# The Low-Frequency Discone

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***If you've been looking for an antenna to feed with a flat line on all bands from 20 meters through 6 meters without switches or tricks, here's the answer.***

SUMMER IS A WONDERFUL TIME to crawl out of the basement into the sunlight to work on antennas. I was able to make that metamorphosis last summer, so if any of you pale-faced, hollow-eyed brass-pounders and microphone addicts plan to emerge from your winter haunts and enjoy the benefits of the great outdoors in the 1950 antenna season, I'd like to recommend a new and healthy antenna prescription.

The construction work on this new antenna will keep you out in the sun long enough to acquire a healthy tan, and the results of your efforts will be an amazing radiation system that performs the way amateurs have wanted antennas to perform since the days when Maxwell was a mathematician and not Jack Benny's automobile. As a matter of fact, Maxwell predicted what radio waves could do, but he didn't tell how they could do it. He certainly didn't dream up the discone—it took almost a century to get around to that development—but he undoubtedly would be pleased to know that at last there is available a method of coupling a radio signal to the ether in a clean-cut, efficient and fool-proof manner.

The discone is an antenna that has a low angle of radiation, presents a natural impedance match to a 52-ohm line over a 10:1 range of frequencies, and has a symmetrical configuration which minimizes the occurence of standing waves on the outside of a coax feeder. The impedance-matching feature is probably the most remarkable thing about the discone. It certainly should please the amateur who has had difficulty obtaining low standing-wave ratios on transmission lines and antenna-coupler links. Actually, with a discone antenna, coax feeder, and low-pass filter, antenna couplers can be dismantled and forgotten.

### Amateur Wizards

Sometimes amateurs have to become magicians with stubs, shorting bars, gamma-matches, T-matches, delta-matches, field-strength indicators, s.w.r.-bridges, grid-dip meters, loading coils, hack-saws, and crowbars to get an antenna system to work well on one frequency. The discone doesn't require any of the cut-and-try magic to make it work perfectly on *any* frequency. From the time the first hole is drilled until the last nut is tightened, the only measuring equipment needed is a ruler, and all that remains to be done after that is to turn on the transmitter.

An article by Joe Boyer, W6UYH, started the amateurs on this discone deal. The July, 1949, *CQ* presented the electrical theory, and it described the construction of high-frequency discones. After reading Joe's article, I was interested in trying the idea at lower frequencies and determining if wire and aluminum angle pieces could be used instead of the sheet metal prescribed for the original discones.

I also wanted to have an antenna for 10, 11, and 20 meters that would radiate and present a reasonably constant load to the transmission line in the television spectrum in order to study the effectiveness of low-pass filters for TVI. Some of the television interference tests also required a reduction of r.f. fields in the vicinity of the transmitter, so the symmetrical discone, promising a minimized standing-wave condition on the outside of the coax, looked like the answer to the antenna problem.

### Antenna Project

With encouragement from Joe Boyer by correspondence and with the approval of the XYL, I assumed responsibility for the top of the garage, and

