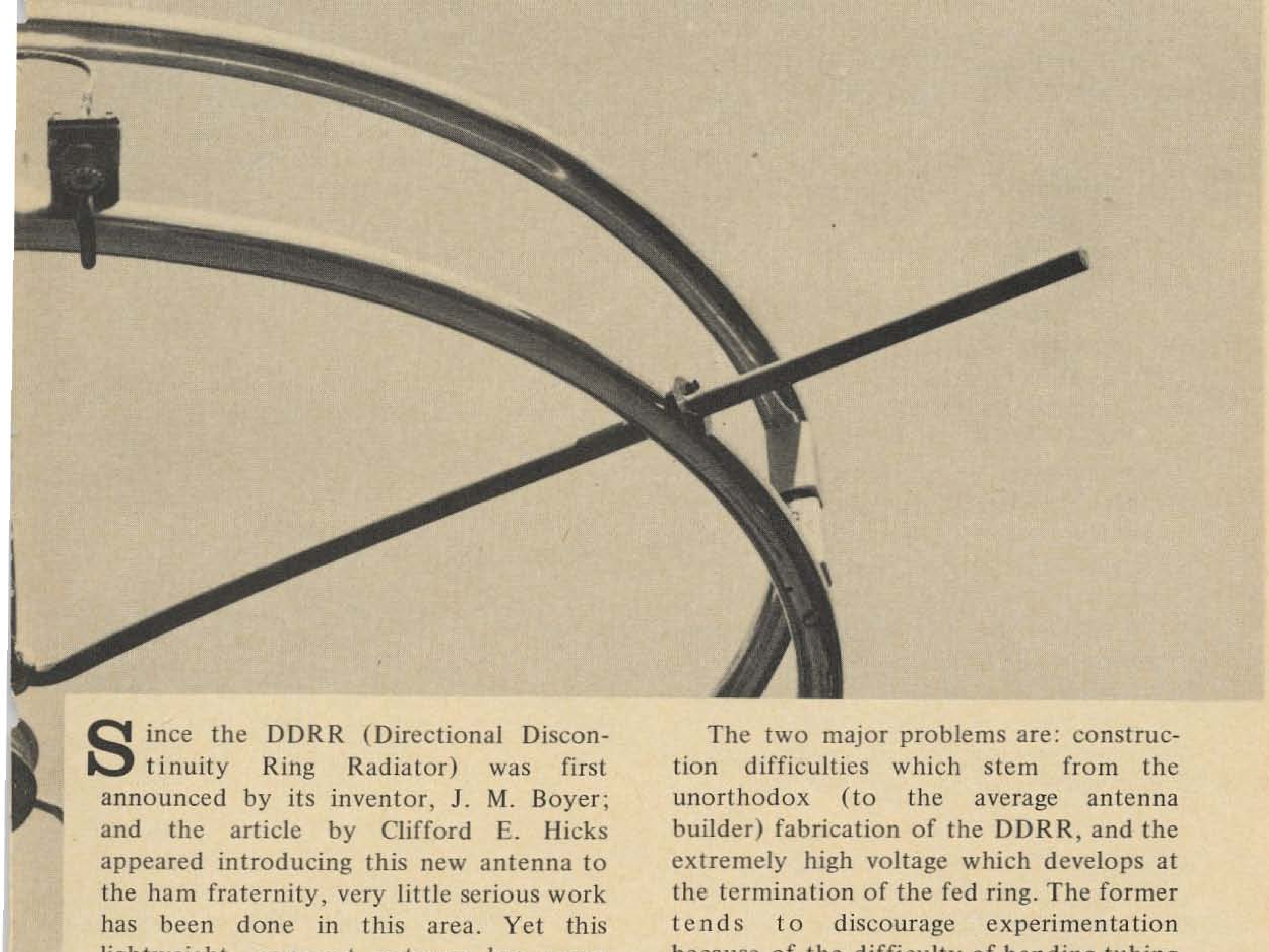
A PRACTICAL

DDRR ANTENNA



Since the DDRR (Directional Discontinuity Ring Radiator) was first announced by its inventor, J. M. Boyer; and the article by Clifford E. Hicks appeared introducing this new antenna to the ham fraternity, very little serious work has been done in this area. Yet this lightweight, compact antenna has many features which recommend it for use by hams. I, for one, have found it a most interesting antenna to work with. In spite of its many advantages the DDRR has some drawbacks which might discourage the otherwise interested amateur.

The two major problems are: construction difficulties which stem from the unorthodox (to the average antenna builder) fabrication of the DDRR, and the extremely high voltage which develops at the termination of the fed ring. The former tends to discourage experimentation because of the difficulty of bending tubing with reasonable accuracy and in arriving at a configuration with the mechanical stability that the sensitive nature of this antenna demands. The latter challenges the average junkbox to produce a tuning capacitor which will withstand the voltage and not

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exceed the dimensions of the antenna itself. Indeed, it is difficult to locate a suitable capacitor for this service among the standard units available from the manufacturers. Another discouraging factor is the fairly large ground plane employed, which makes the antenna difficult to mount and gives it the appearance of a hovering flying saucer.

After working with antennas of this nature since 1965, I have evolved a design which overcomes, or at least minimizes, these problems. This design is such that any amateur, reasonably proficient with common hand tools, should be able to construct a DDRR antenna which will not only work well, but which is also easy to mount and easily equivalent to a quarter-wave vertical in performance.

For those who may not be familiar with this extremely interesting radiator, a brief description is in order. Essentially the DDRR consists of a quarter-wavelength element bent to form a ring, open for a small percentage of its circumference, mounted, horizontally, a few inches above a ground plane surface. The feedline is connected between one end of the circular element and the ground plane. It is usually tuned at the end farthest from the feedpoint by means of a low-capacitance variable condenser between the ring and the ground plane. (See Fig. 1.)

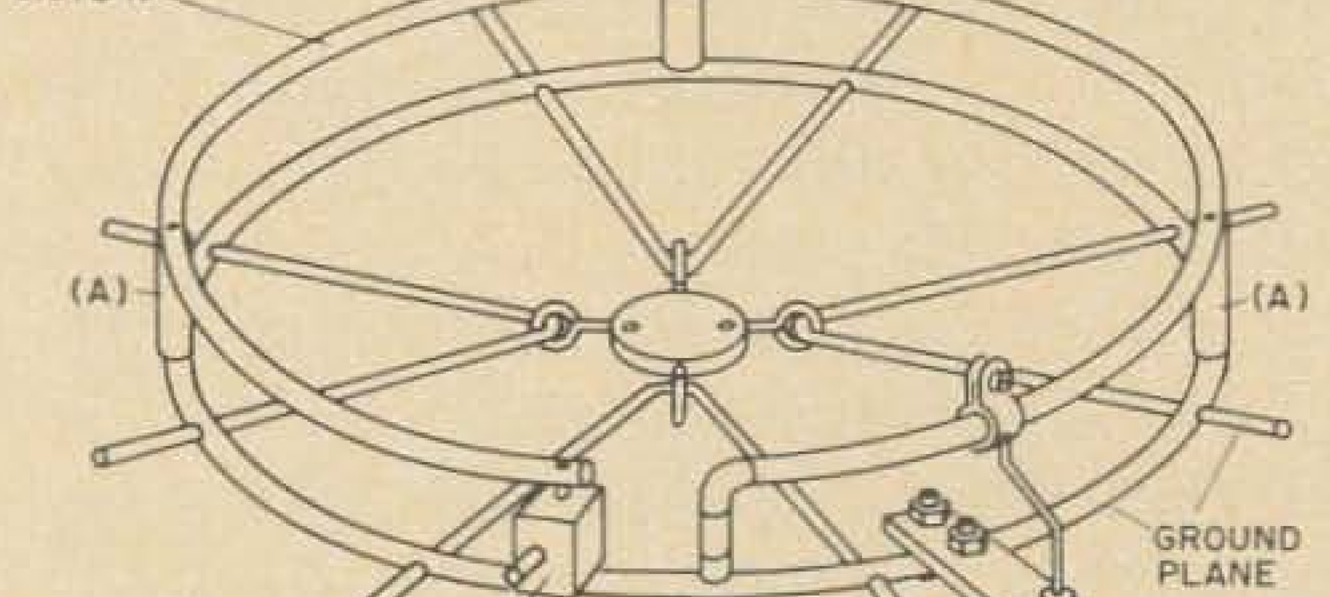


Fig. 1. Basic DDRR.

In contrast to its appearance, this antenna, like a ¼-wavelength vertical, develops a vertically polarized radiation signal. It is also interesting to note that this antenna displays exceptionally high Q and is sharp enough in tuning to be considered an additional tuned circuit in the communications loop. If the fed end of the discontinuous loop is grounded to the ground plane surface, the antenna can be shunt fed with coaxial cable (I used 50Ω RG-8/U and easily achieved an swr of 1.1:1). The physical size of the antenna is one of its most significant advantages. Since the ring is only .078 wavelength in diameter and the ground plane but 25% greater than that, with overall height for any frequency a matter of inches, it is easy to see that the DDRR is an amazingly compact antenna. The 10 meter antenna has a maximum diameter of 36 in. and an overall height of 4 in. The 2 meter version is almost pocket-size, 8 to 10 in. in diameter and 2 in. high.

