20-meter DX with a 2-element Beam

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Assistant Editor

There's no doubt about it. The sunspot cycle is increasing and DX conditions are getting better and better. European stations are being heard on the west coast of W-land over the long (VK) path in the early mornings—a sure sign that "things are looking up." Such rare prefixes as ZD6, VQ8, FB8 and the like are starting to put signals into all parts of the U.S.A. Like bears coming out of a long winter's sleep, some of the big DX-guns are starting to climb out of bed at 6 a.m. to scan the bands for some juicy DX. The beams are coming out of mothballs, all the war-weary 3000-volt filter condensers (long covered with dust in the surplus bins) are being snapped up. Yessir, the signs are pointing to another big DX season.

Is the big DX "wheel" the only man noticing these unmistakable signs? No, little Joe Ham with his folded dipole and 120-watt rig is aware of the coming DX-feast. He, too, is waiting with anticipation for those elusive AC3's and XZ's. Poor little Joe! Guess what will happen to little Joe, dear reader, when he calls the XZ along with ten or twelve DX-minded hams all of whom are running a full gallon into rotary beams 70-feet high? You are so right. Little Joe will go back to exchanging "handles" with the nearest W9. He just doesn't have a chance.

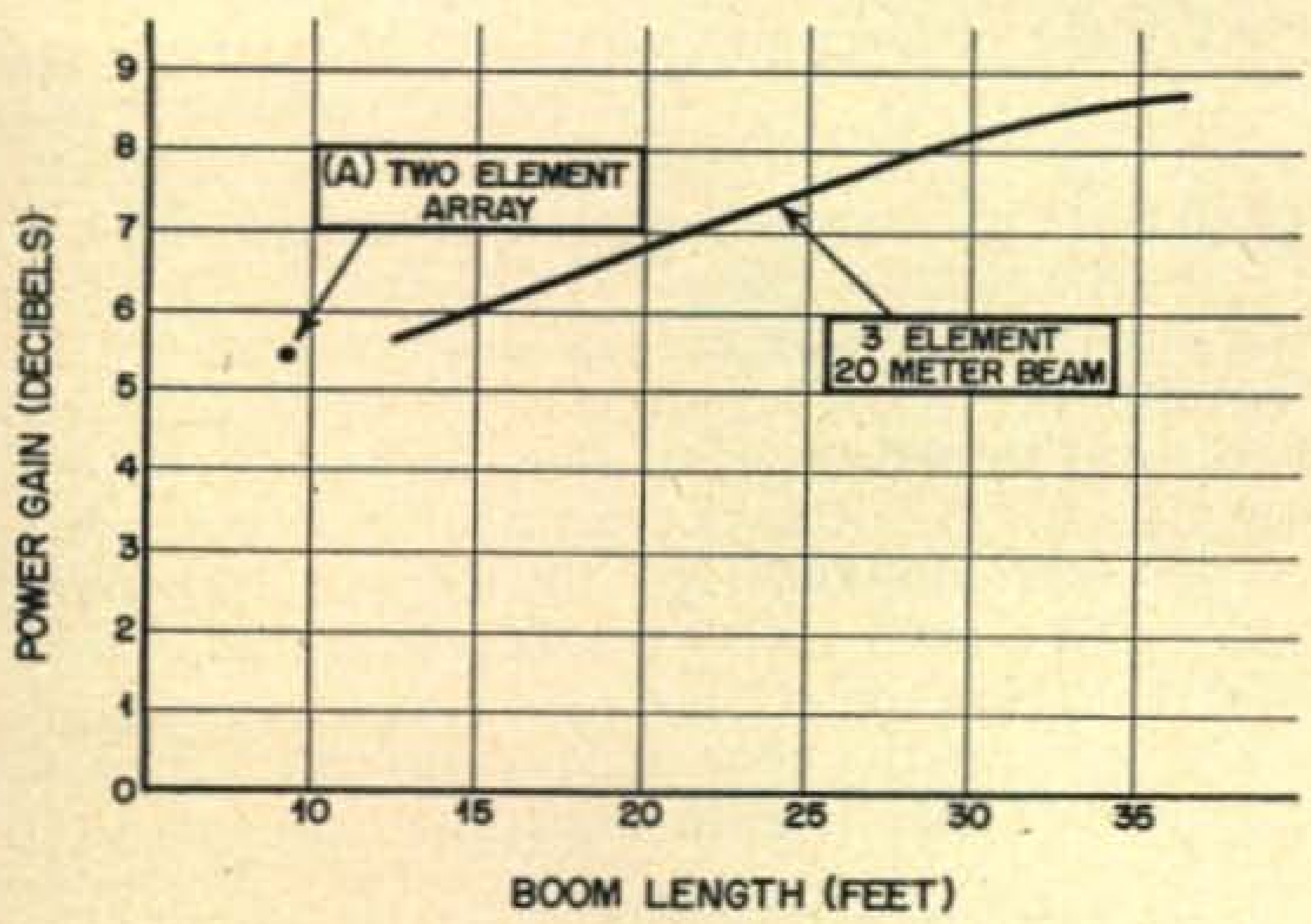

Fig. 1. This is the approximate relationship between overall boom length and the power gain expected from a 3-element beam. The gain of a close-spaced 2-element beam is shown "A."

A word to the wise should be sufficient. With over 120,000 licensed W-hams, it is a good bet that at least half of them will be scanning the DX bands along with Little Joe and his 120 watts and folded dipole. Little Joe, heed well! The only way to work DX is to be LOUD! Little Joe, what you need is a two-element close-spaced parasitic beam to take the place of that folded dipole!

(*A two-element beam? How naive! Don't you know that all the real DX men use three-element 20-meter beams with 24-foot booms?*—**Ed.**) Perhaps so. But here is one DX man that uses a two-element beam. W6SAI may not be at the top of the honor roll of WAZ, but at least he is not crowding the bottom of the list.

The little array to be described has proven its punch in numerous pile-ups and brawls and has come out on top with some choice DX-items. On signal strength checks in Australia, Europe and Africa the difference in performance between the "little wonder" and some of the best 3-element wide-spaced beams in the area has been indistinguishable. This is not to say that a 2-element beam is equal to a 3-element array. The DX gain of the little 2-element array over a dipole is about 5 db. The DX gain of a 3-element wide spaced beam is about 8 db. The

2-element beam has a boom length of less than nine feet for 20 meters, and the 3-element beam has a boom length of 24 feet. Quite a difference!

Figure 1 tells the story. It has been well established by several independent sources that the power gain of a 3-element beam is proportional to the spacing between the elements, and hence proportional to the total length of the supporting boom. Maximum gain for a 3-element array occurs at an element spacing of 0.25 wavelength. A gain of about 8.5 db. is obtained. On 20 meters, this means an overall supporting boom length of 35 feet. The gain drops slowly as the spacing of the elements (and the boom length) is decreased until at 0.1 spacing (using a 14′ boom) the gain figure has dropped to 6 db.

