Tuned Trap Multi-Band Antennas

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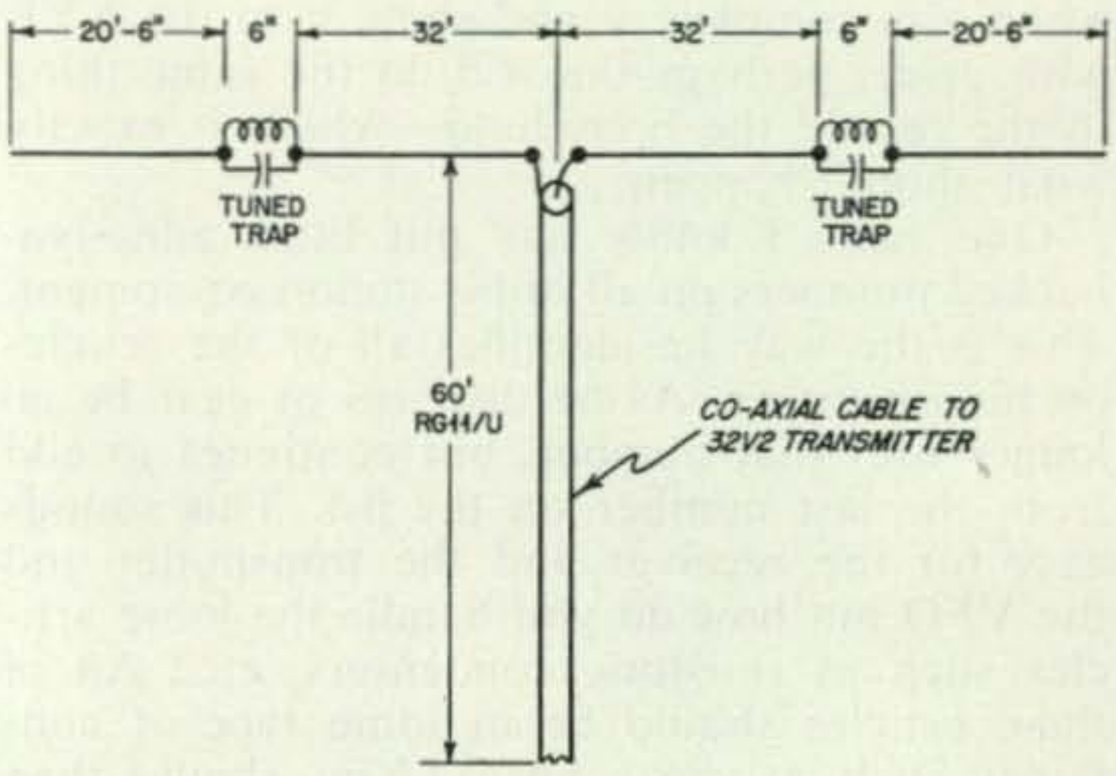
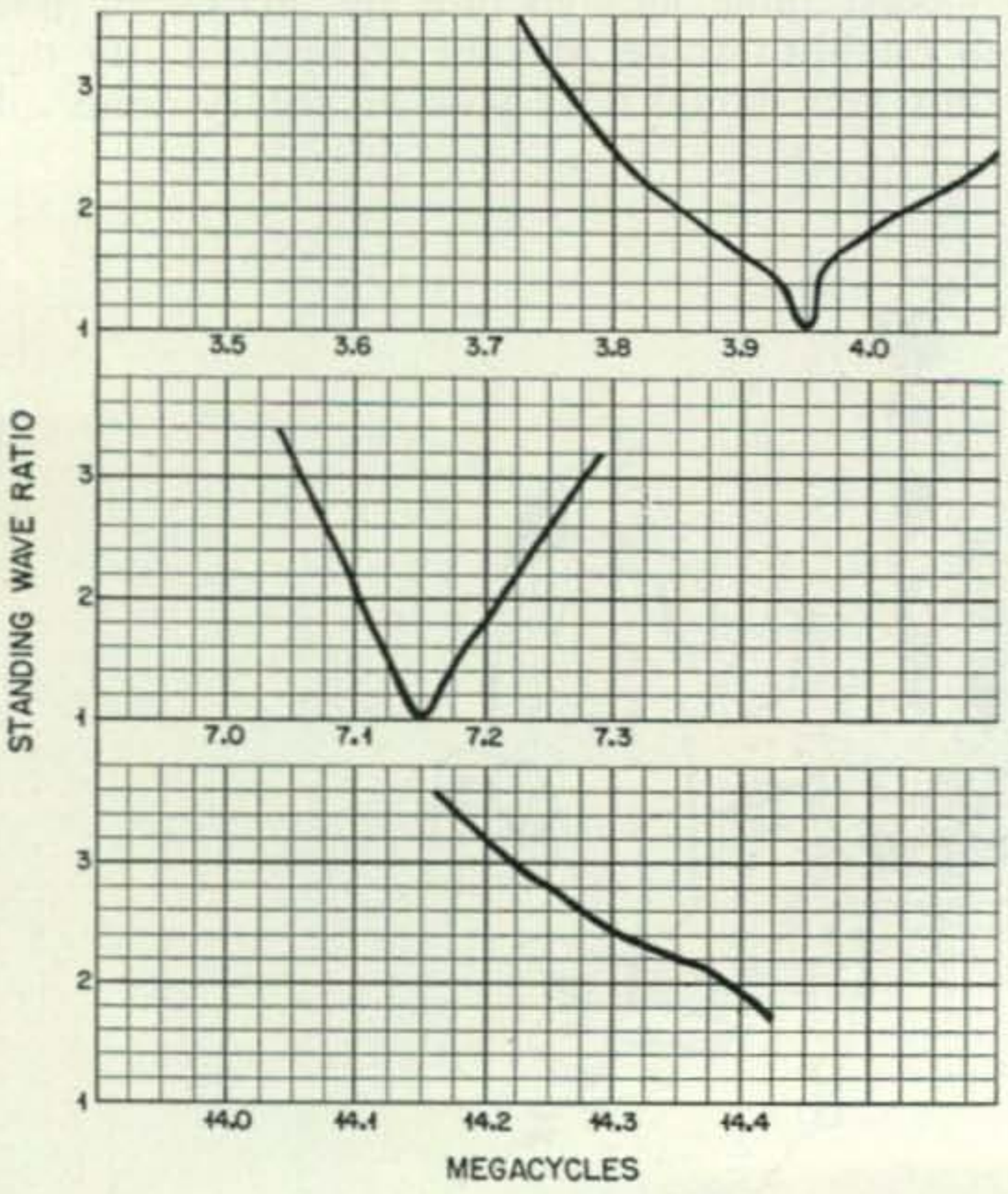
The wide-spread use of band switching and automatically tuned radio transmitters for amateur, commercial and military communication purposes has focused increased attention on multi-band antenna systems. Antennas for operation over a wide range of frequencies have been employed since the days of Marconi. Rhombic, "V" and center-fed tuned transmission line antennas have long been utilized for multi-band operations. Many of the vehicular mounted antennas currently used for mobile radio work can cover the 10 to 75 meter amateur bands.

