The Perfect Setup

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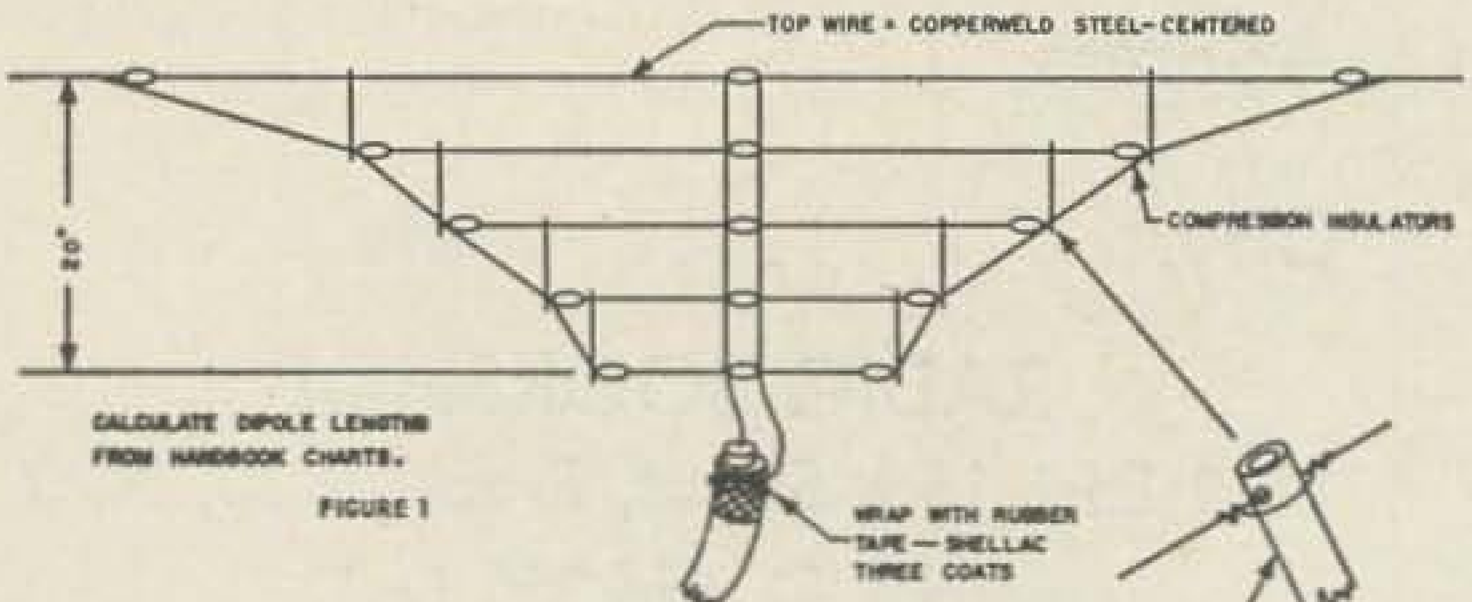
THE key to good hamming is a good station setup, and this is a lot easier to achieve than you may think. Whether you are trying to decide how to set up the new h-f station or have been operating for a while but aren't getting out like you should, this article is for you.

For all the sour-grapes balderdash one hears on the bands about system-engineered ham equipment, the idea is perfectly sound: each part of the system must work properly with at least one other part. If we investigate this working-together concept more closely, however, we find that such a system really is just a number of "twosomes." For example, the following twosomes will be found in any amateur station: space-antenna, antenna-feedline; feedline-transmitter; and feedline-receiver. It makes no difference whether they are made to work together at a factory or you make them work with ingenuity and hot solder.

In fact, it is because of these twosomes, or "interfaces," as they are properly called, that it is easy to set up an amateur station properly and at low cost. It isn't necessary to perform a set of simultaneous equations in a half-dozen unknowns, but on the other hand, a station cannot be set up just one part at a time. (Can you imagine only one connector connecting?)

In general, the antenna, especially the high-current, center portion, should be as high as possible. There are several reasons for this. The higher the antenna is above the average terrain, the lower (and better for d-x) will be the minimum usable radiation angle. The higher the antenna is above trees and other conducting objects, the less power they will absorb during both transmission and reception. The higher (up to a point) an antenna is above ground, the higher will be its radiation resistance and, hence, its efficiency.



