A SHORTENED 40 METER VERTICAL

BY RONALD LUMACHI,* WB2CQM

The author describes a top loaded vertical suitable for operation on 40 or 80 meters. Simple construction and ease of tuning make it ideal for Novice operation.

A FULL size vertical antenna for use at 7 mc and frequencies below offers difficulties, to say the least, in construction for the greater number of amateurs. Since the vertical polarization and resultant low angle of radiation are most desirable, other means are substituted to maintain the vertical configuration but shorten the overall antenna height. For example, if a reasonably high conductive ground is incorporated into the design, the antenna height is immediately halved since the earth's potential acts as a mirror and reflects the second (missing) leg. Bear in mind that the voltage and current distribution on the grounded quarter wave antenna are exactly the same as that present on a full half wave counterpart, *i.e.,* the voltage maximum and the current minimum at the furthest point from ground, and the impedance (ratio of current to voltage) highest at the high voltage point. (See fig. 1.) This important factor affords the oportunity to feed the antenna near the low impedance-high current point at the antenna base.

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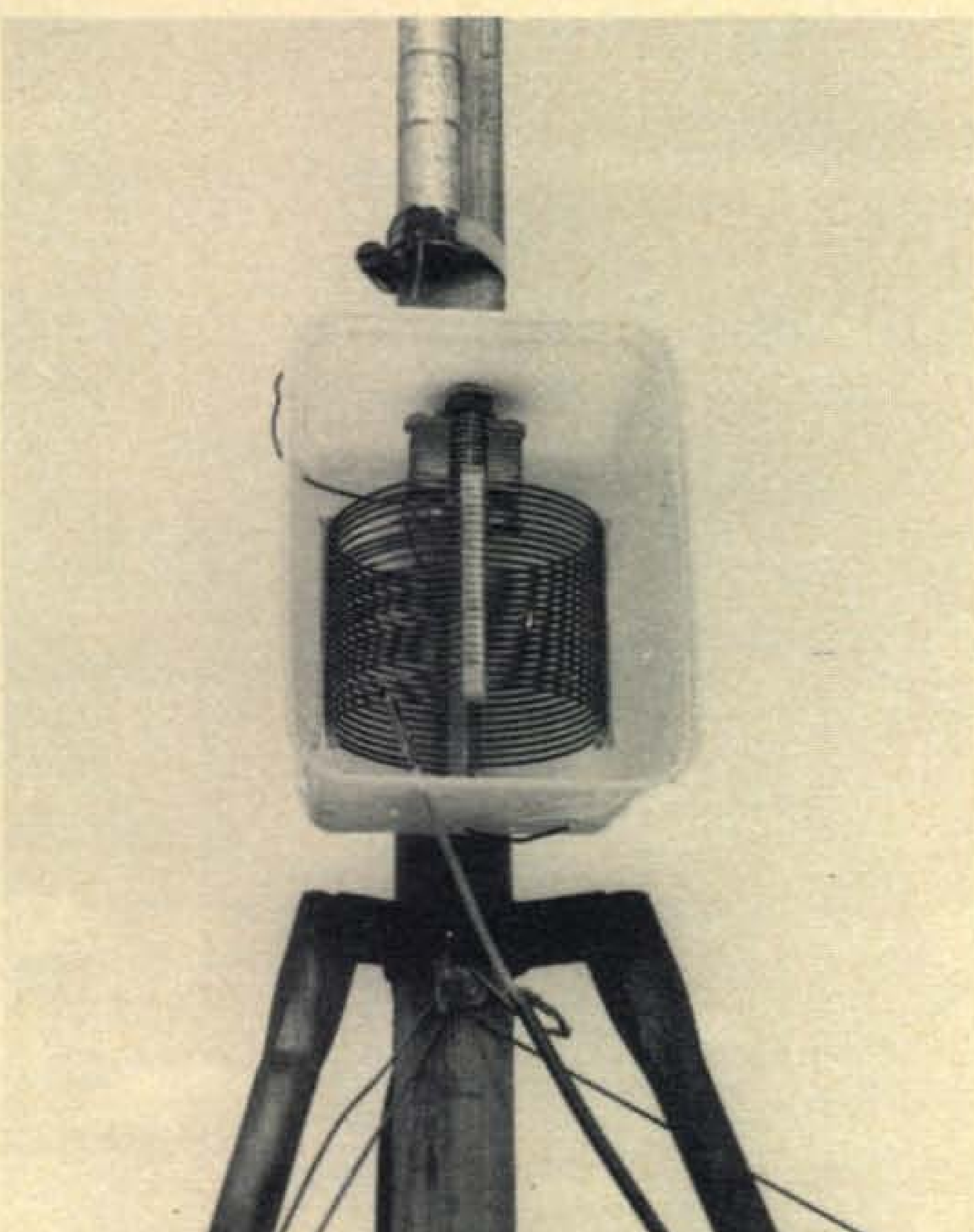


View of the lower portion of the vertical antenna with coil-capacitor combination. Note the connection of the coax braid to the three ground connecting wires. The antenna is mounted on a Bantam TV tower and bracketed to a wooden dowel insulator with two stainless steel hose clamps.