The following construction details pertain to the 10 meter version of the DDRR. Tabular data in Table 1 provide dimensions for antennas for other bands. General construction details are suitable for all frequencies with sizes of assembly hardware being modified accordingly. Signifi-

Table I. Dimensions for antennas for other bands.

		10	15	20	40
Ground Plane Diameter	GPD	36"	50"	78"	135"
Feed Point	FP	1"	1.5"	2"	3"
Gap	G	2"	2.5"	3"	5"
Capacitor	C	15 pf	15 pf	35 pf	70 pf
Spacing	S	3"	4-3/4"	6"	12"
Tubing Diameter	TD	3/4"	3/4"	1"	1-1/4"
Radial Diameter	RD	3/8"	3/8"	3/4"	1-1/4"
Ring Radius	RR	28"	40"	54"	108"
	NR	8"	8"	12-16	12-16

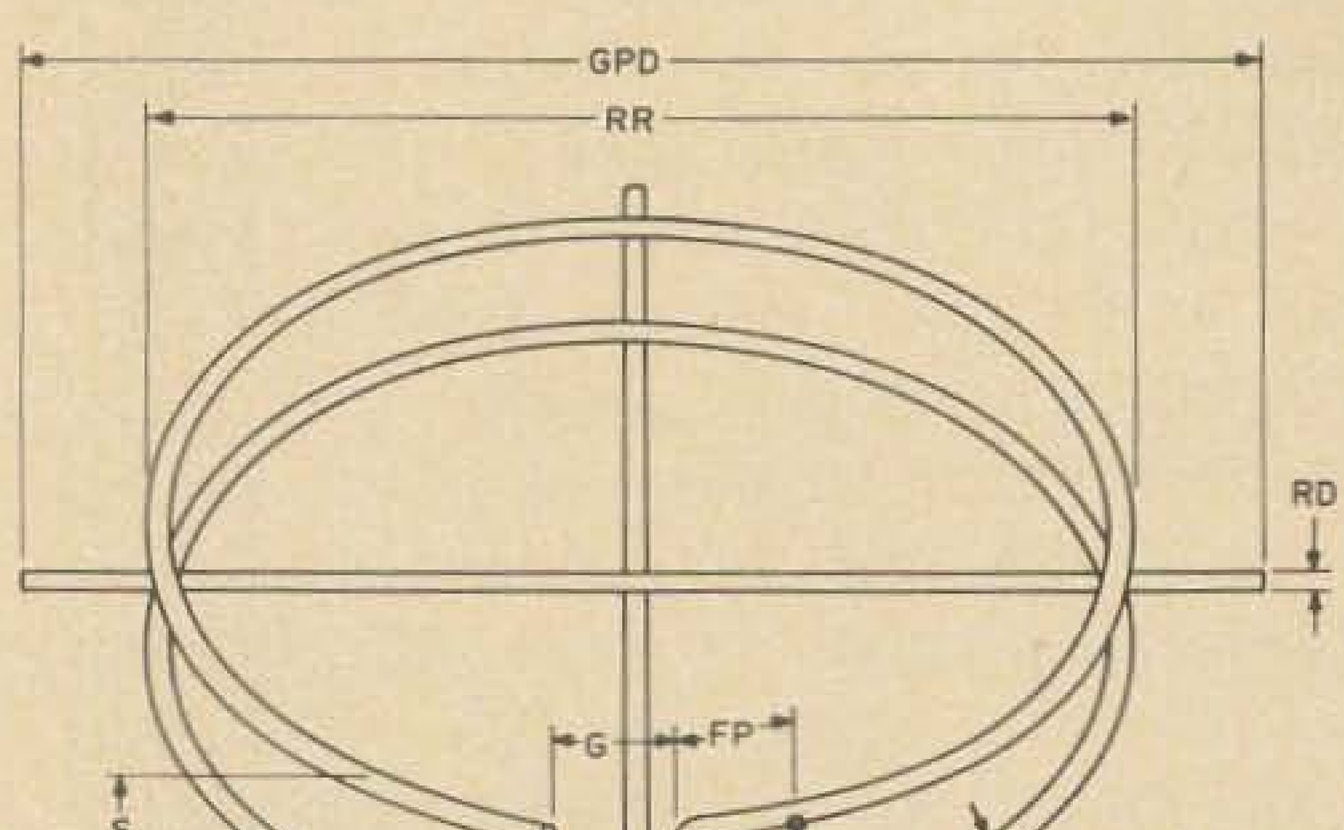


Fig. 2. Dimension key for DDRR.

cant variations, when they occur, such as with radials for low frequency units, will be described in detail.

Constructing the 10m DDRR

The solution to the construction difficulties mentioned earlier stems from use of standard hardware items commonly available in hardware stores throughout the country. If all of the recommended materials are procured before construction begins, assembling the DDRR should be little more difficult than assembling a kit antenna from the commercial supplier. (See Parts List, Table 2.)

Table II. Parts list.

Part	Source	Part No.	Quantity Required For 10	15	20	40
3/4" A1 Tubing	Reynolds	4222[4]	2	3	11	11
1" A1 Tubing	Reynolds	4242	0	0	5	0
1-1/4" A1 Tubing	Reynolds	4262	0	0	0	7
3/8" A1 Rod	Reynolds	1806	2	2	0	0
3/4" T-Butt Connector	Reynolds	7824	1	1	12	12
1" T-Butt Connector	Reynolds	7825	0	0	1	0
1-1/4" T-Butt Connector	Reynolds	7826	0	0	0	1
3/4" 90° Elbow	Reynolds	7832	1	1	0	0
1" 90° Elbow	Reynolds	7833	0	0	1	0
1-1/4" 90° Elbow	Reynolds	7834	0	0	0	1
3/4" Splicer	Reynolds	7840	1	3	0	0
1" Splicer	Reynolds	7841	0	0	4	0
1-1/4" Splicer	Reynolds	7842	0	0	0	7
1x1/4 A-1 Bar	Reynolds	1821	1	1	1	1
3/8" x 2" Eye Bolt			4	4	0	0
1/4-20 Bolt 3"	(Use 4" for 20 & 40)		1	1	1	1
3/4 x 2-1/2 Ceramic Insulator	H. H. Smith	2649[3]	3	0	0	0
1/4-20 Screws 1"			6		0	0
1/8 x 3/4 Washer 1/4" hole			6	For Insulators— See Table I		
3/4" U Bolt	Turnbuckles Inc.	T-308	1	1	0	0
Coax Receptacle SO-239	Allied	47C-0352	1	1	1	1
Variable Cap 0-15 pf	Cardwell	ET-30-AD	1	1	See Table I	
Fixture Box	Universal	56111[1]	1	1	0	0
Fixture Box Cover	Universal	54-C-1	1	1	0	0
1-3/8 x 1-7/8 x 5-1/8 (ID) Plastic Box	Loma Products	401[2]	1	1	0	0
Pipe Flange			1	1	0	0
6" Turn Buckle			0	0	12	12
1/4-20 Threaded Rod (6" Length)			0	0	12	12
1" U Bolt			0	0	1	0
1-1/4" U Bolt			0	0	0	1
Tuning Capacitor (See Text)			-	-	1	1
Insulators (See Text)			-	-	5	5
Misc. Hardware — Lockwashers, washers, cotter pins, pipe clamps, etc. (See Text)						

[1] This is an electrical light fixture box known in the trade as a "Pancake Box"—other numbers are Bowers 410, Appleton 4-CL, Raco 293.

[2] This is a Butter Dish, the Loma Classic Flair, manufactured by Loma Products, Fort Worth, Texas, available in department stores, hardware stores, etc.

[3] The larger DDRR antennas require greater spacing between elements. We found it best to make insulators for the larger units from plastic stock. The selection of these items is left to the ingenuity of the builder.

[4] Standard 1/2 inch EMT (Thin wall Conduit) can ba substituted wherever Reynolds 4222 is specified. The Reynolds fittings can be filed to adapt them to the slightly smaller inside diameter. The prototype antenna seen in many of the photographs was made with EMT. If you wish to make this substitution, you can save money, but there will be about a 30% increase in weight.

Forming the Rings

In my experience, the most difficult operation is bending the tubing to form a 28 in. diameter circle. In the pilot model the tubing was bent by hand (with a little assistance from the foot) and satisfactory results were achieved; however, a more esthetic appearance will result if a jig is used. A 26 or 27 in. bicycle wheel with the tire removed is satisfactory for this purpose. There is sufficient spring-back in the tubing to allow for the slight difference in diameter. With the wheel locked so that it will not rotate, position one end of the tubing in the groove of the rim and secure it. This can be done with a C-clamp, a vice, or simply by wrapping a few turns of wire around the rim and tubing. The free end of the tubing may be pulled around with even pressure until the complete circle is formed. If you do not achieve a perfect circle, no serious electrical problems will result; moreover, minor deviations can be corrected by tightening the radials later. The principal objective is to make two rings as close to circular and as similar as possible, with a center-to-center diameter of 28 in. When this task is completed, your DDRR is practically finished because the remaining construction is very simple.

