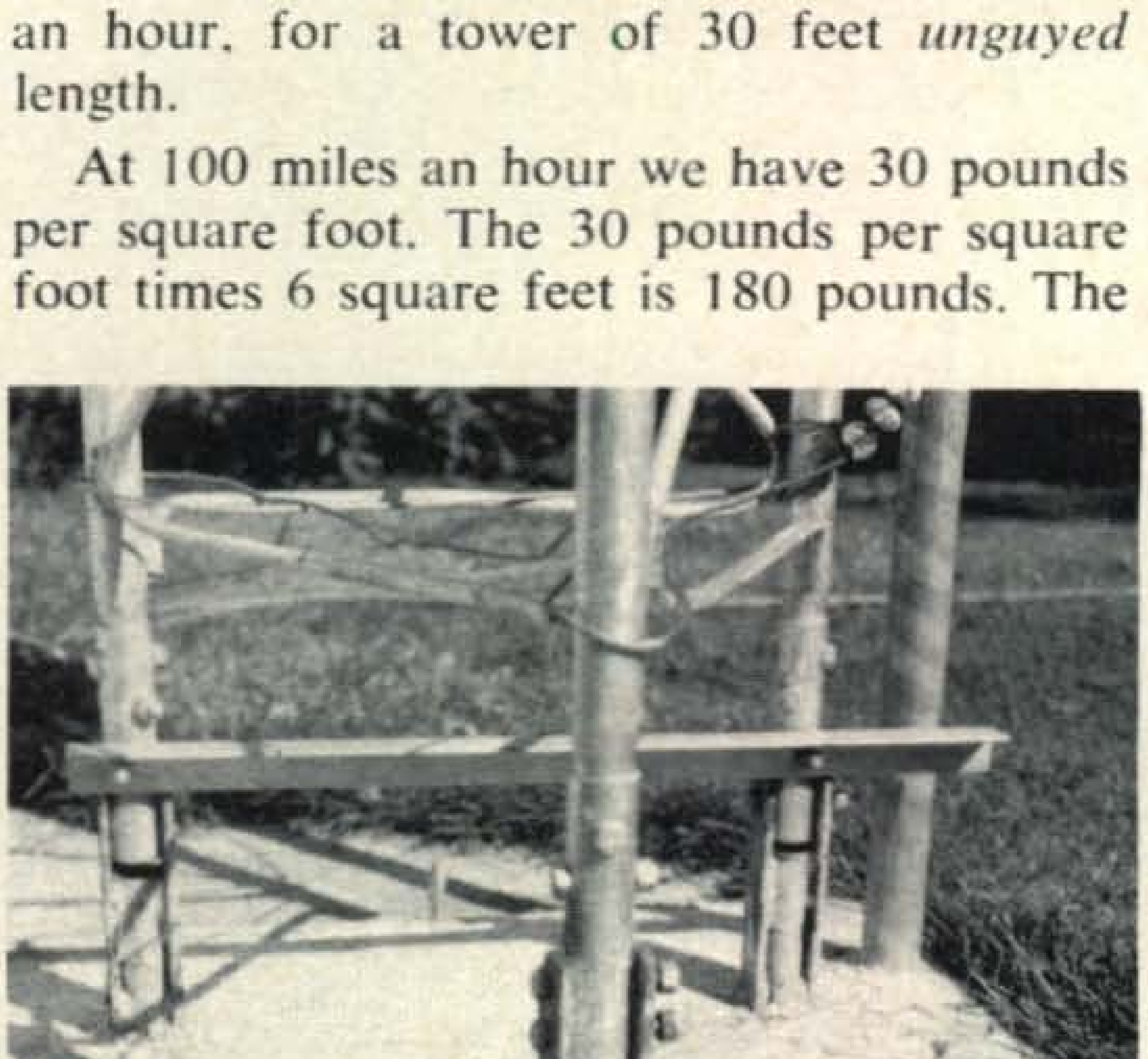

Fig. 8—Tower in the up position. Note the safety bar bolted to the bottom of the tower to keep the tower from falling over backwards.