Most 3-element beams use a 24′ boom length, and the power gain of such an array is about 7.5 db. (Individuals claiming more gain for their 3-element beams than the above figures should be viewed with amusement, if not amazement).

Now, let's look at the "little wonder" two-element beam. If the two elements are spaced 0.12 wavelength apart, and the parasitic element is used as a director, a power gain of slightly over 5 db. may be obtained. This is only 1 db. less than a 3-element beam using a 14′ boom, and only 2.5 db. less than a 3-element beam using a 24′ boom. How important is this drop in signal strength of 2.5 db. compared with the tremendous advantage of using a short, eight-foot supporting boom?

Let's pause a moment and indulge in some investigation of this interesting point:

One day, a few years ago, the writer and W6VAT (now W4EFJ) conducted some tests. W6VAT was equipped with a variable autotransformer in the primary circuit of his transmitter high-voltage supply and was able to run his input from zero to 700 watts at will. W6SAI took the antenna off his trusty receiver and put in its place a small bit of wire, pruned until W6VAT was about *S7* when running full input. W6VAT thereupon sent various test signals at different power levels, and the signal strength was noted at W6SAI. The tests were conducted

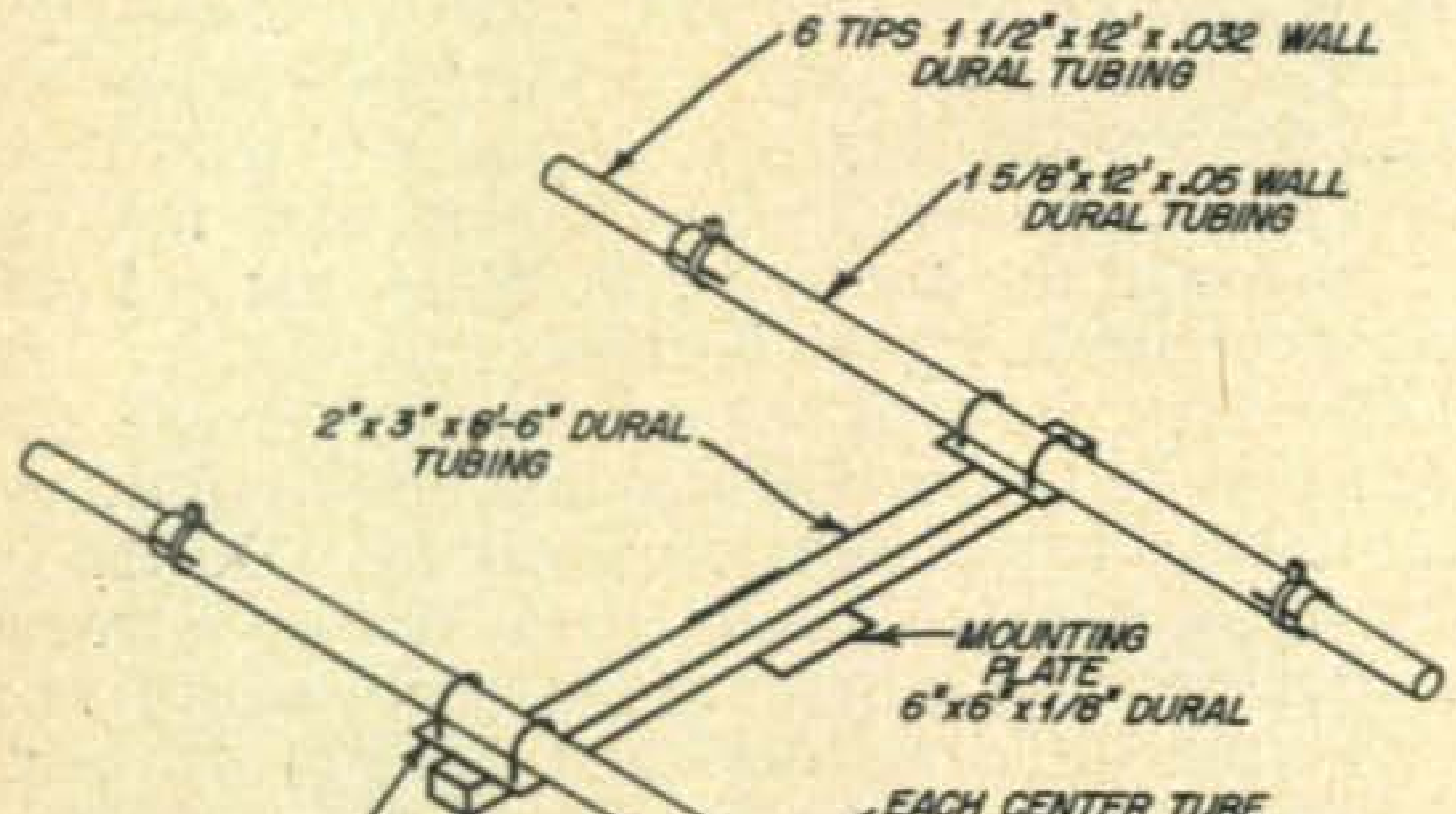

Fig. 3. General working view of the 2-element parasitic beam.