Assembling the Ground Plane

Join the ends of one of the rings using the coupler (Reynolds 7840). Be sure to allow for "makeup" for inserting this part. To do this, the total circumference of the ring should be cut ¼ in. shorter than required.

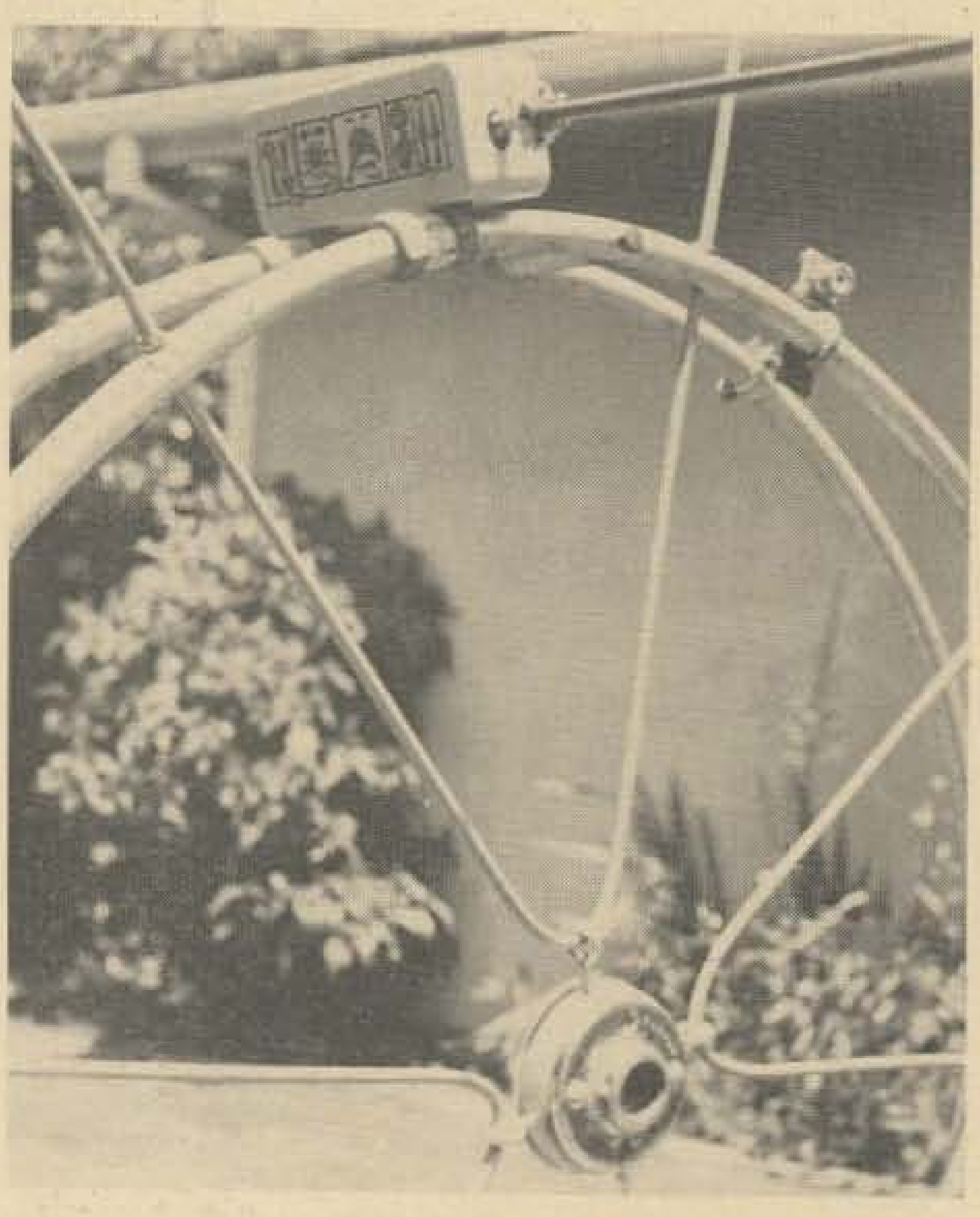
Measuring around the outermost perimeter of the assembled ring, divide the entire ring into 8 equal parts. This spacing, measured around the perimeter, is approximately 11¼ in. Mark each division on the centerline of the tubing with a center punch. Drill completely through the tubing from the center punch mark toward the center of the ring with a 7/16 in. drill. These drilled holes are for the radials.

Cut the 3/8 in. rod (Reynolds 1806), into 36 in. lengths. Bend each length of the center to an angle of 45°. Drill a 1/8 in. hole in each leg of the vee 6 in. from the ends.

Thread a 3/8 x 2 in. eyebolt onto each of the four vees and let it hang at the mid-point.

Mark the fixture box (Universal 56111) around its perimeter at the mid-point between top and bottom. Mark the 90° points around this line with a center punch and drill each point with a 5/16 in. drill. Make sure that the eyebolts remain on the inside of the assembly. Push the vees out far enough to leave about a 6 in. diameter at the center with all of the vees installed. You may find it difficult to get radials started in the holes, but they will go and fit easily when in the final position.

With the ring and radials resting on a flat surface, place the fixture box in the center. Pass the threaded end of the eyebolts through the holes drilled in the sides of the fixture box and run a nut onto each of the eyebolts until one or two threads are visible past the nuts.



The prototype DDRR, a view from the bottom showing details of the hub, mounting flange, feed connection, and tuning condenser.

Slip a washer over each rod tip and push it past the drilled hole toward the ring and install a 1/8 x 3/4 in. cotter pin in each hole. As the work progresses it may be necessary to loosen the nuts at the hub slightly in order to fit the cotter pins and washers.

Once all cotter pins and washers are installed, tighten the nuts at the hub until all radials have equal tension and the circle is not distorted. As a check, the visible portion of the threads inside the hub should be nearly equal for all four eyebolts.

If the outer dimensions are critical for your installation, measure 18 in. from the center of the hub along the radials and cut off the excess length. If outer dimensions are not critical, just make sure that all radials are of equal length. The minimum is 18 in. from center. Any greater length, within reason, will provide a slight improvement in operation.

Turn the assembly over and install the pipe flange on the bottom of the fixture box with two ¼ in. bolts and nuts. You will find that two holes in the fixture box align almost exactly with the two holes in the pipe flange when the flange is centered on the box. When these mounting bolts have been securely tightened, install the cover plate (Universal 54-C-1) on the top of the box using the two 10-32 screws which come with the box. This cover will help to keep water from collecting inside the box and thereby reduce corrosion problems. It also adds a professional finish to the job.

The ground plane for your antenna is now complete. It should be rigid enough to be supported on a pipe, threaded into the pipe flange, without sagging.

