BY BILL ORR, W6SAI

RADIO FUNdamentals

THINGS TO LEARN, PROJECTS TO BUILD, AND GEAR TO USE

Interesting Antennas I Have Known

Marconi started it all with the grounded antenna bearing his name. The Marconi was the antenna of choice at the turn of the century (in most instances), but what about radio transmission from aircraft that were not at ground potential? To be more specific, what about the large Zepplin dirigibles of Count Hugo Eckner of Germany that monopolized long-distance air passenger service in Europe before World War I?

It was vital to keep the transmitting antenna away from the body of the airship, which contained large hydrogen-filled silk bags which gave the aircraft bouyancy. It was necessary to vent hydrogen to lower the airship, or to drop quantities of sand to lighten the weight for ascension. In either case, static electricity could create a spark that would destroy the craft in a flaming outburst. Not a few Zepplins (and crew and passengers) met their fate in this manner.

It was possible for an accidental electric arc to be created by the radio transmitting equipment aboard the Zepplin. The oscillating spark for transmission was carefully mounted in an enclosure, shielding it from the atmosphere. It also was necessary to remove the antenna a distance from the airship. This helped to isolate the metal skeleton of the Zepplin from the immediate field of the antenna, thereby reducing RF potential differences between individual parts of the airship. All metallic parts of the craft were bonded together carefully, and gas escaping from the silk balloon bags was vented away from the radio and electrical equipment. Even so, a radio spark and the high voltages on the transmitting antenna were a constant hazard to the giant dirigibles.

To isolate the antenna, which dropped vertically beneath the airship, a two-wire transmission line was used to feed a half-wave wire (fig. 1). The line was a quarter-wavelength long at the operating frequency, which in some cases was as high as 2 MHz.

The ungrounded airship antenna was called the Zepplin Antenna, and variations of it quickly were adapted by radio amateurs. It was featured in early editions of *The Radio Amateur's Handbook* (now called *The ARRL Handbook*). An early illustration of a "Zepp" antenna for amateur work is shown in fig. 2.

Successful operation of the Zepp is a function of correct feeder design. The two-wire line must be symmetrical—that is, the wires must be the same length, have the same capacitance to nearby objects, and be light enough to swing as a unit when the wind blows. Choosing the proper length for optimum operation was a subject as hotly discussed in the early days of amateur radio as antenna gain and front-to-back ratio of a beam are discussed these days.

In spite of mechanical problems dealing with feeder spacing, the Zepp antenna was a popular amateur radio skywire before World War II. Now few modern amateurs even know of its existence. For a decade or so, however, it was the DX antenna to beat in HF radio.