Although we have shortened the antenna by one half its length, it would still pose a problem in construction for even 40 meter quarter wave operation. Still further shortening of the array

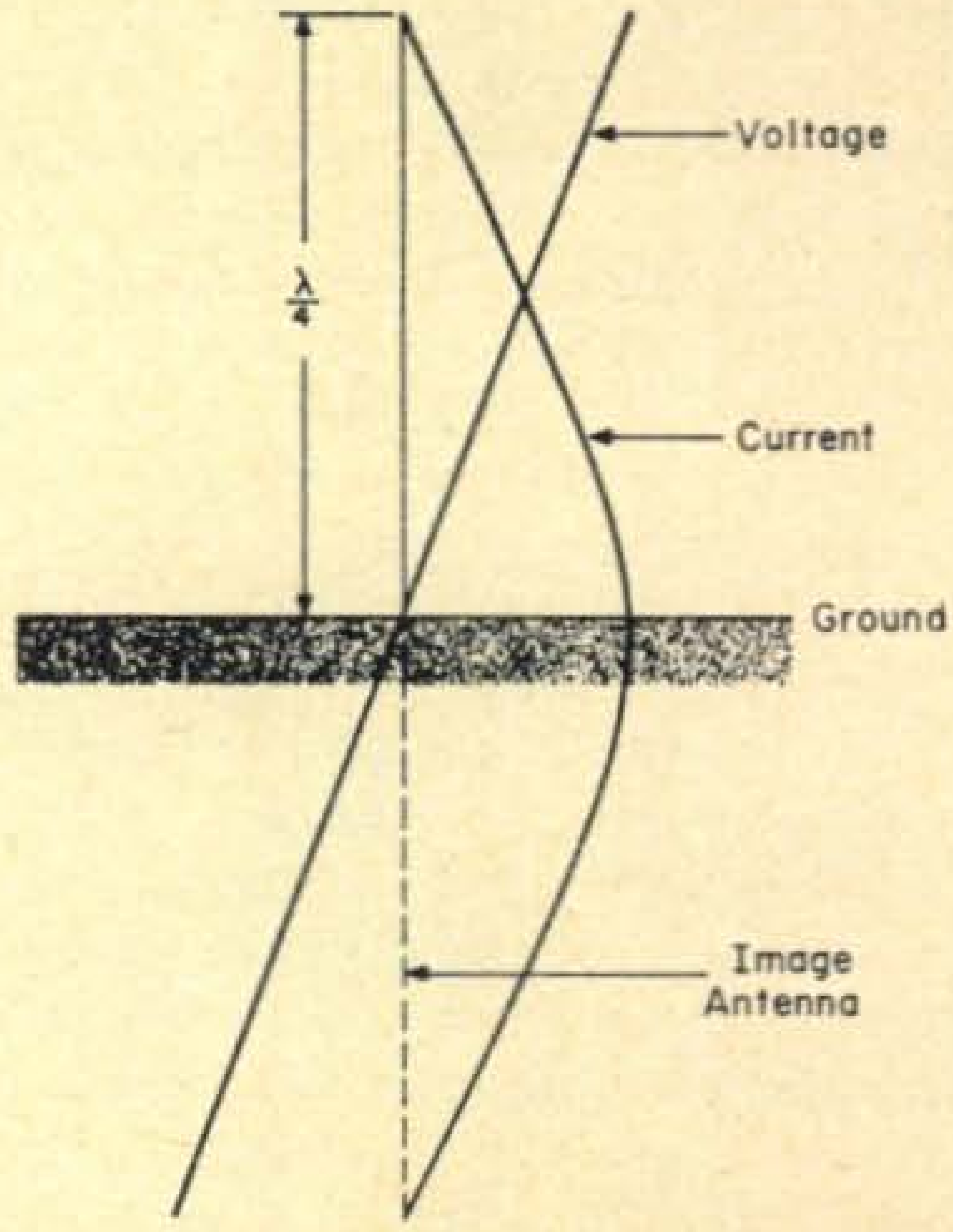
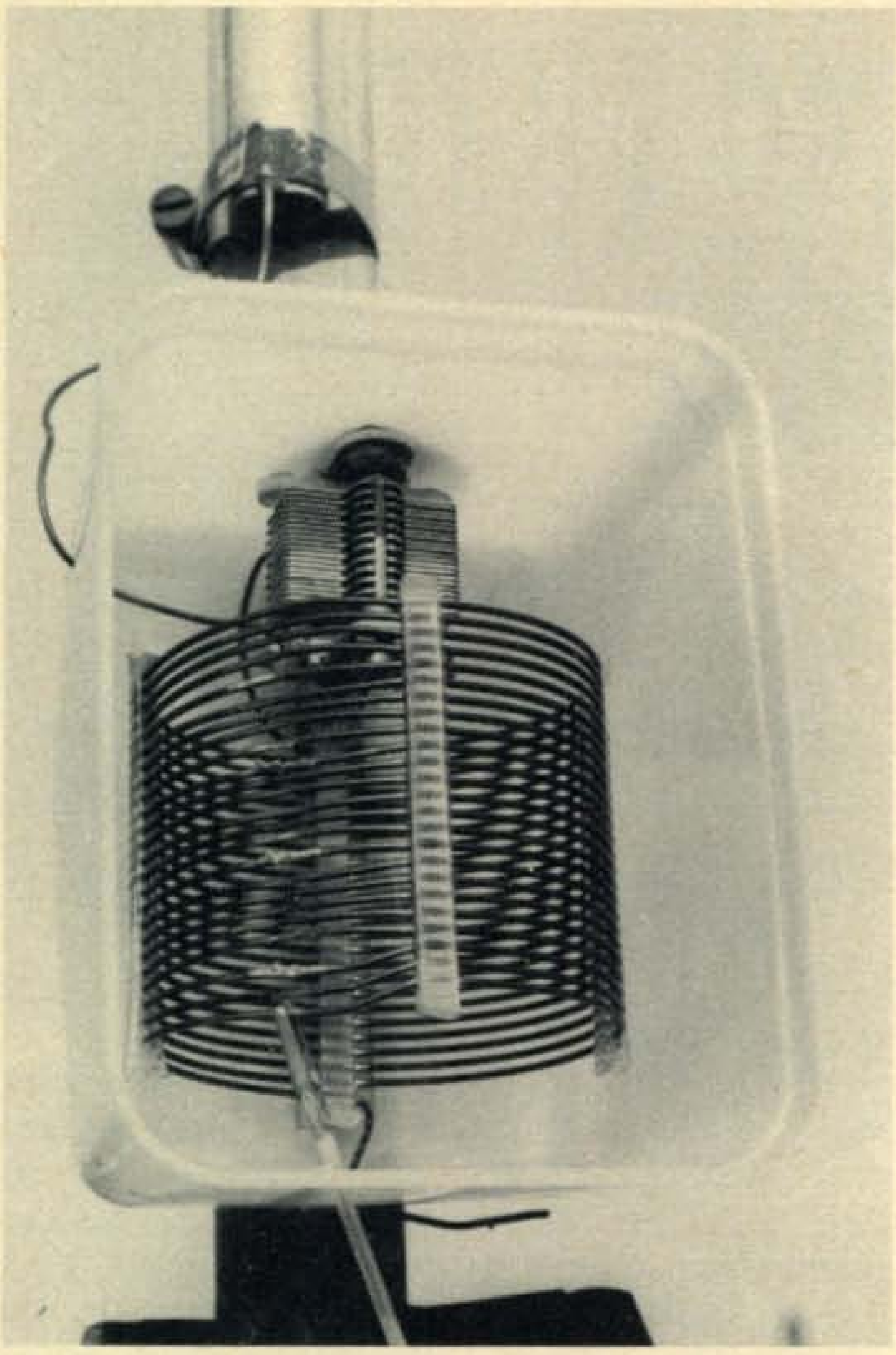