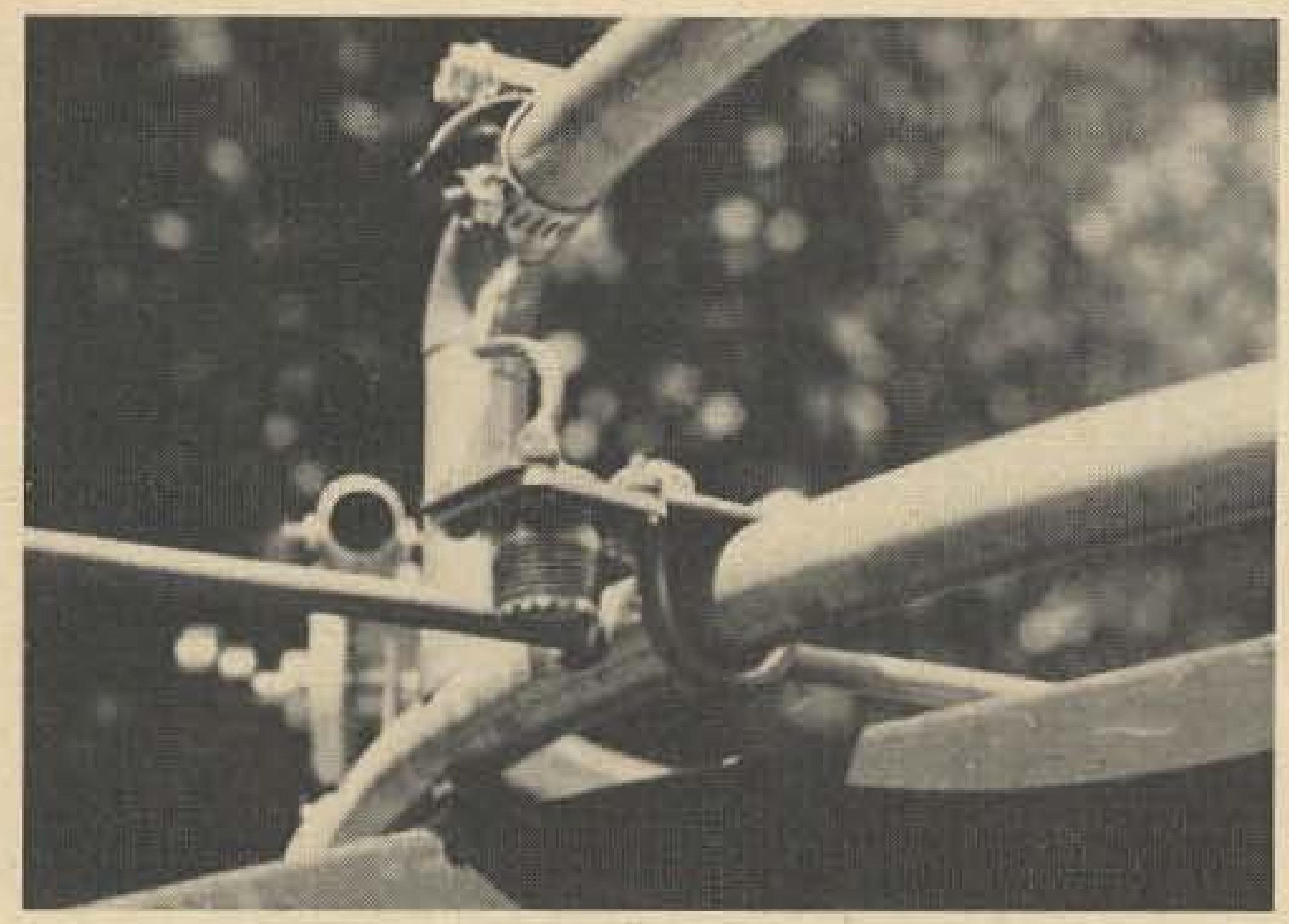
Attaching the Driven Element

Place the second ring of ¾ in. tubing on top of the ground plane assembly and make any last-minute adjustments necessary to cause the two rings to coincide.

With a tubing cutter or a hacksaw, cut the end of the tubing so that a gap of 3-1/8 in. is left in the upper ring.

If you intend to use the base loading feed system, omit installation of the 90° elbow and its associated parts. Cut the gap in the upper ring to 6 in. and proceed with the installation of insulators. You will have to install a fourth insulator an inch or so in from the gap on the fed end of the ring.

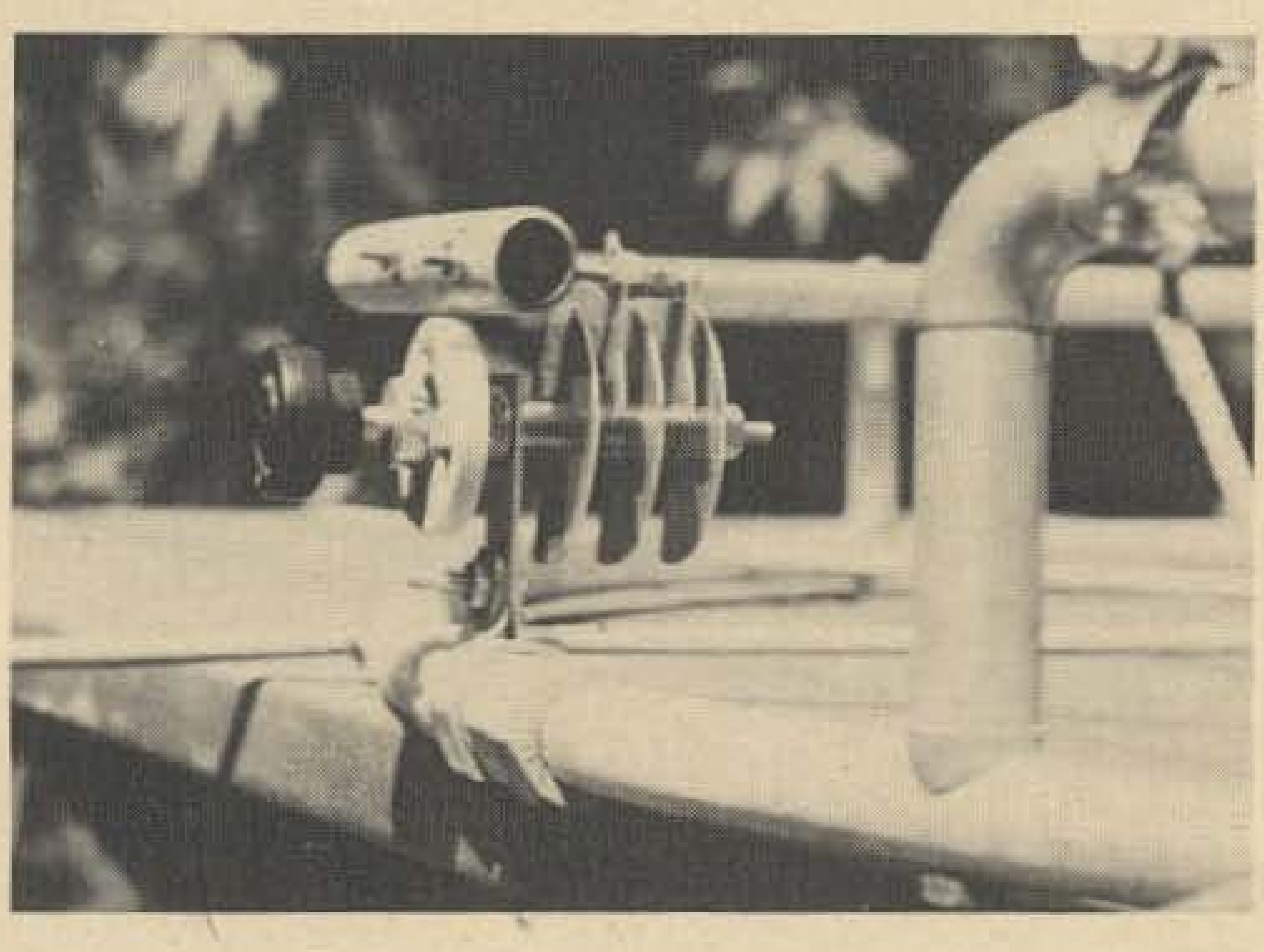
Install the 90° elbow (Reynolds 7832) in one end of the tubing and position it so that it points downward toward the ground plane ring. The elbow comes with an expandable spring clip which is screwed onto the end of the elbow. This attaching system may be used, but it is preferable to omit it and attach the elbow to the ring by drilling a hole horizontally, through the



A view of the feedline connector attached to the prototype DDRR.

tubing and the elbow to take a 8-32 x 1 in. screw. The latter system insures a good electrical connection at this junction and is a stronger mechanical assembly, less likely to fail after the antenna is erected. This precaution was not necessary on the closed ground plane ring at the joiner, because the tension of the radials serves to hold the joint in solid contact.

Cut a 2-1/8 in. length of tubing from the scrap left over from the rings and slip it



The home-made tuning condenser mounted on the prototype DDRR.

over the remaining end of the 90° elbow. Insert the T-butt connector (Reynolds 7824) in the opening at the lower end of the short piece of tubing.

Position the upper ring over the ground plane ring so that the T-butt connector on the lower end of the elbow assembly is midway between two of the radials. Make sure that the joiner in the ground plane ring is not in a position to interfere with installation at the tuning capacitor, T-butt connector, coaxial connector bracket, or any of the insulators. (See Fig. 1.) Drill a ¼ in. hole straight down through the ground plane ring at the selected point. It is important that this hole be as close to vertical as possible. The T-butt connector may be used as a drilling guide.

Discard the bolt supplied with the T-butt connector and replace it with the 3 in. ¼-20 bolt. This bolt passes upward through the hole in the ground plane ring, through the T-butt connector and the short length of tubing, and engages the threads in the 90° elbow. Tighten this bolt just enough to take all of the slack out.

Carefully measure the distance between the centerline of the upper ring and the top of the lower ring close to the 90° elbow, to insure a 3 in. dimension. If this dimension has not been achieved, remove the short length of tubing and adjust its length accordingly. A good electrical connection at this point is crucial.

Installing the Insulators

Mark a point directly opposite the center of the gap on the upper ring and drill a ¼ in. hole directly downward for the first insulator. Measure around the circumference of the upper ring, a distance of 24 in. each side of the hole for the first insulator. At each of these two points drill a ¼ in. hole directly downward for two more insulators. Mark the corresponding points on the ground plane ring and drill each of these points with a ¼ in. drill.

Install the insulators (Smith 2649; Allied 47-C-4357), between the two rings at the drilled points. These insulators are 2½ in. in length, and a 1/16 in. washer must be installed at top and bottom of each insulator to provide the 2-5/8 in.

separation required. Fiber washers sold in plumbing supply houses are ideal here. Once again, a lockwasher under the heads of the 1 in. ¼-20 screws will serve to keep the mechanical structure solid even with vibration caused by wind.

The mechanical construction of your DDRR is now complete. The next operation is to provide for feedline connection and to install the loading condenser.

Installing the Feedline Connector

Cut a length of the 1 in. by 3/16 in. aluminum bar (Reynolds 1821) 2¾ in. long. Drill two ¼ in. holes, ½ in. and 1½ in. from one end and on the centerline. At the opposite end, drill the holes to accept the coaxial fitting (SO-239). (See Fig. 3.)