Horizontal, half-wave dipoles usually are used on the h-f bands, primarily because, dollar for dollar, their simplicity and light weight permit them to be erected at greater heights than any other antenna. To be sure, the low radiation angles of vertical antennas are ideal for DX work; but efficient vertical h-f antennas are cumbersome and difficult to erect, they are more vulnerable to man-made noise, and unless a good artificial ground is constructed for them a prohibitive amount of power will be lost in the earth.

A widely-held, somewhat erroneous idea is that the user of a horizontal antenna can communicate in only two general directions, because the horizontal radiation pattern of a horizontal dipole is two lobes at right angles to the antenna wire. But what about the vertical radiation pattern?

It should be remembered that from a horizontal doublet, only part of the total energy is radiated broadside to the wire and that the polarity-versus-amplitude of the energy radiated in any direction depends on both the elevation angle and the azimuth considered. Much of the energy is radiated from a horizontal dipole in line with the wire, or "off the ends." This energy will be received just as well by an antenna the end of which is toward the transmitting antenna as will the energy radiated at right angles be received by an antenna which is broadside to the transmitting antenna. This vertically-polarized energy is radiated at somewhat high radiation angles; but the only shortcoming of the end-radiated rf is that the skip, or maximum range of communication will be somewhat shorter than that for the horizontally-polarized energy from the same antenna.

It is relatively easy to work all bands, from 3.5 to 29.7 mc, with only one feedline if single-wire, center-fed, half-wave dipoles are used. The dipoles are merely cut to the proper length and connected together as shown in Fig. 1. Most of the amateurs who use this multi-dipole antenna system do not include a dipole for the 15-Meter band, because the 40-Meter dipole will load up fairly well on 15 Meters. However, the radiation pattern thus produced contains several narrow lobes instead of the two wider lobes characteristic of a half-wave dipole when operated on its resonant frequency. The author once used one of these multi-dipole antenna in which a 15-Meter dipole was omitted; operation was excellent on all bands except 5-Meters, until a 15-Meter dipole was added. The new dipole really made a difference, and the author heartily recommends that it be included.

While the impedance of a half-wave dipole may be about 72 ohms in free space, it varies considerably at the heights amateurs have to work with. Most amateurs should be familiar with the standard graph of theoretical antenna impedance (for a half-wave dipole) versus height above perfect ground. The graph also is fairly accurate for heights of more than 0.3 wavelength above "real" ground level. However, it gives no indication of what the actual impedance of a dipole over "real" ground may be for lower heights, because the impedance is shown to approach zero as the height of the antenna approaches zero.