Recent developments in resonant trap antenna systems have[1] aroused the interest of many amateurs. It was at first believed that this type of antenna provided satisfactory automatic coverage of all amateur bands (80 to 10 meters inclusive) using 72 ohm coaxial cable or twin-lead as the transmission line. Unfortunately, this assumption is not entirely correct. The addition of tuned traps in the antenna may make it resonant on the 2nd, 3rd, 4th and other harmonics of the resultant antenna frequency, but it does not necessarily produce a broadband antenna system. It will be necessary, therefore, to change the antenna length, adjust the tuned traps or both to obtain optimum performance and a low standing wave ratio for a particular desired frequency segment of a band.

A resonant trap multi-band antenna has been in use at W2PF for the past several months, and it is the purpose of this article to summarize the results obtained which will also, it is believed, substantiate the above remarks. Fig. 1 is a schematic of the antenna which shows the overall dimensions. A pair of *Reyco* coils[2] are used for the resonant traps in this aerial system. They have similar characteristics to the ones previously described by W3DZZ[1] and W2CYK.[3]





The transmitter used with this multi-band antenna was the *Collins* type 32V2 which was adjusted for operation in the 80, 40, 20, 15 and 10 meter bands. The standing wave ratio measurements were made with a *Jones* Model #261 Micro-Match coupler inserted in the RG-11/U antenna cable at the output terminal of the low-pass filter that was installed on the rear of the transmitter. A sensitive home-made field strength meter was utilized to check for radiation from the RG-11/U coaxial cable leading to the antenna.

The antenna shown in Fig. 1 was installed on the roof of the apartment house, about 70 ft. above the street level. Most of the antenna length was only about 10 to 12 ft. above the roof of the building. The fundamental frequency of this antenna was found to be 3945 kc. The 32V2 transmitter loaded to its normal input on all amateur bands without difficulty.

