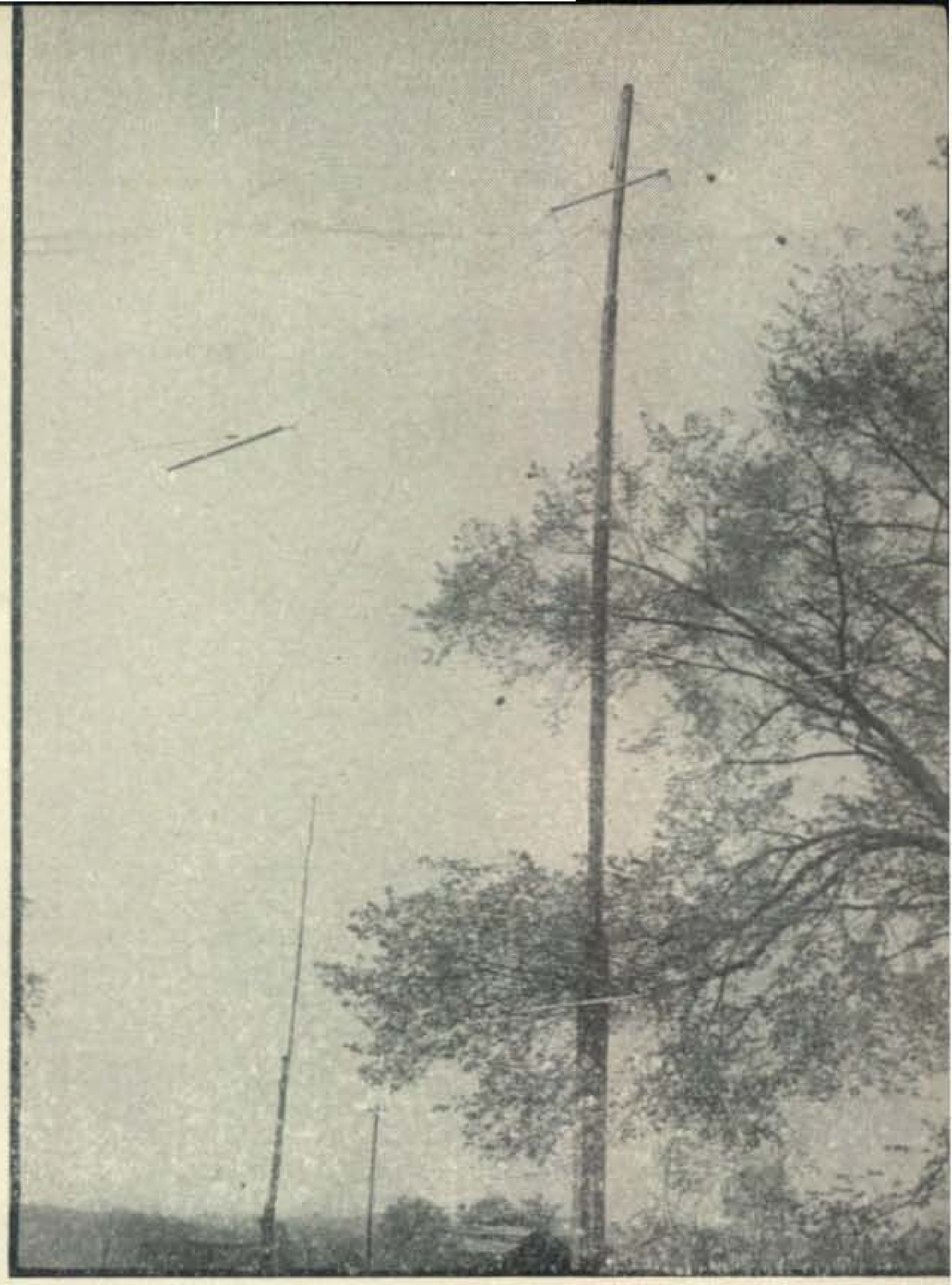
Antenna wire doesn't photograph too well, but this shot will give you an idea of the physical layout for W8BKP's Bi-Square.

THE BI-SQUARE BEAM



...or Working the World on 90 Watts

GEORGE W. MORROW, W8BKP*

Anyone who has worked 77 countries since the war must have something special at his shack. W8BKP modestly gives the credit to his Bi-Square beam. In this article he shares his secret with all who are interested.