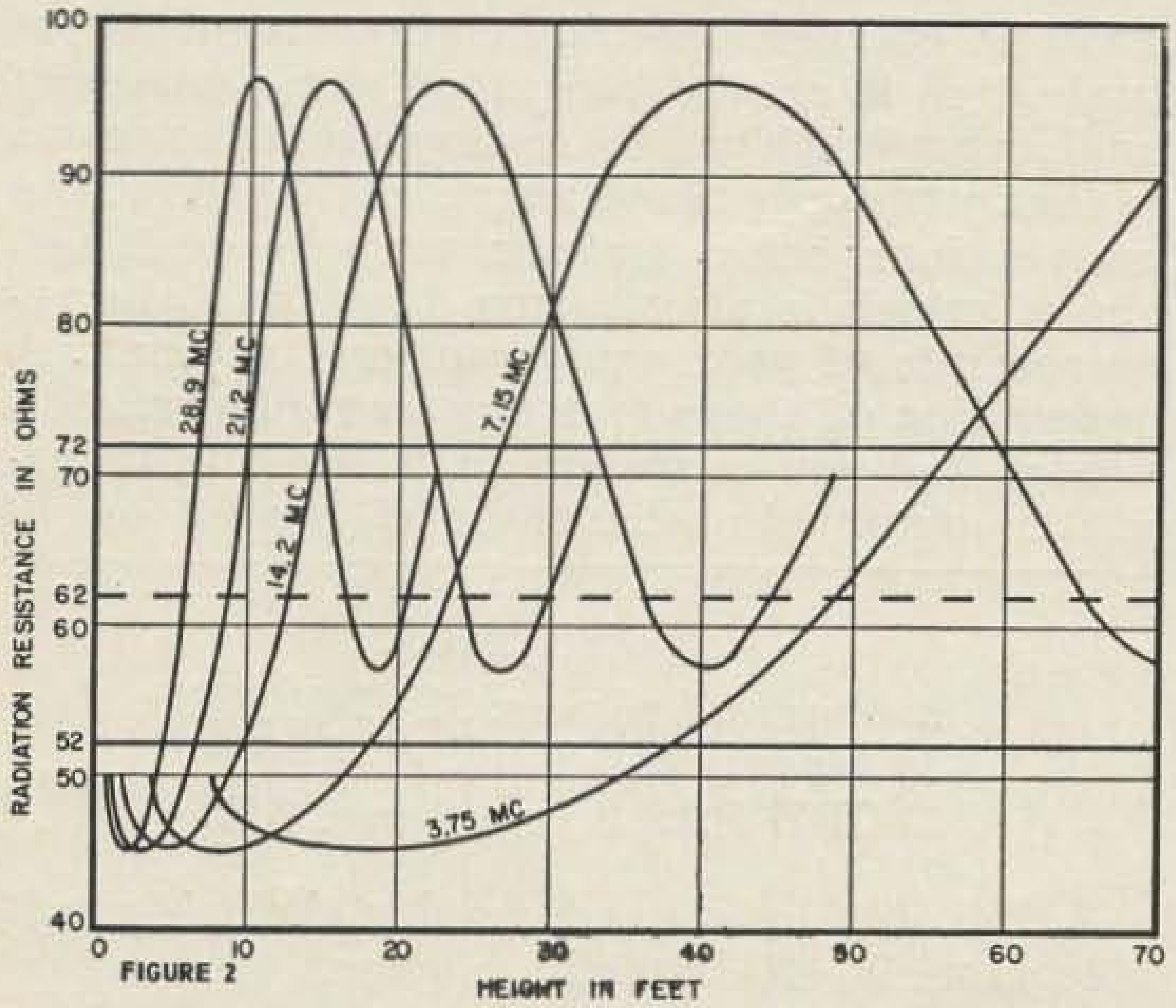


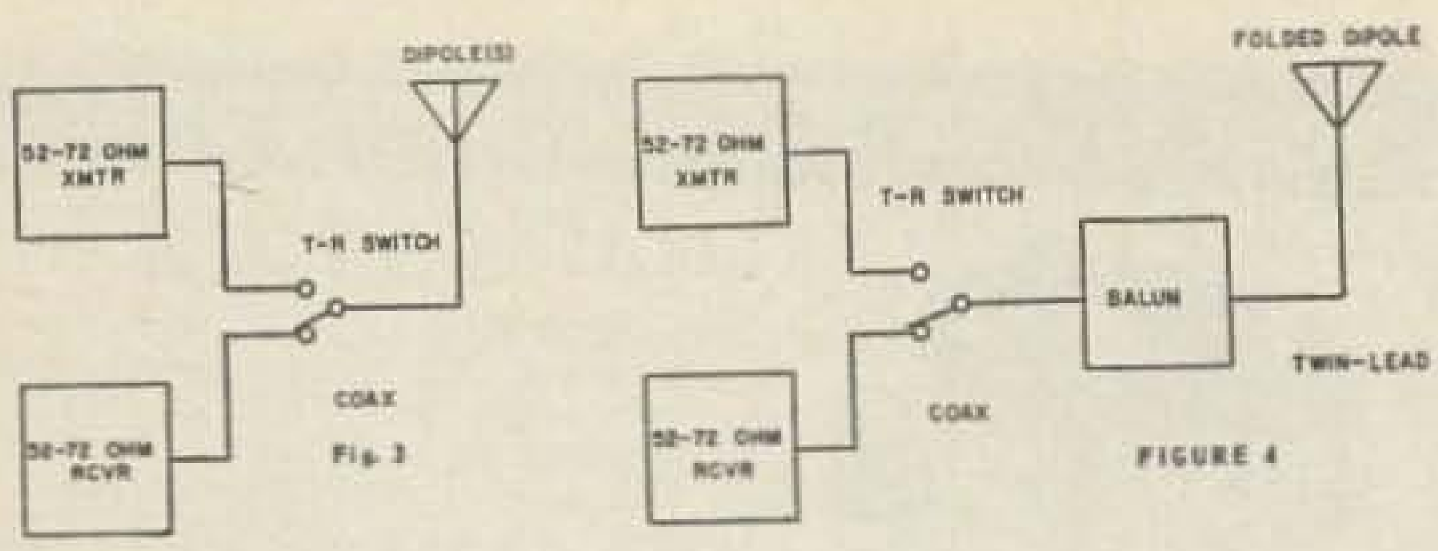
FIGURE 2

Actual measurements* over "real" ground, however, have shown that the antenna impedance falls no lower than about 45 ohms at 0.06 wavelength (16 feet at 3.75 mc), and in fact begins to rise quite rapidly as antenna height decreases further. Fig. 2 shows the antenna impedances to be expected on the h-f bands for heights up to 70 feet or 0.7 wavelength, whichever is lower for a particular band.

Of course, the depth of electrical ground below "real" ground level will vary from location to location, and thus will affect the accuracy of Fig. 2. It should be remembered, however, that electrical ground usually is no more than a few feet below "real" ground at 30 mc, and less than 10 feet below "real" ground at 3.5 mc. Thus, the accuracy of the graph will vary only slightly for different locations, probably not enough to be detectable.