Fig. 1—Distribution of current and voltage in a grounded quarter wave vertical antenna.



Interior view of the plastic housing showing the loading coil and the series capacitor. The single spaced variable was used with low power. The double spaced variable is required for high power.

can be accomplished by substituting a loading coil at the base of the antenna. This will resonate the system in the proper amateur band and making the vertical array shorter and still less cumbersome as shown in fig. 2.

The distribution of voltage and current is affected slightly, but the low current point is still at the antenna base. It is apparent from the diagram that in the base loaded array the voltage-current distribution along the element length is somewhat skewed, however, it does not materially effect the antenna nor detract from its inherent vertical qualities. If the system were viewed from the top, its radiation pattern would appear circular or otherwise stated, omni-directional at the horizontal plane.

Antenna Impedance

The radiation resistance of a grounded quarter wave antenna is just half that of a half wave version. Stated generally, the impedance of a vertical system is a direct function of its length with a slight factor given to its actual structural form. For example, an aluminum tubing-type system would reflect a greater input impedance than a wide based crank-up tower with equal height and inductive components.

Since the impedance of a vertical antenna is considerably lower than 50 ohms, it will be necessary to increase the resistance of the antenna since the power dissipation factor is directly proportional to the radiation resistance ($P = E^2R$). Various approaches are available to the amateur. One briefly touched upon is the necessity of a good ground and the problem of achieving a good mechanical connection to this ground. Although a thorough analysis of antenna grounds and ground connection considerations are beyond the scope of this discussion, they briefly include the placement of interlaced wire and mesh over a large area around the antenna system; metal rods driven into the ground, and even outright treatment of soil to reduce its resistivity for a true closed circuit.

Top Loading

Another method of increasing the transmitting resistance of the antenna includes the placement of a concentrated amount of (self) capacitance

