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more words on...

Antennas

You probably have wondered how some guys get these terrific signals and thought, "He must be running more than a KW," "I can't hear the DX station he's talking to, he must be talking to himself." As you may or may not know, 2 kw has only 3 DB more gain than 1 kw. I have heard hams belittle WØAJL (Denver) and his signal with the remark, "Well, he's got good efficiency with that Collin's KW1" and say nothing about his antenna. Let's stop and examine this point. It is true WØAJL has 76% efficiency or 760 watts *output*. Assume another ham down the street has a home-made KW with 50% efficiency or 500 watts output and exactly the *same* antenna. The difference between 500 and 750 watts is not 20 or 30 db but a measly 1.8 db. But if the antenna in either case were poor, 20 or 30 db could well be the difference.

Those oustanding signals are primarily due to a perfectly matched and resonated *"Home Brew"* beam. I consider Walt one of the best antenna men in the country and his signal tends to verify it.

A whole article could be written about WØAJL's 20m Imp. matching techniques and how the 760 Watt output figure was determined.

A number of hams have measured WØCVG's final down to the inch in an effort to duplicate his 75 meter signal by duplicating his final amplifier. The secret of his signal, if you could call it a secret, can be found by examining the antenna from the link on up rather than the final. He uses an "Inverted Vee."

A ham who accuses another of talking to himself or running more than a KW may be jealous and he certainly is showing his own ignorance. However everybody knows there are a few who exceed a KW. It's much cheaper to get the same gain out of the antenna instead of the transmitter and you will realize the same gain for all received signals as well. Increasing power doesn't help in *hearing* the DX any better. You got to hear them to work 'em.

Outstanding signals result from a combination of things such as antenna, location, height and matchings as well as power, good grounds and other factors. If you are willing to take the time to squeeze those extra db s out of your dipole or beam, your signal will be outstanding also. Don't let anyone tell you theory doesn't work.

There are certain principles one must keep in mind. In reading this, take it slow. It's not difficult, you may have to read it a couple of times, but you must understand it. Some of the least known and most important antenna concepts are described in this article.

First, let's discuss the impedance (Z) vs. height curve for a simple dipole which is the most important curve to have a working knowledge of. One of the first questions that usually comes up is, "What line should I use to feed the dipole or what is the Z of my antenna?" The Z changes as the dipole is raised or lowered to different heights above the ground.

The ARRL Antenna Handbook states (1949 Ed., page 48) "Waves radiated from an antenna directly downward reflect vertically from the ground, and, in passing the antenna on their upward journey, *induce a current in it* which will be in or out of phase depending upon antenna height. This is an important point, the *reflected* wave induces a current in the dipole. The magnitude and phase of this induced current depends upon the height of the antenna above the reflecting surface."

"The total current in the antenna thus consists of two components. The amplitude of the first is determined by the power supplied by the transmitter and the free space radiation resistance of the antenna. The second component is induced in the antenna by the wave reflected from the ground. The second component, while considerably smaller than the first at most useful antenna heights, is by no means inappreciable. At some heights the two components will be more or less in phase, so the total current is larger than would be expected from free space radiation resistance. At other heights the two components are out of phase and at such heights the total current is the difference between the two components." *This second component is the one that changes the impedance.* As the antenna is raised, the reflected wave becomes weaker and has less effect in changing the antenna's impedance as can be seen by the dipole Z curve on the large chart. A beam's Z is low because of the strong, inphase, and reflected component from the director and reflector.

The rotating of a beam will change the impedance and current slightly if the ground or reflecting medium is uneven underneath. See W6SAI, page 63, *Beam Antenna Handbook.*

If the antenna height is raised or lowered, a higher current at the feedpoint at the same value of power means that the effective resistance of the antenna is lower, and vice versa. In other words, power must always equal I^2R. If the power input is constant, and the radiation resistance (impedance) increases, the current at the feed point must decrease so that the value of P will be constant and still equal I^2R. Likewise if you raise or lower the antenna and the current at the *feedpoint* of the antenna goes up, the impedance or R must come down so that again $P = I^2R$ (assuming you're still at the resonate frequency).

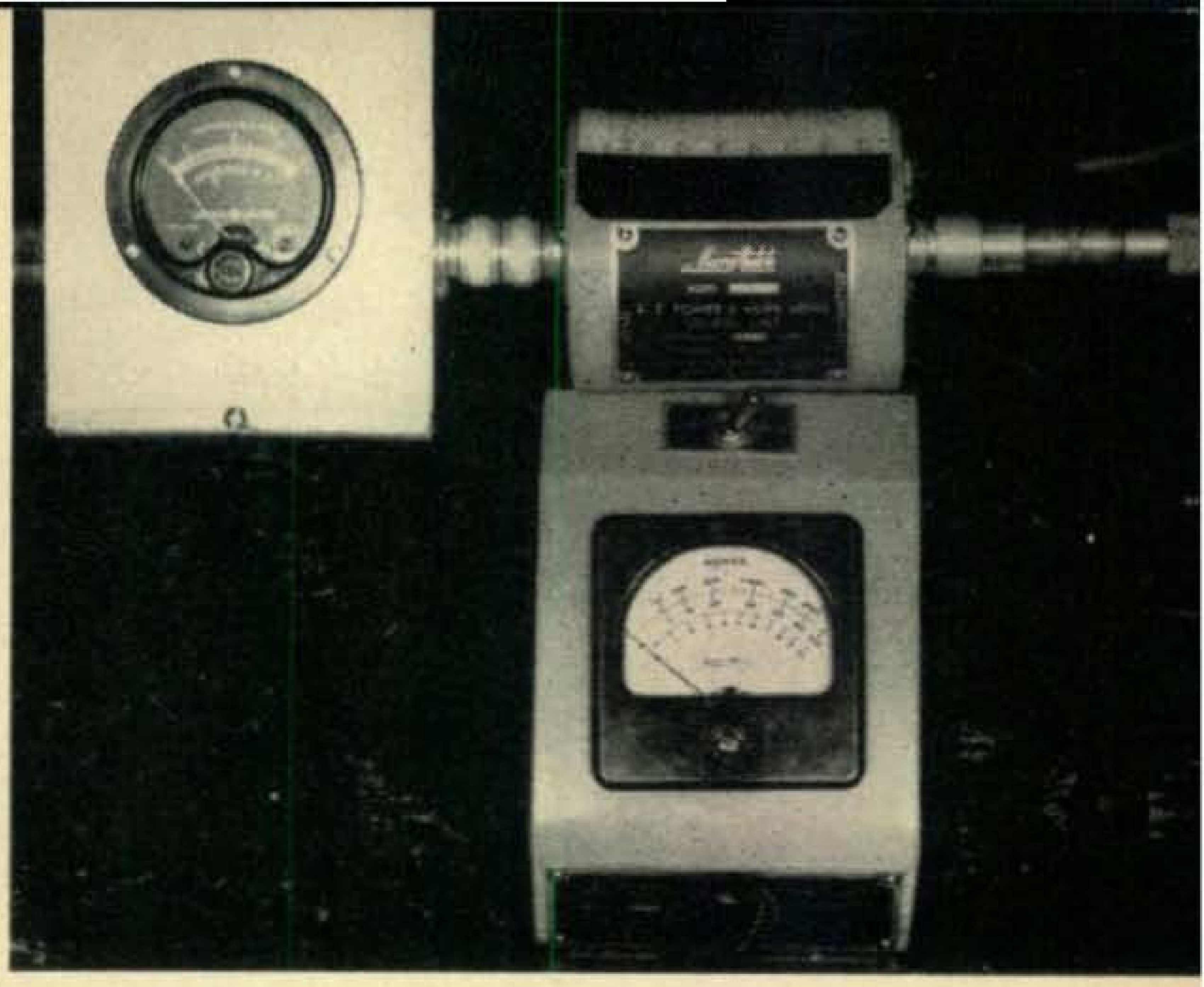
If an antenna that resonates at 3800 kc and has an SWR of 2::1 is operated at a frequency of 3900, it will have a higher SWR and less gain. How can this antenna compare to an antenna that not only resonates at *your* operating frequency, but also has an SWR of 1::1 or very close to it. This antenna can be loaded at the resonate frequency and operated 50 kc on each side without touching the final tank or coupling for most link coupled transmitters. Not only that, your low pass filter will attenuate the harmonics the most and the fundamental the least, if the SWR is very low. Remember low pass filters are rated at 1 KW if SWR is low.

