the gin pole:

a simple lever for raising masts

An easy method for erecting antenna masts using readily available materials

The gin pole is a great help in raising masts. You'll find little information in the amateur radio handbooks on the use of gin poles, so in this article I've included techniques on the proper use of this simple lever to get your antenna mast off the ground and into a position where it will do some good. Information is presented on forces you can expect when using the gin pole, on rigging accessories, and on the correct way to proceed when working with the materials involved.

the mast

A typical example is as follows. The mast butt is to be placed on the ground (or perhaps buried into the ground). If the mast is heavy, certain procedures are in order. Willing helpers can raise the mast to, say 10 feet (3m) or so above ground, then a support, such as a stepladder, can be placed under the mast. The situation is shown in **fig. 1**. A line secured to the point where the mast is supported by the ladder and extended in the direction you want the mast to rise can be used to hoist the mast into place, but this situation also causes some problems.

Assume the mast base is to be located at point X in **fig. 1**; the ladder support touches the mast at a point 25 feet (7.6m) from its base, the ladder is 10 feet (3m) high, and 100 pounds (45 kg) of weight rests on the ladder. Also assume the line is 200 feet (50m) long and attached to a tractor (or a team of helpers). A force of about 256 pounds (1139 newtons) should start the mast rising. Considering the coefficient of friction between tractor (or willing helpers) and ground surface, considerable more than this force would be required, since the force would have to be exerted nearly horizontally.

At the same time, a force of about 279 pounds (1241 newtons) acts to compress the mast between point X and the point where the line is secured. Unless the mast is blocked against movement toward the pulling force, the mast will probably be pulled off the support. To keep the mast at rest until the lift starts and to keep it from swaying later, it's best to have guy wires already attached, with helpers holding the wires to keep the mast steady.

If the mast has been properly blocked, but the mast is flexible, you may suffer the agonies shown in **fig. 2** depending on where the line is secured to the mast. This effect is called buckling and the unhappy result is that the mast will suffer a permanent kink, or you'll hear a loud snap. Buckling is the most common cause of failure of long, thin masts. The answer: use a gin pole.

gin pole number 1

There seem to be as many kinds of gin poles as people who have heard the term, and there seem to be even more ways to use them. The *ARRL Antenna Book*[1] isn't particularly helpful, and I can name at least 20 dictionaries, encyclopedias and technical handbooks (including the *Bluejacket's Manual*) that never mention the word. One reference[2] on gin poles and ropes I've found may be available only in trade school and public libraries.

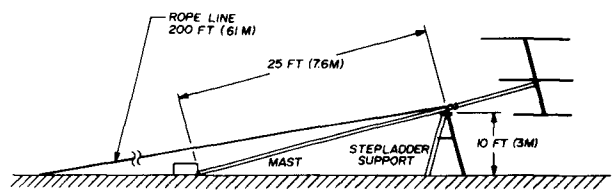

fig. 1. A typical problem — a mast is to be erected at point X. The mast is temporarily propped with a stepladder or other support. Rope is secured to the mast as shown and extended in the direction to which the mast is to rise. Forces involved can be tremendous and the mast may buckle.

All this variety means that perhaps we'd better talk

By David T. Geiser, WA2ANU, RD 2, Box 787, Snowden Hill Road, New Hartford, New York 13413

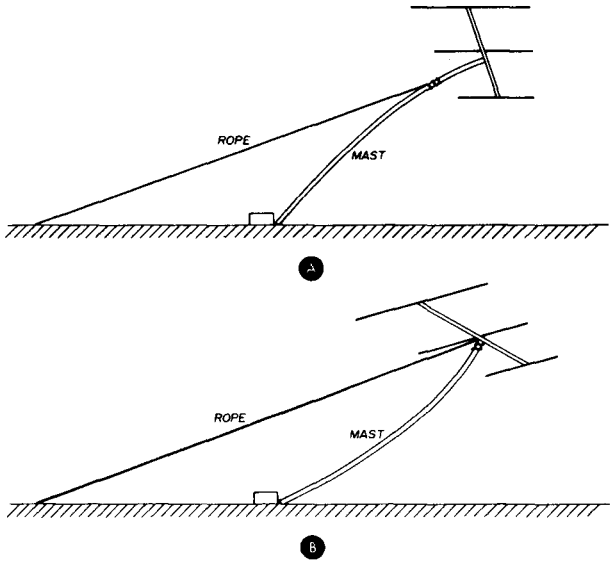

fig. 2. The buckling problem. In sketch (A) a single rope is secured above the mast balance point, which allows the mast to sag, as does a single rope secured to the top of the mast (B). In either case the mast may buckle.

about a few of the more successful kinds of gin poles so you can adapt the material you have to the job when it's time for the antenna-raising party.

