Tilt That Tower

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Tower on the way down with helpful neighbor demonstrating the use of the restraining lines.

How many times have you read "beam antenna" construction articles and thought that you would really like to give it a try—except—how would you get it up on top of your tower. And right there you drop it and just keep on dreaming about 8.5 or 10 or 11 db gain—how it sure would give that extra punch to that rig you have.

Let's face it, no matter how good a rig you have, if you aren't radiating maximum you're not in good shape to compete for that rare DX.

So, if you can't afford a crank up tower, don't have a crane handy or can't muster up enough extra pairs of muscles whenever you want to work on the beam, then this article is for you.

Right now let's quench your fears of special parts, welding, etc., before we go on. Everything used in this project can be found in Sears Roebuck and Co., and a moderately stocked steel supply house. The actual conversion will depend on the type of tower you have, but the basic principle will remain the same.

There is one requirement with this type of construction article that should be kept in mind—be very critical of so called "junk-box" parts. Don't skimp on the quality of the material you use. You are dealing with considerable weight and a component failure could be catastrophic. No matter how confident you are of the finished product never allow anyone to stand under the tower when you are raising or lowering it!

The actual conversion will depend on the type of tower you have and for that reason actual dimensions will not be given. However, using my conversion and pointers as a guide, you should be able to do a safe and lasting job on your tower.

My tower was manufactured some 12 years ago, is 50 feet high, has one inch tubular legs on 12 inch centers and has horizontal braces also made of one inch tubular steel. This type of construction was typical for that era and compares with the newer towers using solid steel "zig-zag" or flat "corrugated" bracing.

The tower conversion can be broken down into four steps once you make sure you have enough room on *your* property on which to lay down the tower.

1. Construct a base hinge.
2. Construct in intermediate pulley mount.
3. Determine the weight to be lifted.
4. Select a proper cable, winch, and pulleys.

Construct base hinge

The base hinge should be constructed one or two feet above the ground. Putting the hinge at that height will allow the winch to be mounted on the tower, eliminating the problems of mounting it on the house. The hinge should not be made any higher than two feet from the base as the thrust of the tower in the horizontal position may cause the vertical portion to bend. Examination of the photo will show the two 1¼ angle brackets that were added between the hinge and lower rear base for that reason.

The hinge itself is constructed by cutting the tower in two, midway between the horizontal supports, about one or two feet above the ground. Two pieces of 2 inch angle iron are bolted horizontally to the front legs. Two ⅜ inch bolts are used in each end of each piece of angle iron. A 1¼ inch length of angle iron is bolted to the rear of the lower front legs under the lower of the two ⅜ inch bolts. The 1¼ inch angle support brackets mentioned earlier are bolted at the upper end to this 1¼ inch angle iron. The lower ends of the 1¼ inch angle irons are bolted to the lower rear horizontal support member. The hinges are of the "Barn-door" variety from Sears Roebuck and Co. and are held to the 2 inch horizontal pieces by ⅜ inch steel bolts. Use the largest hinges that will fit your tower width.

The hinged section of the tower can be made stronger by inserting 18 inch steel rods or pipe into the hollow legs or by removing about 10 inches of the legs between the horizontal members where the hinge will be installed.

The clamp for the rear tower leg is made by splitting a 10 inch piece of one inch ID pipe or tubing with a hacksaw. This clamp is held with four ⅜ inch bolts, two above and two below the cut in the leg. When lowering the tower it is only necessary to remove the top bolts.

Intermediate pulley mount

Since my tower was put up next to my house, the intermediate pulley mount was combined with a home made "house-bracket". The house bracket was made of two 2 inch by four feet lengths of angle iron. These two brackets extend approximately 21 inches out beyond the house. The underside of the roof where they are bolted is reinforced by 2 x 8 inch lumber. Just outboard of the roof of the house a length of 2 inch angle iron is bolted between the two arms. The intermediate pulley is bolted to this angle iron.

A length of 1¼ angle iron is U bolted to the inside of the front two tower legs at a height equal to the two 2 inch angle iron arms of the house bracket. When the tower is raised, this angle iron bolts to the two arms with ⅜ inch bolts.