Once you have heard the results of using such an antenna you will never feel right until all your antennas are the same. I have two 10 meter antennas that are switchable through a coax switch without touching the final because they are both matched and resonated.

Here is one way to check for reactance on a feedline caused by a mismatch or being off the resonate frequency if you are using a link coupled final. Disconnect antenna and dip final. Reconnect antenna. If you have to redip final it means you are tuning out the reactance the feedline has introduced. If final tank capacity was increased for dip, it means an inductive reactance was tuned out of the feedline and vice versa. You can get some idea of the degree of mismatch by the amount the final tank capacity is varied.

The Impedance vs. Height Curve shows the way the radiation resistance of the antenna is affected by the height of the antenna above ground. A ground system effectively establishes the height of the antenna insofar as the radiation resistance is concerned. Over *actual ground* the variations of Z will be somewhat lower due to ground losses which can be reduced by a ground system, but the chart shows the approximate magnitude of the change to be expected. If a ground system is used it should preferably extend at least a half wave length in every direction from the antenna.

I will use electrical ground heights for example purposes. On the top of the graph the heights above electrical ground in feet are given for various frequencies. Lower figures are in terms of wave lengths. The important 52 and 72 ohm heights are shown for the various frequencies also. The depth of electrical ground below physical will vary, of course, but let's assume they are the same for the time being until the principles are understood.



Typical setup to measure antenna resonance.

Let's take a half-wave dipole starting at a height of 26 feet above electrical ground. Assume it resonates at 3800 (and this is not necessarily the frequency it loads the best either) and we wish to know the impedance of the antenna. Using the top figures we find 26 feet on the line to the right of 3800. From this point come straight down to the curve. You will notice that this corresponds to a height of .1 wave-length. Next a straight line from this point to the far right where the impedance values for a dipole, folded dipole, and a folded tripole are shown. The Z will be 25 ohms for a dipole, 100 ohms for a folded dipole, and 225 ohms for a folded tripole. See *fig. 1.*

A little higher on the curve at .13 wavelengths (34 feet) a *folded tripole* will have a Z of 300 ohms—a perfect match for 300 ohm line. See *fig. 2.*

This 3-wire tripole is extremely broad. It will have a *low* feedline loss because the Z is high and the current is low. These antennas

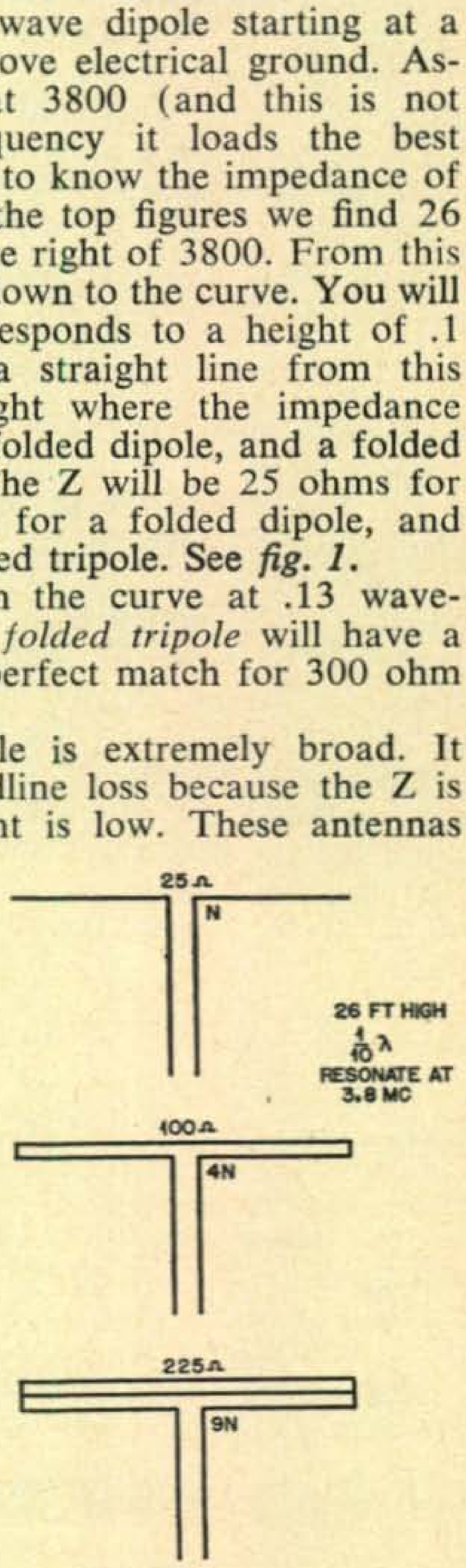


Fig. 1.

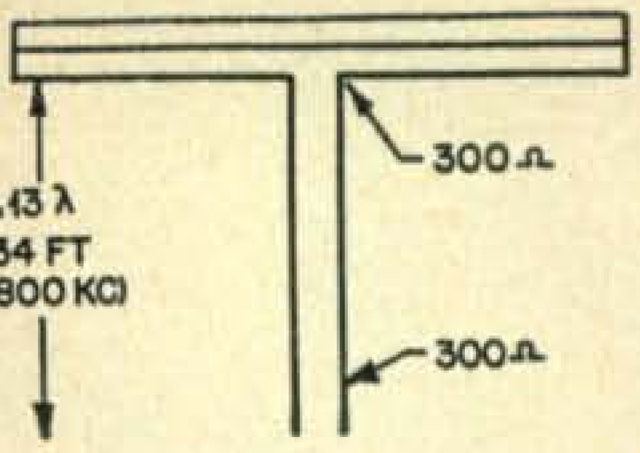


Fig 2.

are often fed with 600 ohm line as recommended by the handbooks, but at a height of 34 feet, it is a 2:1 mismatch. A little higher on curve at .18 wavelengths it can be seen that a 3-wire tripole would be a perfect match for 450 Z line which is commercially available, open wire too. With this type of antenna the current would be very low in the feedline also; therefore, long lengths of feedline could be used if needed.

A little higher on the curve and the desired 52 ohm impedance point for a dipole occurs. Following the broken line up this value of impedance (52) 1st occurs respectively at 93, *47*, 25, 13, 8, and 6 feet on 160, *75*, 40, 20, 15, and 10 meters for a dipole. *47 feet at 3800.* This 52 ohm height of 47 feet has checked out on several antennas. The last one I checked was W7RSY/6's (Doc Hemington), now K6TSR in Santa Anna.

For 600 ohm line feed to a folded tripole at a height of about .23 wavelengths or 60 feet would be necessary for 3800 kc.

Next the famous 72 ohm point. This value of impedance 1st occurs at a height of 130, *65*, 34, 19, 12 and 9 feet on 160, 75, 40, 20, 15 and 10 meters. This point is a $\frac{\lambda}{4}$ or *quarter wavelength in height*. So for a perfect match to a dipole with 72 ohm line resonated at 3800 kc the height should be 65 feet above electrical ground—perhaps 60 feet above physical ground.

Just a little higher the 75 ohm point for a dipole and also the 300 ohm point for a folded dipole are found on the curve. By following the broken line across the page, a dipole or a folded dipole at any of the heights will have an impedance of 75 or 300 ohms and a perfect match for the respective feedlines.

At the high point on the curve .36 wavelengths above ground the Z will be 95 ohms for a dipole. In actual practice due to ground losses it will be a few ohms less. A folded dipole at that height would have an Z of 380 ohms.