ANTENNAS being the most talked of subject in amateur radio today, this simple beam and an additional element which may be added to give improved results is of interest to every DX minded ham. The radiator alone will perform well, and by adding the parasitic element the results are really "hot."

The single element or Bi-Square is a horizontally polarized radiator concentrating most of its radiation at low useful vertical angles. The radiation is bi-directional, at right angles to the plane of the wires in the radiator and, while not too directional horizontally, the nulls are very noticeable (off the ends). The horizontal polarization of this antenna results in a minimum of noise and a maximum of signal pickup on reception, and high ground reflection efficiency when transmitting.

Theoretically, the radiation resistance of an antenna is unimportant from the standpoint of efficiency, so long as it is a sizable percentage of the total resistance. The high voltages encountered when the radiation resistance is low complicate the insulation problem. The chief advantage of a high radiation resistance is that the antenna is not so critical as to frequency. This means the antenna is not critical in adjustment and can be used with equal effectiveness over the present 28 mc amateur band, both for transmitting or receiving. Because the Bi-Square has a high radiation resistance (higher than the average doublet), ordinary inexpensive insulators may be used for suspending the radiators. It also means it is easy to tune up and get going, and on reception one part of the band will not be "hotter" than another.

Construction

The supporting pole need not be of particu-

*Box 101, Washingtonville, Ohio

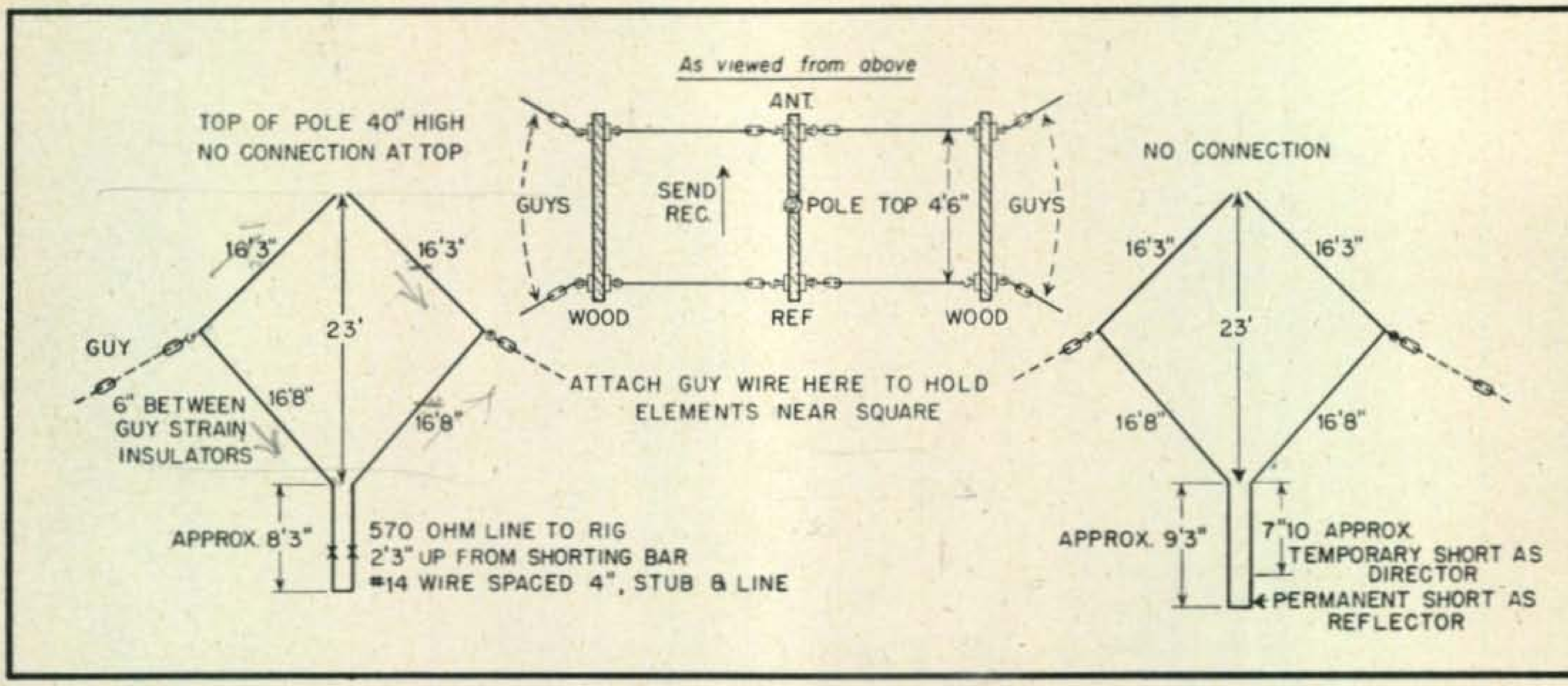


Fig. 1. Bi-Square radiator (left). Wire lengths as given in text are not critical. High radiation resistance remains relatively stable in wet weather. Radiation is at right angles to plane of wires. Parasitic element (right) is mounted on wood spreaders with no direct connection to Bi-Square. Addition of radiator lowers vertical angle of radiation and increases gain.

larly large cross section since there is little strain or pull upon it. A 40-foot pole constructed of 2" x 3" has been used here, but surrounding trees or buildings may be such as to require greater height to get the radiator in the clear.

Because neither the current nor voltage reach a high value the loss in the wood pole is negligible; the pole is not in a strong field.

The radiator elements are laid out as in *Fig. 1*. The top legs of each radiator should be exactly 16'3" long and the bottom legs 16'8" for optimum performance from 28 to 28.5 mc. The insulators for the bottom legs attach 23' down from the top of the pole or from the point where the top legs attach to the pole 'if not the top'. Each radiator is insulated with an ordinary 3" glass insulator at the top and bottom where attached to pole. At each corner of the radiators there is attached a guy wire insulator. A long guy wire from this point to the guy anchor point is used to guy the array. If the length of each radiator is equal and they are attached to the pole as described, when the guys are pulled tight the result is a near perfect square. It is necessary for proper operation of the radiator that the legs of the radiator form a near perfect square.