[*Continued on page 98*]

1. "The MultiMatch Antenna System"—C. L. Buchanan, W3DZZ, March, 1955 QST
2. Manufactured by W2VS, Reyco, Rochester, N. Y.
3. 'Simple Trap Construction for the Multiband Antenna"—Arthur Greenberg, W2CYK, Oct. 1956 QST and "Multimatch Antenna *for Phone*"—*Pemberton*, W9YJH, Dec. 1955 QST

Simple [*from page 57*]

this circuit, which is the voltage of the battery being charged. Now connect the generator to a 6-volt battery instead of a 12-volt one. Half voltage will appear across the field circuit, and so half current will flow in the field. And behold! This is just the proper condition to develop half voltage (6 volts) in the armature circuit. Thus the output voltage of the charger is automatically equal to the voltage of the battery to which it is connected, as long as you don't try to go too high.

R_1 is determined experimentally. Start the engine, and set the governor to about the speed you want. It isn't critical, but make it fast enough so that the engine will develop somewhere near its rated power. Now, put a voltmeter across the output of the unit, and connect about ten ohms of nichrome wire from a replacement coffee-pot element in as a trial R_1. Decrease this resistance gradually until the output voltage takes a sudden rise to 30 volts or so. This is the critical resistance; decrease it a few percent more, for good measure, wind it on a scrap of asbestos board (it puts out several watts of heat) and mount it permanently in the circuit. Now connect the rig to your car battery, whatever its voltage, and you will find that you can run from zero to full charge by just a slight adjustment of the engine governor.

Disadvantages

Such simplicity does, of course, involve a couple of drawbacks, but they are minor. First, this rig will overcharge your battery if you let it, so best sink six bits in a battery hydrometer if in doubt. Second, you must be sure the engine is running at all times that the battery is connected to the unit. A stalled generator has a very low resistance, and a heavy reverse current would flow from the battery. However, you can change the polarity of the generator at will by stopping the engine and touching the leads momentarily to the battery, connecting the positive pole to the lead you wish to be positive. Residual field magnetism takes care of the rest; subsequent voltage build-ups in the generator will have the desired polarity.

Use heavy flexible 2-conductor cable for the leads (at least #12), and make the cable about 25 feet long, so you can get the noisy thing a respectable distance from the car when you are operating. If you get ignition noise or generator hash from the unit, treat it as you would in the car itself. Keep a can of gasoline and a little oil near the rig, so you will have everything together if you should need it in a hurry. My generator will run about 11 hours on a gallon when putting out 7 amps at 12 volts, which is the average drain of my rig when making only occasional transmissions. ■

Trap Antennas [*from page 40*]

The resultant standing wave ratio measurements are indicated in Fig. 2. It was not possible to reduce the SWR on the 15 and 10 meter bands below 5:1. The RG-11/U cable showed considerable radiation on the 15 and 10 meter bands and a small amount when the transmitter was operated on 20 meters.

In addition to the above multi-band antenna system at W2PF, there are two folded dipole antennas; one for 15 meters and the other for 20 meter operation. This made it possible to quickly shift from one antenna system to another when making tests on 15 and 20 meters. A pair of B&W balun coils were used in the 300 ohm feeders from the folded dipole antenna to couple to the 32V2 transmitter. Switching was accomplished with coaxial relays so that comparisons could be quickly made.

Local stations (within about 25 mile radius) always reported that the multi-band antenna gave louder 20 meter signals than the folded dipole. Reports from distant stations and those on the West Coast usually favored the folded dipole by about one S unit. In this connection, it should be noted that the folded dipole antenna was more directional to the South and North, while the multi-band antenna which ran in a North-South direction favored the East and West bearings from New York City. The 15 meter folded dipole gave superior results in all cases to the multi-band tuned trap antenna.

Conclusions

The resonant trap type multi-band antenna, it is felt, will give excellent results on the 80, 40 and 20 meter bands if properly designed and installed. The standing wave ratios are satisfactory only over a small portion of each band as illustrated in Fig. 2. By changing the dimensions of the antenna section from the resonant trap to the end of the antenna, it is possible to make the multi-band antenna resonant over other desired portions of the 80, 40 and 20 meter bands with an SWR in the order of 2:1 or less. For example, the antenna per Fig. 1 on 80 meters has a bandwidth of 150 kc (from 3850 kc to 4000 kc) on the basis of an SWR not exceeding 2:1. On the 40 meter band, its satisfactory SWR portion is about 125 kc wide (from 7100 to 7225 kc); while on 20 meters the SWR is over 2:1 for the 14200 to 14350 kc range.

Therefore, one should not expect to cover the entire portion of each amateur band with the resonant trap multi-band type of antenna system and obtain a low SWR; that is, below 2:1. However, as an automatic tuned antenna, it is quite satisfactory for general communication purposes if the transmitter can withstand a high SWR without damage. ■