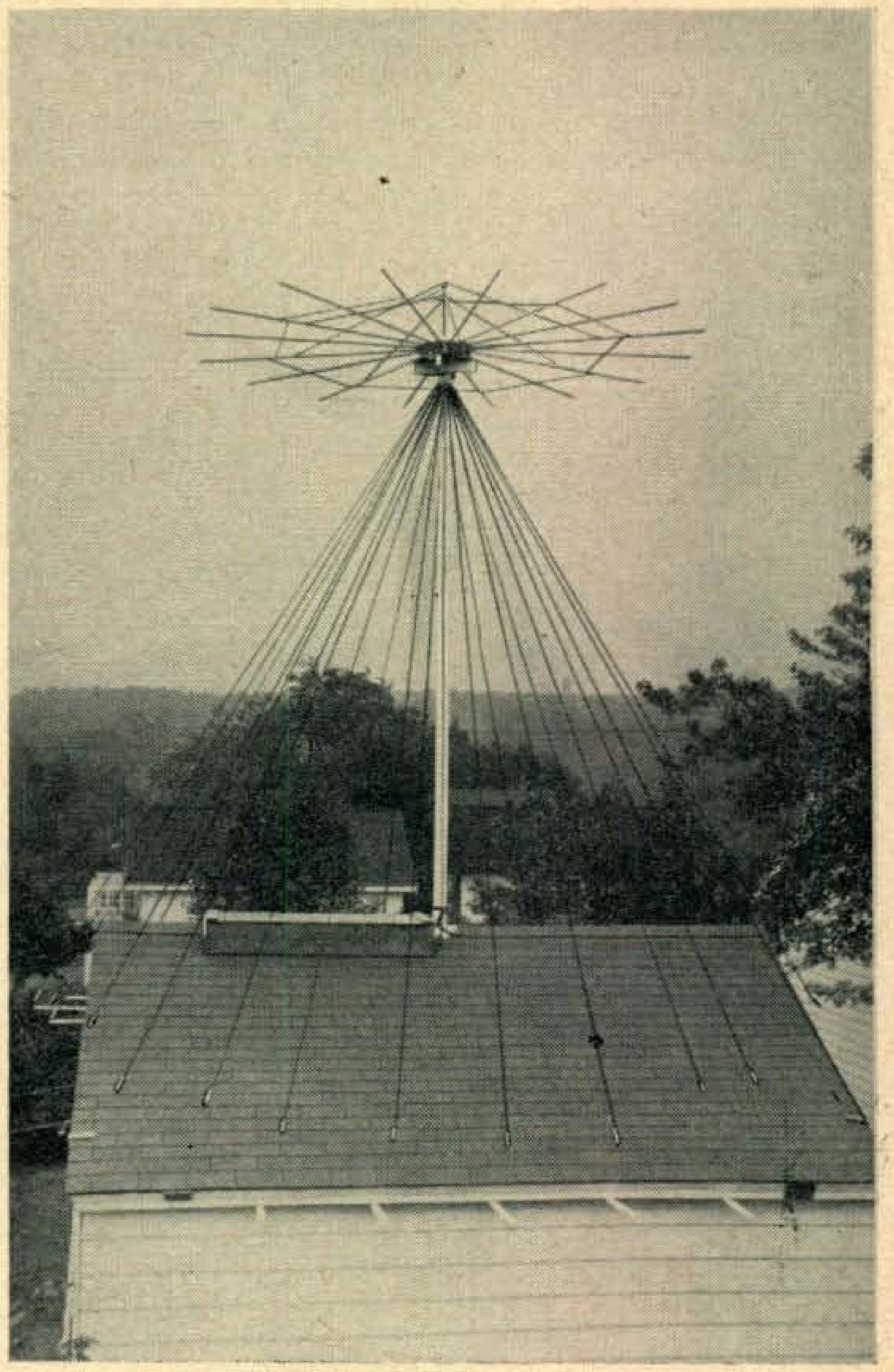

**Fig. 1. Side view of the 11-mc discone. The disc is made of angle aluminum, and the cone consists of 28 wires which are fastened to specific points on the garage roof and to outriggers. The 52-ohm coax feeder runs up the mast and terminates at the tip of the cone and the center of the disc assembly.**