Amateurs usually use either 52- or 72-ohm coax or 72-ohm twin-lead to feed half-wave dipoles. Referring to Figure 2, the dashed line represents 62 ohms, or half-way between 52

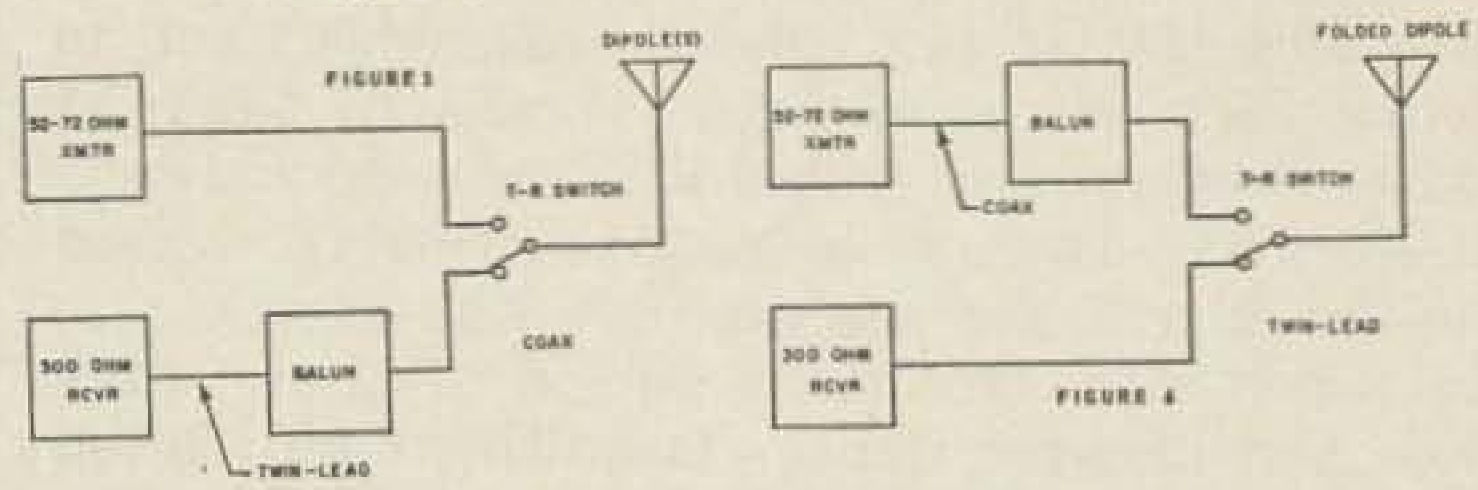
*Henny, Keith. **Radio Engineering Handbook**, Fourth Edition, 1950, McGraw-Hill, page 635 (graph).



ohms and 72 ohms. The closer the impedance of the feedline matches the impedance of the antenna, the more power will be transferred between the antenna and the feedline, and the lower will be the standing wave ratio. Therefore, if the impedance of an antenna (as determined from Fig. 2) will be higher than 62 ohms, it should be fed with 72-ohm twin-lead or coax. If the impedance will be lower than 62 ohms, the antenna should be fed with 52 ohm coax.