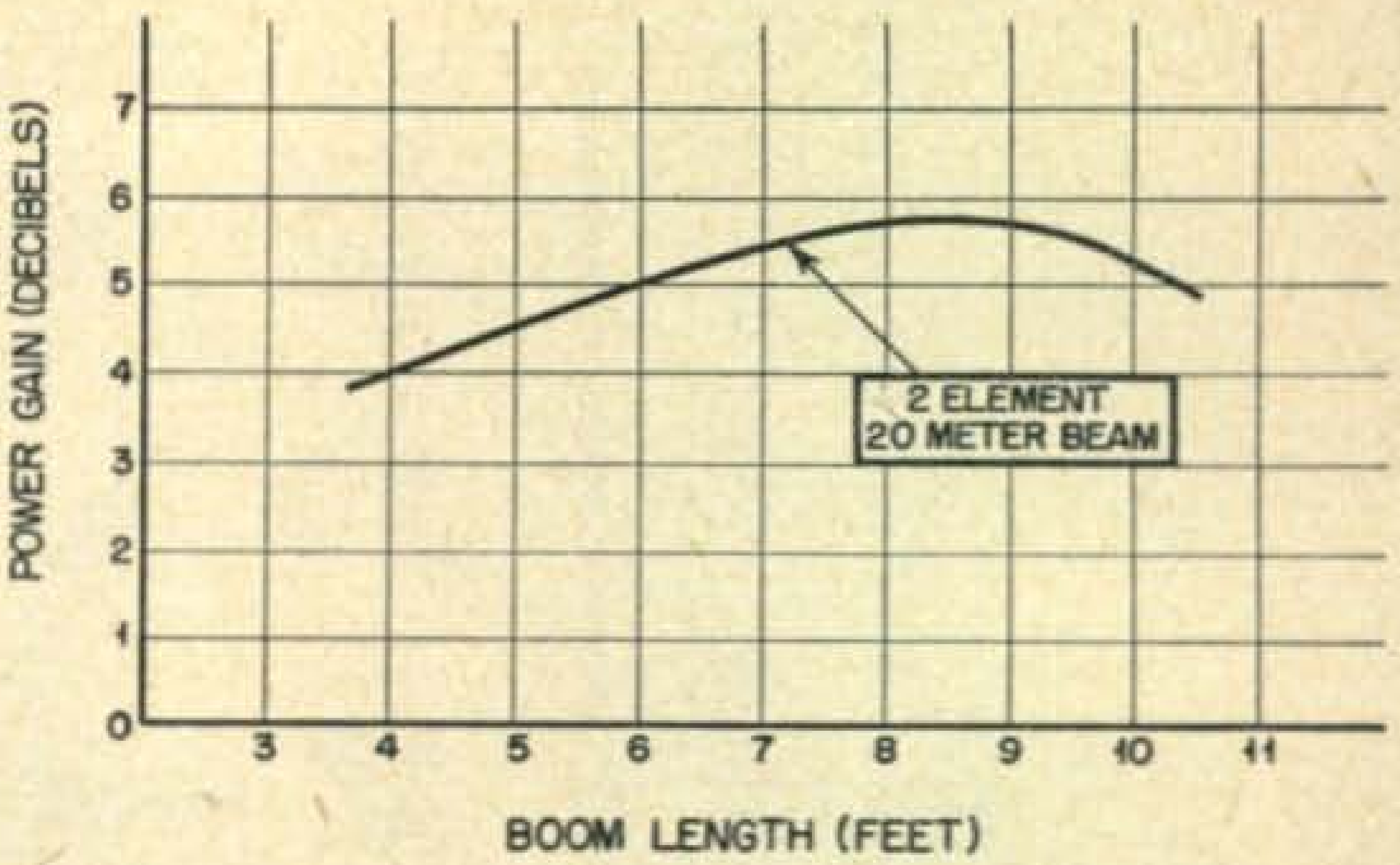

Fig. 2. Typical gain figures for a 2-element parasitic array (director and radiator) tuned for maximum "on-the-nose."

on c.w. no *S*-meter being used, to duplicate actual conditions found when working DX. It was found that the absolute minimum change in power that could be accurately noted was 3 db. (A power change of 2). Changes of power less than this were not noticeable, no matter whether W6VAT was *S2* or *S9*. This information was duly noted in the station log book. The idea of trying a 2-element beam was born as the result of these tests. If a variance of 3 db. was allowable, why not deliberately drop 2.5 db. or so, and use a compact beam that would not give the neighbors high blood presure when it was erected?

A Practical 2-Element Parasitic Array

The maximum power gain obtainable from one parasitic element is obtained when this element is acting as a director. Under these conditions, the parasitic element is slightly shorter than the normal resonant length, and is spaced about 0.12 wavelength away from the driven element of the beam. A gain vs. element spacing for a beam of this type is shown in *Fig. 2*. An element spacing of 8½′ for the 20-meter band is just about optimum for maximum forward gain. The front-to-back ratio of a beam of this type is of the order of 10 db. The front-to-back ratio of a good 3-element beam is about 25 db. However, very few signals arrive directly at the "back" of the beam. Local ground-wave signals may do that, but the usual 1200 to 1500 mile distant "local" QRM that is so bothersome on DX contacts is usually high angle skip that arrives at an angle of 30 to 40 degrees. The discrimination of a two-element beam to signals arriving at such an angle is comparable to the discrimination of the larger 3-element array. Thus while the smaller beam may not offer as much rejection to ground wave signals arriving from the rear, it does a very respectable job on rejection of high angle signals that sneak up behind it.

Armed with this information, a 2-element parasitic array was built and placed in operation on the 20-meter band. The results were so gratifying, that this little story is the result. This antenna may be the answer to your problem.

Construction

The 2-element array is shown in *Fig. 3*. The boom consists of an 8½′ length of rectangular dural tube, measuring 2x3″ in cross section, and having a wall thickness of 0.064.″ A boom as short as this requires no top guys or bracing to hold it steady. Another local ham, making a "Chinese copy" of the beam, used a section of round, 2″ steel TV mast for the boom. It worked just as well as the rectangular dural tube, and was a lot cheaper.

The two elements are composed of 6 pieces of 12-foot dural tubing, 3 pieces to each element. The center sections are 1⅝″ diameter, with an 0.050″ wall, and the tips are made of 1½″ diameter material, with an 0.032″ wall. The elements may be made of either *24ST* or *52ST* dural. Because of the sky-rocketing surplus prices of dural tubing, it is almost as inexpensive to buy new, clean pieces of tubing from a large metal supply house than it is to buy beat-up surplus tubing at the junkyard!

During a series of preliminary tests on this antenna the two elements were insulated from the boom, with a switching arrangement allowing either element to be grounded to the boom.