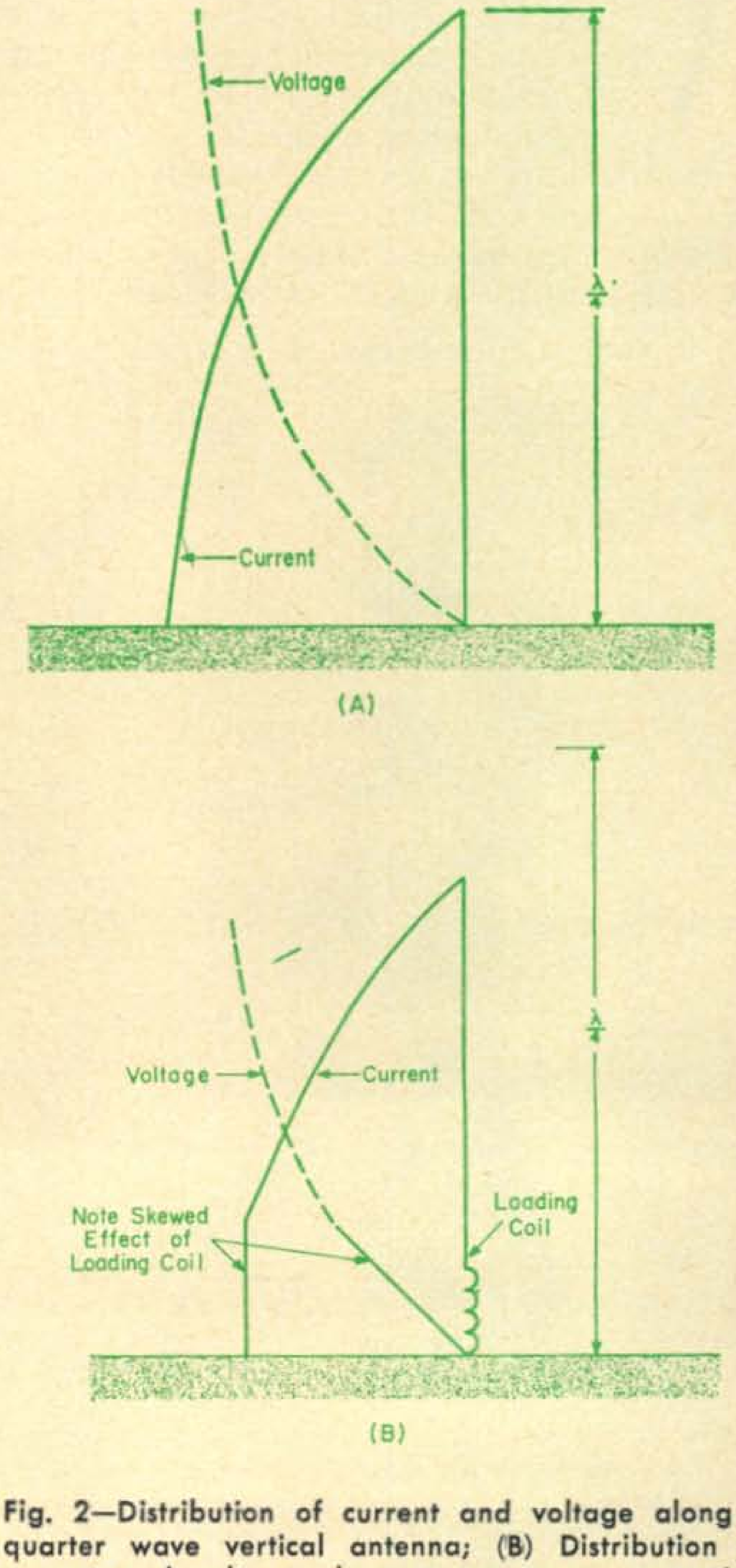
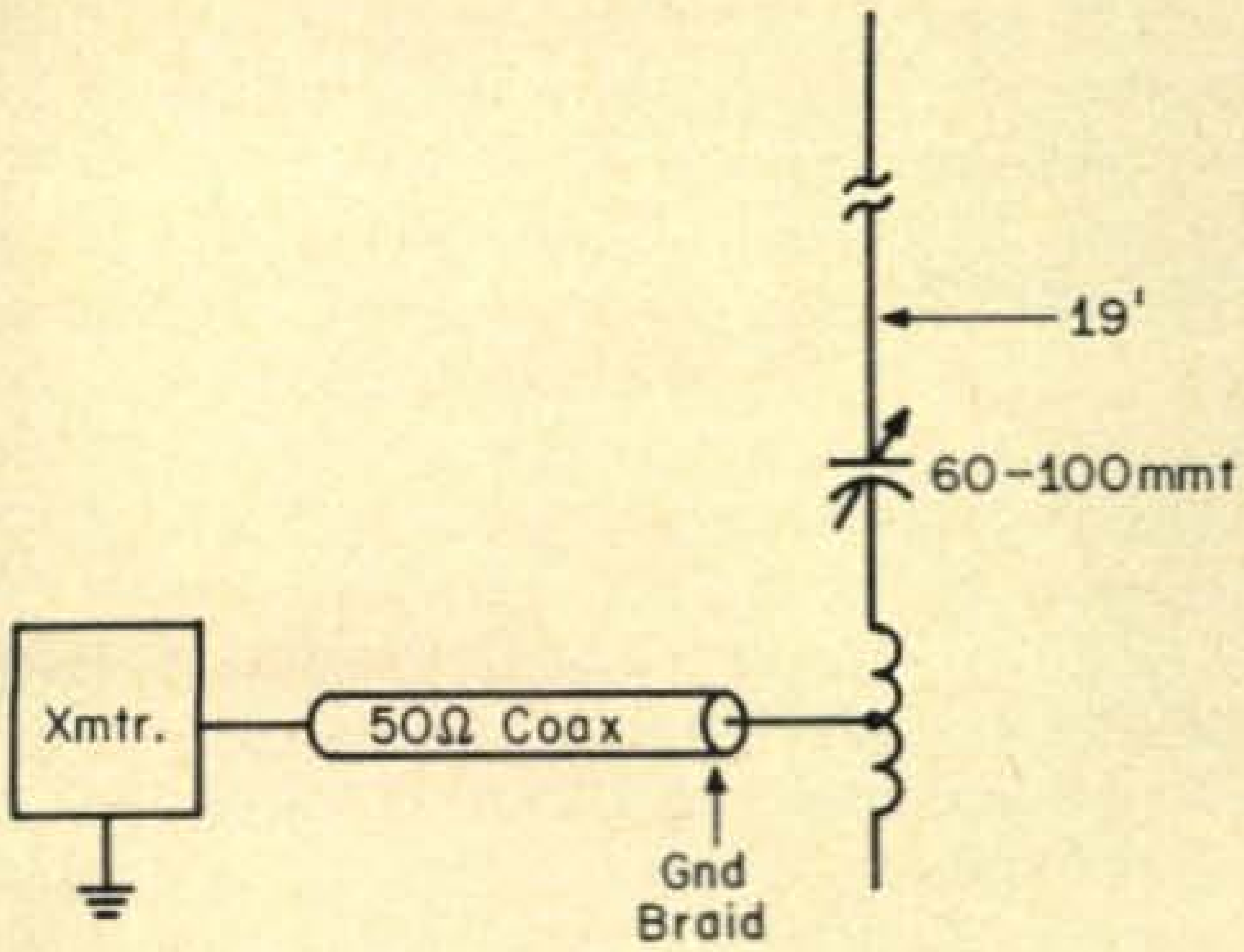