Continuing on down the curve, we see at a height of *one-half wavelength*, $\frac{\lambda}{2}$, the Z is again 72 ohms—now at 130 feet in height. Farther down the curve at (.6) wavelength the Z goes as low as 56 ohms. A folded dipole at a height of 83 feet on 75 m. or 42 feet on 40 m. would have an impedance of 224 ohms.

At a height of ¾λ the Z is 72 ohms again and at a height of one wavelength the Z is again 72 ohms and for every multiple of $\frac{\lambda}{4}$ this is again true. This is an important point to remember. *A dipole or folded dipole has a Z of 72 or 288 ohms at multiples of one-quarter wavelength in height above electrical ground.* Thus it is possible to select an optimum height for best angle and radiation and best matching of impedances. W6SAI did not elaborate in his *Beam Antenna Handbook,* page 24, where he said "For a simple half-wave dipole the radiation resistance at the center is about 72 ohms when the dipole is located *one-half* wavelength above a good ground surface." He is correct, of course, but not complete. If that were all the average ham knew he would think, "That means I'll have to have my 75 meter dipole 130 feet high in order to get a match for 72 ohm line." He could also do it at 65 feet.

Another rule of thumb should be emphasized here. A folded dipole's impedance will be *four times that of a dipole at the same height,* and a folded tripole will have an impedance of *9 times that of* a dipole at the same height. Also use $\frac{492}{\text{Freq}}$ for determining height above ground or beam spacing, not $\frac{468}{\text{Freq}}$.

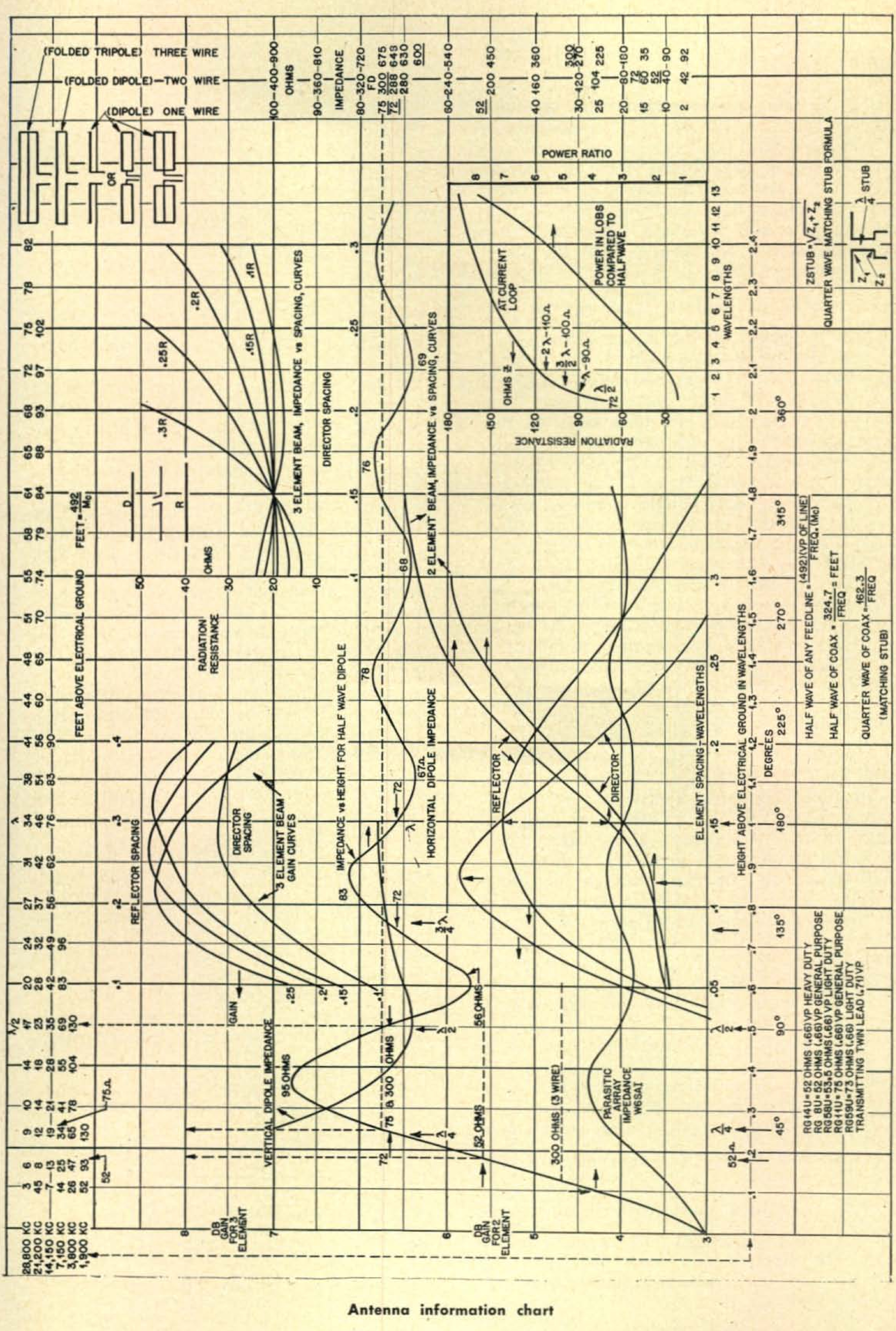
If you have a flat line (SWR = 1:1) regardless of what feedline used the impedance, current and voltage are constant throughout the entire feedline. Because of this fact an RF ammeter can be inserted at any point in the feed line and will read the same value providing it doesn't upset the line. Using this measured value of current the *power output* of your transmitter can be calculated from $P = I^2R$ where R = impedance of feedline.

If you have an antennascope and half-wave pieces of feed line for the various bands or a SWR bridge, you can measure your dipole's Z very quickly and after comparing your estimated to measured values of impedance on several antennas, you will be able to estimate very accurately the effect of surrounding objects on future antennas.

To illustrate the discussion above, let's take an actual example.

I estimated my 40-meter dipole's Z right on the nose. The dipole center was at a height of 35 feet although the entire dipole was at an angle of about 30°. The ground was paved concrete. The concrete has wire screen in it for strength. Although the wire was not connected to the ground directly, I figured it would act as the ground. The street is about 50 feet wide, but the antenna was strung at about a 45° angle across it so that the antenna was well inside the outer limits of the street.

From the chart 34 feet is a quarter wave $\frac{\lambda}{4}$; hence Z = 72 ohms at 7,150 kc. I connected a half wave $\frac{\lambda}{2}$ of 52 ohm coax



Antenna information chart

$\left(\frac{492}{7.150} \times .66\right) = 45.4$ feet, to the feed point and the other end to my antenna scope, twisted the dials of the grid dip and antenna scope and, presto, 73 ohms. I ran downstairs and tuned across the 40 meter band to find the grid dip signal and, presto, there it was at 7,145 kc. I might add that the 52 ohm *half wave* stub could have been 72 or 300 ohm line because a half wave will reflect the same impedance at one end as it sees at the other end regardless of the Z of the line; providing the coax is half a wave $\frac{\lambda}{2}$ at the resonate frequency of the dipole. This is not too critical, but *the closer the better*. I have had a deviation of 100 kc between the two on 75 meters and still got the same Z value. I then connected a length of 75 ohm coax to the dipole just long enough to reach into the shack. Using my Johnson SWR bridge with 75 ohm resistor I got an SWR of 1.01:1 at 7,143 kc. The antenna's physical length happened to be just right for this measurement. When using an SWR bridge the coax length is not critical. The SWR was very, very close to 1 to 1. The problem that always occurs when using an SWR bridge is whether the Z is above or below the Z of the line. All you get from the bridge is the ratio of mismach. For example, say that the lowest SWR you get is 1.3 to 1, what's the Z? It