48 Campbell Lane, Menlo Park, CA 94025

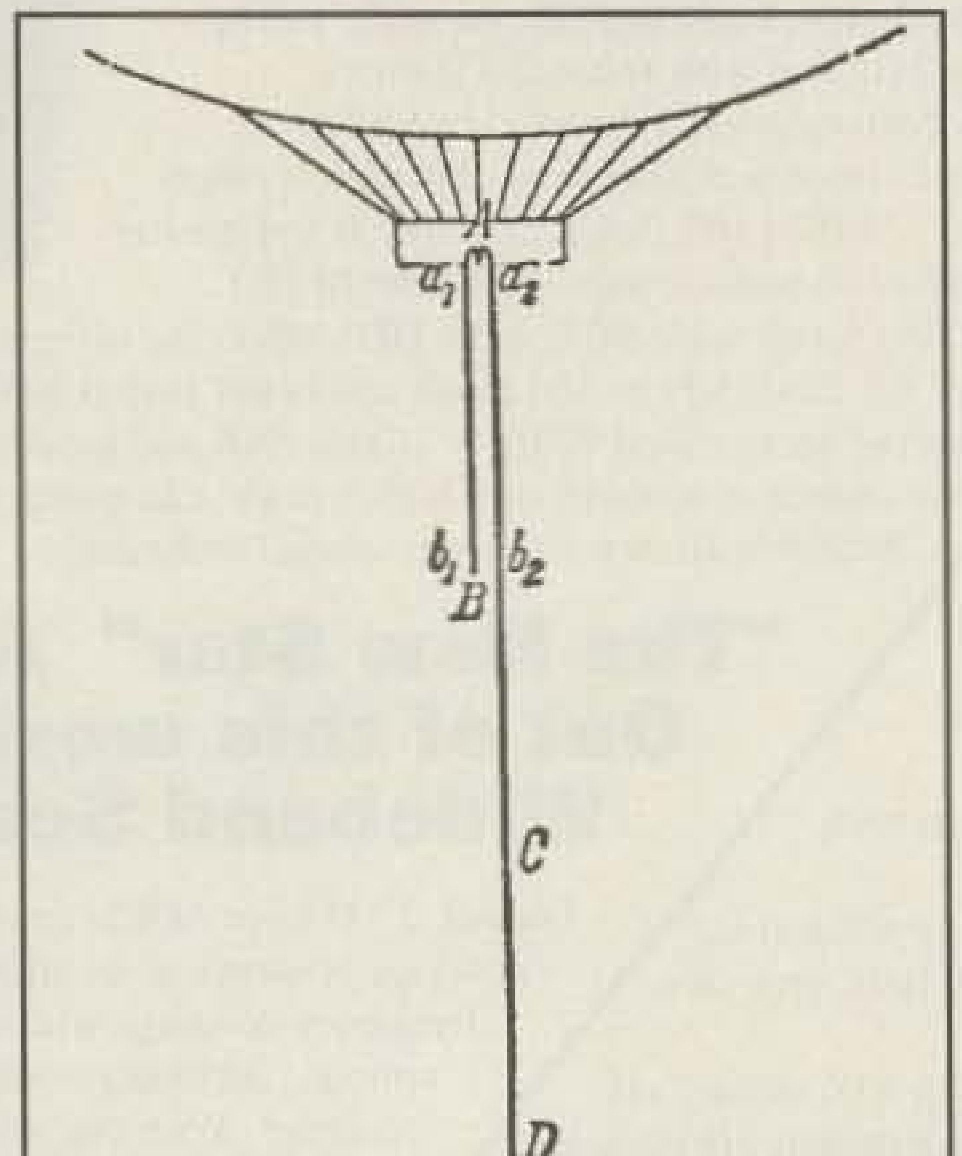

Fig. 1– The Zepp antenna hung beneath a dirigible. The feedline consists of a_1a_2–b_1b_2. The antenna is B-C-D. (Original drawing from Zenneck's Wireless Telegraphy, *1st ed. [1915], McGraw Hill Book Company. Zenneck was a smart engineer; he knew a thing or two!)*