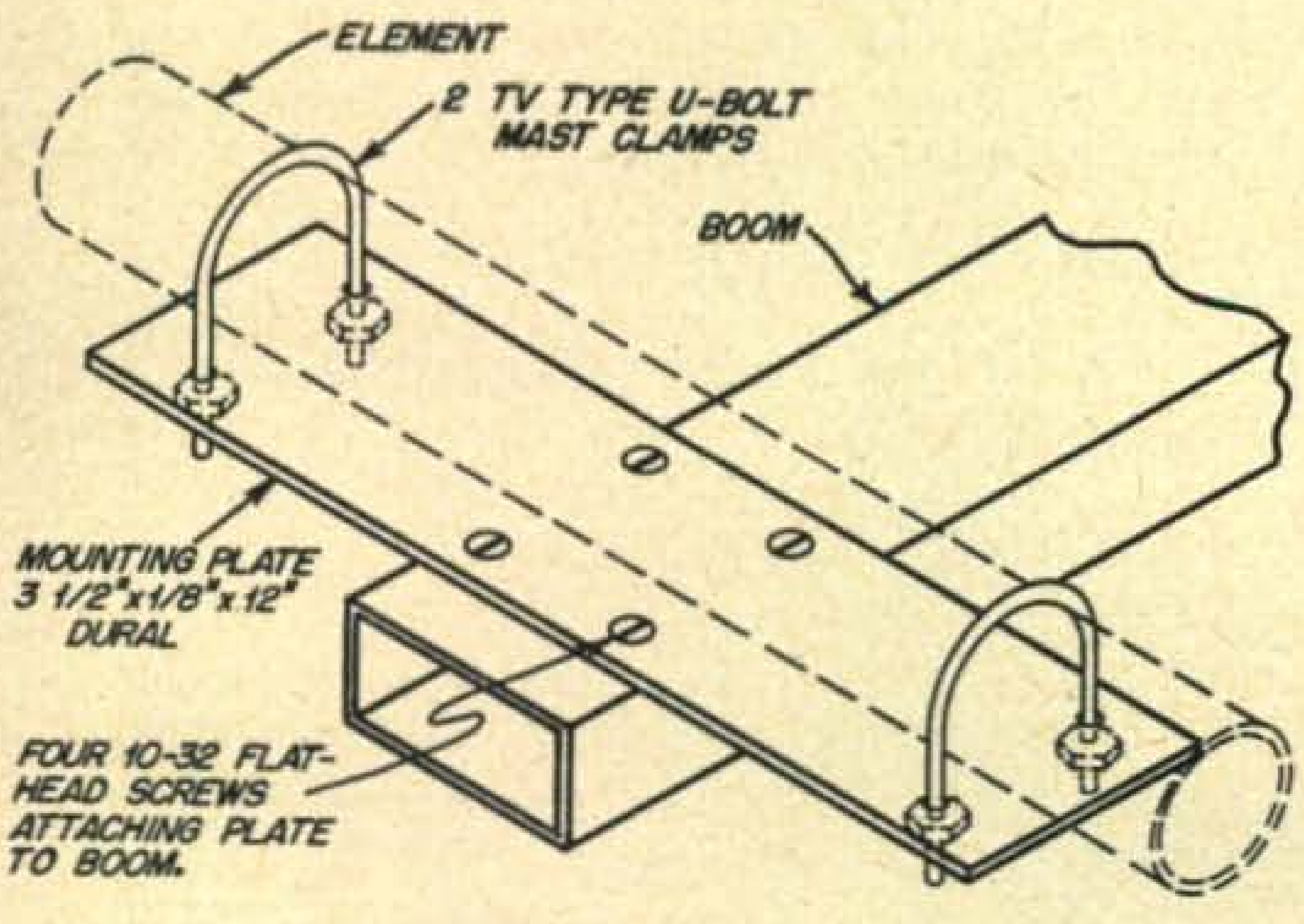

Fig. 4. Detail of the metal plate and clamps that hold the elements to the boom.

It was found that if a metal boom was used, it was imperative to ground the elements to the boom. A simple mounting was made from a plate of dural and two TV mast clamps that would hold the elements securely to the boom. This assembly is shown in *Fig. 4*.

If a wooden boom (such as a length of 3x4″ lumber) is used, the elements need not be connected (grounded). The director is left "floating" in this case. A metal boom is recommended, however, as it aids greatly in making a mechanically rugged structure.

Element Lengths

The response of the 2-element beam is broad enough to cover the whole 350 kilocycles of the 20-meter band. However, the elements should be set for lowest standing wave ratio on the transmission line for that portion of the band in which the operator has the greatest interest. Since W6SAI was primarily interested in CW operation, the beam was cut to 14,100 kc. as shown in *Fig. 5*. For phone operation, the beam should be cut as shown in *Fig. 6*. In either case, the operation of the beam is identical. The SWR curve is merely shifted back and forth from the CW portion of the band to the phone band. In practice, no operational difference has been found when operating the beam several hundred kilocycles from the point of resonance.

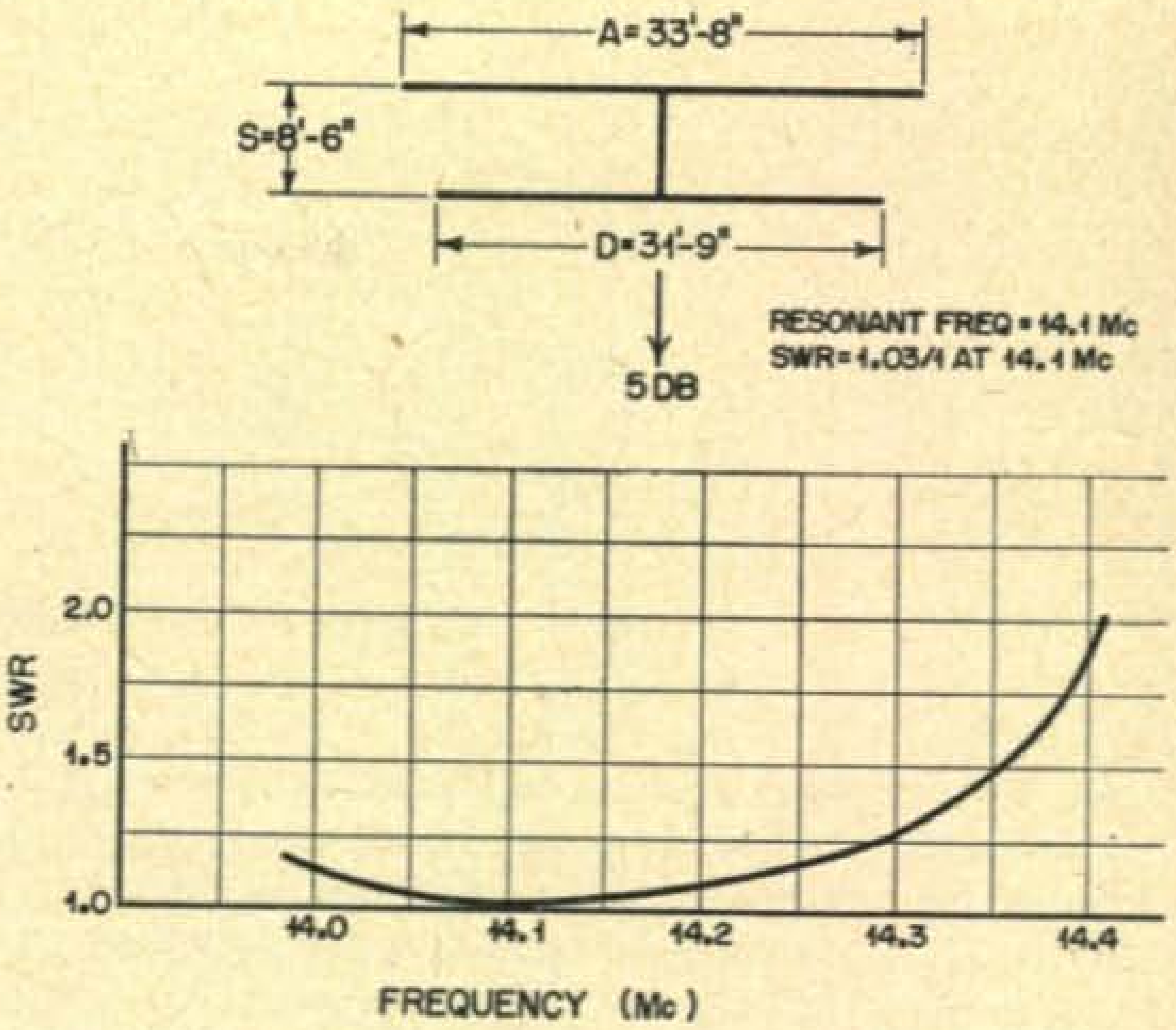

Fig. 5. Dimensions and gain figures for a 2-element beam tuned for optimum performance in the CW portion of the 20-meter band.