Fig. 2—Distribution of current and voltage along a quarter wave vertical antenna; (B) Distribution of current and voltage along a quarter wave vertical with a loading coil at the base.



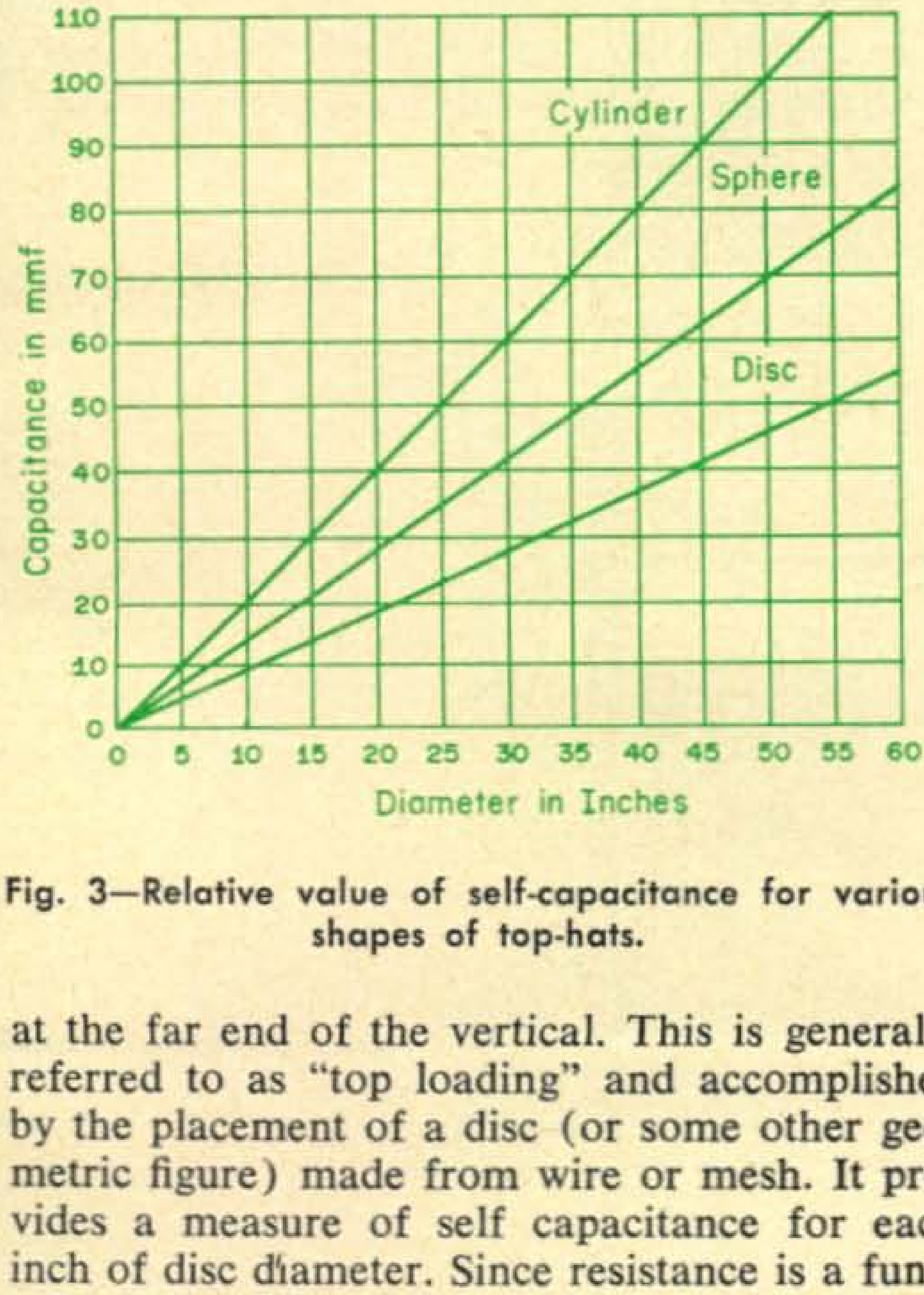


Fig. 3—Relative value of self-capacitance for various shapes of top-hats.