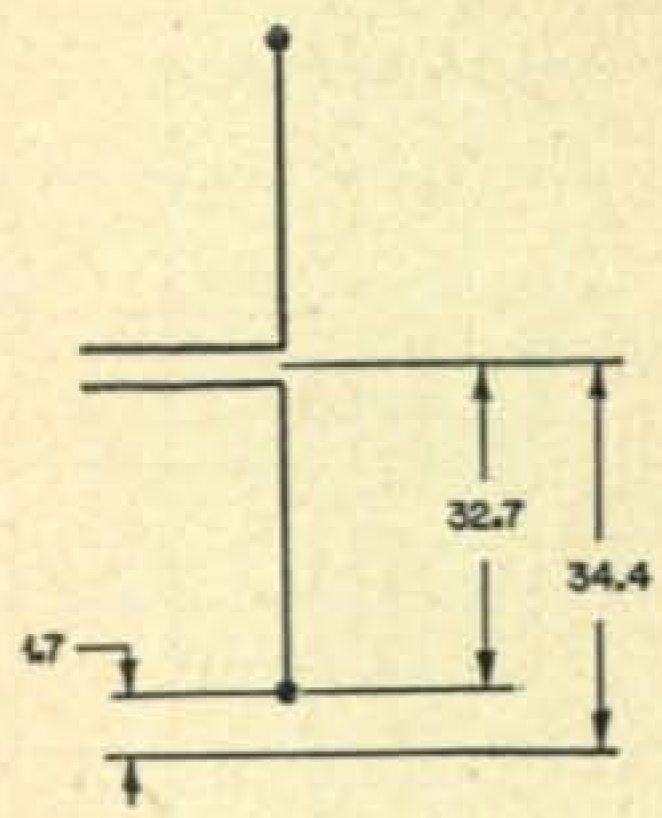
(52 or 75) (Resistor in bridge must be same value)

$$Z = \frac{\text{(Feedline Z)}}{\text{SWR}}$$

could be $Z = 52/1.3 = 40$ ohms or $Z = 52 \times 1.3 = 67.5$ ohms. You would use 75 instead of 52 if you used 75 ohm coax with the bridge and 75 Ω Resistor. This is one place where the graph comes in handy or if the estimation wouldn't be close enough the thing to do is *lower the antenna a few feet and take another reading*. From these two readings you can tell just where you are on the curve. When the SWR is around 1.1 to 1 the method of lowering the antenna and taking another reading is about the only way to determine whether or not the Z is above or below the Z of your feedline, that is, just using an SWR bridge.

The second Z vs. Height curve is that of a vertical dipole. The center of the dipole is used as the measuring point. The curve starts at a quarter-wave $\frac{\lambda}{4}$ in height because one leg will be a quarter-wave $\frac{\lambda}{4}$ long minus the .025 end effect length. For instance, on 40 meters the dipole center would be 34.4 feet high at 7,150 kc. The total length of a dipole at 7,150 is $468/7.15 = 65.5$ feet. The center will be 34.4 feet high. See also *fig. 3*. A quarter-wave $\frac{\lambda}{4}$ is 34.4 feet, but a quarter-wave of dipole antenna is 32.7 feet, so the end will be 1.7 feet above the ground.

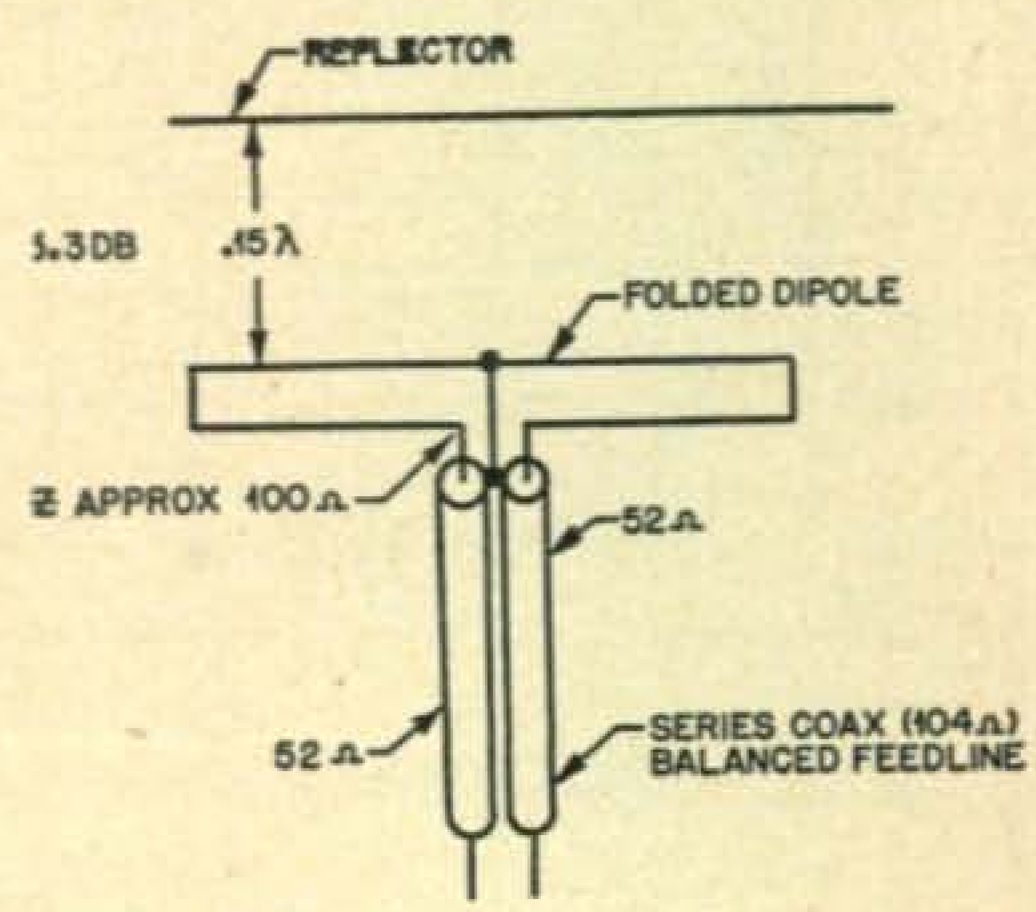
Fig 3.



The next curves are the 2-element beam gain curves. The gain is read on the left and the spacing on the bottom. For a driven element and a director the maximum gain, 5.8 DB is at a spacing of about .115 wavelengths or (492/14.2) (.115) (2) = 7.98 feet on 20 meters. For a reflector the maximum gain of 5.3 db is realized at a spacing of .15 wavelengths or (492/14.2) (.15) (2) = 10.4 feet. *Gonset* uses 10 feet spacing on their Bantom Beam. The impedance curves will give a Z of about 15 ohms for the director. If a folded dipole is used as a driven element the Z will be about 4x15 = 60 ohms. If a 3-wire or conductor dipole is used the Z will be about 9x15 = 135 ohms. The Z using a reflector at a spacing of .15 will be about 25 ohms If a folded dipole is used the Z will be about 100 ohms. This would provide a good match for series 52 ohms coax (104 ohm). The line would be balanced, high Z, low ignition pickup and low loss due to lower currents. See also *fig. 4*.