Several of the preceeding steps require the bending of the ends of angle iron. This is easily accomplished by hacksawing the unneeded side off the angle iron and then using a hammer to obtain the required bend in the tab.

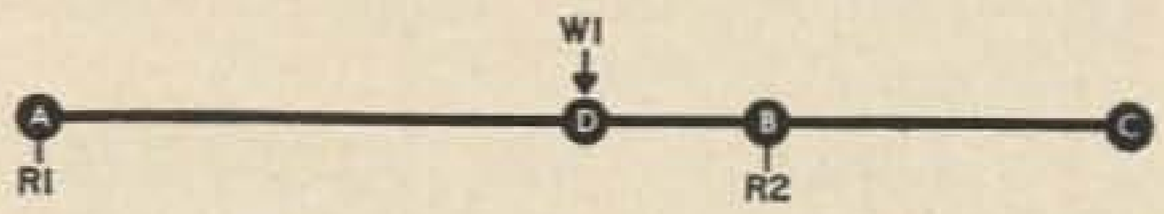
The winch is mounted on a 1½ x 3 inch "U" channel 19 inches long. A one inch hole is drilled 10½ inches from the left side of the channel. The channel is then slipped over the rear leg before the rear clamp is installed. One ⅜ inch hole is drilled through the channel and rear leg and another through the channel and front horizontal member. ⅜ inch bolts are used to secure the channel to the tower.

Determine weight to be lifted

Three or four formulas will be used to determine the tension in the lifting cable, pully and winch:

A1. Determine lifting weight of tower alone:

For uniform construction towers.



W1= Weight of tower alone (weight per section times number of sections).
AD= ½ tower length or AC/2.
R2= Point tower raising cable attaches to tower.
R1= Base or hinge pivot point of tower.

To solve for R2:

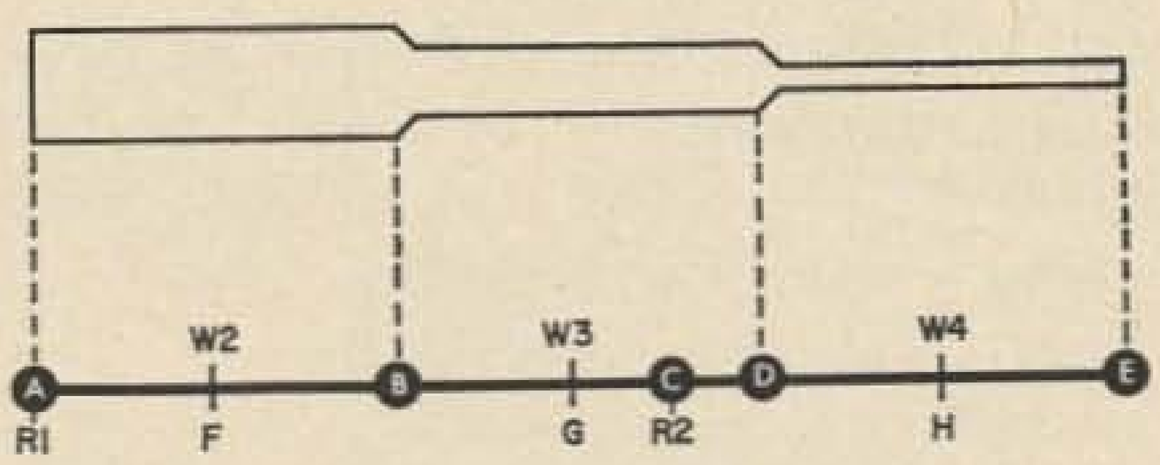
$$(AD)(W1)-(AB)(R2)=O \quad R2=\frac{(AD)(W1)}{AB}$$

To solve for R1:

$$R1+R2=W1$$
$$R1=W1-R2$$

A2. Determine lifting weight of tower alone:

For tapered tower construction such as the Spaulding "Strato-Tower".