The Feed System

The feed impedance of the antenna is very close to 16 ohms. The beam may be fed with a 300-ohm line, and 72 ohm matching transformer as shown in *Fig. 7*, or a coaxial line and

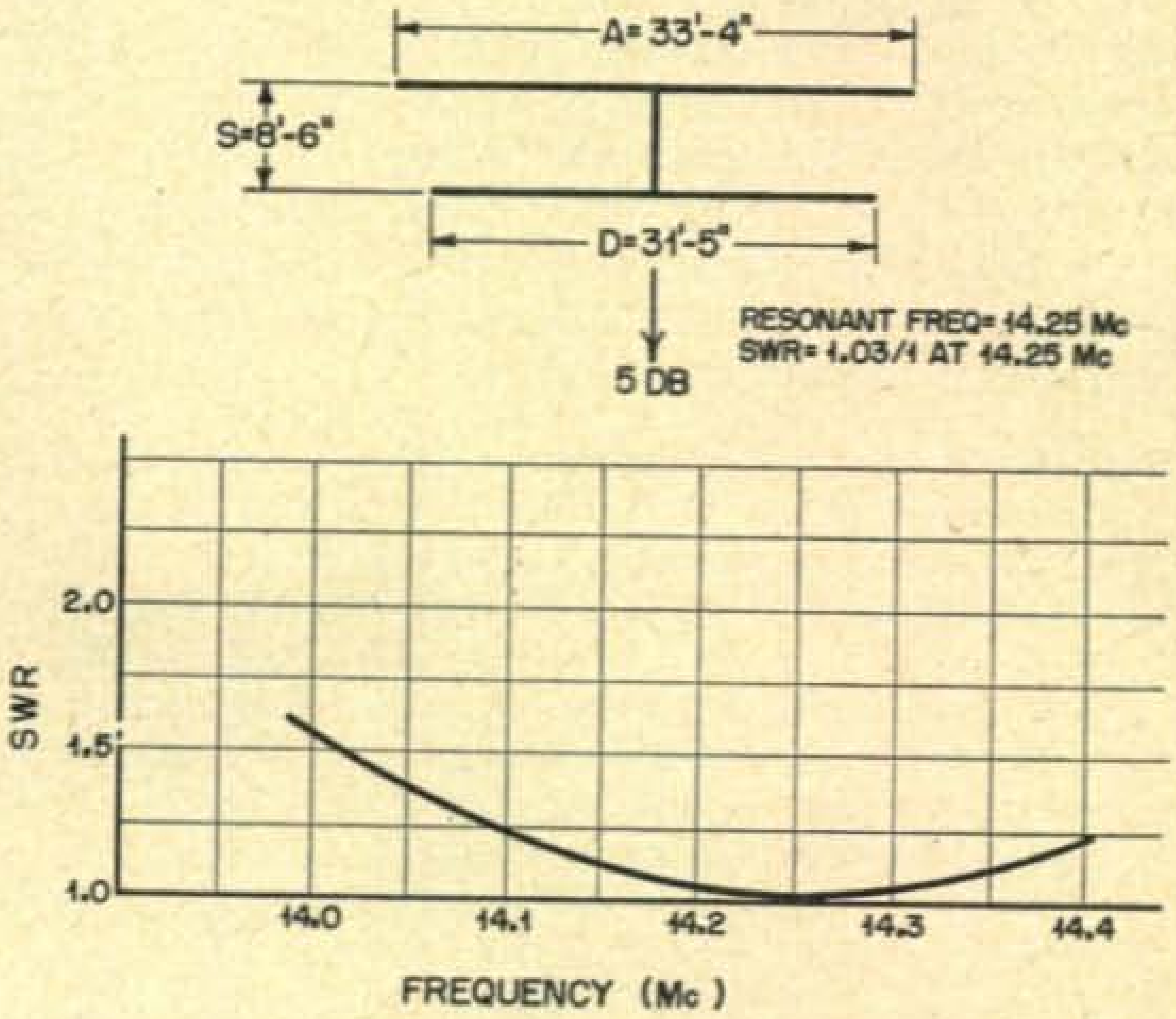

Fig. 6. Dimensions and gain figures for a 2-element beam tuned for optimum performance in the phone portion of the 20-meter band.