Just as maximum power will be transferred between the feedline and the antenna if the impedances are the same, maximum power will be transferred between the feedline and the transmitter or receiver if the feedline impedance is the same as that of the transmitter or receiver.

Before the days of pi-output circuits, transmitters usually were link-coupled to the feedlines, if feedlines were used at all. The impedance or the link didn't matter much, because the coupling of the link to the final tank coil could be changed to compensate for wide ranges of link-feedline impedance mismatches. Receivers had all kinds of input impedances; each manufacturer apparently threw dice or else counted tea leaves, which was about all that could be done anyway because there were no standard impedances at the time. Standing waves could stand until they got tired, and open-wire feeders were the thing. Those were the days of the universal, indispensable antenna coupler.



Today, however, the impedances most often encountered in amateur installations are 52, 72, and 300 ohms. With only these three impedances to match, amateurs now can use baluns instead of antenna couplers. Unlike the antenna coupler, the balun never requires retuning, so it can be tucked up out of the way and forgotten. Even more important, however, is that with only three values of impedance to match, four basic systems may be designed, one of which is almost sure to satisfy the requirements of your equipment and antenna. A description of these four systems follows.

Fig. 3 shows a system in which the transmitter output impedance is either 52 or 72

Heath SB-10 on Six

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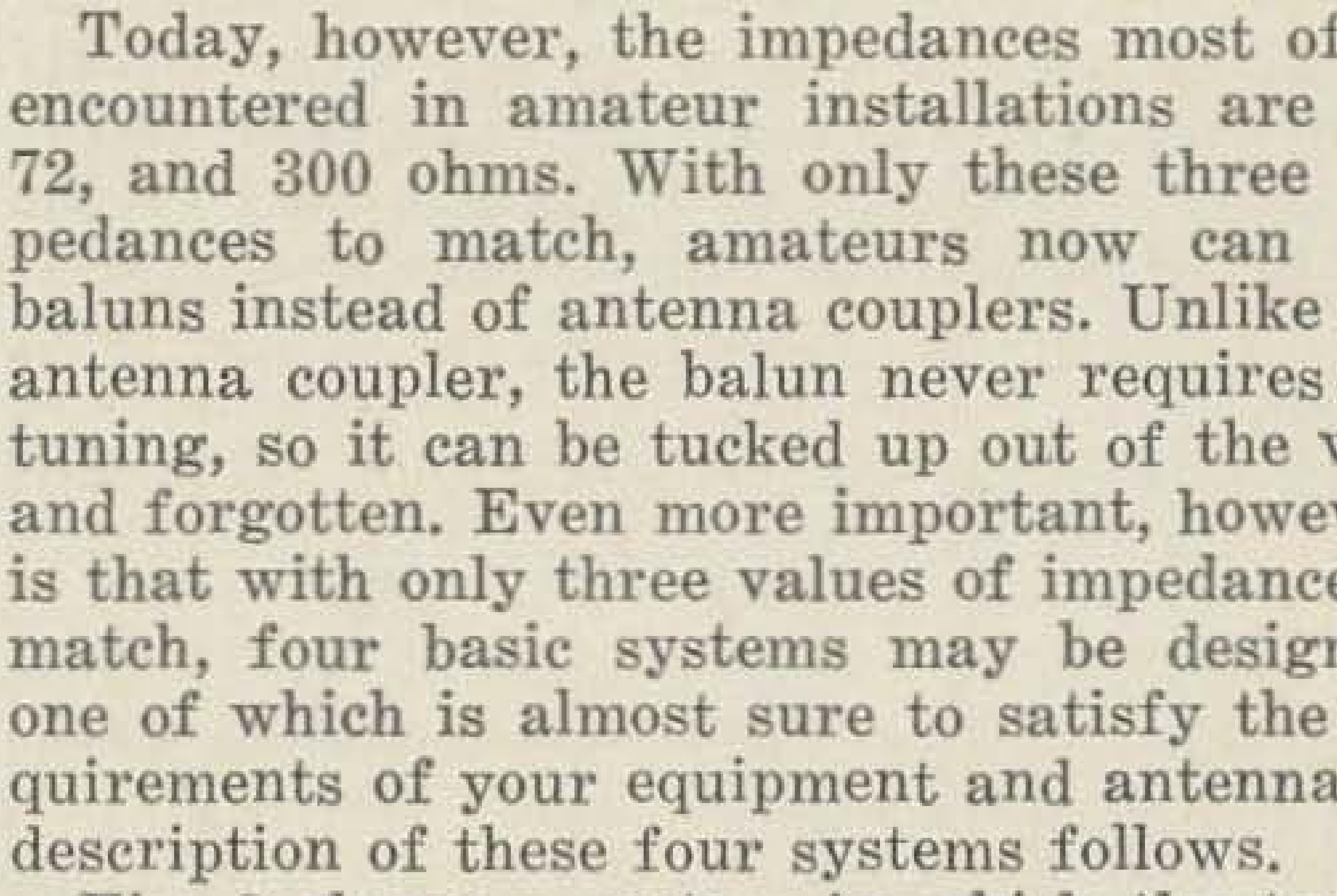
Being a VHF addict, I recently purchased a SB-10 from Heath for the express purpose of putting this phasing type Single Sideband Adapter on 6 meters. The object was to use it in conjunction with the Heath VHF 1 "Seneca." Using the 50 mc drive from the Seneca, converting to single sideband with the SB-10, then driving either the Seneca final in AB or other linear that would require no more than 8 watts of drive.