Rossnagel[2] credits the American Standards Association with defining a gin pole as shown in **fig. 3**. (In Rossnagel's text, both weight to be lifted and pulling forces were directly below the pulley, or block). If we take the previous example but use a 20-foot-long (6.1m) gin pole located at the mast butt (point X), the required vertical force on the line would be 250 pounds (1112 newtons). The backstay would have to support 324 pounds (146 kg) and the gin pole 579 pounds (251 kg), assuming a 45-degree angle for the backstay. As the mast rises more than 53 degrees from horizontal, other people pulling on the mast guys (in the direction of the backstay) would have more effect than people pulling the gin pole line; however, the possibility of buckling still exists. Buckling would be less if one line went to our previous intermediate attachment point on the mast and another to the top of the mast. Pulling two lines at different speeds through the same block at the same time is a little like trying to pass someone when you're both going down the same playground slide. However, the two lines could be run through different blocks at the same point. (Another solution would be to run the two lines over a U-shaped bracket mounted on top of the gin pole; but the friction — and therefore needed pull — would be increased tremendously and the possibility still exists of the lines interfering with each other.

Before discussing other varieties of gin poles, something must be said about ropes and working with ropes. Rope is convenient, but the character of rope and the forces involved are dangerous to careless people.

A new Manila rope of ½ inch (12.5mm) diameter has a breaking strength of over 2600 pounds (1179kg). However, the safe working load for such rope[2] is only 265 pounds (116 kg). Such a rope would be marginal for the direct pull in the example of **fig. 1** and the mast line of **fig. 3**. Its use as a backstay in **fig. 3** would result in an overload. Doubling the rope is acceptable if both halves can be made to take the same stress. A rope should be used at about 10 per cent of its breaking strength (**table 1**).

Ropes that are old, rotted, kinked, wet, or frozen should be distrusted. (A wet rope or a wet splice is strong, but a wet rope kinks.) The old rules of the sailor apply: never step across a rope, never step inside a rope loop, and never wrap a rope around your hand or arm unless you want the rope to pull you. Always use heavy gloves when working with rope lines; old ropes; particularly used ones, can produce nasty burns.

table 1. Safe working loads for Manila rope (from reference 2). Data is based on no. 1 Manila rope, 3 strands, with a safety factor of 10.

diameter		working load	
inches	(mm)	pounds	(kg)
0.375	(9.5)	135	(61)
0.5	(12.5)	265	(120)
0.625	(16.0)	440	(200)
0.75	(19.0)	540	(245)
0.875	(22.0)	770	(349)
1.0	(25.5)	900	(408)

gin pole number 2

By now it should be apparent that the gin pole is shorter than the mast. The gin pole should be 1/3 to 1/2 the height of the mast. There is an advantage (but not an

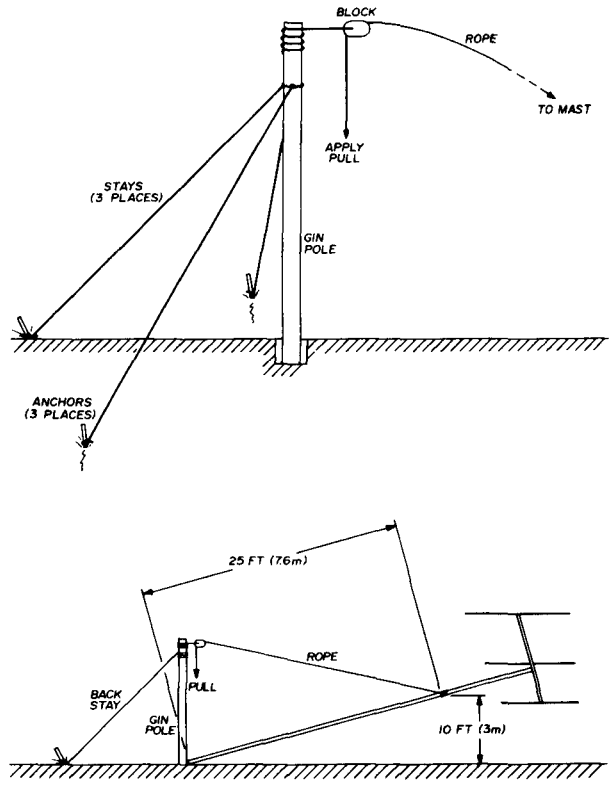

fig. 3. Gin pole no. 1: a fully guyed gin pole whose butt is located at the butt of the mast to be raised.

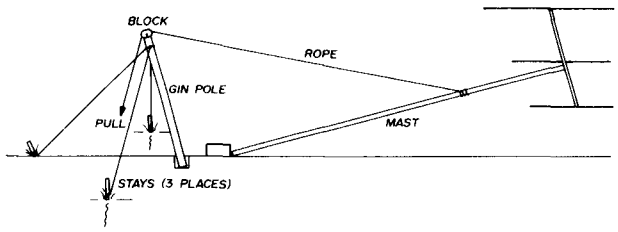

fig. 4. Gin pole no. 2: a fully guyed gin pole located some distance from the mast.

overriding one) in having the gin pole as high as the balance point on the mast.