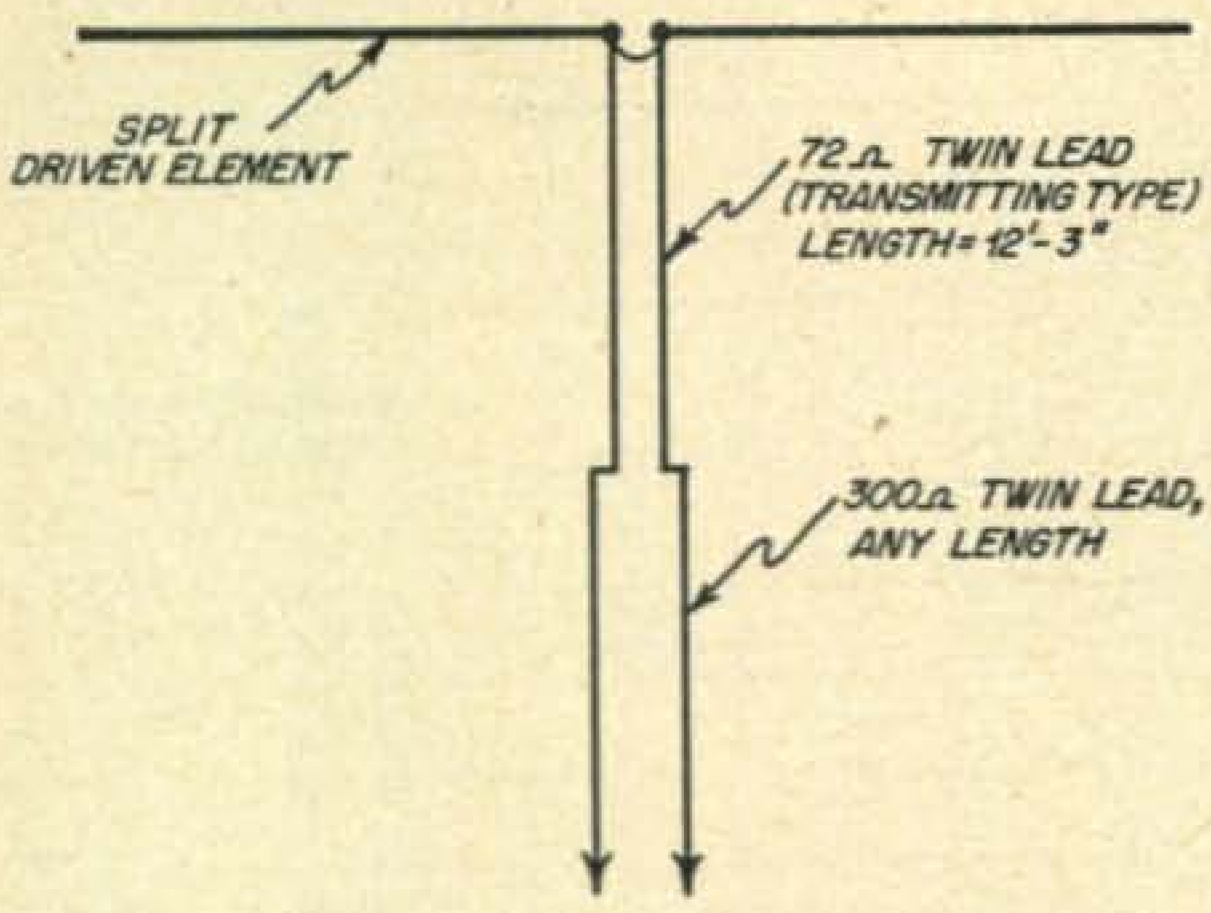

Fig. 7. It is possible to use twin-lead as the feedline for the 2-element beam. This drawing illustrates the method of a cutting short length of twin-lead to serve as a quarter-wave matching transformer. This method of feed is useful when a balanced system is called for.

gamma match may be used. Personally, I feel that the open wire line is to be frowned upon, since it is necessary to split the element to feed it with a matching transformer. This entails a lot of work and numerous difficulties of a mechanical nature. One way around this problem is to match the 300-ohm line to the driven element of the beam with a T-match.[1]

However, the coaxial feed system and pi-network tank circuit have become extremely popular in the last few years, and this arrangement is recommended over all others. A suitable gamma match for 52-ohm coaxial line is shown in *Fig. 8*.

Gamma Adjustments

If the antenna is set to the measurements given in *Figs. 5 and 6* there are no real "antenna" adjustments. The two adjustments to be made are the setting of the gamma condenser, and the correct length of the gamma rod. If the dimensions of the gamma rod specified in *Fig. 8* are followed, the setting of the gamma may be considered to be correct. The one remaining adjustment is the gamma tuning condenser. A standing wave meter, such as shown in *Fig. 9* is needed. This instrument should be placed in series with the coaxial line to the antenna, and then this procedure followed:

1. Attach the SWR meter to your exciter and supply one or two watts of power to the SWR meter—enough to cause a full scale reading on the meter. In many cases, a grid-dip oscillator will deliver sufficient power for full scale reading of the SWR meter.
2. Attach the output terminal of the SWR meter to the coaxial line of the beam antenna. Note how far the meter drops back from full scale reading when the antenna line is connected to the meter.
3. Have an eager assistant slowly rotate the gamma condenser for lowest reading on the SWR meter. If the meter reading can be brought down to 0.1, or less, of the full-scale meter reading, the antenna may be assumed to be tuned in a satisfactory manner.
4. The frequency of the grid-dip oscillator or exciter should be varied across the 20-meter band. The point of lowest SWR is the resonant frequency of the antenna system. This point of lowest SWR may be varied several hundred kilocycles by the setting of the gamma condenser. It is not necessary to change element lengths of the antenna to position the resonant frequency in the amateur band.
5. If it is not possible to obtain a minimum resonant reading of 0.1 of full scale reading on the SWR meter by rotation of the gamma condenser, the length of the gamma rod should be changed slightly, 2" at a time. After each change, a new SWR reading should be taken after the gamma condenser is re-resonated. It is suggested that the rod be lengthened at first, rather than shortened.
6. Several duplicate beams have been built to the above pre-cut dimensions and have all performed in fine style. If your beam is located in a reasonably clear area, these dimensions will probably work as-is for you. Try and stay clear of overhead power lines, tin garage roofs and the like. If a nearby powerline cannot be avoided, position the beam either above or beneath the line. Locating the beam in the same horizontal plane as a nearby power line is the best way of funneling your signal into the nearby TV sets that I know of!

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1. "The Terrible T, and Gamma, Too," William I. Orr, W6SAI, *CQ*, October, 1953, page 15.