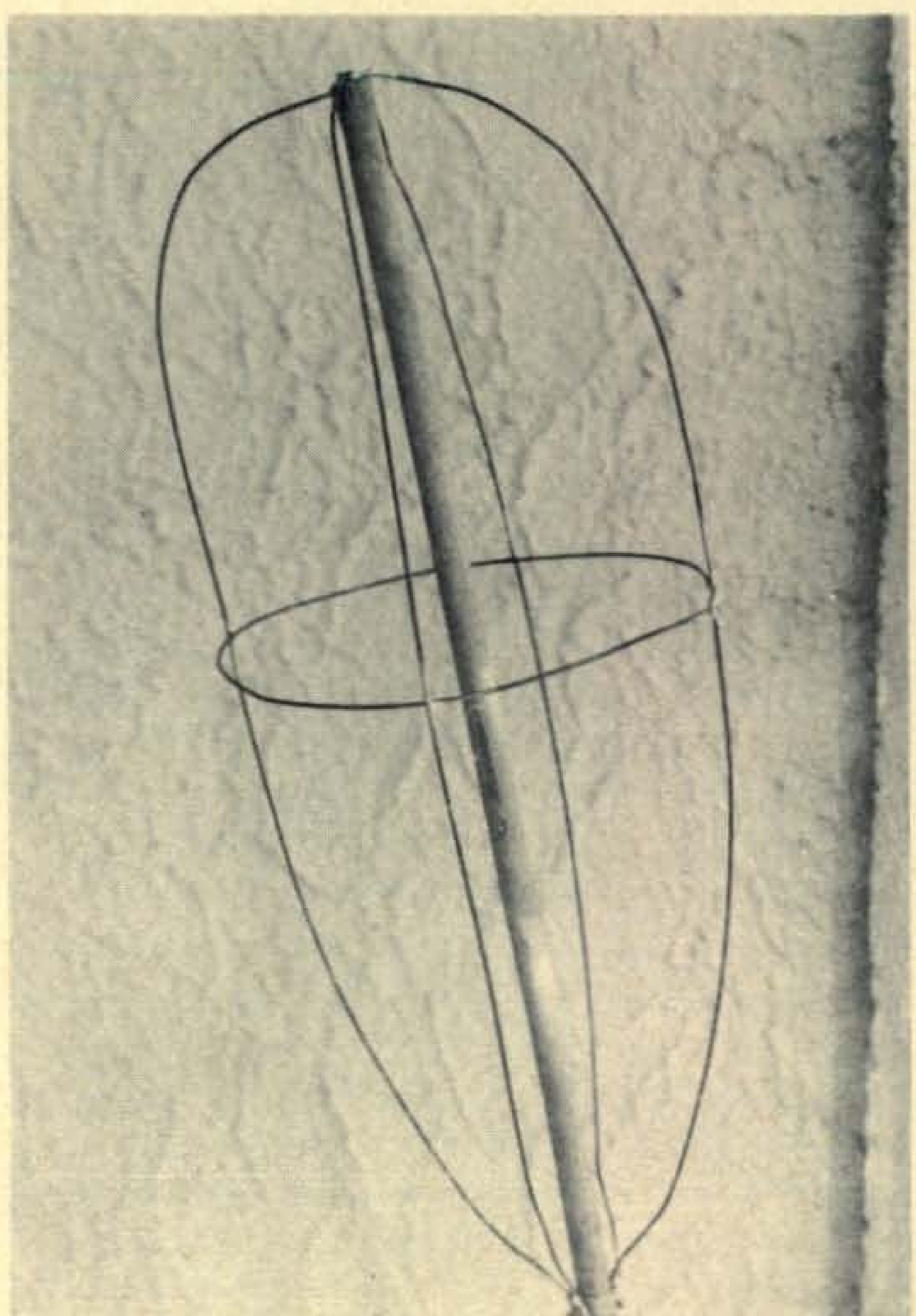
at the far end of the vertical. This is generally referred to as "top loading" and accomplished by the placement of a disc (or some other geometric figure) made from wire or mesh. It provides a measure of self capacitance for each inch of disc diameter. Since resistance is a function of antenna height, it naturally benefits the amateur to at least increase the electrical length of his system by incorporating the top-hat method. By the careful design and placement of a suitable top component, advantages such as a lower s.w.r. and greater power radiation results.

This component generally takes the shape of a sphere disc, or cylinder. Investigation has shown the cylinder shape as the most desirable since its inherent charateristics reflects the greatest value of capacitance. The relative merits of the three geometric figures are shown in fig. 3. Although the values presuppose a solid form, a wire skeleton can be substituted with only a negligible capacitor-loss factor. Needless to say, actual construction will be greatly simplified.