There is one thing to remember now that is very important. The Z's I just quoted will be found only if the beam is at multiples of one-quarter wavelengths high. In other words *if* the driven element were suspended alone the Z would be 72 ohms for a dipole or 288 ohms for a folded dipole and 648 ohms for a 3-wire dipole. The beam Z from the chart will hold only if the beam is at a quarter wave multiple of height. The approximate impedance values

Fig 4.



to be expected are given by the parasitic array impedance curve at the bottom of the graph. The amount of deviation from this value will depend on what part of the curve your antenna impedance is. For instance, assume a 20-meter 2 element beam is 42 feet high, a common height. The Z of a beam (.15 spacing), using reflector, will not be 25 ohms. The Z of a dipole alone at that height (42 ft.) is only 56 ohms, so it will probably be around 20 ohms. For a 3 element parasitic array the Z will be about 16 ohms. *These Z values will not be of any importance* if *you are using a T or a Gamma match or W6TTB's tuned feeders.* Yes, W6TTB's 15 meter beam uses tuned feeders (300 ohm or 450 ohm) and this is a system that should not be overlooked. If you have heard W6TTB's, W6OZC's or W5HBV's 100-watt 15-meter signal you will stand up and take notice. These Z values will be of importance if you use quarter wave stubs to raise the Z, so a higher Z line can be used the rest of the way. The only thing left then is to

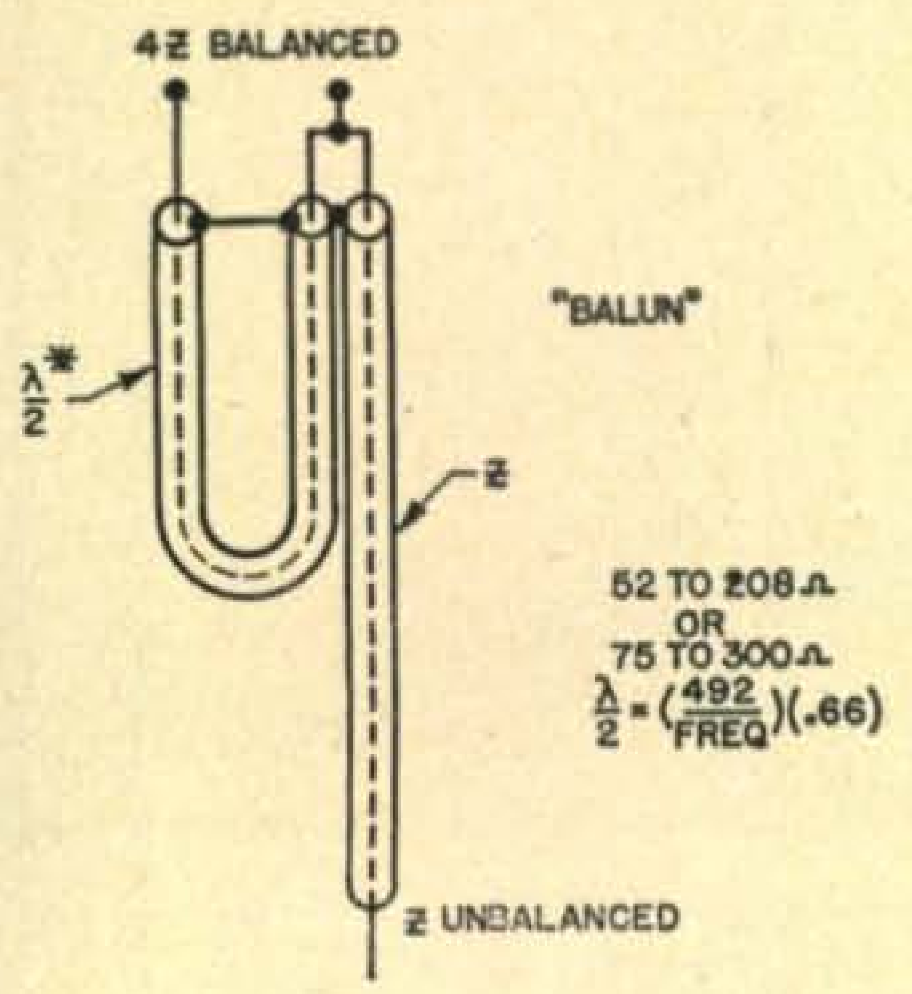


Fig 5.

adjust the T or Gamma correctly and that can be very quickly done with an antenna scope or an SWR bridge. For complete adjustment of T or Gamma match refer to W6SAI's article in *CQ*, Oct. '53. "Terrible T and Gamma Too." Or his *Beam Antenna Handbook*. Do not fail to read this.

One of the most popular feed systems now for a beam is the T match with a "Balun" on the end of the coax. With this the Z of the feedline is raised 4 times at the feedpoint and in addition it makes a balanced feedline out of an unbalanced feed line, *fig. 5*. It also stops any RF from coming back down the shield and radiating vertically polarized waves, one cause of TVI.

A Balun coil is just a half wave of line taken from the chart. Be sure to calculate the various VP's if you figure the length yourself.

Next are the 3-element beam gain and impedance curves. What spacing will give maximum gain? Example, if director is spaced at .2 λ the reflector will have to be spaced at .25 λ or D.25, R.2 or D.15, R.3 λ. A beam using these spacings will be very broad over the entire band also. The Z will be about 30 ohms in the first two cases.

The impedance values are of no importance if you are going to use a T or Gamma. The values given are for a split-driven element. Example, D.15, R.25 Z = 20 ohms *if beam is at multiples of* $\frac{\lambda}{4}$ *in height.* Refer to W6SAI's parasitic array impedance curve, vs. height on graph for most close and medium spaced beams (*Beam Antenna Handbook*, page 24).

Next, is Z at current loop vs. length of wire in wavelengths? Assume *fig. 6* (A) a $\frac{\lambda}{2}$ dipole at any $\frac{\lambda}{4}$ multiple in height. The Z is 72 ohms at the current loop. Assume a piece of wire at the same height a wavelength long (B). The Z at the current loops is no longer

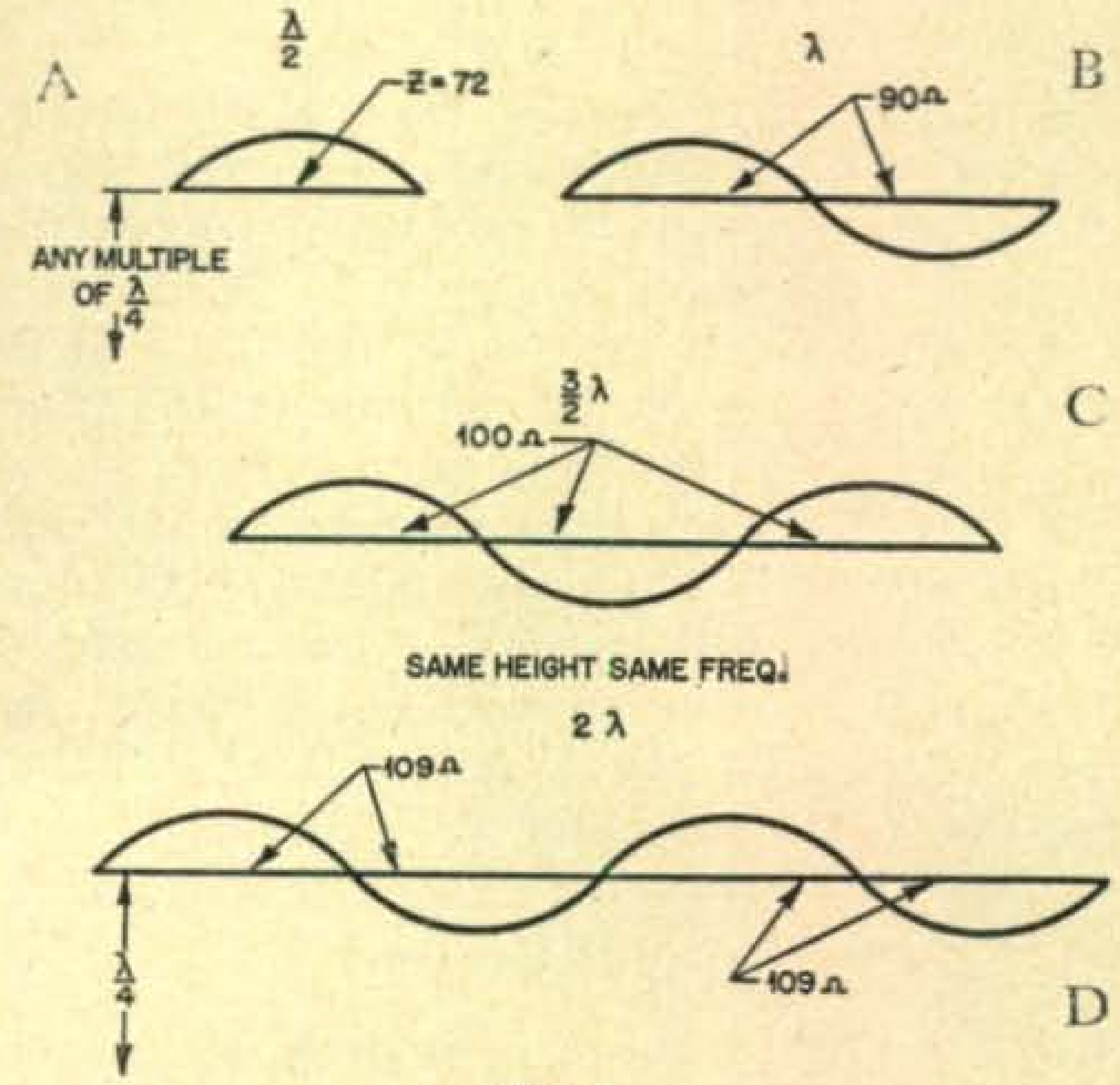


Fig 6.