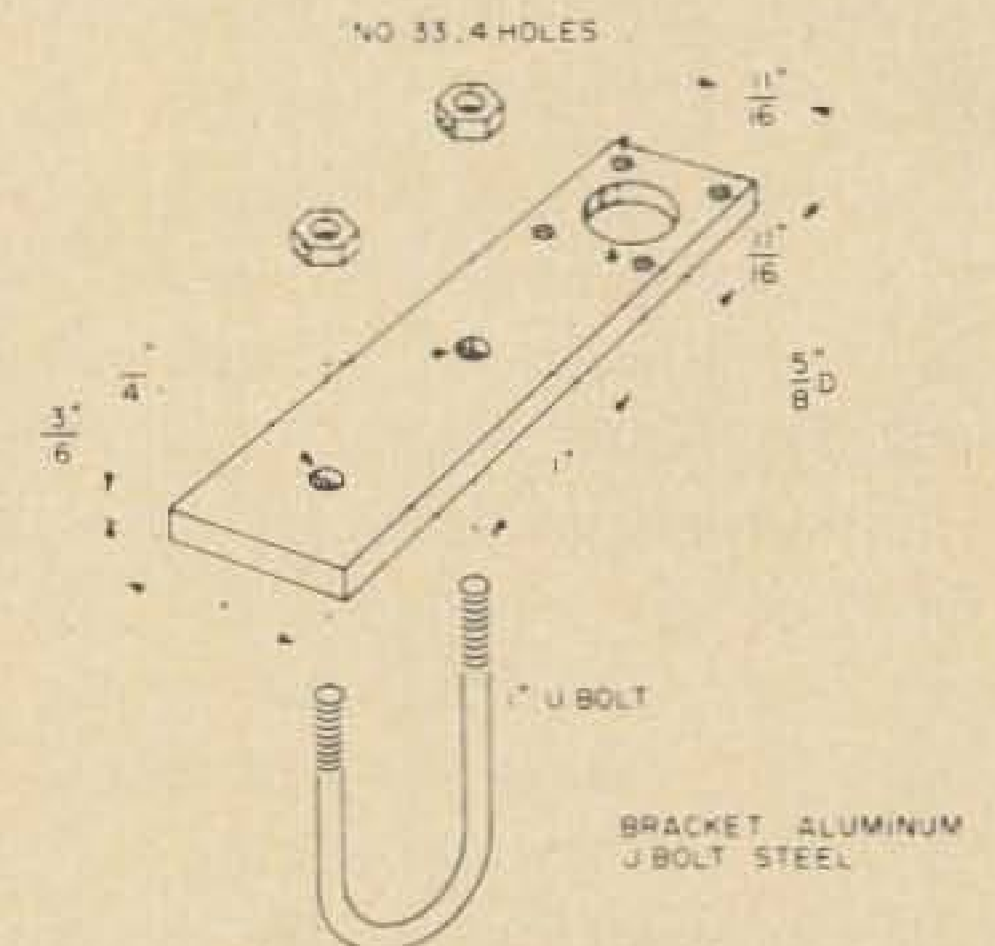


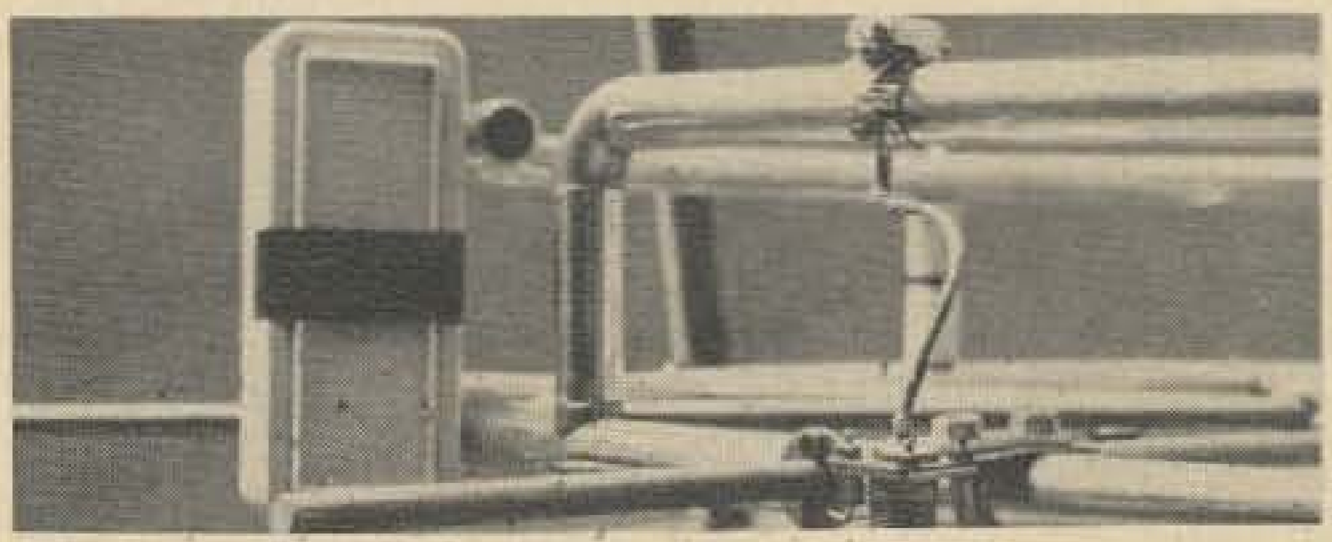
Fig. 3. Dimension details for feed line connector.

Install the coaxial fitting in the bracket and attach the bracket to the ground plane ring about 4 in. from the junction of the 90° elbow and the ground plane ring. (See photo.) The bracket should be on top of the ground plane straddling the ring and passing through the holes provided in the bracket. When the bracket has been clamped in place, any excess of the threaded ends of the U-bolt should be cut off flush with the top of the nuts. If you are planning to use the base-loading feed system, follow these same instructions, but position the bracket at about the mid-point of the 6 in. gap.

Installing the Tuning Condenser

There are a number of variables affecting condenser installation. These have been discussed in the section on condenser considerations. If you do not intend to use the recommended part, it would be advisable to review that section before proceeding. If you are planning to use the base-loading feed system, you will not need to install a tuning condenser at the top end of the ring. (See the section on alternate feed system.)

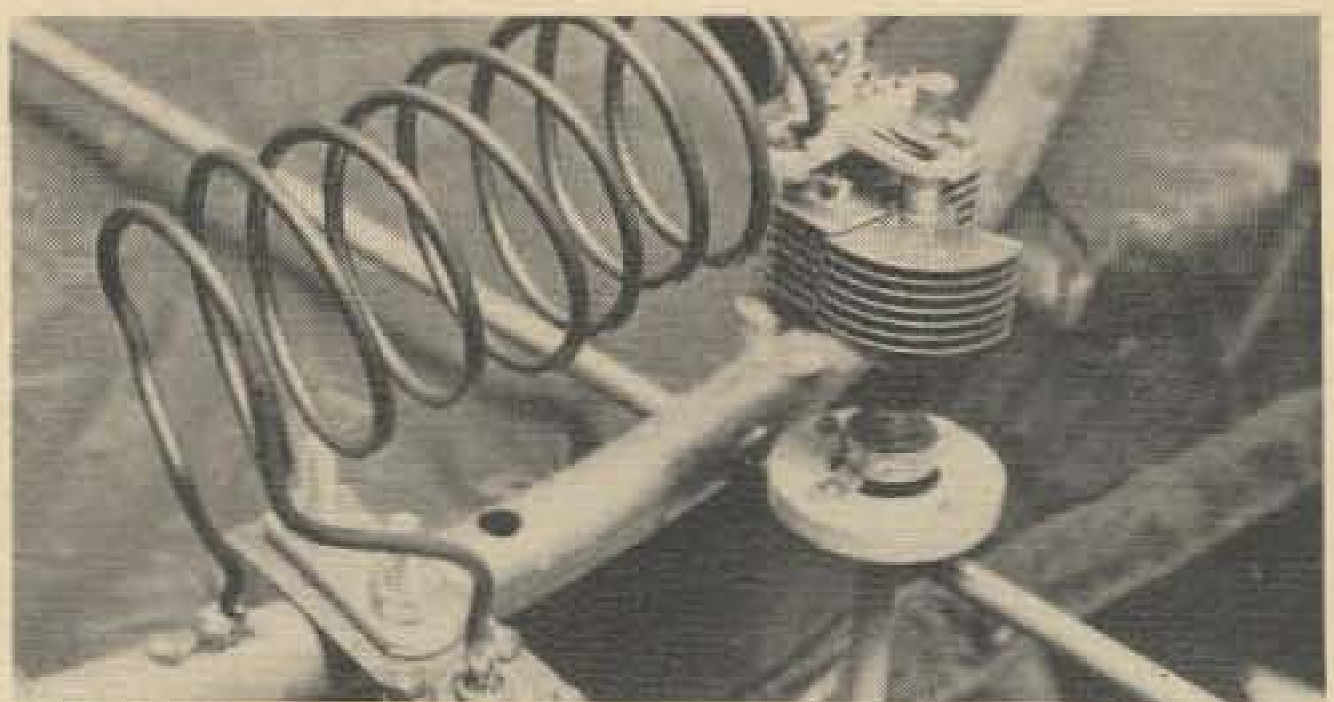
The Cardwell ET-30-AD dual-section condenser was chosen as the best component for this application, because it has the low minimum capacitance required; and, with the two sections connected in series, it withstands the high voltage encountered.