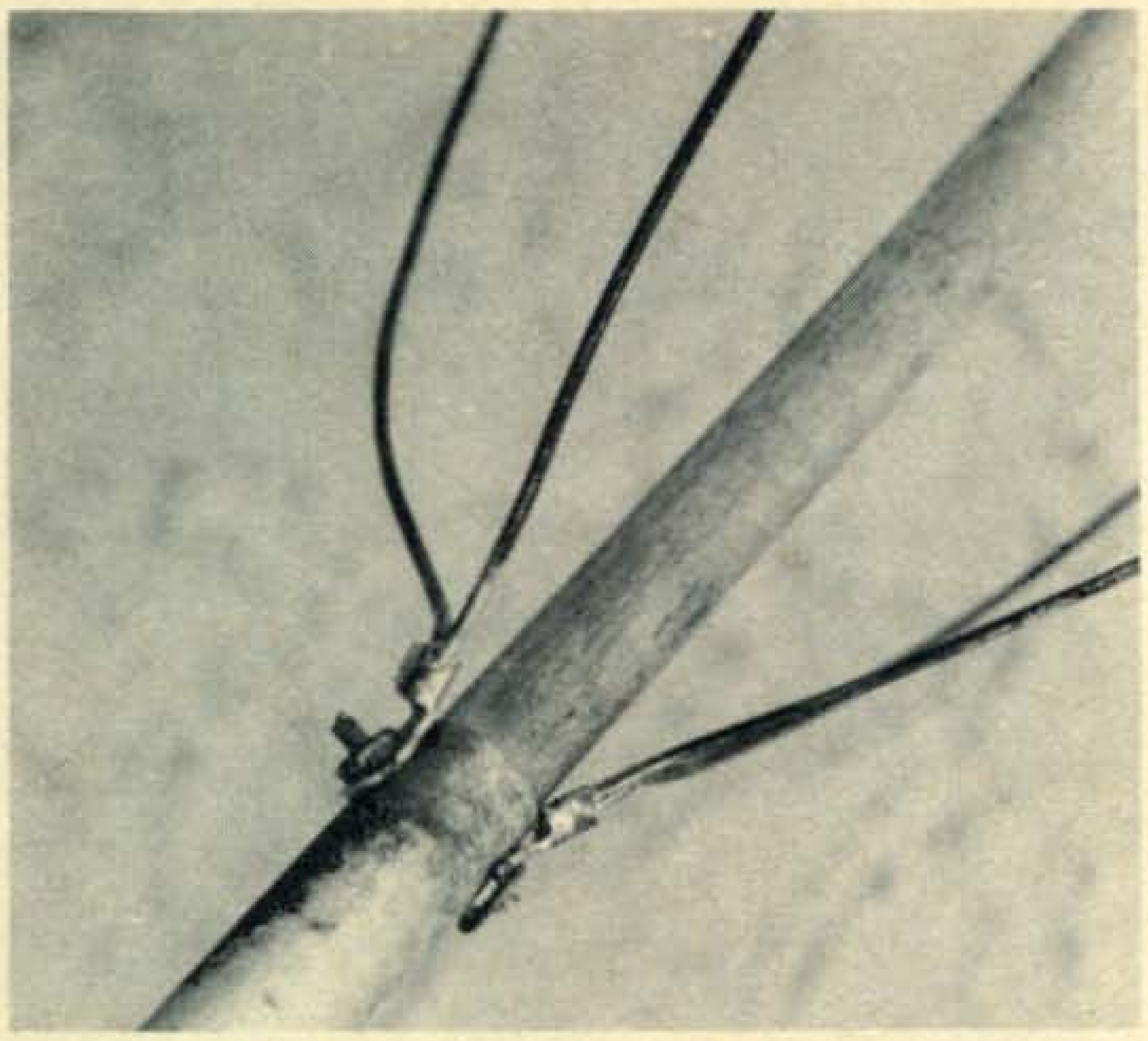
In the determination of antenna radiation resistance, some importance should be placed on the material used in the actual construction of the vertical, however, it is of little importance in the practical consideration and can be overlooked. Bear in mind however that a larger conductor will, as a consequence of its diameter, reflect a lower impedance. This factor may be of significance if a particular antenna installation reflects too high a radiation resistance factor and the vertical antenna material can be replaced with other diameters.

A Practical Application

Since the Novice is privileged to operate for only a one year period of time, a quickly assembled antenna system with good radiation characteristics is an absolute necessity. The vertical's ease of construction, low cost, and simple matching technique should command almost universal acceptance. Although the text has applicability for the Novice, the General operator can benefit materially from the vertical's low angle of radiation, rapid band switching, and DX possibilities. Admittedly this system is not the most favored as its lack of directivity is of chief concern; however, it is far better than the average means of getting a signal into the air. As far as the Novice is concerned, antenna



View of the top loading feature of the vertical supported by a ⅝" dowel.



Connecting point of the top hat to the upper-most portion of the vertical. Note the insertion of the nut-bolt combination through the solder lugs, wooden support insulator and through the tubing.

sophistication comes with the higher grade license once the pressures of theory and code accomplishment have been overcome.

Construction A 40 Meter Vertical

A 40 meter vertical antenna is constructed from two 10′ lengths of 1⅞″ telescoping tubing (0.058″ wall thickness) and adjusted to measure 19′. Bind the telescoped lengths with a stainless steel self tapping screw for a good mechanical bond.

The base loaded coil is series installed at the lower portion of the antenna. Wind the coil on a 3½″ form with 8 t.p.i. Use #14 enameled wire and wind 16 turns if 80 meter operation is contemplated. A reasonably spaced capacitor of about 60-100 mmf may be series installed between the coil top and the antenna base to assist in tuning. This component is in essence a means of fine tuning the individual system once the proper tap on the coil has been selected.

It is advisable to incorporate some means of protecting the coil from the weather. Rain, for example, can materially alter the inductance of the coil and upset the resonant frequency of a finely tuned array.

Wiring is rather straightforward. Keep leads short and solder all permanent mechanical connections. If the system will ultimately be installed on top of a roof, provide a good ground. Generally a vent pipe protrudes through the roof and allows for the connection to the necessary ground. Use 50 ohm coaxial line and attach the braid to the earth ground. The point at which the center conductor connects to the coil will determine the band and can either be moved manually or through some remote switching arrangement.