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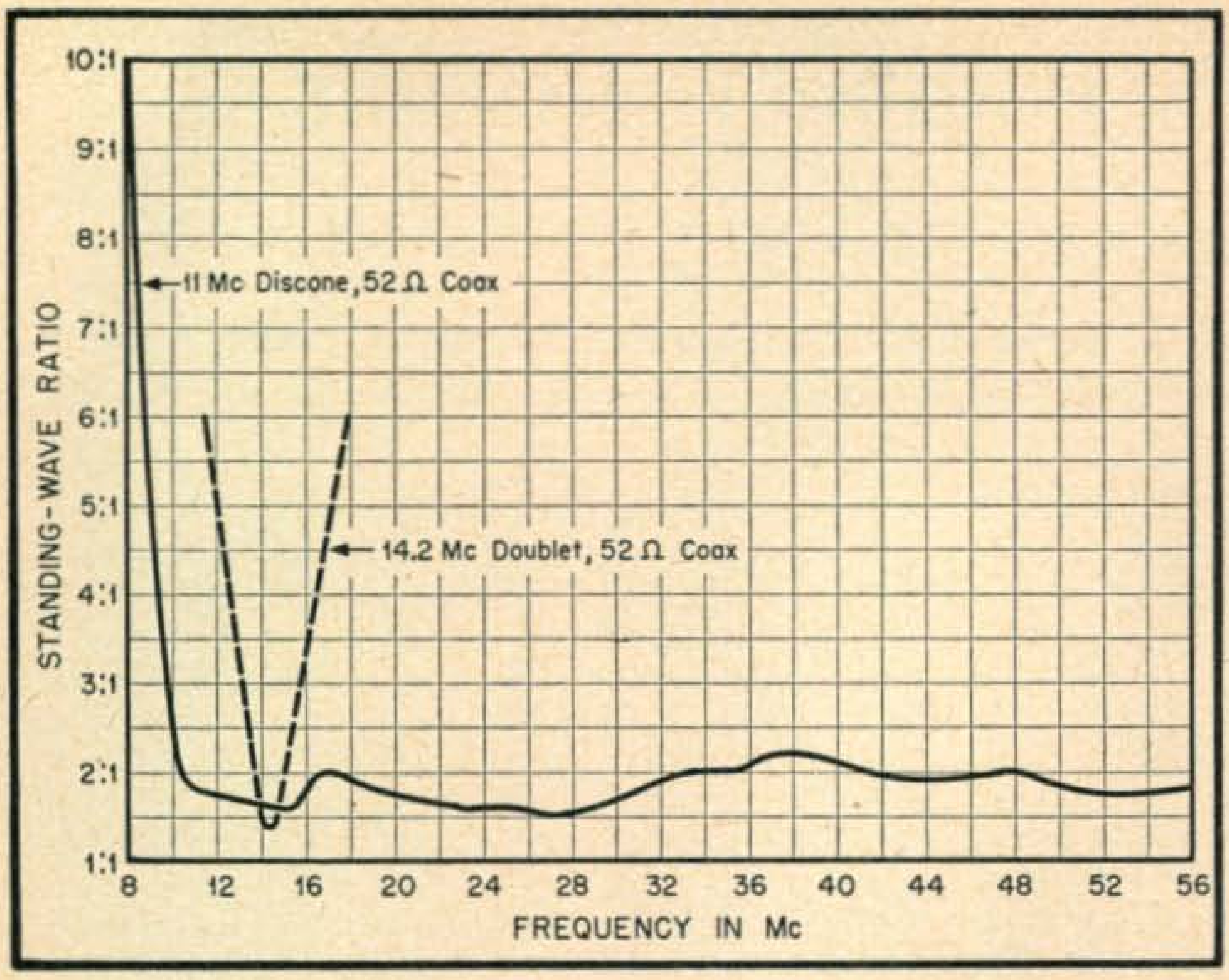


**Fig. 2. A plot of standing wave ratio vs. frequency of the l.f. discone when fed with 52-ohm coax line. The broken line is the s.w.r. curve of a conventional 14-mc doublet.**

began to work on the new antenna. There was just enough of the unknown and the element of uncertainty in the project "Monstro Discone" to make the adventure in the back yard during the summer of 1949 interesting and exciting. The results, however, were even more exciting, because when the antenna was finished it surprised everyone, including myself, by working perfectly, and it has been on the air ever since.

The specifications for the 11-mc discone are as follows:

| | |
|---|---|
| Length of cone wires .. | 21′ |
| Disc diameter ........ | 14′ 6″ |
| Cone-to-disc spacing ... | 1′ |
| Cone apex angle ....... | 60° |
| Diameter of cone base .. | 21′ |
| Height of cone ........ | 18′ |

This discone is the one shown in *Fig. 1*. It was cut for 11 mc because of an uncertainty in the safety factor required for good results at 14 mc. It is obvious from the s.w.r. curve, *Fig. 2*, that a much smaller safety factor is required.

For 20 meters, a 13.5-mc cut-off frequency should be adequate, so the dimensions for a 20-meter discone, along with 15- and 11-meter antennas are given in the following table.

**Fig. 3. The 100-mc discone, as arranged for photographing by the jr. op, Susie. The aluminum disc is 20″ in diameter, and the 60° cone is formed of 48 wires, each 37″ long. This bird cage is permanently installed in the attic and is used mainly for 2-meter work.**