The transmission line may use anything from 2 to 6 inch spacing although 4" spacing is recommended since the radiation from such a line is less than from a 6" spaced line. It is not so critical that slight variations in spacing will have a noticeable effect on the surge impedance. A ten foot length of line, approximately a quarter-wave stub, is cut and attached to the radiator and this line is used to tune the array to resonance.

Tuning the Beam

As a resonance indicator a 6.3 volt dial lamp with 2" leads and clips soldered to it or a low range r-f meter can be used. In our case we used the dial lamp.

The transmission line is inductively coupled to the final amplifier. At the radiator end of this line we attach a make-shift doublet, which is under the Bi-Square radiator, a few inches off the ground. Power is now fed to this makeshift antenna and our dial lamp resonance indicator is slid up and down the stub to locate the point at which to attach a shorting bar. This resonance point is not sharp and is indicated by maximum brilliance of the lamp; this is usually about 8'6" down the stub from the radiator.

The resonance indicator is removed and replaced by a heavy, well-soldered shorting bar at the resonant point. This point is zero voltage and the center of the shorting bar may be grounded for lightning protection.

The next step is to find the proper point to attach the feed line to the stub. As a starting point attach the feed line to the stub about 2'6" up from the shorting bar and then measure the standing waves on the feed line. An inexpensive method is to attach 6.3 volt dial lights, shunted across 6" of the line (on either side) spaced approximately 4'6" between lamps. We have found three are usually sufficient. These should not be attached close to the stub, since there is a field around it that may cause one of these lamps to glow with greater brilliance due to inductive pickup from the stub.

FREQ. (MC)	METER Single Bi-square	Bi-square + Reflector
28.0	S-5	S-9+ 6db
28.15	S-5	S-9+20db
28.3	S-5.5	S-9+36db
28.45	S-5	S-9+10db
28.6	S-4.8	S-9+10db
28.75	S-5.2	S-9+ 5db

Fig. 3. Field strength readings taken on Bi-Square with and without reflector.

The feed line is now slid up and down from the first point of attachment until a point is found at which the brilliance of each of the three lamps is equal. It is *not* necessary that the standing waves be *completely* eliminated from the line; the line will operate with very low losses even though there is a slight variation in current and voltage. Another method would be to check the voltage and current excursions along the line with an r-f galvanometer or low range milliammeter and rectifier connected to a pickup coil.

These detailed instructions are intended for the amateur who is not satisfied unless he is certain his radiator is operating at peak performance. Actually the adjustments are not critical and good results can be obtained by merely cutting the radiators and stub to the dimensions given and letting it go at that. By actual tests this radiator is at least as good as the Lazy H, one of the best 28 mc arrays, and covers a greater horizontal path. It will out-perform most simpler 28 mc arrays and compare quite favorably with the more elaborate ones, without going to the trouble to get everything right "on the nose."