72, but about 90 ohms from graph. Assume a piece of wire a wavelength and a half long (C). The Z at the current loops is now 100 ohms. At (D) antenna is 2 wavelengths long and the Z is about 109 ohms at the current loops.

Likewise if a half wave dipole on 80 is a $\frac{\lambda}{4}$ high, the Z is 72 ohms at the current loop. If the same antenna is used on 40 meters, it is now a half wave in height and a full wave long with the Z at the current loops equal to 90 ohms. If used on 20 meters the same antenna is 1 wavelength high and the Z at the current loops is now equal to 109 ohms (*fig. 7*). Assume a 40 meter dipole (quarter wave high, 72 ohm) (resonates at 7,100 kc) is used on 15 meters, where it will be one and a half wavelengths long. Unfortunately it will not resonate at 21,300, but at 22,000 and have

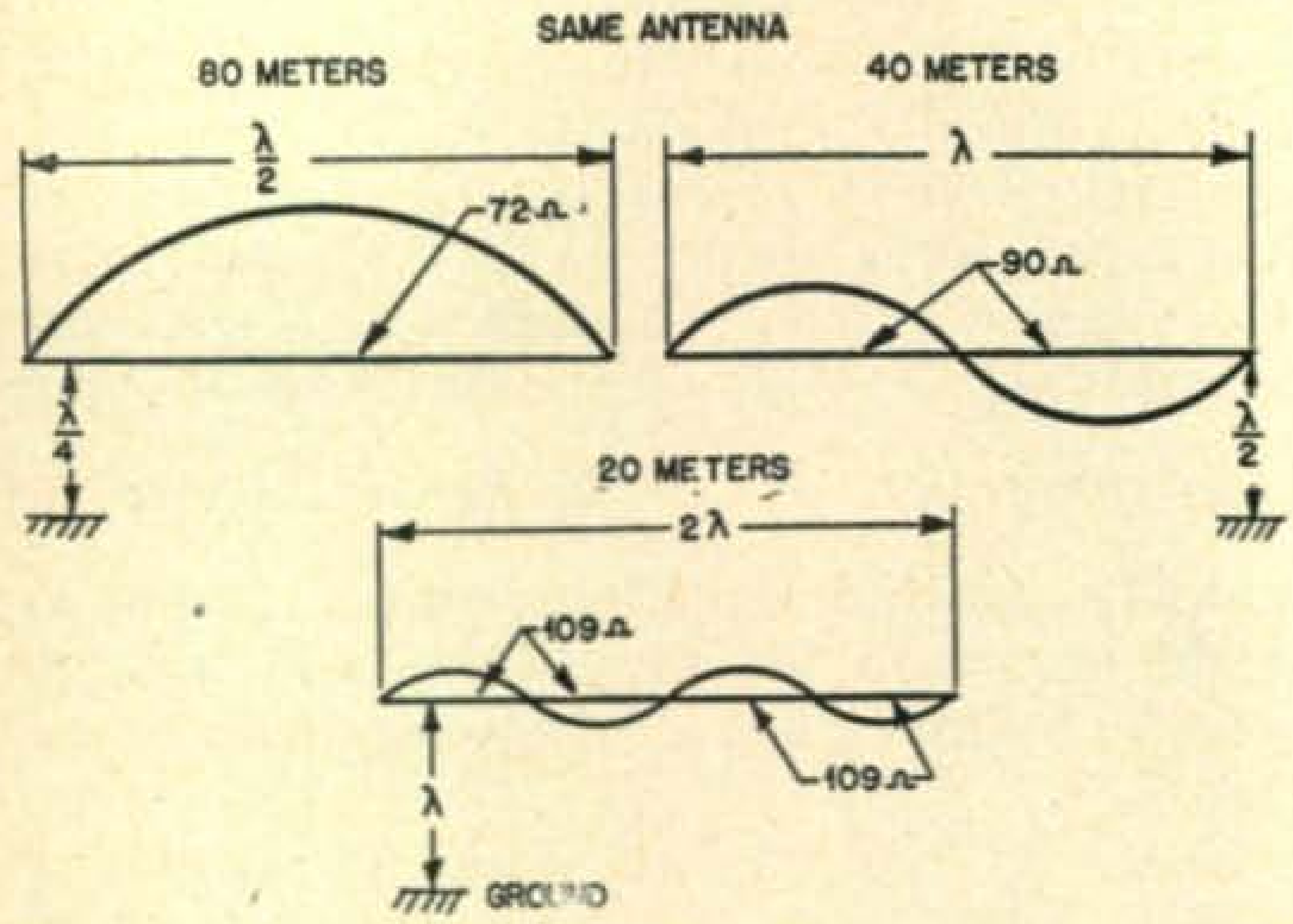


Fig 7.

an impedance of 100 ohms. The 100 ohm value will be correct only if on 40 M the antenna is at a quarter wave multiple in height. For harmonic antennas use formula

$$\text{Feet} = \frac{492\ (N-.05)}{\text{Freq.}}$$

where N = number of half waves.

The theory and curves for (Karl Dreher, Denver, Colo.) WØWO's off-center fed 300 Ω windom antenna were drawn on the basis that a harmonic antenna's Z stayed at 72 ohms at the current loops. If that were true the Z at the physical 1/3 mark of the antenna is 265 ohms each band. Actually the Z at the feedpoint is higher than 265 each time another higher band is used, but it is close enough to 300 ohms and may very well be 300 ohms on one of the bands. It is also assumed at the lowest frequency used, that the antenna is at a height where the Z at the center is 72 ohms.

Electrical Ground

How electrical ground is determined. A simple example—If dipole is resonate at 3800 and is at a height of 60 feet and the measured Z is 72 ohms, the procedure is this. From the graph it can be seen that a 75 m. dipole resonate at 3800 should be 65 feet high for a Z of 72 ohms. Therefore, *electrical ground* is 5 feet below physical ground. Nearby objects, of course, affect this and in some cases you may find that electrical ground may be a foot above physical ground. The nearby objects in this case had enough effect on the antenna to do this. If the nearby objects are metal the wave will reflect off of them and as far as the antenna knows that is electrical ground or the reflecting medium.

A Micro-Match SWR bridge really simplifies tuning up a mobile whip. All you would do is adjust taps on coil for lowest SWR at the operating frequency. An all-band coil can be resonated on all bands accurately in fifteen minutes' time. If you have ever tried to resonate a mobile coil without an SWR bridge you would really appreciate this feature. With the bridge there is no guesswork and it makes things so easy to say nothing of what it does for the home station antenna. The Jone's Micro-Match is made to order for use between your transmitter and the Johnson Match Box.

And the 75 Ω and 52 Ω resistors in the Johnson bridge. Solder these quickly. It helps to put a clip on the wire before the resistor to absorb the heat.