W2= Weight of 1st section.
W3 =Weight of 2nd section.
W4= Weight of 3rd section.
R1= Base or hinge pivot point of tower.
R2 =Point tower raising cable attaches to tower.

$$AF=\frac{AB}{2} \quad BG=\frac{BD}{2} \quad DH=\frac{DE}{2}$$

$$AG=AB+BG \qquad AH=AB+BD+DH$$

To solve for R2:

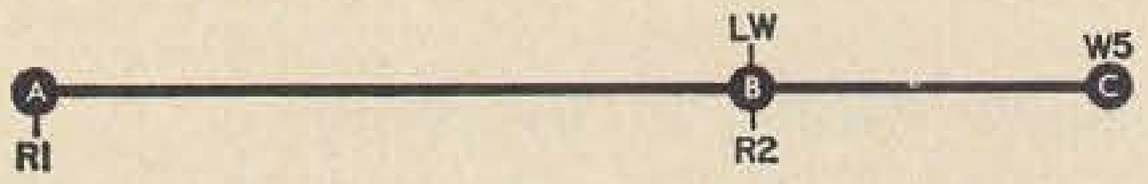
$$(AF)(W2)+(AG)(W3)+(AH)(W4)-(AC)(R2)=O$$

$$R2=\frac{(AF)(W2)+(AG)(W3)+(AH)(W4)}{AC}$$

To solve for R1:

$$R1+R2=W2+W3+W4$$
$$R1=W2+W3+W4-R2$$

B. Determine lifting weight of tower, antenna, rotor, etc. combined:



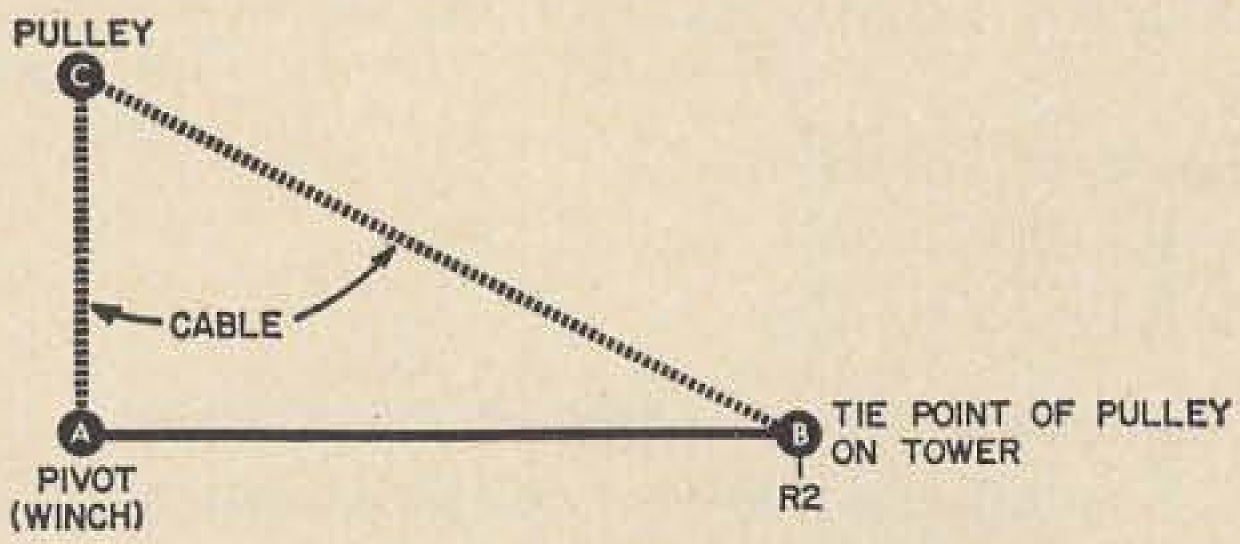
LW= Lifting weight of tower where cable attaches.
R1 and R2= From formula A1 or A2.
W5= Combined weight of antenna, rotor, etc.
AB= Distance from hinge base to lifting cable point on tower.
BC= Distance from lifting cable tie point to antenna at top of tower.