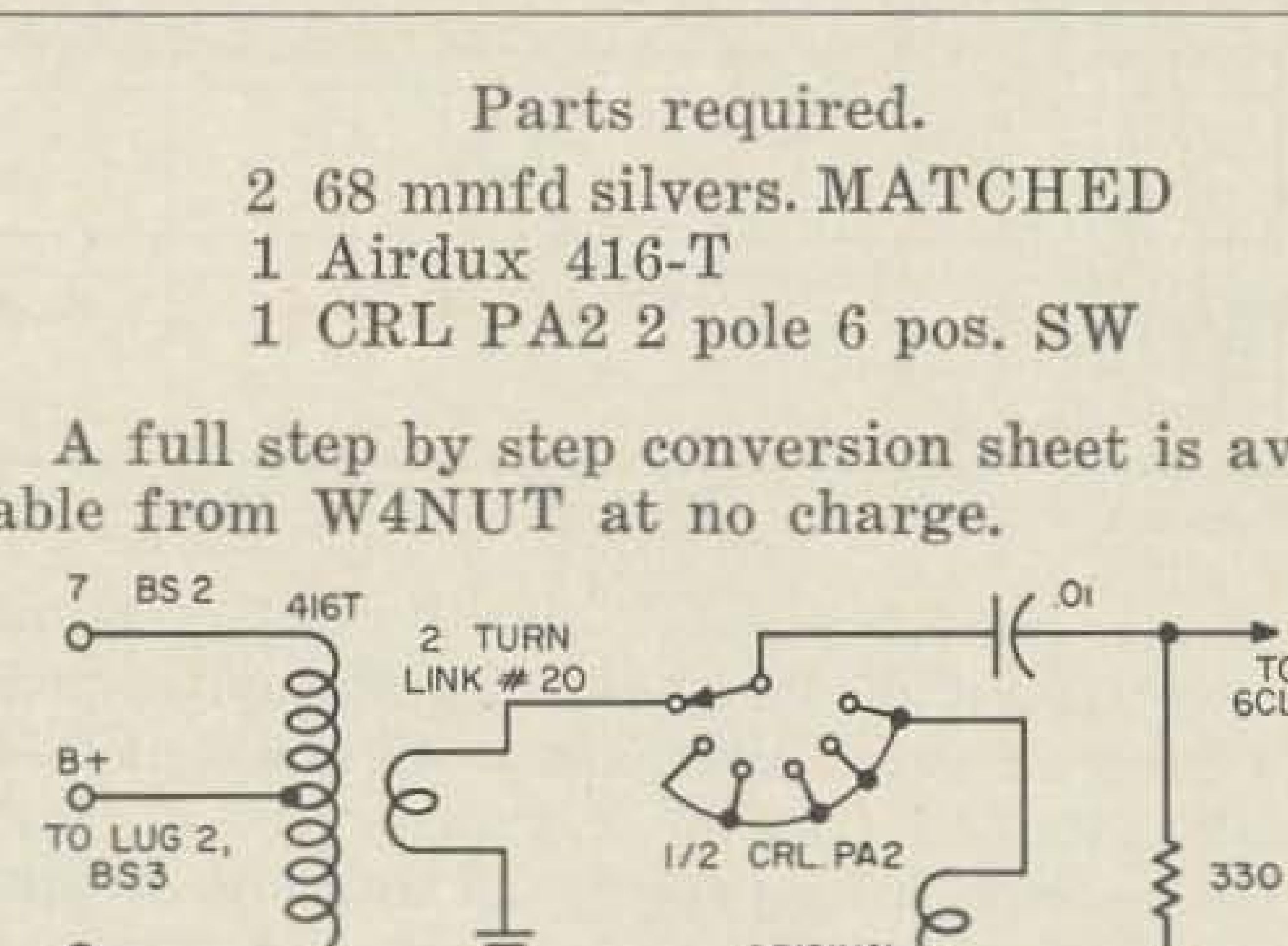
The operation was successful, the SB-10 works as intended, 50 mc sideband driven from the Seneca. The SB-10 conversion is as follows. Disconnect the 10 meter section of the adapter, and insert 6 meter coil sections outboard of the existing coils, using the wafer switch points formerly used for 10 meters. Add one more ceramic wafer switch to the existing stack, replace the 110 mmfd 1% micas in the phasing stack with a matched pair of 68 mmfd silvers. Remove 3 turns from the 10 meter slug tuned coil, feed three watts of 50 mc drive and 8 watts PEP 50 mc single sideband, upper, or lower comes out the back end. Easier than hetrodyning, no mixers, just tune as per the SB-10 instructions.