The top hat component is made from two lengths of #12 wire cut to 53″. Attach four solder lugs, one at each end. From the photograph it is seen that this unit resermbles a somewhat elongated oval thereby encompassing a degree of rigidity with the high capacitance factor of the cylinder. The diameter of the oval's center measures 8½″ and its form is maintained by securing a circular shaped length of wire at the four intersecting points about midpoint of the oval. For additional support of the oval, extend the vertical by installing a 26″ length of ⅝″ wooden dowel. Insert 3″ of dowel into the end of the vertical. Drill a hole through the tubing and dowel and insert at 1″ nut and bolt combination through the solder lugs, tubing, and dowel and tighten securely. A small "U" tack hammered into the top end of the dowel will complete this phase of construction.

The 40 meter band will resonate about 8½ turns from the vertical's end of the coil. If other ferquencies are of interest simply grid dip the coil while adjusting the coil length. Bandwidth is rather good and only major frequency changes will require additional coil-tap consideration. ■

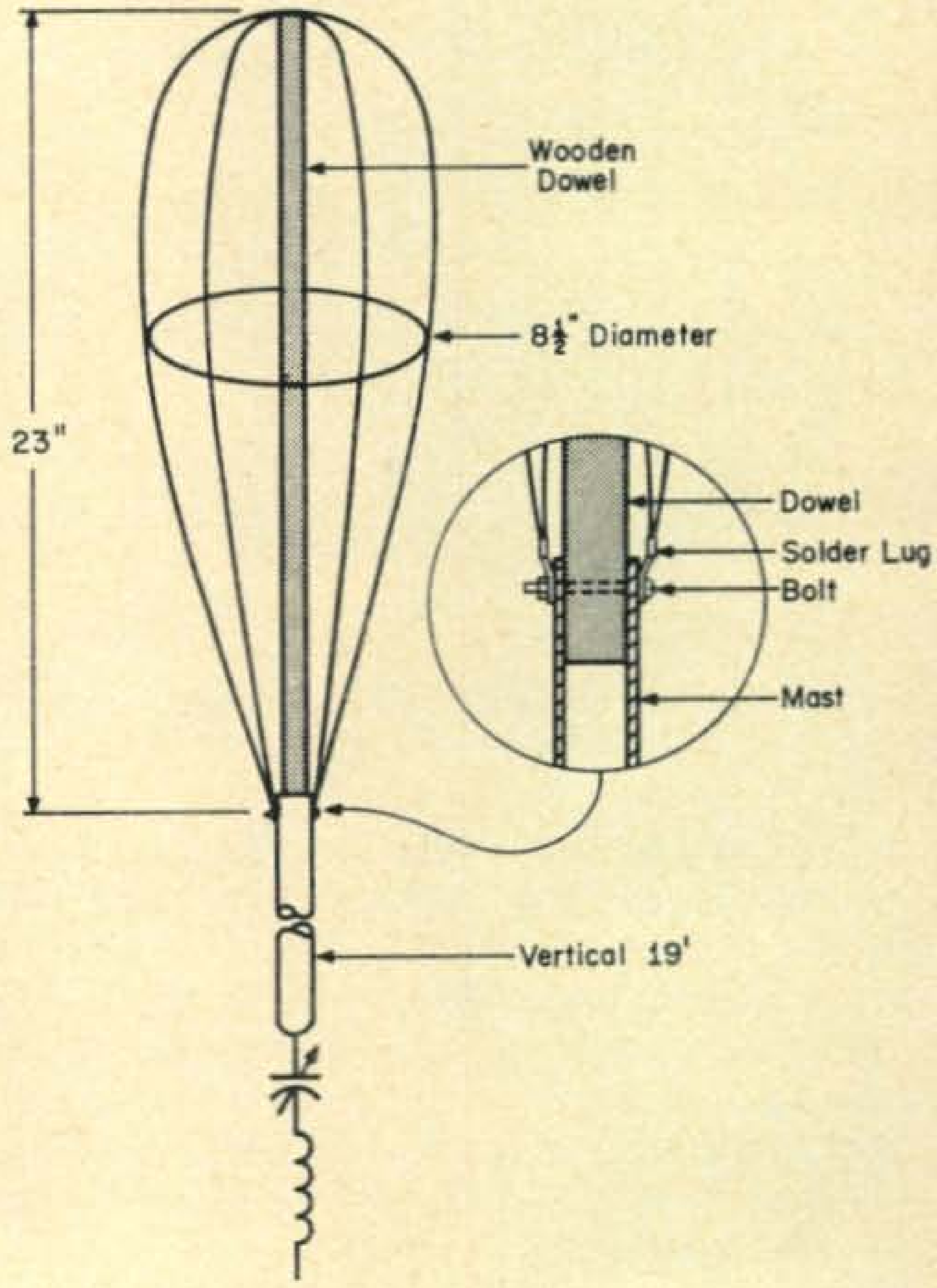


Fig. 4—Specifications and dimensions of the top loaded vertical antenna.

PARTS LIST

1—length of 10′ alum. tubing, 1″ dia. (0.058″ wall).
1—length of 10′ alum. tubing, ⅞″ dia. (0.058″ wall).
1—length of ⅝″ wooden dowel, 26″ long.
1—coil, 16t. # 14e., 8 t.p.i.
12′—#12 copper wire.
4—¼″ solder lugs.
1—60-100 mmf double spaced variable capacitor.
1—plastic container to house coil and capacitor.