To solve for LW:

$$R1+(AB)(R2)+(AC)(W5)-(AB)(LW)=O$$

$$LW=\frac{R1+(AB)(R2)+(AC)(W5)}{AB}$$

C. Determine tension in lifting cable, pulley and winch:



R2= From formula B.
AB= Distance from hinge base pivot of tower horizontally to cable tie point.
AC= Distance from hinge base pivot of tower vertically to pulley.
T= Tension in cable ACB

$$CB=\sqrt{(AB)^2+(AC)^2}$$

To solve for T:

$$T=\frac{R2}{AC+CB}$$

Examination of the formulas will show that:

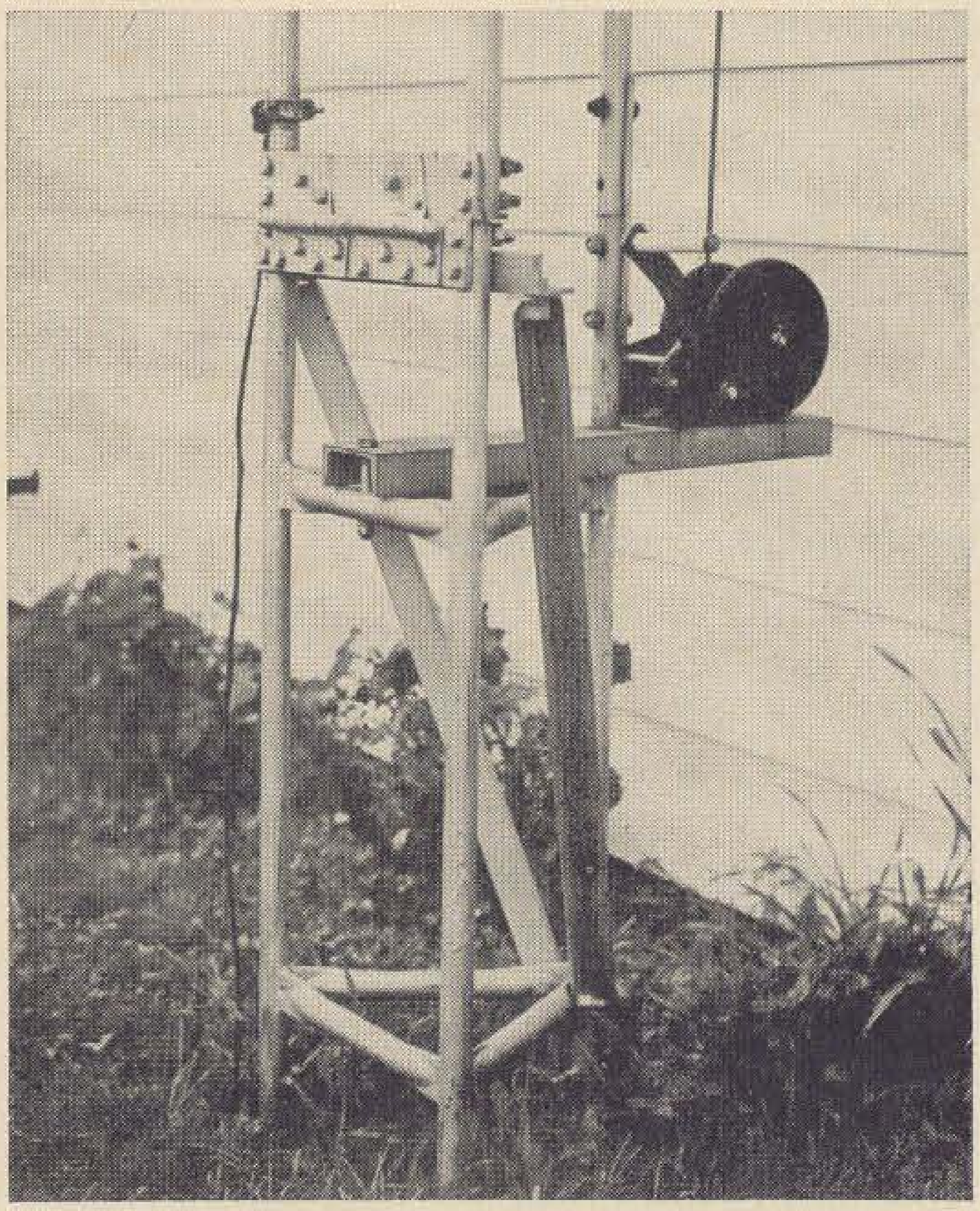
1. Establish the intermediate pulley point, point "C" in formula C as high as possible. The higher that point is the less the tension in the lifting cable.