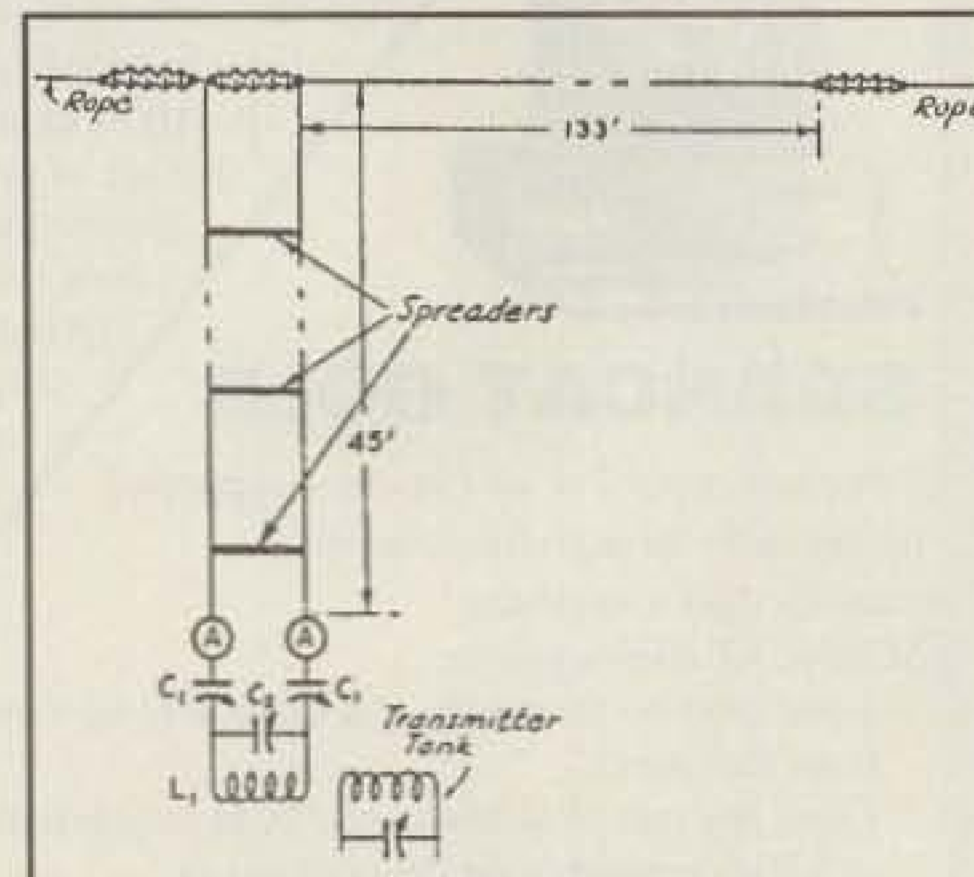

FIG. 1210—A ZEPPELIN (VOLTAGE FEED) ANTENNA FOR SEVERAL BANDS.

The antenna has a fundamental frequency of 3550 kc. but could be of any fundamental frequency between 3500 and 3600 kc. Since the feeders are less than a quarter-wave long for 3500 kc., parallel tuning should be used for this band. Series tuning will be best on the 7000- and 14,000-kc. bands and probably for the 28,000-kc. band. The condensers C_1 and C_2 may be of 250- or 350-μμfd. capacity.

Fig. 2– Early Radio Amateur's Handbook *drawing of the Zepp antenna. (Courtesy the ARRL.)*

Did The Zepp Really Work As Theorized?

The theory of the Zepp antenna is simple. The out-of-phase currents in the feeder wires are self-cancelling and prevent radiation from this section of the antenna, leaving the half-wave section to do its stuff. It permits a flat-top to be end-fed without the nuisance of having the high-voltage portion of the antenna enter the shack. This was ideal for an antenna on a dirigible, and had merit for an amateur installation, where the radiator was placed in the horizontal plane and the Zepp feeders dropped down the side of the home to the operating position.

Amateurs soon found that the Zepp antenna could operate on harmonic frequencies, provided a suitable tuning unit was used at the transmitter (fig. 3). Either series or parallel tuning would do the job, matching the terminal impedance of the feedline to the transmitter output circuit. With this flexible arrangement, it was apparent that feeder length was not so critical after all; the tuner could make up any deviation from the desired quarter wavelength. Radiation from the feeders was deemed unimportant.

Some engineers and amateurs believed that the Zepp could not possibly work in its true form because of the single-point connection to the radiator, with no path for return current. Successful operation of the Zepp was attributed to stray coupling and luck, and there the matter rested. By 1945 it was a forgotten antenna.

Recently Brian Beezley, K6STI (3532 Linda Vista Cr., San Marcos, CA 92069 [619-599-4962]), provided a computer analysis of the Zepp antenna in one of his antenna programs. The results are pleasantly suprising in that a properly constructed Zepp shows that feedline currents are remarkably equal and out-of-phase throughout most of the line length. Radiation from the feedline exists, but it is minimal, more than 20 dB below the field of the flat-top antenna. Thus, Zepp-feed can provide practically the same results as does center feed. The advantages of end-feed in certain installations are obvious.

The two-wire feeder provides a nice system for an end-fed antenna. Many amateurs run a wire antenna from their residence to a nearby tree or pole. Bringing the end of the antenna into the house is a poor idea, as it can lead to interference problems (TVI, telephone interference, etc.). Ground losses are high, and the setup also can make the chassis of the transceiver "hot" with RF. The end-fed Zepp permits the antenna to be coupled to the transmitter at a low-voltage, low-impedance point that works best with simple antenna tuners.

Many of today's tuners are single-ended circuits and use a ferrite balun to provide a balanced output. This is okay, provided the balun feeds a low-impedance, balanced load. This can be achieved easily with the Zepp, if the flat-top is multiples of a half-wave long, and the feeder is an odd multiple of quarter wavelengths long.