In the first discussion it was assumed that the mast butt rested on the ground when the ladder support was used. If the support had been too close to the mast butt, the butt would have swung into the air, and the top of the mast would have crashed to earth. It's important that the gin-pole rope be fastened to a free mast *above* the balance point. This is what I meant when I said the butt end of the mast was supposed to be against the ground.

If the mast butt end is hinged to a heavy weight (such

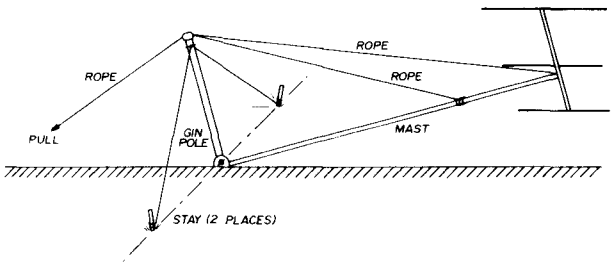

fig. 5. Gin pole no. 3: a swinging gin pole with mast and pull ropes secured at the gin-pole top. Gin pole swings vertically. Side sway is prevented with guys or stays.

as a foundation for the mast), the gin-pole rope line may be attached to (or even slightly below) the balance point, although I wouldn't consider that a very good idea. If the mast is of uniform cross section and the mast carries no extra load on top, the balance point is in the center. **Table 2** shows how the balance point moves on the mast as n changes. (n is the ratio of mast to top load, such as an antenna and rotator.) Thus if the mast weighs 4 times as much as the antenna and rotator, the balance point would be 60 per cent of the mast height. If the mast butt is larger than the top (and of the same general type of construction), the balance point would tend to be lower.

In the discussion of gin pole no. 1, pulling the rope is less effective when the mast rises to more than a certain angle. The reason is that the gin-pole rope tends to pull the mast down toward the gin pole rather than up into the air. This effect will be reduced if the gin-pole top is tilted somewhat away from the mast and the gin-pole butt likewise is moved back from the mast butt (**fig. 4**). The change of gin-pole position makes the first part of the mast raising harder but the last part easier. It does not cure the possibility of buckling, however.

While it's apparent that it's desirable to tie gin-pole ropes both at the top and slightly above the mast balance point, it may not be obvious what would be lifted by a single rope at each point in turn. On a perfectly stiff and uniform mast, a rope at the top would have to lift the top load and half of the mast weight. A rope at the balance point would lift the total weight of top load and mast. Thus the rope at the top may be considered to make up for the flexibility of the mast.

table 2. Ratio of mast weight to top-load weight as a function of balance-point location of mast height.

mast weight / top-load weight (n)	balance point location (% of mast height)
0.5	83.4
1	75.0
2	66.7
3	62.5
4	60.0
5	58.3
6	57.1
7	56.3
8	55.6
9	55.0
10	54.5

gin pole number 3

The swinging gin pole (**fig. 5**) has its bottom end pinned very close to the mast butt so that the top can swing downward as the rope is pulled. If the pull rope and two mast ropes are tied to the top of the gin pole, the mast will rise as the top of the gin pole is pulled down. The pulls at the top and slightly above the mast balance point will remain in good proportion so long as the mast butt is blocked so that the mast butt can move no further in the direction of the gin pole. (The ideal condition is when the mast butt and the gin-pole butt rotate around the same pin.) If the angle of the gin pole to the mast is 90 degrees (or a little less), the mast becomes vertical as the gin pole approaches the horizontal.

Note that the gin pole needs side strays anchored in line with the pin. This helps the gin pole to remain in a vertical plane. If the gin pole is narrow in the direction of the plane of movement, several sets of side stays along its height may help the gin pole bear much heavier loads.

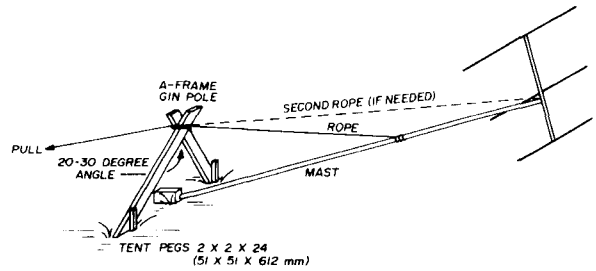

fig. 6. Gin pole no. 4: A-frame swinging gin pole. The spread legs provide help against side sway and allow mast and gin-pole butts to line up. Tent pegs are used to butt mast and gin-pole assembly.

Remember this as in the other procedures: helpers prevent *mast* sidesway by controlling the mast guy wires.