2. Keep the cable tie point on the tower out as far as possible—at least half the tower length. The maximum distance out for the point will usually depend on the height of the intermediate pulley.

Select proper cable, winch and pulleys.

A. Cable

Steel cable (wire rope) comes in a variety of sizes, strandings and strengths. Wire rope is commonly designated by two figures, the first indicating the number of strands and the second the number of wires per strand. That is: 6 x 7 is a six-strand rope having seven wires per strand. The higher the number of strands and wires per strand the more flexible the cable. For instance a 8 x 19 cable is much more flexible than a 6 x 7 cable. Because you will be using a small (2 or 3 inch) pulley you will want a flexible cable, say 6 x 29 or 8 x 25.



Base hinge and winch mount. Note angle iron support struts going from upper front legs to lower rear leg.

The strength of cable depends upon its size, kind of material of which the wires are made and their number, the type of core, and whether the wire is galvanized or not. This table gives the medium strengths of cable appropriate for this type of application:

3/16 2500 pounds
1/4 4000 pounds
5/16 6500 pounds
3/8 9500 pounds

A minimum factor of safety of three should be used when selecting cable. That is, multiply the cable tension previously calculated by three to determine what strength and therefore size cable to use.

B. Winch

Winch selection, as with cable, should be based on cable tension times a safety factor of three. Sears Roebuck and Co. has a good selection of winches ranging from 1000 pound capacity with a 3:1 gear ratio (maximum mechanical advantage of 38:1) to 2500 pound capacity with a 12:1 gear ratio (maximum mechanical advantage of 21:1). Even if you don't need the higher lifting capacity the selection to the higher capacity model with the mechanical advantage and higher gear ratio will save wear and tear on your arm muscles.

C. Pulleys

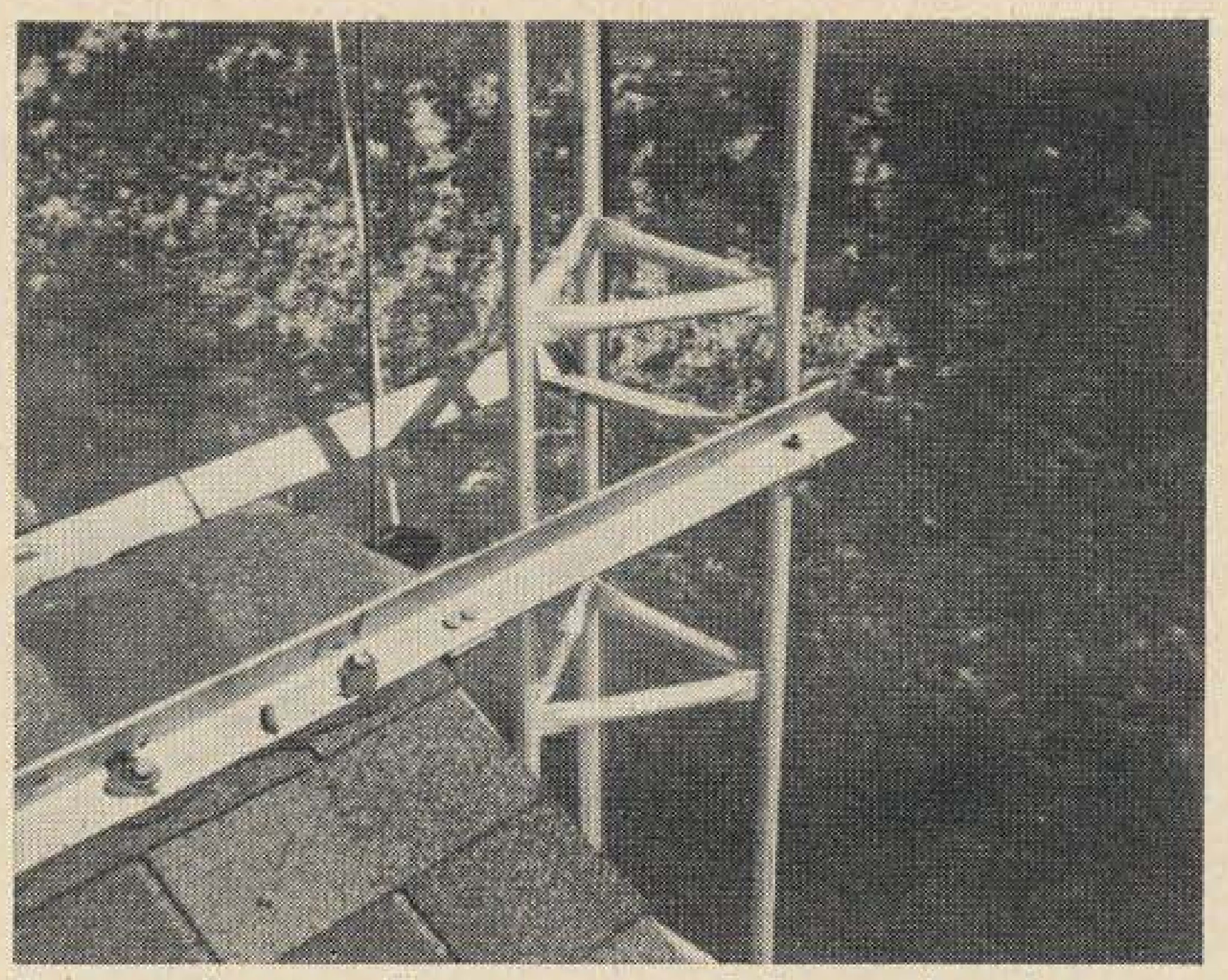
The pulley should also be selected based on required lifting tension times safety factor. The other pulley considerations are diameter and groove size. To realize maximum cable life the diameter of the pulley should be: for 6 x 7 cable D=72d (d= diameter of cable), for 8 x 19 cable D=31d. Note that the more flexible cables require smaller diameter pulleys. Because, at most, the cable in this application will see highly intermittent use it would be appropriate to use pulleys as much as one half that diameter specified.