I use a portable antenna scope and grid dip. This battery pack idea really pays

Stub Lengths

$$\frac{(492)\ (.659)}{\text{Freq.}} = \frac{\text{Half}}{\text{Wave}}$$

Freq. kc	¼ wave	½ wave
3800	42′ 7.8″	85′ 3.6″
3850	42′ 1.2″	84′ 2.4″
3900	41′ 5″	83′
7050	23′	46′
7100	22′ 9.6″	45′ 8.4″
7150	22′ 8″	45′ 3.6″
7200	22′ 6″	45′
7250	22′ 3.6″	44′ 8″
14100	11′ 6″	23′
14200	11′ 5″	22′ 10″
14250	11′ 4″	22′ 9″
21100	7′ 8″	15′ 4″
21200	7′ 7.6″	15′ 3″
21300	7′ 7″	15′ 2″
28500	5′ 8″	11′ 4″
28750	5′ 7.7″	11′ 3″
29000	5′ 7″	11′ 2″
29500	5′ 6″	11″

Fig 8.

off and is so simple. I got tired of running a 110 volt extension cord all the time so I rigged this up. (See *fig. 9.*)

I usually make three and sometimes four way checks on the mobile whip's Z and resonate frequency. First I connect it directly to the base of the mounted whip. Second at the end of a half wave of coax cut to the operating frequency. Third at the end of a quarter-wave of coax. Be sure to use quarter wavelength matching stub formula when making Z measurements with quarter wave stubs.

$Z\ \text{stub} = \sqrt{Z_1 Z_2}$ quarter wave measurement example.

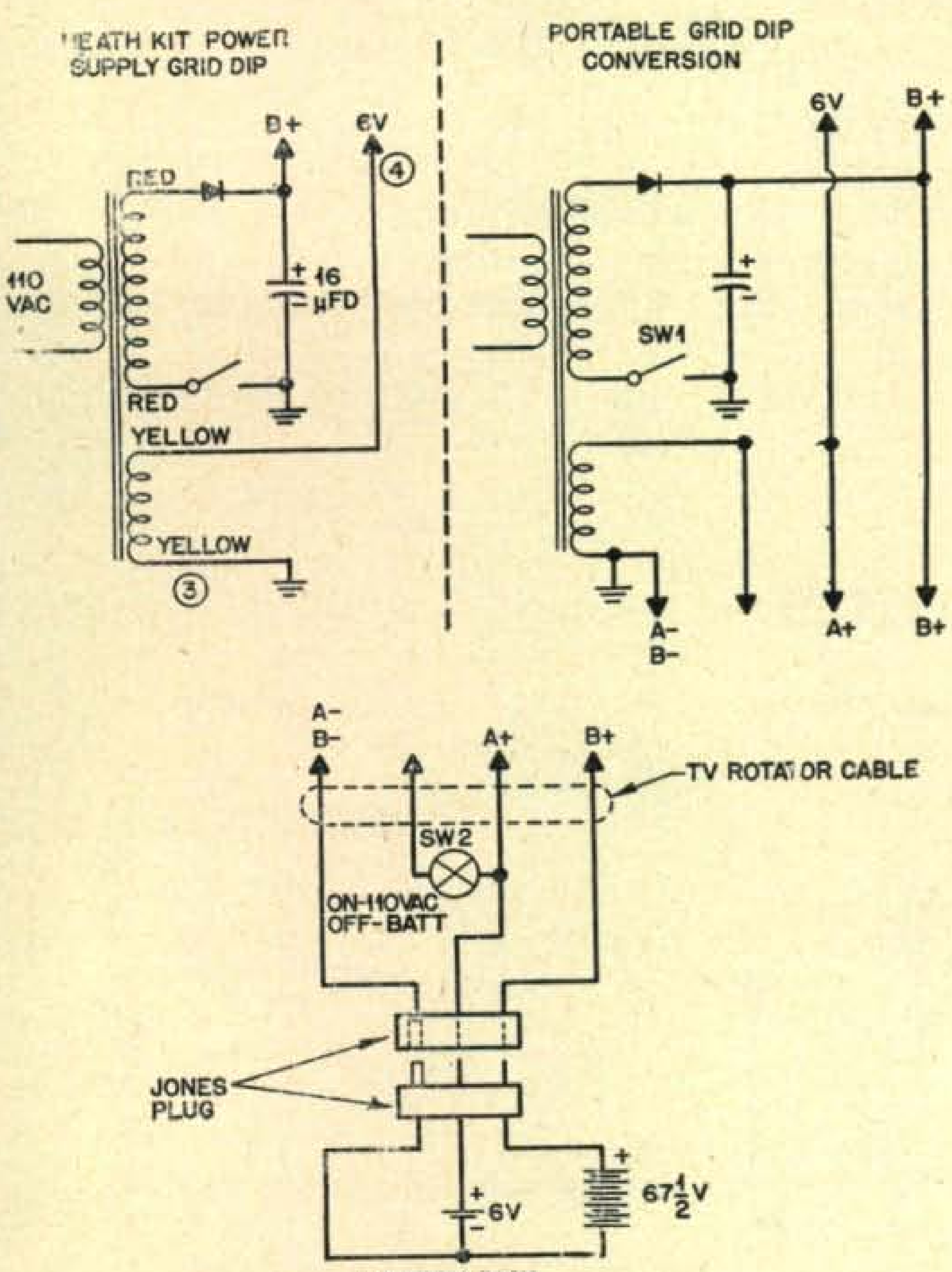
Using 53.5 ohm coax (RG58U) quarter wave stub, assume ant. scope reads 75 ohms. This means that the Z of the antenna is lower than the Z of the stub. $53.5 = \sqrt{Z_1 .75}$ or $2852 = 75Z_1$ or $Z_1 = \frac{2852}{75}$ Hence $Z_1 = 38$ ohms (antenna impedance). On the other hand if the antenna scope would have read 38 ohms the Z of the antenna would be higher than the Z of the stub. In this case the Z of the antenna would be 75 ohms. $53.5 = \sqrt{Z_1 38}$ or $\frac{2852}{38}$ $Z_1 = 75$ ohms..

This is a very important concept to understand. This, of course, with the antenna scope and grid dip. The final check of Z and resonate frequency is with the SWR bridge. When you get all four to check, brother, that's it.

Don't be surprised if the antenna doesn't load easy. Remember the transmitter is working into a resistive load. If it loads real easy be a little leery about it especially if a very small change in loading makes a large change in the plate current. The antenna scope makes a very good mobile field strength meter that can be connected to the B.C. antenna. When using an r-f ammeter note that at the resonate frequency the current will be the lowest and on either side the R.F. current will be higher for the same power input.

Example, the R.F. current value to expect will depend on SWR, Z of feedline, power and, of course, how far off resonate frequency you are. On 15 meters my whip's Z is strangely enough 52 ohms exactly. I run 40 watts. The *power* output can be found like this if the line is flat. My R.F. current is .75A, $P = I^2R$, $P = (.75)^2 \times 52 = 29$ watts output minus the loss in the coil and feedline. Yes, I have just .75 amperes in the line, but it's a purely resistive load. On 75 m, I use a $\frac{\lambda}{4}$ stub and the Z at the R.F. ammeter is 150 Ω. The Z at the antenna is 18 Ω. The current in the R.F.

Fig 9.



ammeter is .45 amperes. $P = I^2R$, $P = (.45)^2 150 = (.202)(150) = 30.3$ watts output minus the loss in the coil and feedline.

I have two Jones' Micro-Match VSWR bridges and I don't know how I got along without them before. The Johnson SWR bridge works fine but the Jones' bridge can be left right in the line for a mobile antenna or a fixed KW station. It's the only thing.