Details of the DDRR built in accordance with the instructions in the article. Note the methods of attaching the radials, the feed connections and the box containing the tuning condenser.

Since most antenna installations using the DDRR will involve manual tuning, the condenser has been oriented with the shaft extending downward. This position allows easy access for portable, mobile, or emergency installations. Horizontal positioning may be used and is advisable if motor-driven tuning is contemplated.

To mount the ET-30-AD in a vertical position with a plastic box for protection, proceed as follows:



Closeup of the "base loaded" feed system assembled on the prototype DDRR.

In one end of the box (Loma 401) drill a 7/16 in. hole on the centerline and 11/16 in. from the inside bottom. Drill four holes 5/32 in. diameter in the bottom of the box to accept the mounting screws which come with the capacitor. These holes must be symmetrical about the centerline, in pairs and on 1-1/8 in. centers. The first pair must be 13/16 in. from the end with large holes drilled previously. The next pair must be 3-3/8 in. from the first pair and in line with them. On the centerline of one side of the box, drill two holes for 10-32 screws 1 in. from each end. In this last pair of holes, install two 10-32 x 1 in. screws with solder lugs under the head of each screw on the inside of the box. Run nuts onto these screws and tighten them securely. Install the capacitor in the box by slipping the shaft through the large hole in one end and with the mounting bars toward the bottom. Install the four capacitor mounting screws and tighten them securely. Connect a short length of wire from the solder lug under one of the 10-32 screws to the solder lug on the nearest set of stator plates. Connect the other set of stator plates to the other 10-32 screw in a similar manner. The solder lugs for the rotor, at each end of the shaft, must be cut off flush with the ceramic end plates to provide clearance for the cover.

Measure 1¼ in. in from the gap end of the driven ring, that is the end farthest from the feed point. Drill a hole horizontally and on the centerline through the tubing with a #10 drill. Directly below this hole drill a similar hole in the ground plane ring.

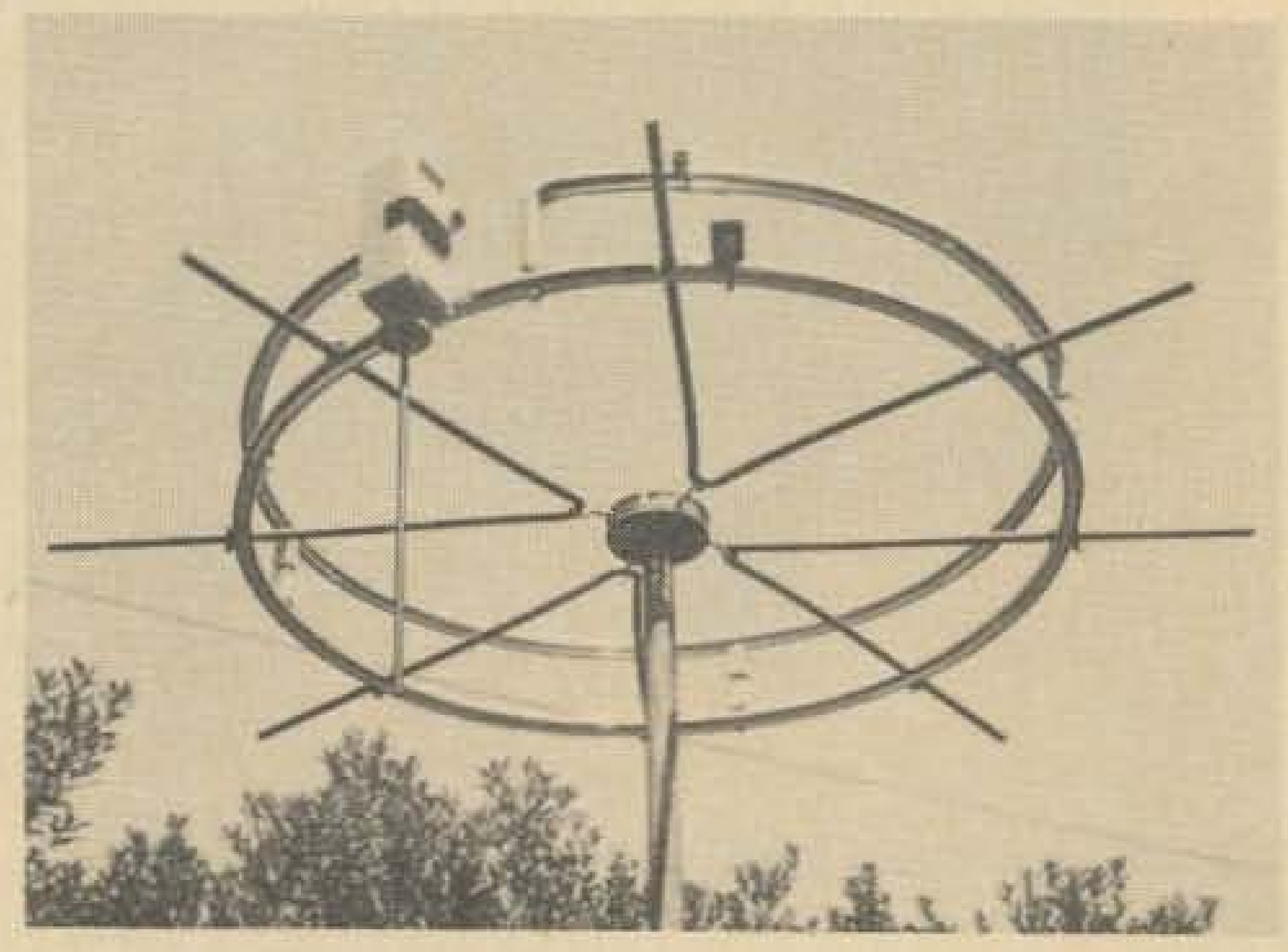
Slip the two 10-32 screws protruding from the side of the plastic box through the two holes in the rings. Be sure that the shaft is pointing down. Using lockwashers and nuts, securely fasten these two points.

Install an insulated shaft coupler on the shaft of the condenser.

There is a base attached to the cover of the plastic box which may be removed. This is the olive green portion cemented to what was originally the bottom of the box and which now serves as a cover. This unnecessary portion can be removed by carefully cutting around the edge with a knife to separate the glued area. The friction fit of the cover should be adequate to hold it in place; but for mobile service, and if the antenna is to be mounted at considerable height, it is advisable to provide some means of locking the cover securely in place. The simplest approach is to wrap the joined edge of box and cover with plastic electrician's tape, which will also provide a degree of weatherproofing.

Connect a 6 or 7 in. length of 1/8 in. flexible braided lead to the coaxial connector in the bracket. Slip the free end of the lead through a ¾ in. pipe clamp installed on the upper ring about 1 in. from the end of the elbow. Tighten the clamp only enough to provide a good sliding connection.

Your DDRR is now ready for tuning.



The final version of the DDRR atop the pipe mast.

Tuning The Antenna

Tuning the DDRR is a relatively simple operation, when done with an swr bridge in the line – and very nearly impossible without one. If you do not own one of these valuable devices, it would be wise to borrow, build, or buy one before attempting the tuning procedure.

With the DDRR supported at least two or three feet above the ground, connect a coaxial cable to the connector on the bracket. Install an insulated shaft on the coupler at the bottom of the tuning con-

A view of the dual section condenser installed in the "butter box" and mounted on the prototype antenna.

denser. Connect the other end of the coaxial cable through the swr bridge to a low-power rf source on the desired frequency. (I used a Globe DSB 100.) The low power is a safety precaution to hold the high voltage hazard to a minimum. With power on, *slowly* adjust the tuning capacitor for minimum indicated swr. With an insulated screwdriver or plastic rod, push the sliding connection at the feed point back and forth until the minimum swr is indicated.

There appears to be a transformer action which occurs between the different diameters of the tubing and the lead from the coaxial fitting by moving the bracket on the lower ring. You should be able to achieve a match with the bracket nearly directly under the contact point on the upper ring. Slight deviation one way or the other from this position will have no significant effect on the efficiency, so any pair of points which provide a satisfactory swr should do. Whatever the end point of the lead is, it should be direct and fairly taut so that it will not shift position later.

There will be interaction between the setting of the condenser and the position of the feed point, so it will be necessary to adjust each one alternately during the tuning procedures. Once a satisfactory swr has been achieved by adjusting the condenser and the feed point, tighten the feedline to the transmitter to be used or increase power to normal operating level and recheck the swr. If the low-power source had the same output impedance as the operating rig, no further adjustment should be necessary. If an unacceptably high swr is encountered, retune the condenser for minimum swr. You should be able to achieve an indicated swr of 1.2:1 with ease. If not, the feed tap must be reset to match the transmitter. This must be done by moving the tap slightly with transmitter power off and checking the resultant swr with power on. It is a bit tedious, but usually a satisfactory setting located in this manner will be good for any antenna location. Once the preliminary adjustments have been made, you should be able to vary the transmitter frequency over a range of ±250 kHz and maintain an swr below 2:1 without resetting the capacitor. By resetting the capacitor, you should be able to maintain an swr close to 1:1 over the entire band.