For instance, the flat-top can be 1/2, 1, 1 1/2,

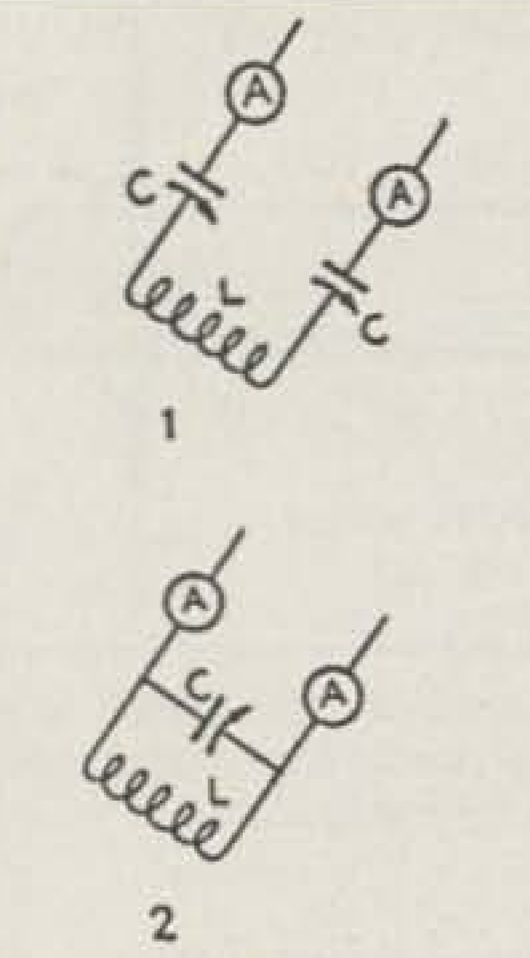

FIG. 1209—SERIES AND PARALLEL FEEDER TUNING.
Series tuning is used when there is a current loop on the feeders at the coupling point; parallel tuning when a voltage loop appears at the coupling point. The feeders are operating properly when the currents indicated by the two ammeters are identical.

TABLE I—SOME SUGGESTED ZEPPELIN FEEDER LENGTHS AND RECOMMENDED TUNING METHODS FOR THE VARIOUS AMATEUR BANDS.

This table may also be used to determine the tuning method for the center-fed antenna system of fig. 1212. In this case it will be necessary merely to use the method opposite to that stated. Where series tuning is specified for a given feeder length for the Zepp, parallel tuning should be used with the same length of feeders in the center-feed system.

Approximate Length of Each Wire, Feet	*Tuning Arrangement for Various Bands* 1750 kc. (160 m.)	3500 kc. (80 m.)	7000 kc. (40 m.)	14000 kc. (20 m.)	28000 kc. (10 m.)
120	Ser.	Par.	Par.	Par.	Ser. or Par.
90	Par.	Ser.	Ser.	Par.	Ser. or Par.
60	Par.	Ser.	Par.	Par.	Ser. or Par.
40	(---)	Par.	Ser.	Par.	Par.
30	(---)	(---)	Ser.	Par.	Ser. or Par.
15	(---)	(---)	Par.	Ser.	Par.
8	(---)	(---)	(---)	Par.	Ser.

Ser.—Series Tuning. Par.—Parallel Tuning. (---)—Not Recommended.

Fig. 3– ATU data from early Handbook *showing how it is supposed to be.*

or 2 wavelengths long, with the feeder being 1/4, 3/4, or 5/4 wavelengths long. The longer the feedline, though, the harder it is to achieve proper line balance. Hence, most amateurs opted for a quarter-wave feed line in the early days.

Build A Zepp Antenna? Surely You Jest!

Well, why not? It doesn't cost much money or take much time to build a Zepp. It may be just the ticket if you yearn to end-feed your antenna. Let's say you want a 40 meter Zepp cut for the high end of the band (7.2 MHz). By the well-known formula the half-wave flat-top will be about 65 feet long, and the feedline will be half this, or 32 ft. 6 in. long. Line spacing is not critical, so 4 inches is chosen as a workable value.

In the good old days, ceramic feeder spreaders could be bought for a few cents each. Not so today. You have to make your own. Plastic rod will do the job (fig. 4). The best way to make the line is to stretch the two wires between fixed points, about waist high, under tension. The spreaders are then wired to the line. Need help? Ask any Old Timer.

Affixing the feeders at the antenna can be tricky, as you may wish to bring the feeders off at some odd angle to the antenna. The insulator shown in fig. 5 will do the job. It's made of a small plastic plate, with two standoff insulators affixed to it. Using this device, the feedline can be brought off at any angle to the flat-top without causing any physical unbalance or flexing of the wires.

The purist can use a dip meter at the feedpoint to trim the system to resonance. Simply short the end of the feed line with a one-turn loop coupled to the meter. Trim or lengthen the line until you get antenna system resonance at 7.2 MHz. This provides a balanced, low-impedance point to attach to the output terminals of the ATU.