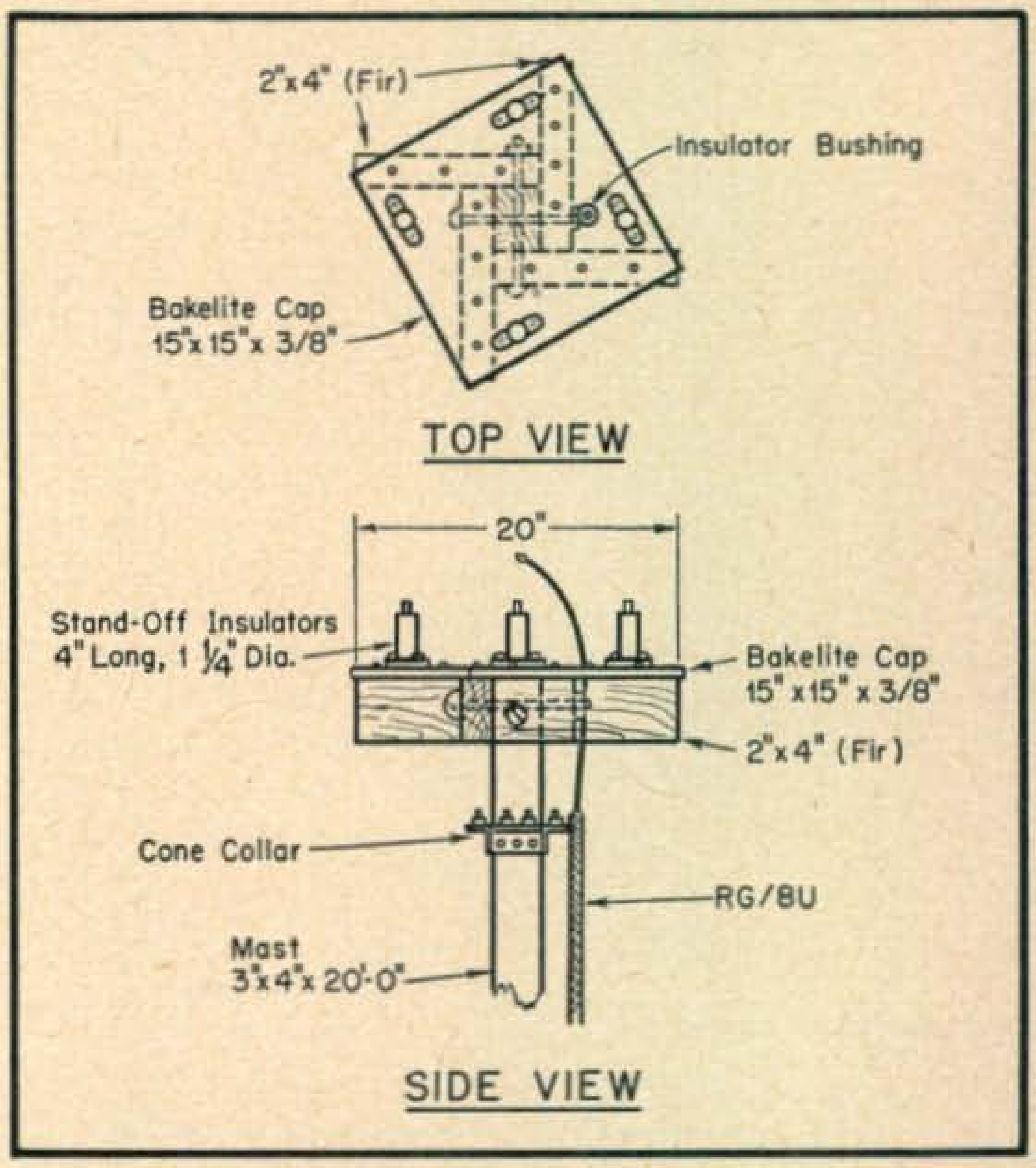


**Fig. 4. The insulator assembly. The disc of the discone fits over the bolts in the tops of the standoff insulators. The angle-brass cone collar is fastened to the mast with wood screws.**

*Table I*

| | | | |
|---|---|---|---|
| Cutoff frequency | 13.5 mc | 20.5 mc | 26. mc |
| Length of cone wires | 18′ | 12′ | 9′ 6″ |
| Disc diameter | 12′ | 7′ 10″ | 6′ 2″ |
| Cone-to-disc spacing | 10″ | 6″ | 4″ |
| Diameter of cone | 18′ | 12′ | 9′ 6″ |
| Height of cone | 15′ 7″ | 10′ 5″ | 8′ 3″ |
| Amateur bands | 20, 15, 11, 10, 6, 2 meters | 15, 11, 10, 6, 2 meters | 11, 10, 6, 2, 1.5 meters |

Joe Boyer's original article covers the discones for 50 mc and upwards, so the dimensions will not be given here. *Fig. 3,* shows a 100-mc model that now hangs from the rafters in the attic at W2RYI. Even though it is an "inside" antenna, it gets identical reports on comparison tests with an outside antenna cut for 2 meters. The "outside" radiator is a vertical, omni-directional antenna having three half-wave sections that are in phase. My 100-mc discone has 48 wires in the cone and an aluminum plate for the disc.

#### 11-mc Discone

Open-mesh design simplifies construction of large discones and offers low wind resistance. One-third of the cone elements in the 11-mc discone are made of #14 Copperweld. The rest of the cone elements are solid copper wire, but they all act as guy wires in addition to their primary function of radiating r.f. power. Since there are 28 of these elements, the mast is held firmly and does not sway in the wind. In the January "hurricane," the wind blew down our television antenna, but the discone mast weathered the gale without a tremor.