There is a way to tune up a mobile antenna without the use of a bridge, etc., that works out very well because the antennas are generally sharp tuning. I have found many times that the resonate frequency is not the

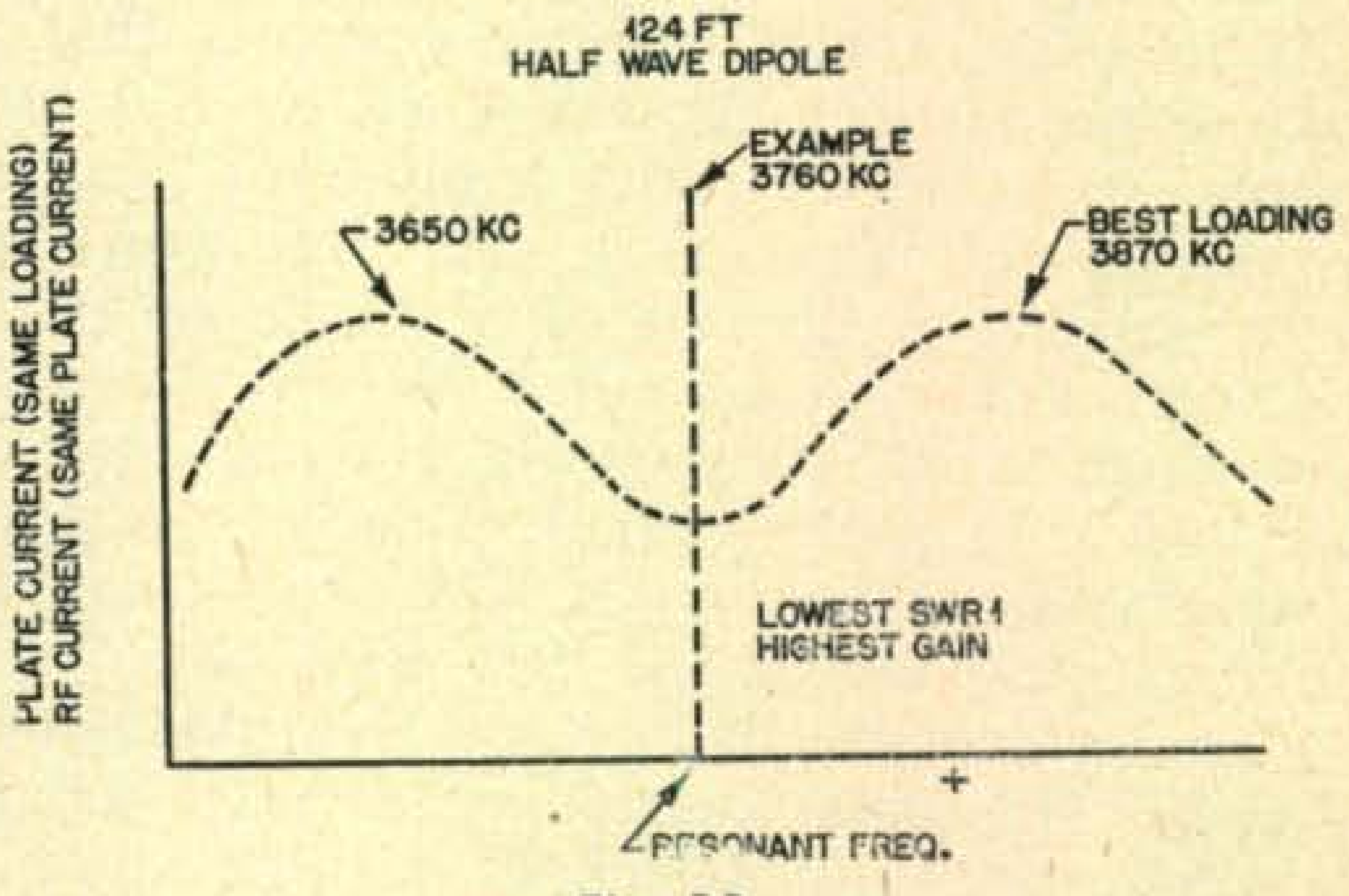


Fig 10.

frequency where the antenna loads the best using link coupling. The antenna will load the best on either side of the resonate frequency something like that shown in *fig. 10.* Also the RF current in the feedline is the lowest at the resonate frequency and increases on either side and then drops off. The plate current does the same. One way to check for a high SWR is as follows: If a very small increase in the link coupling causes a large change in plate current, this means the SWR is high. A matched and resonated antenna is harder to load. The procedure to use is to start at one end of the band and load it up at 50 kc intervals and observe the r-f current in the antenna for the same plate current loading or observe the plate current for the same loading.

The South Dakota net meets on a frequency of 3870 kc. WØDKJ, WØGWA and WØEXX had dipoles that loaded the best at 3870 but upon checking their antennas with my equipment I found the resonate frequency to be 3760 kc not 3870 kc. The lengths were 124 feet. According to formula that length was just 6 inches short for 3760 kc. We shortened the antennas and now they resonate—one at 3850 and the other two at 3860 kc and they are very happy with the way they get out now.

I wouldn't feel right if I didn't know what the Z of my antenna was. It's so easy to find out with an SWR Bridge too. I wouldn't put a high power rig on unless I had my antenna at least 70 per cent efficient. I would be too embarrassed to have some low-power guy with a matched antenna cover me up. How many times have you heard a V3 or Viking II cover some high-power boy up. Have you ever stopped to think of the power wasted in a year's time because it's not being radiated but dissipated in the form of heat. It's enough to pay for an SWR Bridge easy. If some guy with a matched and resonated antenna with 250 watts can do the same as a KW with an average antenna he not only saves the 750 watts of RF but the extra power to the modulator, to say nothing of the cost of the extra transformers, etc., which can easily run into hundreds of dollars.

Just stop and think what a waste of money it is to have a KW and an antenna that is wasting just 3 db of power when by adding a couple of inches or using a different feedline or raising the antenna a few feet you can easily squeeze 3 db out of a dipole or beam and oftentimes even more. 3 db down is equivalent to a 500 watt rig and an antenna that has 3 db more gain than yours does, assuming you are running a KW. Just think of the money saved by the 500 watt boy.

I use an oversize dial on my Heathkit antennascope. This must be calibrated by an accurate ohmmeter and checked at least once a month. It will change!!!!

A back-to-back connector for use on the antennascope can be obtained from the Dow Key Co., Inc., Warren, Minnesota—$1.85. This is used when measuring the Z right at the base of the whip. Two regular male coax connectors can be used back-to-back also as shown on the picture with the antennascope and grid-dip together.

I use a Johnson SWR bridge also, but find a lower power source is needed to drive it (1 watt). The Micro-Match SWR bridge will handle a KW and, of course, can be left in the line at all times.

So, if you want to have some fun and see this theory really work get yourself a SWR Bridge, or, an antennascope plus a grid dip meter or both. Make yourself some quarter and a half wave feedlines out of the light 53.5 ohm RG58U coax (coax connectors on each end with adapters) and go to it. The lengths are given in *fig. 8*. Remember the Z values read on the anntennascope will be accurate *providing the antenna is resonate at the same frequency that the stubs are cut for and most of all the antennascope is accurately calibrated.* Remember RF is something like water. It tends to seek its own level. There is an explanation for everything it does.

Notes

I highly recommend the use of quarter wave bazookas such as suggested by Collins in their transmitter hand book. This stub makes a balanced feedline out of an unbalanced, creates the opposite reactance of which the antenna does making the bandwidth of the antenna very broad and presents a high impedance to any RF preventing it from flowback down the shield and radiating vertically, (one cause of TVI).

The antennas I recommend are Inverted Vee's for the low frequencies.

Since lowering the ends of a dipole raises the resonate frequency I have found the factor 475 to be closer than 468 for determining the resonate frequency. (Angle of droop about 45 degrees).

One pole can be used to support a 75 and 40 meter inverted vee. It is advisable to run the two antennas at right angles for min. effect on each other and both can be connected to the same feedline.

The factor to use when calculating the length of a half wave 3 wire dipole or a folded tripole is $\frac{430}{Freq}$ not 468 because of the added capacity to ground, etc.

Incidentally a 40 meter dipole works very well on 15 meters despite a SWR of 2::1 and sometimes higher. A three wire dipole on 40 meters would lower the SWR in the 15 meter band.

K6RWC, John L. Armstrong helped in preparing this article.

the Novice operator as seen by . . .