You may wish to cover a greater area than permitted with a single Bi-Square. This can be done easily by building an exact duplicate of the one described above and placing it at right angles. Arrange an r-f relay to switch the transmission line from one stub to another and you are all set to cover the globe in great style. There will be no coupling between radiators so long as they are exactly alike and at exact right angles to each other, even though both are mounted on the same pole.

Adding a Reflector

Our next step in search for greater antenna gain was to build a duplicate to the single Bi-Square described above and mount these two on one pole parallel to each other across-connected and

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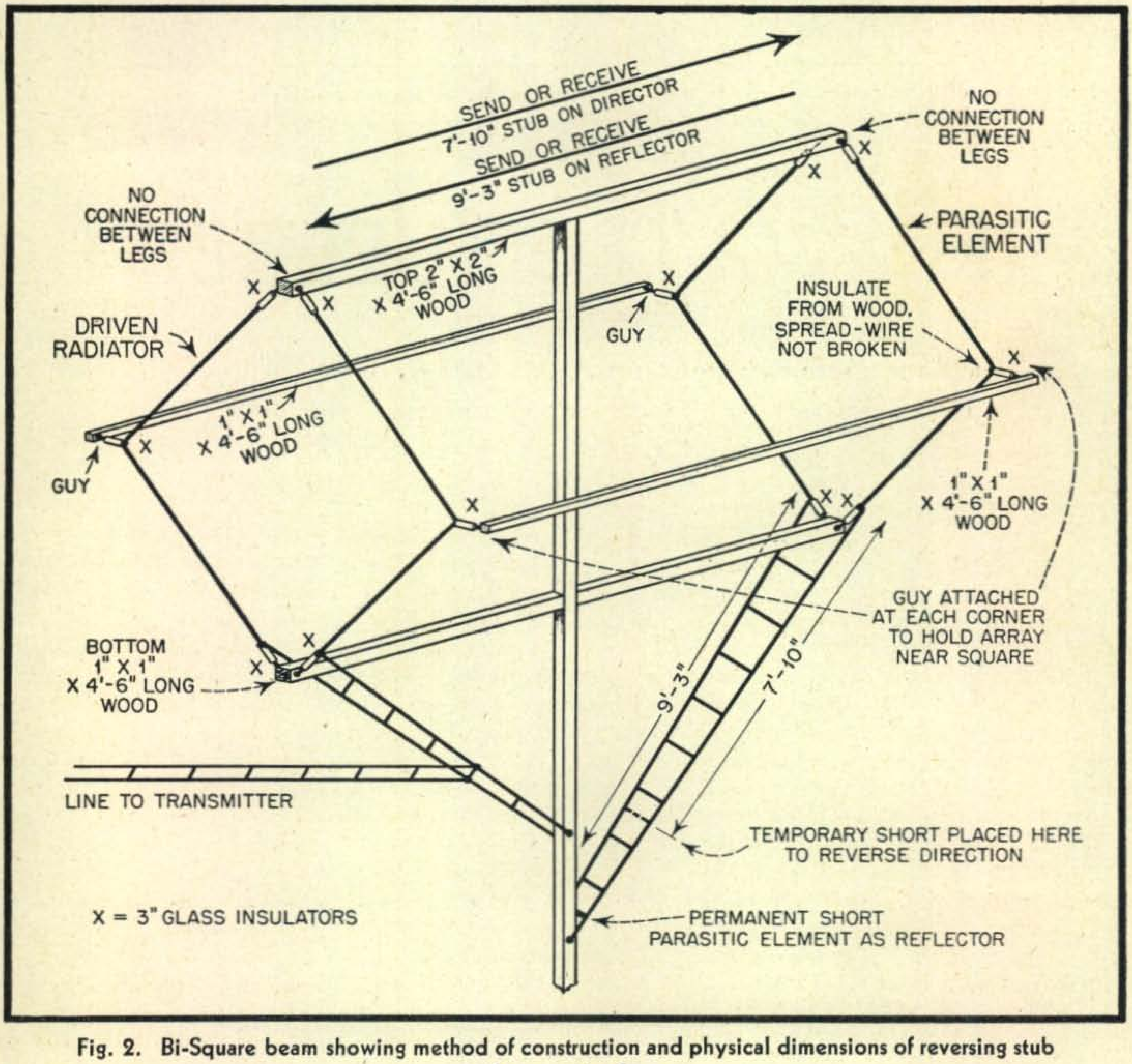

Fig. 2. Bi-Square beam showing method of construction and physical dimensions of reversing stub and supporting frame.

for watt, the Watt Squeezer I, gets a lot out for a little, which is something these days.