The disc assembly is also constructed to offer minimum wind resistance. A sheet-metal disc 14.5 feet in diameter would require extensive reinforcement, strong anchorage, and would exert a tremendous force on the mast in a high wind. The disc must also be insulated from the mast and cone, so any dielectric used to support the disc would have to be capable of withstanding great stress and strain.

By using 16 radials instead of sheet metal for the disc, the electrical properties of a continuous surface are approached, but the wind resistance of the disc is minimized. Strong winds do produce torsion at the center of the disc, and the mast twists a few degrees, but with the base of the mast held firmly in place, the twist distributes itself throughout the length of the mast, and no immediate damage can be done. In time this action might produce longitudinal cracks in the wood, but in the nine months that the 11-mc discone has been in operation, no fissures have been found.

Because of the radial construction of the "disc" and consequent minimized wind resistance, stock stand-off insulations may be used to support the disc assembly. Four porcelain insulators 4″ long and 1¼″ in diameter, are bolted to a bakelite mast cap. The cap (*Fig. 4*) is fastened with wood screws to four short 2 X 4's which are nailed to the top of the mast. This "insulating" structure makes a firm anchorage for the disc assembly which is bolted to the tops of the four porcelain insulators.

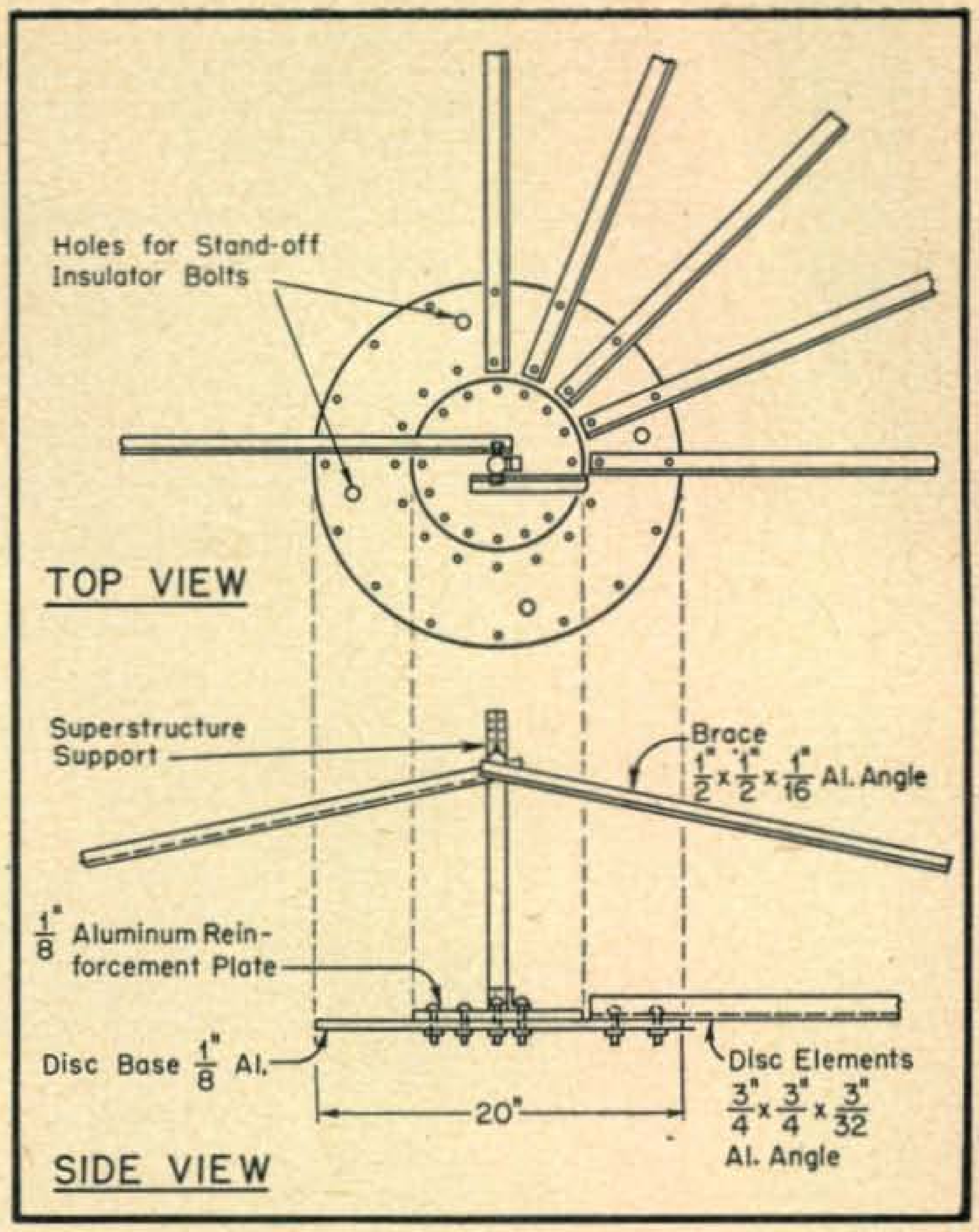


**Fig. 5. Views of the center portion of the disc, partially assembled. Five of the 16 disc elements and two of the eight superstructure braces are shown.**

#### Assembling the Disc

The disc structure can be assembled on the ground. An aluminum plate, ⅛″ thick and about 20″ in diameter, is drilled to take the radials, the insulator bolts, and the superstructure support. The superstructure support is a vertical member seated on top of the disc at the center, and it is held in place by two angle brackets which are bolted to a reinforcement plate (*Fig. 5*). After the aluminum-angle radials have been bolted loosely in place, the horizontal struts are added, then all bolts are tightened. Next, 8 aluminum-angle braces

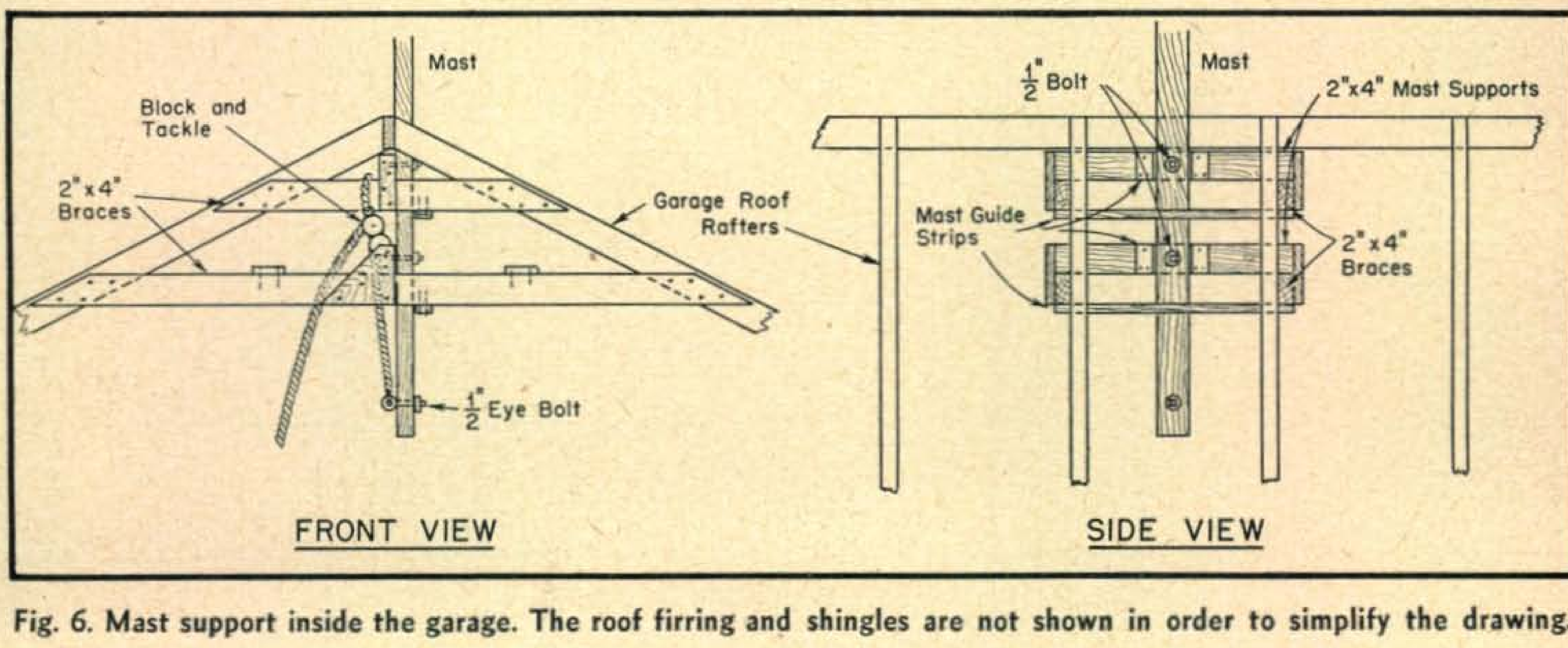


**Fig. 6. Mast support inside the garage. The roof firring and shingles are not shown in order to simplify the drawing.**

are bolted between the top end of the super-structure support and the midpoints of alternate radials. The intervening radials are connected from their midpoints to the tip of the super-structure support with galvanized-iron guy wires. The entire disc assembly is rigid and light, and can be lifted by one man into position on the insulators at the top of the mast.