The Zepp can be operated on harmonic frequencies, but this requires a balanced antenna tuner capable of operating into a high-impedance load. Construction of such a tuner seems to be a lost art. You'll have to look for old editions of *The ARRL Handbook* or *The*

Radio Handbook to find construction information, or else try to locate an old Johnson "Matchbox" tuner at a fleamarket.

Another alternative is to change the length of the feedline so that it is one- or three-quarter waves long at the harmonic frequency. In any event, the Zepp is a fun antenna to play with, and the end-feed idea may be helpful in your particular QTH.

The 73 kHz Amateur Band

Our friends the Brits have a leg up on us with regard to a new amateur band! According to *Radio Communication*, the flagship publication of the RSGB, on April 29, 1996 the Radiocommunication Agency (the British equivalent of the FCC) announced a new low-frequency amateur band, running from 71.6 to 74.4 kHz. Maximum ERP is 1 watt.

While it is true that American amateurs can operate at any spot in the low-frequency spectrum under rather stringent rules, there is no official recognition, per se, of strictly amateur operation using amateur radio calls. If my memory is correct, LF operation is severely limited by antenna length and power input. The scheme was originally conceived for so-called wireless record players, in vogue during the 1940s.

The British assignment is a real amateur radio band, where callsigns are used. It's not much of an assignment, as the bandwidth is very small (slightly less than one speech channel) and the power level is insignificant. This is a step in the right direction, however.

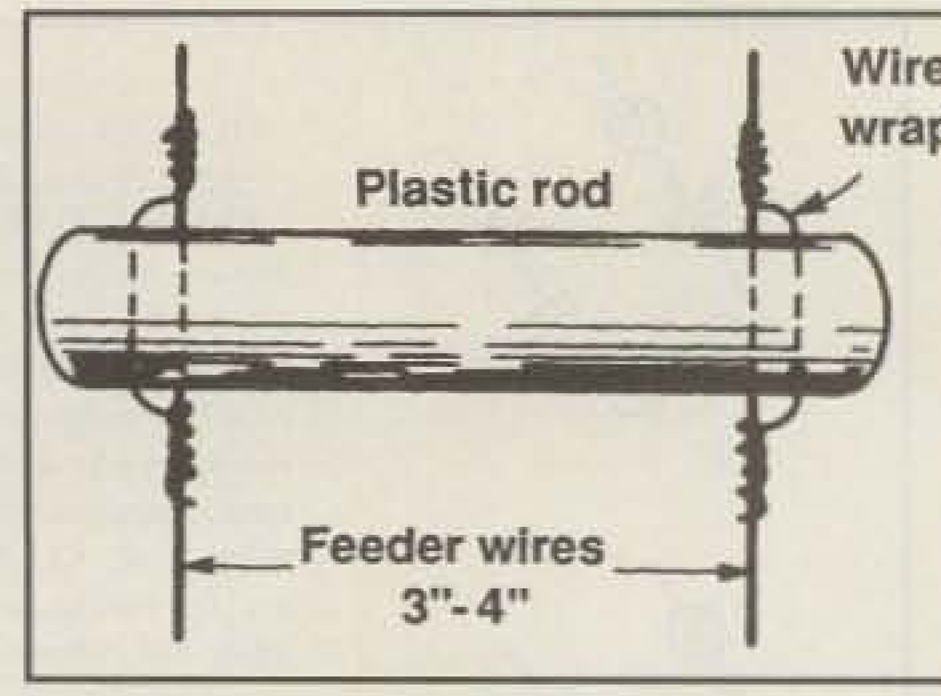

Fig. 4– Double sets of holes drilled at each end of a spreader permit wire wrap to hold the feed wires in place.

New Zealand, I understand, has an LF amateur assignment (165–190 kHz) with a power limit of 100 watts. Now that's something worthwhile! Australia too has special amateur permits for LF operation.

It would seem to me that some portion of the LF spectrum could be set aside for amateur work in the United States. I would opt for 20 or 30 kHz in the 150 to 350 kHz region, with a power level of 100 watts and no antenna restrictions. That would be something to look forward to before the turn of the century! Why not?

KB6GJX, The "Ghost of Guam"

On December 8, 1941 the bombardment of the island of Guam took place, spearheaded by the Imperial Naval forces of the Japanese Empire. This was followed up by invasion and occupation—the only populated American territory to suffer such a fate.