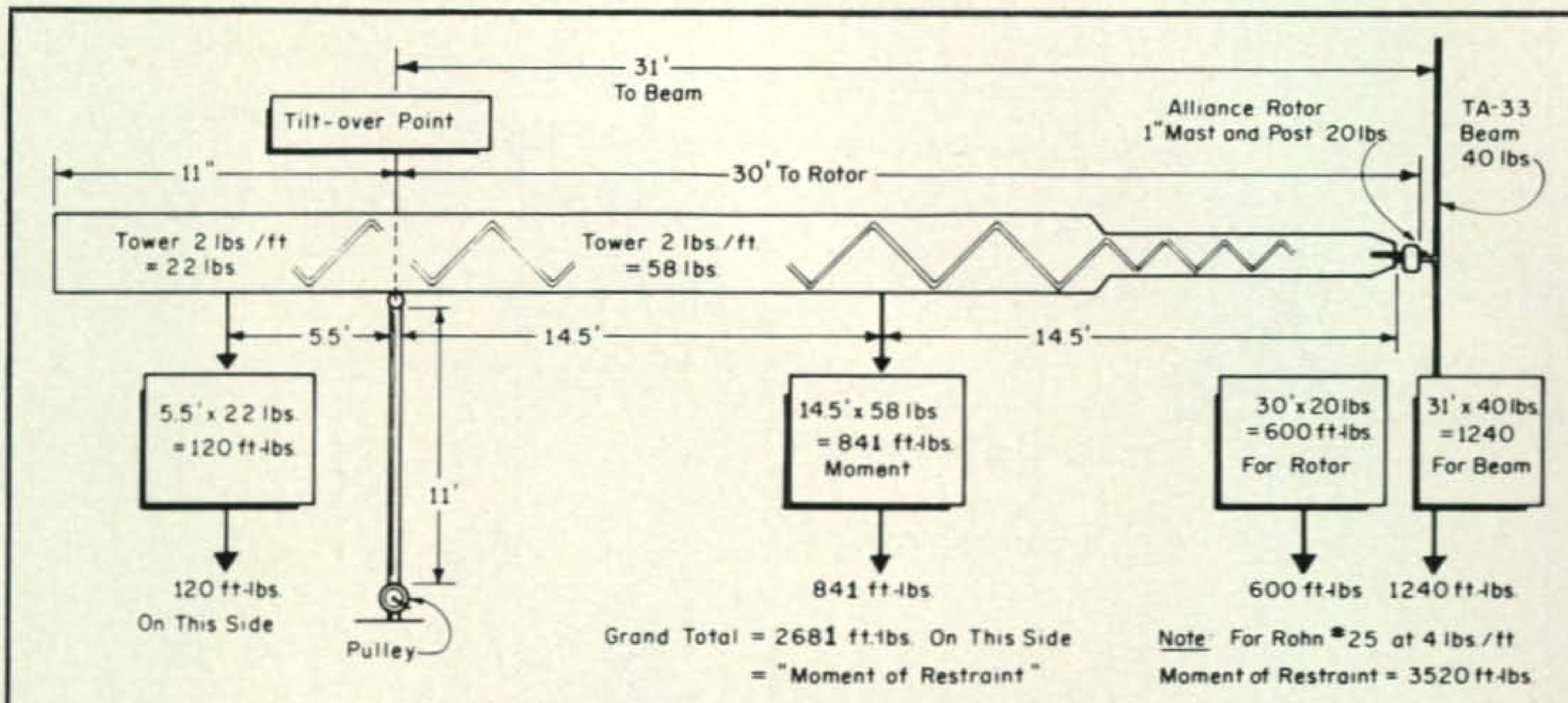

Fig. 9—Typical loading diagram for 40' aluminum tower.

180 pounds times 30 is 5400 foot pounds. This is conservative, since it ignores wind loading on the tower itself.

But suppose the manufacturer gives you six square feet of antenna at 70 miles per hour, for 30 feet of unguyed length. The 70 miles an hour produces a loading of 15 pounds per square foot, so the allowable moment of restraint is about 2700 foot pounds. This would work out with the sketch we showed in fig. 9.

Cable Loading

Figure 10 shows how we compute the cable loading. We have 2681 foot pounds *down* on the right side, which has the same effect as if it were 2681 foot pounds *up* on the left side. We have 120 foot pounds down on the left side. So we need to add 2561 foot pounds on the left side to balance the set up. Assuming we hook up a cable to the extreme left hand side, we need 233 pounds *down* on the cable to balance the setup. But we are at an angle with the pull. It takes almost 1.5 times as much pull, say 350 pounds, in the cable to get the 233 pounds we need. This is why one must have a hoist or winch; one man can't pull that much.