### Mast and Feeder

The mast is a fir 3 X 4, 20 feet long. It passes through a hole in the center of the garage and is bolted to a structure inside the garage (*Fig. 6*). A block and tackle slung from the same structure makes it possible to raise and lower the mast. At its lowest position, the top of the mast can be reached from a step ladder placed on a roof platform that can be seen in *Fig. 1*. The step ladder is comfortable to work on when mounting the disc and attaching the cone wires.

A collar, made of angle brass, is screwed to the four sides of the mast at a position one foot below the disc. Around the periphery of the collar are 14 bolts (8-32s), each of which secures two cone wires. The collar also has one bolt to secure the lug that is soldered to the outer conductor of the coax feeder. Because the collar is the point at which the transmission line terminates, an extension made of #12 copper wire is soldered to the center conductor of the coax. This extension passes through a ceramic sleeve set in a hole in the bakelite cap, and then goes directly to a bolt in the center of the disc. Details are shown in *Fig. 4*.

### Cone Wires

Each of the cone wires is 21 feet long. Each has a strain insulator at one end, the other end having been bolted to the mast collar. The insulator terminates the radiating portion of each cone element, but wire extensions connected to the insulators are used to fasten the cone elements to the garage. Actually, some of the cone elements must be fastened to outriggers in order to establish a perfect conical structure.

The exact position and length of each outrigger, and the tie points on the garage for all the rest of the cone elements, can be obtained from a three-view drawing of the structure. Cut-and-try methods are also possible, but it saves time if the locations of all the tie-points have been determined in advance. *Fig. 7* shows the drawing used to locate the 11-mc discone on the top of our double garage.

Before the cone elements are fastened to the outriggers, the mast is raised and bolted in position. Aluminum foil of the type used by the XYL in the kitchen is cemented to the mast and roof with asphalt caulking compound to make a water-proof joint. Foil is advantageous because it will tear

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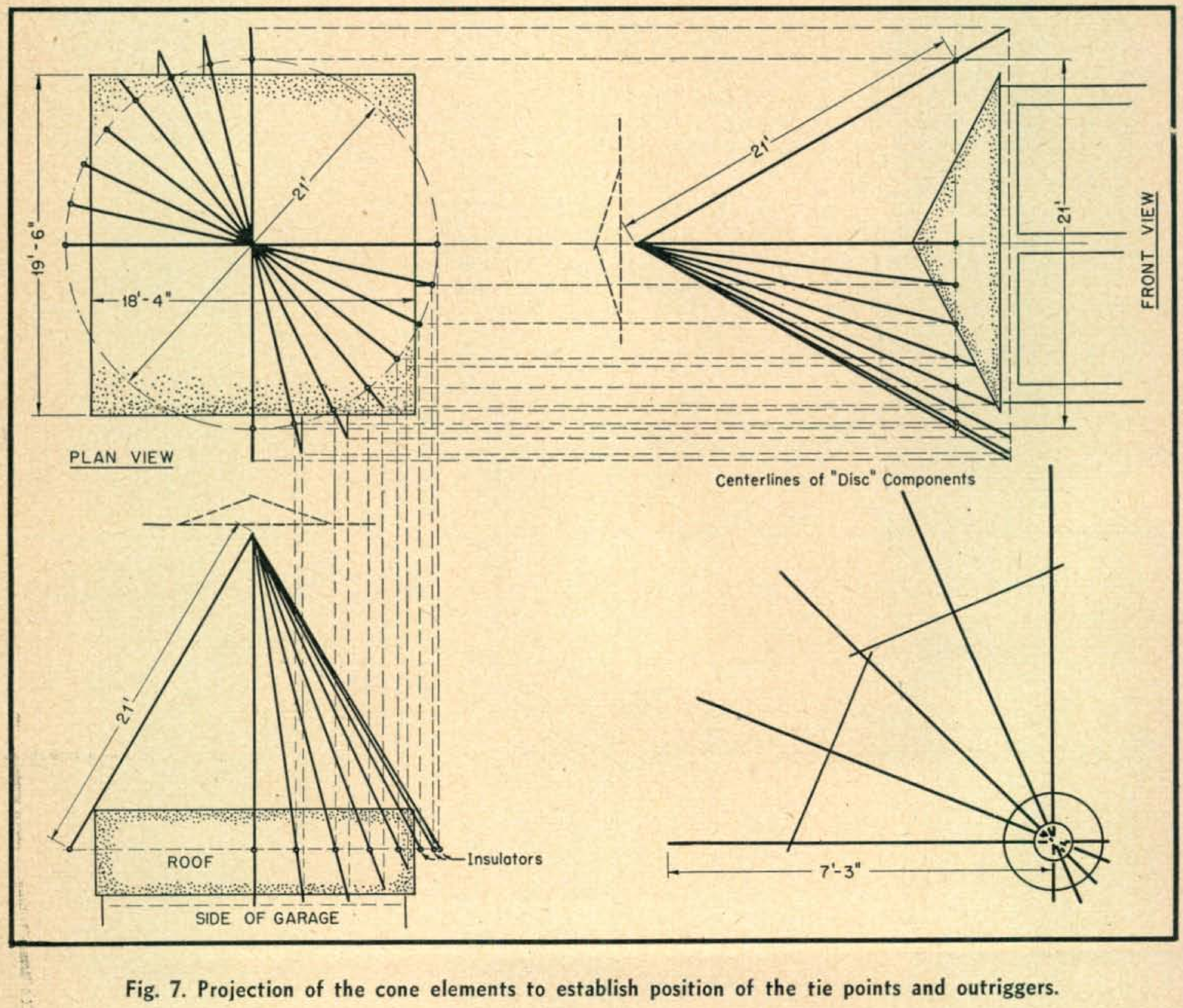