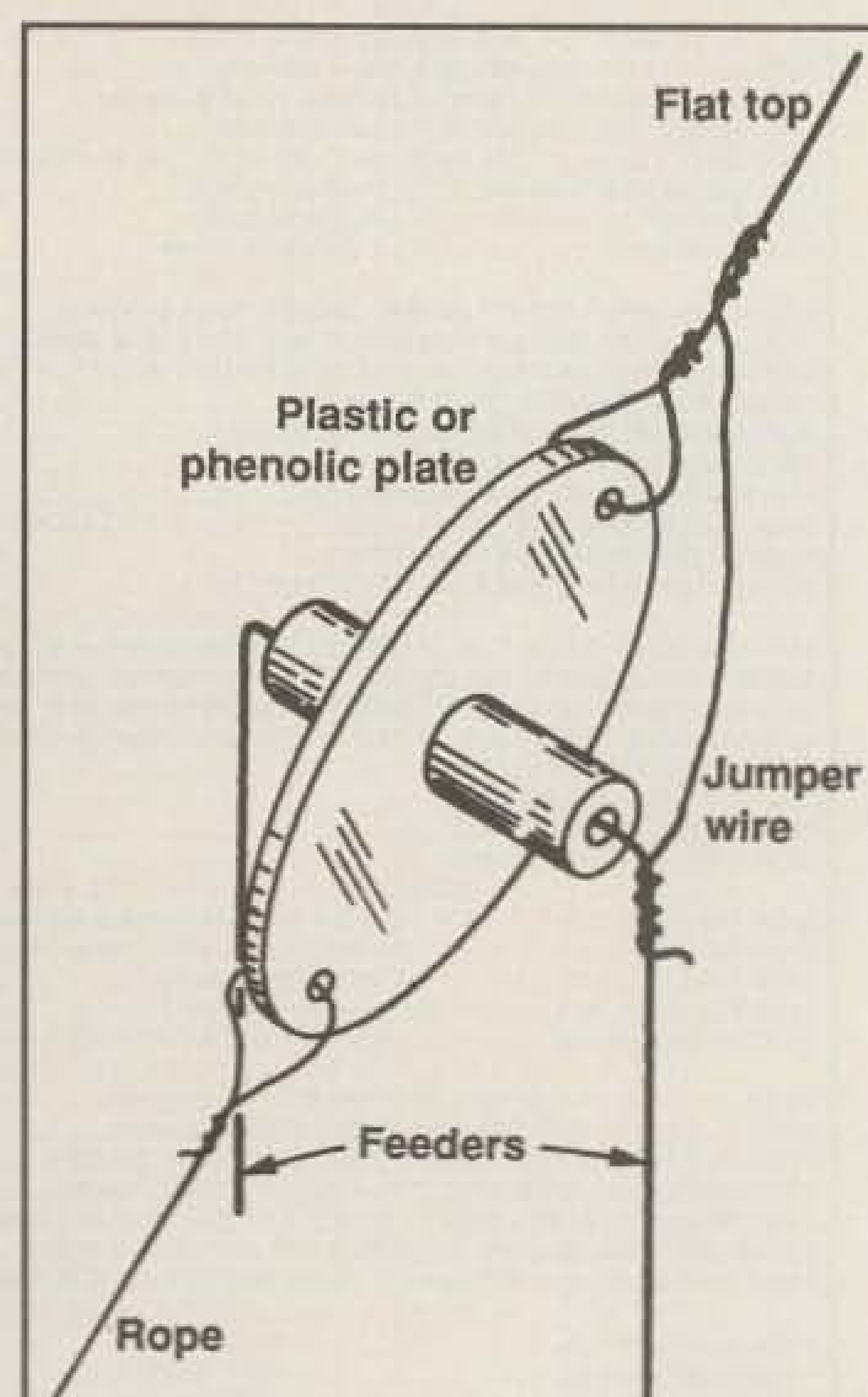

Fig. 5– Feeder-antenna junction plate. Old Timers used brown "beehive" insulators for best results. One-half inch maple boiled in paraffin was used. Feeders may be brought off at any angle. (Adapted from photo in The Radio Amateur's Handbook, *12th ed. (1935).*

Radio amateur activity on Guam had been closed down the previous June by the U.S. Navy, and all amateur transmitting equipment had been impounded and stored for delivery to the rightful owner at some time in the future.