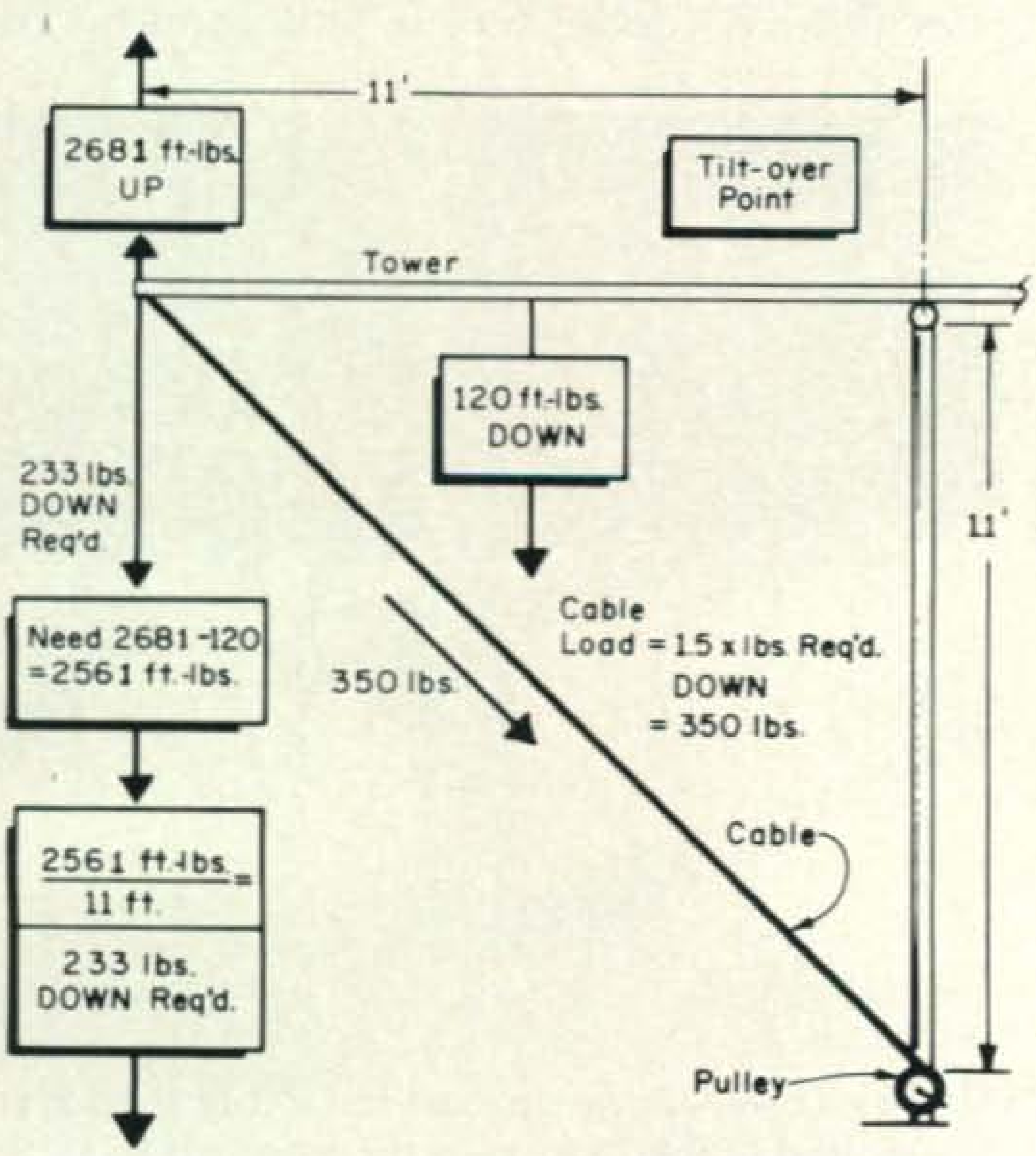

Fig. 10—Cable loading diagram.

"Now," we ask, "how big a cable?" Better use a 10 × safety factor for hoisting work; Table II is based on the 10 times safety factor. This shows that a 3/16″ galvanized stranded cable will do very nicely. Table II also gives you the story of screw eyes and eyebolts—don't go below a 1/2″ eyebolt, firmly embedded in four feet of concrete. ■

Wire and Cable	Pounds
1/8″ single strand galvanized	100
1/8″ stranded galvanized	225
5/32″ stranded galvanized	290
3/16″ stranded galvanized	425
1/4″ stranded galvanized (H.S.)	470
1/4″ stranded galvanized (E.H.S.)	660
Bolts	
1/4″ screw eye, open	100
3/8″ screw eye, open	170
1/2″ closed eyebolt	1100
3/4″ closed eyebolt	1800

Table II—Allowable loads for hoisting with a safety factor of 10, and data on screw-eyes.

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