Erecting the Antenna

The 10m or 15m DDRR antenna constructed as described can be mounted atop a pipe threaded into the pipe flange bolted to the fixture box used as a hub. A length of pipe may be used as a mast or clamped to any existing tower or pole. After the antenna has been raised to the desired height, it will be necessary to readjust the capacitor setting to center the minimum swr on the desired frequency. Once this has been done, the condenser shaft should be locked in place to avoid undesirable movement from vibration. After all adjustments have been made and all mechanical connections secured, it is a good idea to give the entire assembly a protective coating of acrylic to reduce corrosion.

When choosing the permanent location for your DDRR, consider the following factors: Extreme height does not appear to be a significant consideration with this antenna. As with other antennas, it should be located clear of metal objects which might alter its characteristics. Sometimes height is the best way to accomplish this. As height increases so, necessarily, does the length of the coaxial cable. As the length of coaxial cable is increased, the capacitor setting needs to be adjusted to compensate. Therefore the final adjustment of the tuning condenser must be made with the antenna at, or near, the final operating position. This is fairly easy if the antenna is to be relatively close to the ground as in portable or mobile installations. It may become more difficult if the antenna is to be mounted atop a high tower or pole. In this latter case, if it is impossible to do the final tuning in place, one approach is to tune the antenna at the highest possible height and with the full length of feedline connected. If this is done at least one half-wavelength above the ground, satisfactory final tuning adjustment should result.

An Alternate Method of Feeding the DDRR

If the conventional tuning method proves to be too troublesome, or if you wish to avoid the high-voltage problem, an alternate method of feed is possible.

If we consider the ring radiator as a quarter-wave vertical which is resonant just above the desired frequency, we can feed it as though it were a short vertical whip. In this case base loading lends itself to the mechanical configuration. (See Fig. 4.)

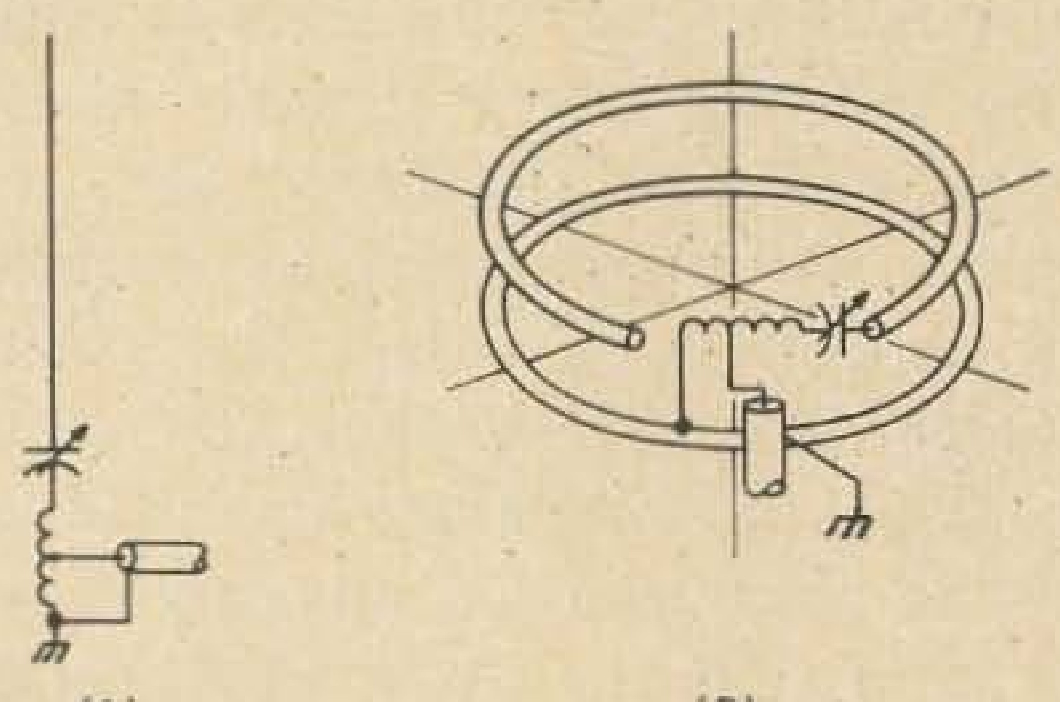


Fig. 4. Comparison between base loaded whip antenna (A) and "base loaded" DDRR (B).

Technical considerations concerning feeding quarter-wave vertical antennas in the manner described can be found in the ARRL handbook in the antenna section. The application of this method of feed to the DDRR is consistent with the electrical principles contained in the reference.

Some modification of mechanical construction is required to incorporate this method of feed for the DDRR antenna described herein. Essentially this amounts to omitting the 90° elbow and its associated hardware and replacing that part of the structure with tuned circuit elements. Mounting of these components must provide for sufficient mechanical strength and also yield the electrical characteristics necessary for proper operation.

The method devised and tested in experiments of W6WYQ is as follows:

Drill a hole horizontally through the upper ring 3/8 in. in from the end. Bolt the rear foot of a 100 pF capacitor (Johnson, Type R, 149-5), with an 8-32 screw through this hole. The capacitor shaft should point downward. Wind a coil of 1/8 in. copper tubing; 7¾ turns, 1-5/16 in. inside diameter, evenly spaced over the 4 in. length. Leave sufficient length at one end of the coil to provide a 1½ in. upright support. Solder a lug to the end of this length and bend it at right angles, in line with the axis of the coil.

Drill a hole downward through the lower ring at a point 2 in. into the gap space measured from the upper end of the fed ring. Bolt the upright support of the coil to the lower ring with an 8-32 screw through this hole. The other end of the coil should terminate at a point very close to the stator connection of the capacitor. A good solder connection should be made between these two points. Attach a length of 1/8 in. copper tubing, or similar size wire, from the coaxial connector to a point ½ to ¾ turns in from the grounded end of the coil. Some experimentation will be necessary to find the exact point for your setup. I matched a 52Ω feedline to this antenna 5/8 turn in on the coil. When mechanical mounting is complete, the gap end of the coil should be bent to reestablish the 2 in. gap prescribed for the 10m DDRR. I found that I could tune the entire 10m band with less than half of the 100 pF capacitor. The standard Type R, with .024 air gap easily handled all that the Galaxy had to offer. If you run higher power, you might need wider spacing. The Type R is available with: .036, .050, .071, and .095 in. air gap. If you must go to wider spacing to handle your power, space might be saved by going to a 50 pF maximum capacitance. Whatever capacitor is used, it should be protected with a weatherproof cover. Since minimum capacitance is not a limiting factor with this type of feed, a minibox should do nicely for the purpose.

Tuning the Base-Loaded DDRR

Tuning procedures are the same as for the shunt-fed system except that the lead from the coaxial connector is moved along the coil until a minimum swr is obtained. We found this point to be 5/8 turn from the bottom end of the coil for RG-8/U.

The advantages of this method of feed are: A narrow spaced capacitor is quite adequate, extremely high voltages are not encountered in the tuning circuit, the system is not highly sensitive to stray capacitance, and the problems of minimum capacitance associated with the shunt-fed system do not apply.

Theoretically, this method of feed should be less efficient than the shunt-fed method. This may be true for the long haul, poor conditions, DX work; however, no significant difference could be detected between the two antennas under normal operating conditions.

Expanding Band Coverage

One of the advantages of the DDRR is its high-Q characteristics, which greatly reduce noise and help to minimize interference. Unfortunately, these characteristics limit the band coverage of a fixed-tuned DDRR. This shortcoming can be circumvented by providing some means of remotely adjusting the capacitor. This consideration applies to both the shunt-fed and base-loaded feed systems. If the antenna is to be mounted close to the operating position an extension shaft is all that is required. In some installations, chain drives, pulley and cord, or other mechanical linkage can be applied. By far the most satisfactory arrangement is a low-speed reversible motor geared to the capacitor's shaft. There are numerous reversible motors available on the surplus market which would be suitable for this purpose. Since no specific unit is identifiable, no detailed installation instructions are included here. However, certain general precautions must be observed when installing any motor. To begin with, if the motor is to be installed close to the capacitor, which is the most logical location for it, the motor windings are in a strong rf field. To minimize the effects of this environment, the motor should be mounted directly to the ground plane ring and bypass condensers installed on the leads to the motor as close as possible to the grounded case. Leads to the capacitors should be as short as possible. The power lead for the motor should come away from the antenna as nearly as possible to a right angle with the ground plane for a distance of one-half wavelength. A well grounded shielded cable would be an advantage, but is by no means mandatory. There is no requirement to incorporate a selsyn indicator in the system as the minimum swr indication is all that is required.