Parts required.

2 68 mmfd silvers. MATCHED
1 Airdux 416-T
1 CRL PA2 2 pole 6 pos. SW

A full step by step conversion sheet is available from W4NUT at no charge.





ohms, the receiver impedance is 52 or 72 ohms, and the antenna is either a dipole or a multi-dipole system. Although it is the simplest system possible, it also is the best, because everything except the antenna is shielded by the outer conductor of the coax (keeping spurious radiation in and noise out). Incidentally, coax (unbalanced) feed is just as good as twin-lead (balanced) for h-f work; feeding a balanced antenna with coax becomes a problem only when the diameter of the coax becomes more than a small fraction of a wavelength.

Fig. 4 shows a 52- or 72-ohm receiver and transmitter used with a balun and 300-ohm twin-lead for feeding a folded dipole. Notice that the balun, which matches the receiver and transmitter to the 300-ohm line, is on the antenna side of the T-R switch, and it must carry the output power of the transmitter.

Figure 5 shows a 52- or 72-ohm transmitter used with a 300-ohm receiver and either a dipole or multi-dipole antenna. In this system, the balun is placed between the receiver and the T-R switch, and thus does not carry appreciable power.

Fig. 6 shows a 52- or 72-ohm transmitter and a 300-ohm receiver used with 300-ohm twin-lead and a folded dipole. In this system, an open relay or switch may be used.

In summary, if your equipment is in good operating condition, and if all connections are made properly, a very satisfactory amateur station can be assembled if the following suggestions are heeded:

(1) Place the antenna as high in the air as possible.

(2) Use horizontal, half-wave, center-fed antenna(s).

(3) Select the feedline impedance on the basis of the antenna impedance.

(4) Use a balun to match impedances.