Since the Sears winches have small diameter drums, several layers of cable should be turned on the drum before the weight carrying cable is wound on.

It is recommended that the pulley groove diameter be the same size or 1/64 larger than the nominal cable diameter. Too small a groove for the cable it is to carry will prevent proper seating of the cable in the bottom of the groove and consequently uneven distribution of load on the cable will result. Too large a groove will not give the cable sufficient support.

Operation

One important consideration in lowering a tower of any size is the lateral leverage (or twist) the tower exerts on the vertical base and hinges. This leverage reaches maximum when the tower is completely horizontal but not resting on the ground. In that position any wind from the side, especially with a large antenna mounted at the tower apex, will tend to swing the tower sideways twisting the base. After one sad experience in which the author's tower was



Intermediate pulley mount and house bracket.

swung 45 degrees by a gust of wind; restraining lines were used on all lowering and raising operations.

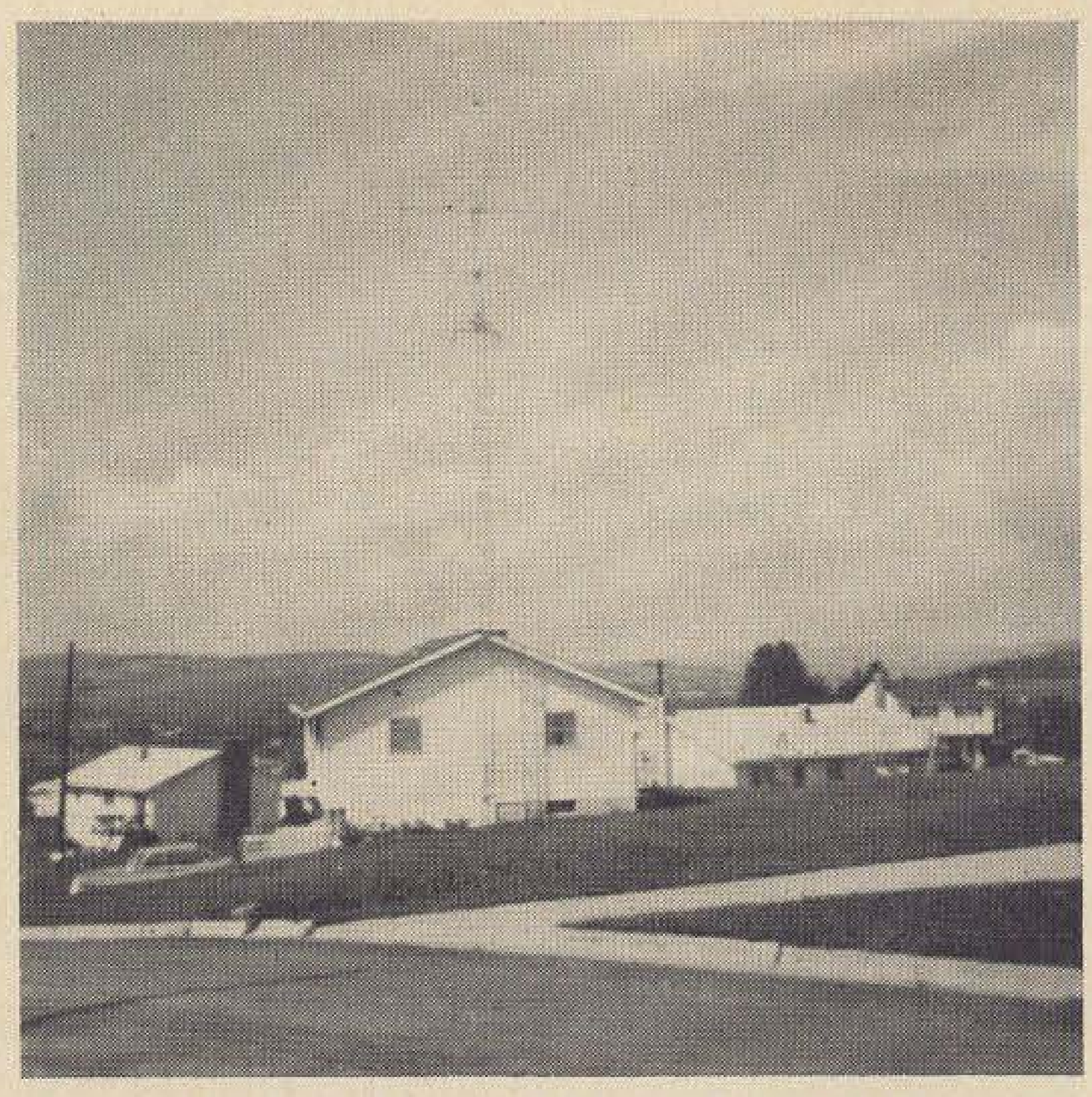
The restraining line operation consists of running one end of a 1/4 inch line through a guy thimble, used to hold one set of guy lines, then on to a point about 20 foot up the tower where it is made fast. The other end of the line is run through the other guy thimble and likewise tied to the 20 foot point on the tower. The center of the line then is brought back to the base of the tower where the slack can be taken up by the operator. The line is either taken in or let out depending on whether the tower is being taken up or down. (My tower has one set of guys at the top, one anchored to the roof of the house and the other two to the earth anchors).

This use of restraining lines requires very little effort to keep the tower from swinging about the base even in quite strong wind gusts. The best solution, of course, is to wait for a calm day. However, even in that case, it is best to have some insurance in the form of the restraining lines.

Reducing winch load

One method to reduce the load on the winch and save muscle power is:

1. Mount the intermediate pulley as before.
2. Mount a second intermediate pulley at the tower lift point.
3. Fasten one end of the lifting cable to the angle iron holding the first intermediate pulley. Run the cable through the 2nd intermediate pulley on the tower then back through the first intermediate pulley then down to the winch. This arrangement can cut the lifting



The erect tower—A neat installation

load on the winch by as much as 5 percent.

Operating procedure

1. Connect restraining line.
2. Remove guy lines (if used) from side of tower opposite hinge.
3. Remove house bracket holding screws.
4. Remove rear leg (base) holding screws.
5. MAKE SURE NO ONE IS STANDING IN FALL PATH OF TOWER!
6. Lower tower taking up slack in restraining line. The restraining line job is an easy job for the XYL or neighbor.

Finally—frequently inspect the tower construction, winch, cable, hinges, pulleys and other hardware for signs of strain and wear!

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MOVING?

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