Capacitor Considerations

It is anticipated that many who read this article will wish to make modifications to the design to incorporate their own ideas or introduce improvements. Some will also wish to press into service some of the junkbox components they have on hand but which do not conform to the specifications in this article. Most aspects of the mechanical construction allow for fairly wide deviation; however, there are some restrictions on the type of capacitor which is suitable for the DDRR which limit the selection severely. I discovered these by the age-old method of trial and error, with the latter leading all the way. To save the adventuresome experimenter from frustration, these considerations are included here. Most of the limitations mentioned pertain to antennas for 20 MHz and above. The lower frequency antennas require more capacitance for tuning and a little stray capacity has less effect on the overall circuit. The high voltage problem, however, seems to be more aggravated on the lower frequencies.

In my experiments I first used a single-bearing capacitor similar to the E. F. Johnson Type M with .017 in. spacing. While the capacitor was completely satisfactory in terms of minimum capacitance, it arced at rf power levels above about 300W. I tried substituting a glass-insulated piston trimmer with about 1/32 in. glass walls, which arced at 400W. Next, I went to a wide-spaced unit (Bud 1543), with a .175 in. spacing. This capacitor withstood the voltage easily, but even in the fully open position, the antenna system would not resonate above 26 MHz. (It was at 29 MHz with the other components installed.) The cause of this was determined to be the high minimum capacitance caused by the large metal end bearing plates which were a little over 2 in. apart and with an area of about 4 sq in. I had on hand a Cardwell NG-35-DS which was of similar construction to the Bud unit but with end plates spaced 4 in. apart. This, too, proved to have too much capacitance, even at the minimum setting. I then found that the Cardwell ET-30-AD, specified here for the 10m unit, was entirely satisfactory. This condenser has ceramic end plates and the minimum capacitance is well within bounds. Plate-to-plate spacing is 1/16 in. and connecting the two sections in parallel gives an effective plate spacing at 1/8 in., which is adequate for the 500W maximum power used. Wider spacing might be necessary if higher power is applied. Although the ET-30-AD was satisfactory in electrical operation, it is a little long for the installation. I hoped to find a capacitor which would fit between the two rings. Finding no suitable unit listed in the manufacturer's catalog, I manufactured one. The plates were removed from a National capacitor of similar construction to the Bud and Cardwell units which were rejected. The National capacitor was tried and rejected also, but the stator and rotor plates were mounted on shafts with a bolt and spacer arrangement which made it ideal as a source of parts. With the parts from this capacitor, a capacitor was assembled directly onto the antenna. The stator plates were bolted to the driven ring and the rotor mounted to a bearing attached to the ground plane ring by a bracket. The plates, two stators, and three rotors were spaced to about ¼ in. This arrangement seems to be the most satisfactory all around, since it not only withstands the voltage, but also fits within the limited space. This method has not been prescribed in this article because of the additional mechanical construction involved and because of the difficulties in providing a weatherproof housing for it. It is described here because it may well be that those running full legal power may have to resort to this approach in order to make the antenna work at those power levels. Of course it is not necessary to dismantle an old capacitor for parts. Suitable plates may be cut from stock. Those I used had an area of about 2 sq in.

If you have an old disc-type neutralizing capacitor (Millen 15011) this can be made to work. It is particularly well suited to fixed-tuned applications but can be used as a variable with proper linkage.

If you are only interested in fixed-tuned systems, by far the easiest solution to the capacitor problem is to install a length of coaxial cable between the two rings with the shield connected to the ground plane and the center conductor to the driven element. I found that 2-5/8 in. of RG-8/U tuned the 10m antenna to 29 MHz.

DDRR Antennas For Other Frequencies

Details for construction of the 10m DDRR described herein are suitable for frequencies down to 21 MHz. Above 30 MHz, sheet metal or screen ground plane surfaces are more easily fabricated. Smaller tubing sizes recommend copper, and soldering techniques replace pipe clamps and U-bolts. Those who wish to use this antenna on 6 or 2m would do well to review the article by G. W. Horn I1MK, in the September 1967 issue of CQ.

The general construction details described above for the 10m DDRR are applicable to lower frequency units, but below 21 MHz. The method of making and attaching the radials requires some modification. The V-shaped radials of ¼ or 3/8 inch aluminum rod do not provide adequate mechanical strength, and there is some doubt as to their electrical efficiency when used in conjunction with the larger size tubing. Moreover, a larger number of radials should be used to improve both electrical efficiency and mechanical strength. Obviously the small utility box used as a hub would not be adequate on these large antennas.

We tried several methods of making radials for the 20m antenna and finally adopted the following system as most suitable. (See Fig. 5.)

The hub on this larger antenna is a disc of aluminum ¼ in. thick and 12 in.

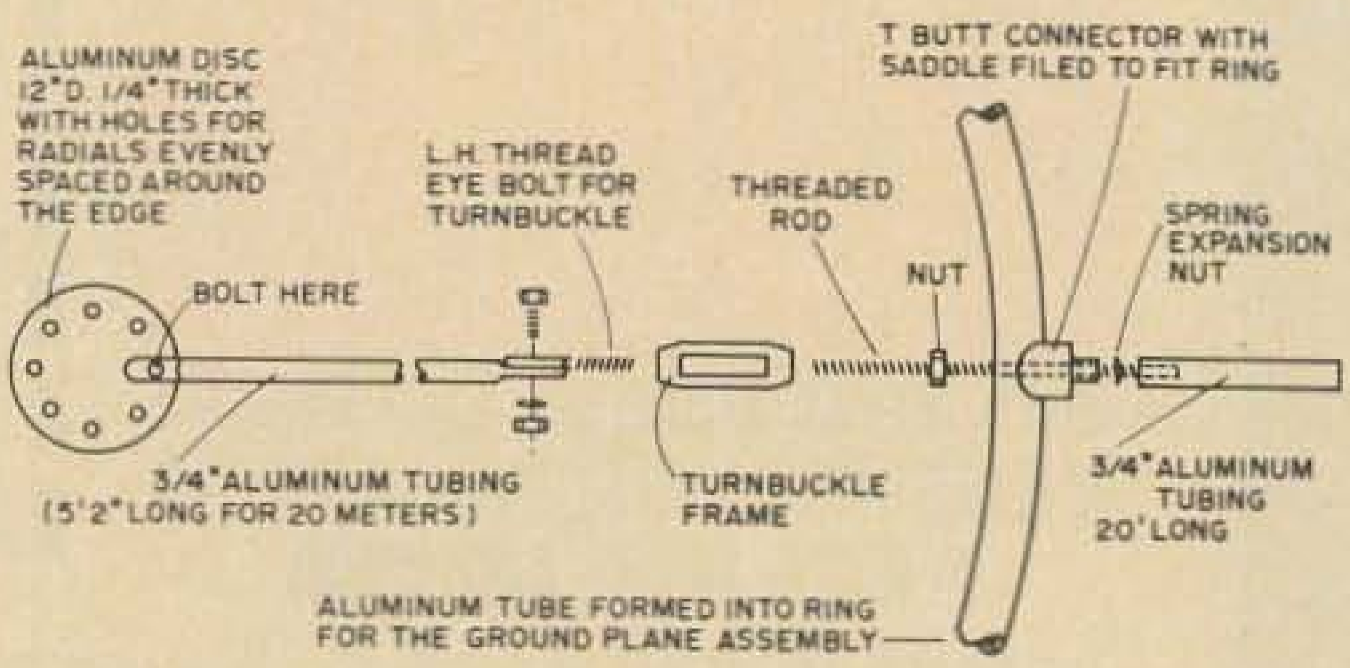


Fig. 5. Assembly technique for DDRR ground plane radials for 20 and 40 meter antennas.

diameter. The radials are ¾ in. aluminum tubing. The inner portion of each radial is 5 ft 2 in. long. A 1¼ in. section on each end of these radials is flattened and a ½ in. hole drilled through the flat part one inch from the ends. Radials are bolted to the edge of the aluminum disc, at about 3 in. intervals. The left-hand-thread end of a 6 in. turnbuckle is bolted to the opposite end of each radial; 20 in. lengths of ¾ in. tubing are mounted around the outer perimeter of the ring. These stubs are attached using T-butt connectors with the bolt replaced with a length of ¼-20 threaded rod with a nut run on it to cinch it up against the ring. The right-hand-thread-end of the turnbuckle is run onto the rod; then, by turning the turnbuckle, tension can be applied to each rod in turn. The whole assembly presents a neat appearance and is quite strong enough for pole mounting, although we added 3 legs from the midpoint of 3 radials down to the mast to provide more stability.

Performance

The 10m DDRR as described in this article has been in use at W6WYQ for about 4 months. On-the-air checks show its performance to be equal to that of a standard isotropic radiator mounted on the roof. The DDRR has been handicapped by being located variously: on a box in the middle of the garage, in the rafters of the garage, on the roof, on top of the car, and even resting on the ground. In spite of this, solid contacts have been made with W1s, W4s, VE7s, and many stations in between. The DDRR doesn't compete with the multielement beams, but it seems to be right in there with the verticals. It has shown itself to be superior to the multiband trap-type verticals. Most of the best contacts have been made with stations using verticals or quads, which is, no doubt, the vertical polarization of the DDRR antenna being demonstrated. The sharp tuning characteristic markedly reduces QRM and noise, and that aspect has been quite enjoyable.

The 20m DDRR is presently undergoing evaluation at another station. Initial tests indicate that its performance is very similar to that of the 10m version. . . . W6WYQ ■