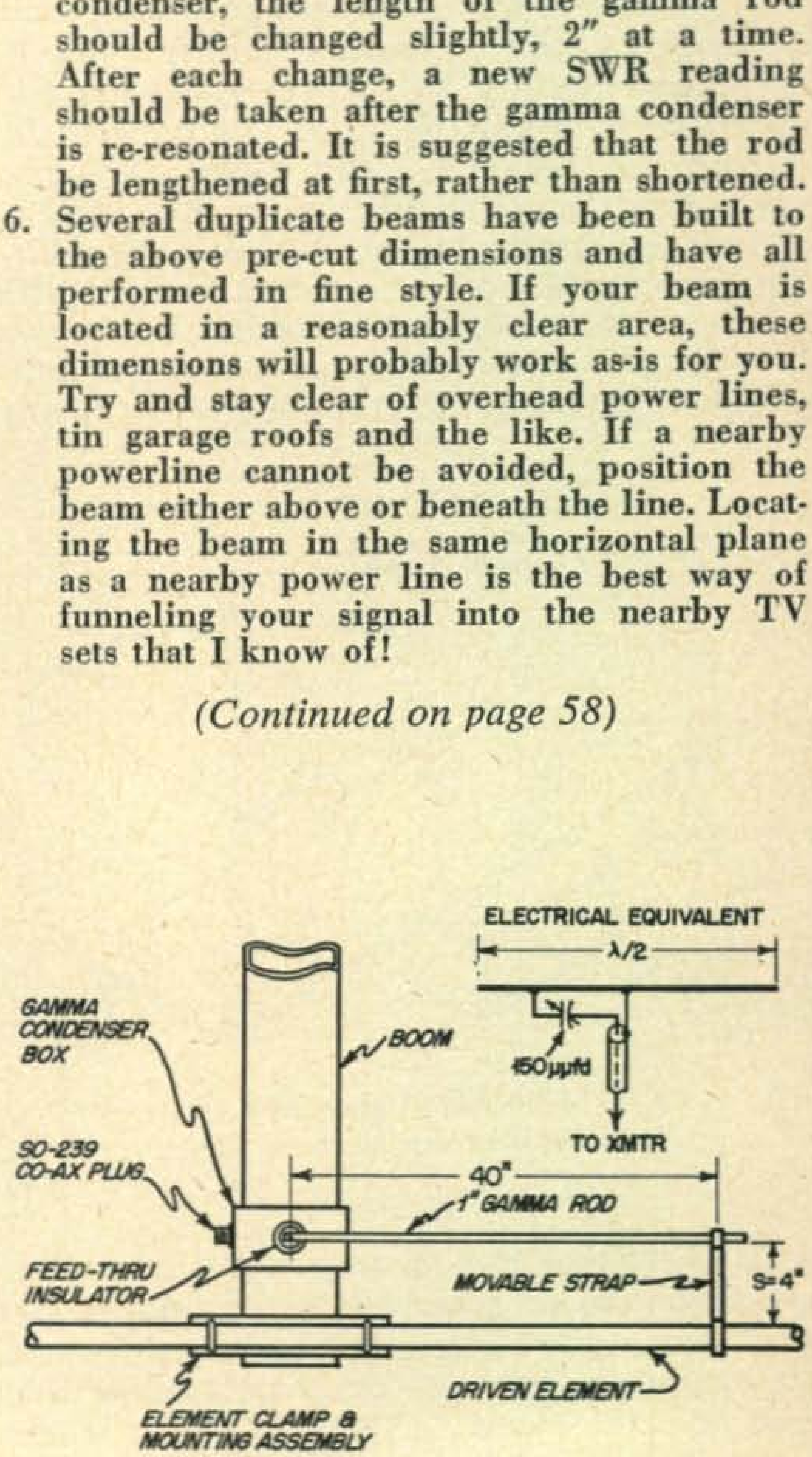

Fig. 8. This is a mechanical drawing of a possible gamma matching assembly. A small metal utility box houses the 150 μμfd. double-spaced tuning condenser. The box must be sealed at the seams with "roofing compound." The gamma condenser is mounted on ceramic stand-off insulators. A quarter-inch hole in the side of the box allows the slotted shaft of the condenser to be tuned with an insulated screwdriver. The gamma rod is attached to the box by a 1½-inch high feed-thru insulator. A coaxial cable connector is mounted on the end of the box and then the box is securely grounded to the metal boom.

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Finn, **LB8YB**, now in OX-land says that last of LB8YB QSL's should be on their way by January. Fin will be on from Jan Fayen for ONE day next Summer. . . . Fan, **FM7WN**, seeks Montana, Oregon and North Dakota to complete *WAS*. He may be found daily on 14 Mc. from 1300 to 1400 GMT except on Thursdays and Saturdays when he works phone on 14150 (Tks to W5KUJ). . . . *REMINDER:* Bob, **G2RO**, may be heard from Cocos as ZC2RO on or about Feb. 6 to 8. Then from Mauritius as VQ8AY. Also, If things went well, W6MHB, may be heard from TI9 around this time. **73 Dick**

Two-Element Beams

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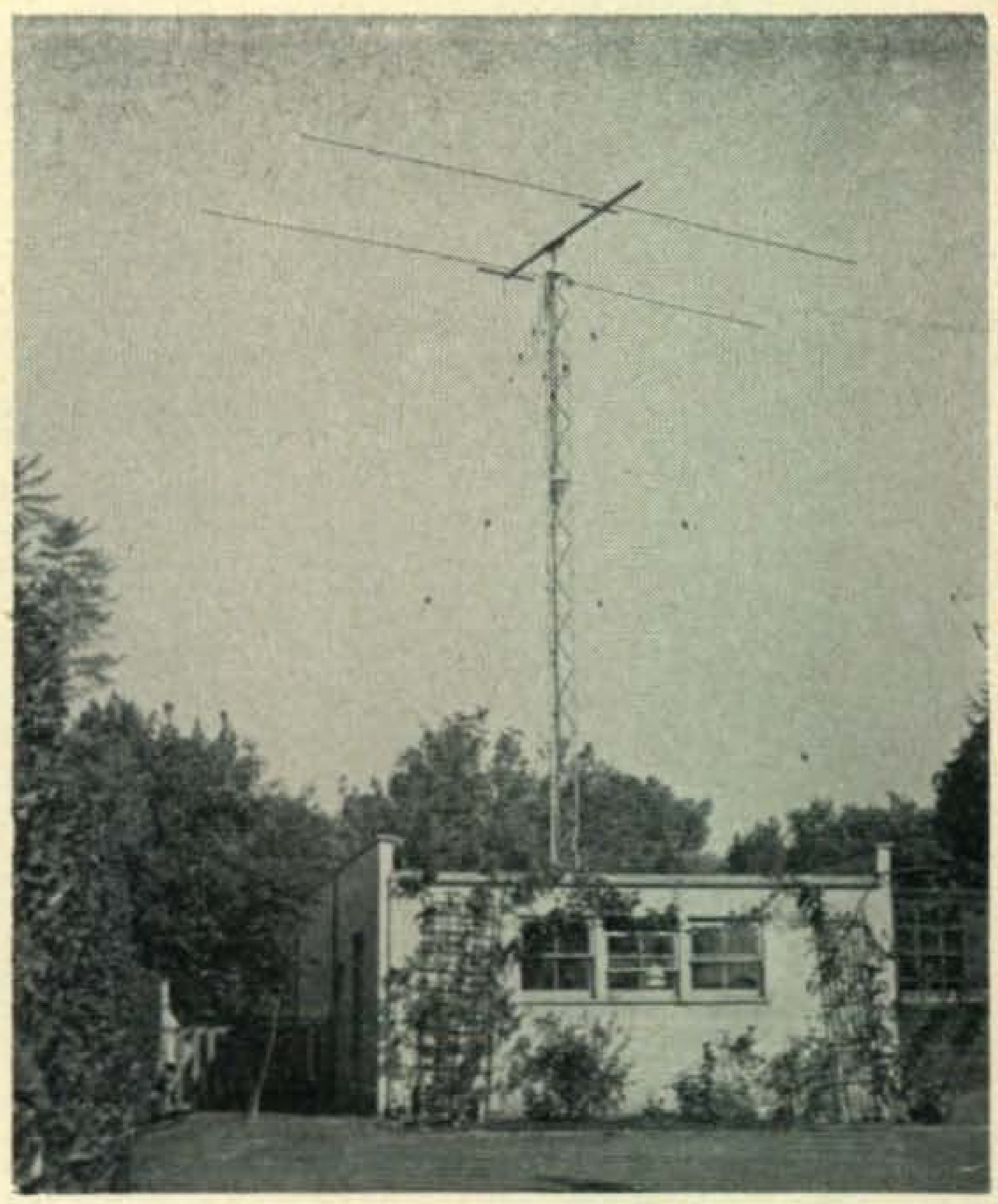
15 Meters

A small duplicate of this beam was made for the fifteen-meter band. One-inch diameter elements were used, with ⅞" extension tips on the ends. The complete beam dimensions are



A view of the two-element parasitic installation at W6SAI.

shown in *Fig. 10*. The beam is light enough to be turned with a heavy-duty TV-type rotator, such as the *Cornell-Dubilier model TR-12*. One of the new TV crank-up towers may be used for the installation of the beam.