Appendix

There are two simple methods of metering the Watt Squeezer I. A choice must first be made as to whether or not both stages will be keyed simultaneously. Both stages are keyed simultaneously when the solid connections on the schematic diagram are followed, omitting the dotted jumper between points x_5 and x_6. In this connection, a SPDT switch may be used to shunt a single 0-150 ma milliammeter across either *R-4* or *R-8*, the 20-ohm meter shunts. Since both cathode circuits are closed only when keying, the 807 plate current limiting tube, the 6A3, is in reality not absolutely necessary as a part of the circuit. However, in the event that while the key is down the oscillator suddenly becomes inoperative due to a fault of some kind, the 6A3 circuit will insure that the 807 is fully protected from overload. To make the most of the novel 6A3 system, one can omit the connection between points x_3 and x_4 substituting a jumper from x_4 to x_5 which results in oscillator keying only. This arrangement necessitates the use of a two circuit two position rotary switch to accomplish single milliammeter metering of both stages. In this latter case the meter is connected between x_1 and x_3 when reading oscillator cathode current and between x_2 and x_5 (or ground) when reading final cathode current.

An additional factor governing the above choice is that almost the full 807 plate voltage appears across the key (in the up position) when both stages are keyed together whereas only the 6V6 plate voltage is at the key with jumper x_4 to x_5 in the circuit and x_3 to x_4 open.

BI-SQUARE BEAM

[*from page 11*]

fed with a 3/16 wave stub. This gave a bi-directional pattern quite similar to the W8JK 2-section flat top, with somewhat more gain, but was very hard to feed and quite critical as to frequency and weather. So our next thought was—why not use the added element as a reflector? After numerous tests we have found it to be the answer to a real antenna for 28 mc and low power!

The parasitic element is shown in *Fig. 2* and is an exact duplicate of the radiator in *Fig. 1* except that the stub is longer.

This is mounted on the same pole as the driven radiator and in back of same, the two squares being separated 4′6″ (1/8 wave) by wood spreaders which support the wires. There is no connection between the two. Using a field strength meter located about 1000 feet from the array, the shorting bar on the stub attached to the parasitic element, was run up and down until the point of greatest gain was located, the power input to the driven radiator being held at a constant value after each change.

In our case using the parasitic element as a reflector the proper stub length was 9′3″ but this is not critical to about 2″ either way.

We then moved the field strength meter to the other side of the array at the same distance from it. Leaving a permanent short on the parasitic stub, (at 9′3″ down) we started temporarily shortening this stub until a point was located that gave maximum gain in this direction from the array. This was 7′10″ from the point at which the stub attached to the parasitic radiators. We were then all set, with a real gain. Uni-directional, North or South, depending on where we short the stub on the parasitic element. There is a change in loading when going from reflector to director but this is no doubt due to changed impedance. However, it worked so well we have been too busy on the band to correct this condition.

The complete array is more critical as to frequency than the single Bi-Square but does a very good job over a wide band of frequencies as shown by *Fig. 3*. These reports are by meter on an SX28A at a distance of 24 miles at 90 watts input here to the final.

Results

Since using this complete array we have many times been accused by South Americans of using 900 and not 90 watts. We have been able to work *every* station heard from South America and all except one Asian. This antenna is broadside North and South and is used only for South America and Asia.

We use a single Bi-Square broadside E & W for Australia, New Zealand and Africa and even though the "Zedders" are about 35° off the center of beam, reports have averaged S7. In North Africa the reports are just as good as those obtained with a 3-element close-spaced rotary aimed right on Algeria and that point too is about 30° off the center of the Bi-Square beam.

All in all, for the time, money and effort involved these two antennas have given us more and better DX than any others tried here in over 26 years as an amateur and we have tried them all except the rhombic. We have noticed our reports with 90 watts are usually as good and many times better than those obtained from DX by the 1 kw boys. Sure it's just the location—maybe. We think it is a couple of darned good antennas, which helped by the 3-element rotary, have worked 77 countries since November 1945.