That put Warrant Officer George Tweed, USN, off the air. As KB6GJX he was very active on 20 meters phone, with a 200 watt home-made transmitter and a Zepp antenna. One of the first bombs to hit Guam on the day of the invasion landed on George's house. No one was hurt, but most of the gear, including his receiver and test equipment, was blown up.

Aside from KB6GJX there were two other amateurs on Guam: KB6CBN, Roy Hennings, and KB6OCL, a club station operated by a Marine named Anderson. Henning was captured by the Japanese and taken away to a prison camp, and Anderson was killed in an air raid. George, KB6GJX, the only amateur left alive, prepared boxes of food and clothing before escaping into the hills, with the invaders firing at his car as he sped away.

A companion Navy radio man who escaped with him was killed and George was left alone, hiding in a cave in the interior of the island. He was assisted by friendly natives who told him that the Japanese had issued orders that all radios must be turned in and anyone caught with radio gear would be put to death.

In spite of the danger, George was anxious to know what was going on in the world, and he asked his friends to bring him a receiver. They brought him a Hallicrafters SX-16, stolen from the Japanese, plus a power supply and some storage batteries from wrecked cars. With effort George got the receiver and power supply working, and soon thereafter the natives brought him a collection of tools, a soldering iron, and a gas-driven 110 volt, 60 Hz generator! They also brought gas for the generator from wrecked military vehicles.

As time went by, George collected a Triplett analyzer, wire, solder, and various radio components. Eventually he got a copy of *The ARRL Handbook* and a typewriter. It looked as if he had enough junk at hand to build a transmitter!

All this time the Japanese were searching for the American radio man. KB6GJX had to change his location several times. His main objective was to stay alive, and building a transmitter took second place to that! Progress was slow. He listened daily to news broadcasts from KGEI in San Francisco, and even typed up a one-page newsletter for his native friends.

Eventually, one of the natives volunteered to take the parts to town, where it would be easier to assemble a transmitter. Alas, the good samaritan never returned, and George heard that he had been captured and shot. Chances of getting on the air now seemed slim indeed. Most of the transmitter components were gone, and there was a price of 1000 yen on his head. Finally, with the Japanese close on his trail, he gave his receiver and remaining equipment to a native to hide. When George later retrieved the equipment, it was damaged beyond repair by water and dampness.

For 31 months George Tweed dodged the Japanese. He finally was rescued when the Americans reclaimed Guam. A portion of his adventures were told in the March 1945 issue of *QST*. Soon after the publication of this article, Tweed collaborated with Blake Clark to write *Robinson Crusoe, USN: the Adventures of Grorge R. Tweed, RM1C, on Jap-held Guam.*

The book initally was a resounding success, but its sales were suppressed by powerful political problems on Guam. It soon disappeared and was unavailable for almost 50 years. Some years after the war the story of George Tweed was made into a movie starring Jeffery Hunter and entitled *No Man is an Island.*

The U.S. Naval Institute has announced that the book is now reprinted, with additional information about the characters and issues of conflict. It is in the public domain, and Tweed's widow, Doris, receives royalty checks on sales. The book is not available through bookstores, but may be ordered from the publisher for $24.95, which includes shipping by priority mail. The address is: The Pacific Research Institute, Box 26270, Barrigada, Guam 96921.

The story of KB6GJX is an amazing tale of human spirit, and his suppressed memoirs reveal an interesting story of intrigue and politics in a life or death situation.

And Finally . . .

My heartfelt thanks to the following amateurs who have written to me over the past months. I'm sorry I can't reply to all of you personally, but believe me, I read your input and really appreciate it. It's comforting to know that somebody actually reads this column!

Kudos to: W8FAZ, W9JUV, W8LVN, N4FG, W5IKB, N5AR, W8DMR, W7CG, W6LU, W6UVC, AH6NY, W4SXK, W2NBJ, K6YGK, KM6EH, N2TAI, W4WDS, WB4GNR, K2BRY, N1TEV, W8LVN, W1VMH, W9BRD, YS1AG, WA6PJQ, KB2TON, VE7FIF, W1KL, AAØRN/IT9, W7CG, WB6YJE, N6PUO, KR6A, W9CWG, W2QOC, K3VMS, AB5XV, W3LWX, W5AAD, KØBIT, W7XK, W4IBZ, K4VRN, W6TFG, N2KPE, W9CWG, NTØW, and NW2L.

73, Bill, W6SAI