This technique is somewhat idealized as it isn't easy to use a single pin for mast and gin pole, and the forces on the pin can be fierce. (Since both butts can't be in the same place at the same time, the pin is subjected to bending as well as shear.)

gin pole number 4

My preference (because of a short mast, heavy rotator, and heavy beam antenna) is the A-frame swinging gin pole of **fig. 6**. Here, two pieces of 2x4-inch (5x10cm) lumber are pinned together with a bolt, and the bottom ends of the pieces are spread into a 20 to 30 degree X. The rope is tied in the manner shown in **fig. 7**.

The A-frame legs are blocked with 2x2 inch (5x5cm) tent pegs. The tent pegs are driven into the ground in line with the pin on the hinged mast. The mast butt is likewise blocked. Each butt (mast and A-frame) should be in line with, and at right angles to, the plane of the gin pole and mast movement.

Using the swinging gin poles, the longer the pull rope (within reason), the easier will be the job of rasing the

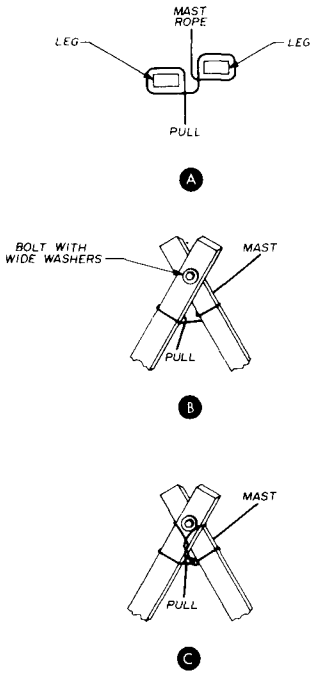

fig. 7. Rope ties at A-frame cross. Basic method is shown in (A) and (B). Rig at (C) is preferred to minimize slipping and bind the joint.

mast. From experience I recommend that the pull-rope length, from the gin pole to helpers, be two or three times the length of the gin pole. If a tractor (or an auto) is available to do the pulling, there's an advantage in having more rope length because of the better traction.

An auto (or any other conveniently located anchor) is more useful standing still if a long rope is available. The auto need only be moved to a location where the rope is snug. Then the pulling crew can raise the antenna by walking toward the antenna while pressing down on the rope (**fig. 8**). This procedure can bend or pull off an auto bumper, so it's best to anchor the pull rope to the auto frame.

This "walking-in" procedure is necessary at some time when raising a mast with any swinging gin pole. If the angle between gin pole and pull rope becomes more than 90 degrees, some of the pull force will tend to lift the gin-pole butt from its pivot. The last few degrees of

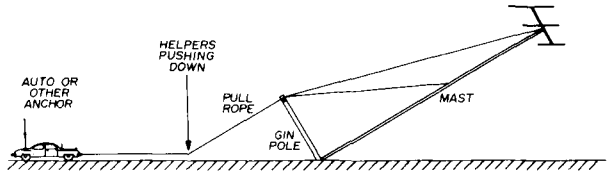

fig. 8. The "walking-up" procedure. With pull rope tight and anchored, the pulling crew walks toward the gin pole, pushing down on the pull rope. As the mast rises, crew pulls rope during the last few feet of rise (see text).

swing should be easy while pulling down on the rope — perhaps *too* easy! The weight of a heavy gin pole, without any pulling during the last few degrees of swing, may be enough to swing the mast to the vertical position and beyond. As the mast approaches the vertical, helpers on the mast guys away from the gin pole should keep their guys under tension so that the mast won't get out of control.

gin pole strength

A 20-foot (6.1m) length of 2x4 inch (5x10cm) lumber isn't very strong. A finished 20-foot (6.1m) length of 4x4 inch (10x10cm) lumber will safely bear about five times the load of a finished piece of 2x4 inch (5x10cm) lumber. The larger the pole, in thickness and width, the more load it will bear. It doesn't do much good to increase one dimension of the gin pole without increasing the other, although sometimes (as with the side stays discussed for gin-pole no. 3) lateral guys will help on the narrow side.

removing the ropes

When the mast is erect, the strain can be taken off the ropes and the gin pole can be removed. If the mast can be climbed, a helper can remove the ropes (don't forget the safety belt and its proper use). I prefer to use a heavy knob at the lift points while the mast is on the ground and use a doubled rope line from the gin pole to the lift points and looped over the knob. Thus the rope doesn't have to be tied to the pole. With two ends of the rope loose at the gin pole, one loose end is merely pulled over the knob, and the rope is down.

references

1. *The ARRL Antenna Book*, 1st edition, 1939, page 117, or 11th edition, page 259, ARRL, Newington, Connecticut.
2. W. E. Rossnagel, *Handbook of Rigging*, 1st edition, McGraw-Hill, New York, 1950.

ham radio