Fig. 7. Projection of the cone elements to establish position of the tie points and outriggers.

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easily if the mast has to be lowered at a time when the roof is icy and inaccessible.

The cone elements are fastened with just enough tension to keep them from sagging, and then, alternating from side to side and from back to the front of the garage, they are tightened to guy the mast uniformly. The coax is then connected to the transmitter, and the system is ready for operation.

### Feeder Systems

In order to keep the RG-8/U cable as far from the field of the discone as possible, I buried it at a depth of 10 inches for the 60 feet it traverses to the house. R.f. on the outside of the feeder is kept to a minimum, and no deterioration of the cable has been noticed thus far. A deeper ditch would have been dug if it had not been for the rocks. As far as transmissions are concerned, the coax can be strung eight feet above the ground with good results, but for the low-pass filter tests, the underground feeder operating into the discone presented an excellent, symmetrical load.

### Results

The 11-mc discone was finished on Labor Day last year. Since then, numerous comparison tests have been run on 20, 10, and 2 meters. Generalizations fom the data obtained indicate that the vertically polarized signal emanating from the discone is about 2-db stronger than a signal from a vertical dipole. Polarization is important on 10-meter ground-wave contacts, but it is only important that the receiving antenna and transmitting antenna be polarized the same way. If they are not in the same plane, as much as 40-db difference in signal strength can be found. The discone is a sure-fire target for signals from the mobile gang, and many enjoyable QSOs have been had over long ground-wave paths.

Evidence for the behavior of the discone at 29 mc in the range from 1000 to 1500 miles is conflicting. At times a horizontal dipole was 6 to 9 db better. At other times the discone was superior. On the long skip paths, however, the discone was always superior to a horizontal or a vertical dipole.

On 20 meters, polarization did not have as marked an effect over ground-wave paths as it did on 10, and comparisons with a horizontal dipole over short-skip, long-skip and DX paths always showed the discone to be the better radiator. After a month or more of such tests, I was convinced that the 20-meter dipole was superfluous, and took it down.

Six-meter tests have not been run, but some are planned in the near future. At 2 meters the 11-mc discone does radiate, but it is 10 db below the level of the "bird-cage" 100-mc discone. Loading is no problem at 144 mc because the S.W.R. is still reasonable at that frequency, but the large spacing between the disc and cone is probably the cause of the poor radiation pattern. Naturally, I use the 100-mc discone for 2-meter work.

The 11-mc discone will be used at W2RYI on 21 mc as soon as the 15-meter band it made available. When that important date arrives, the big discone will be the basic antenna for operations on 20, 15, 11, and 10 meters, and I don't think it's going to be too long before an 829-B will be feeding that buried coax in the long-neglected 6-meter band.