At first, the 15-meter beam was stacked above the 20-meter beam, with a separation of about

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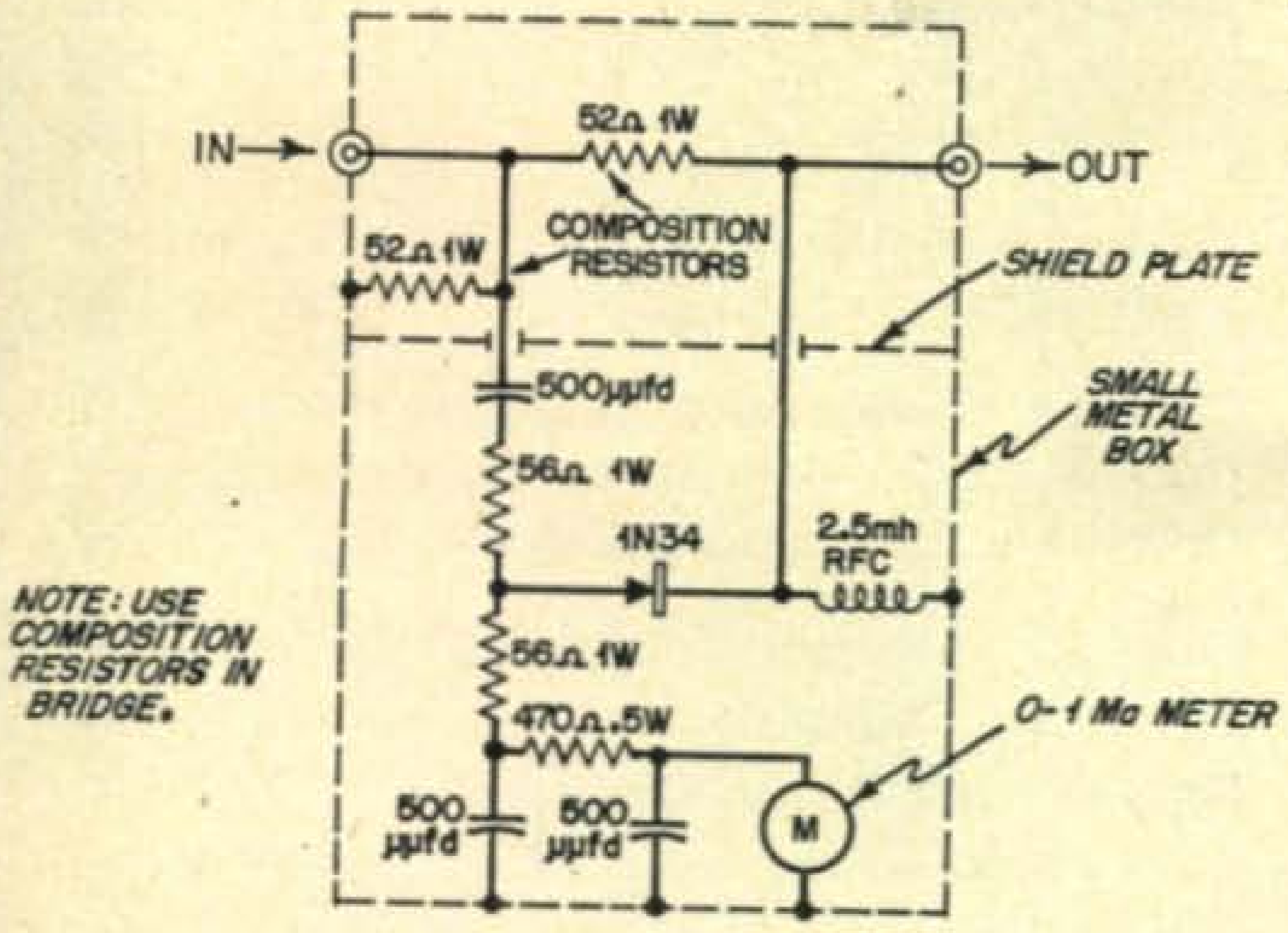

Fig. 9. Simple SWR measuring bridge for use with 52-ohm coaxial lines. A watt or two of r.f. at the operating frequency is applied to the "in" connector, and the r.f. level adjusted for full-scale meter deflection. The antenna coaxial line is then attached to the "out" connector. For SWR of less than 1.5:1.0 the meter should drop to 0.1 of a full scale reading.

4 feet between the two beams. A SWR check showed that the two beams detuned each other about 200 kilocycles. Oddly enough, the 20-meter beam was detuned to a lower frequency, while the 15-meter beam was detuned to a higher frequency! It was as if bringing the two beams together physically actually pushed them apart, electrically speaking.

The beams were used for a month or so, but the degradation of performance on each band was very noticeable. Over the objections of the

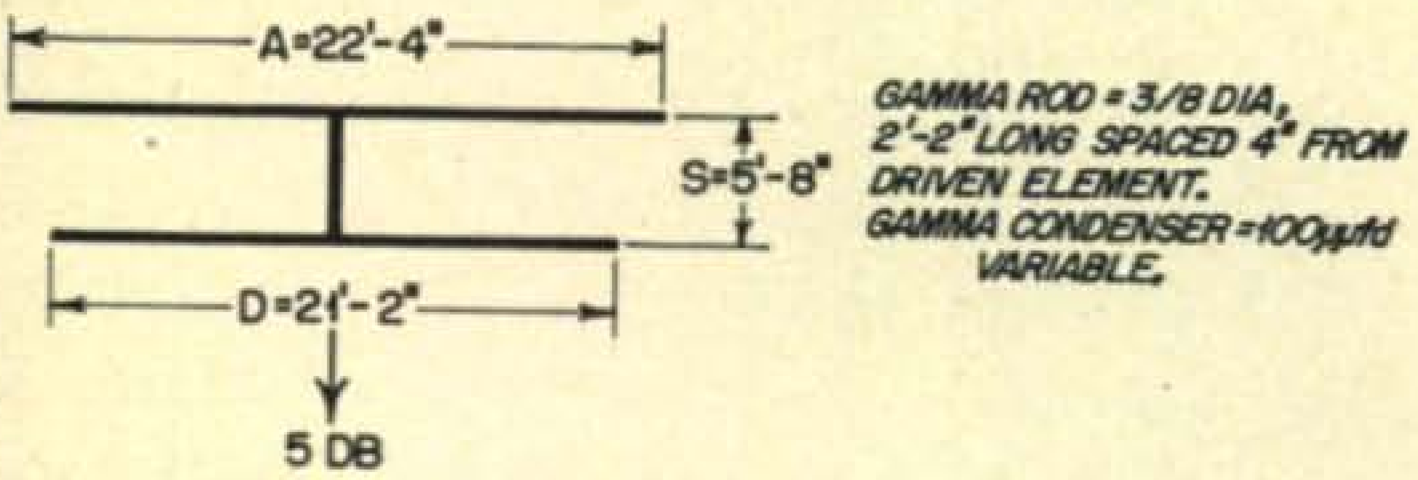

Fig. 10. Suggested dimensions of a 2-element 15-meter beam antenna.

XYL, a second tower was procured, and the 15-meter beam erected on it. It immediately began to "bore a hole" in the band. It is obvious that a little more thought must be applied to the problem of stacking two beams on one tower.

In any event, the operation of the beams proved the original contention: a 2-element beam is an excellent DX antenna for those who prefer not to decorate their house with a full sized 3-element wide spaced beam. Try it! I know you will be pleasantly surprised with the results.