A Lazy-Quad Antenna for the 21 mc Novice

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Why Use A Beam Antenna?

World wide communication is possible on the higher radio frequencies because of the presence of a tenuous layer of ionized air hovering 150-250 miles above the surface of the earth. A product of the action of ultra-violet radiations of the sun upon the atmosphere, the *ionosphere* acts as a mirror-reflector, returning radio signals to earth over spans of thousands of miles.

The use of a beam antenna for transmission and reception concentrates the greater portion of radio energy at those angles which are most readily reflected by the sky-mirror. The radio signal transmitted directly upwards towards the ionosphere is often lost through the layer into outer space, or is reflected to a nearby point on the surface of the globe. Signals arriving at lower angles are reflected to far-away earth points with but little loss of strength. The beam antenna concentrates the radio signal in one direction, much as in the manner an automobile headlight throws the light beam before the car. Radiations in unwanted directions are thereby suppressed, and the radio signal in the desired direction is enhanced, thereby making full use of the reflective properties of the ionosphere for long distance transmission. (See fig. 1.)

The beam antenna described in this article provides an actual power gain of approximately three (4 decibels) as compared to a simple dipole. Using this antenna, the 75-watt Novice transmitter is comparable to a 225 watt transmitter using a dipole radiator. Best of all, the power gain of the antenna is available for reception, where the extra boost in signal strength may make all the difference between copying a signal and not being able to read it at all!

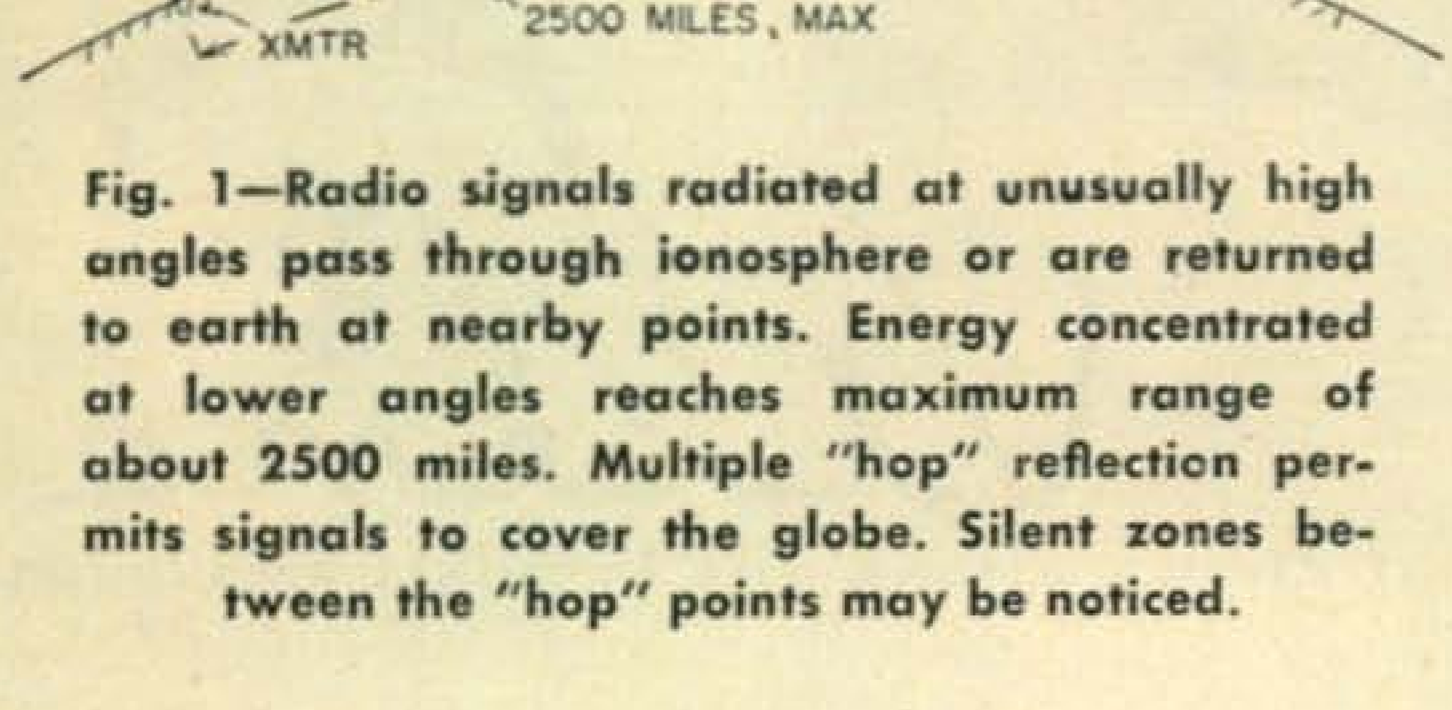

Fig. 1—Radio signals radiated at unusually high angles pass through ionosphere or are returned to earth at nearby points. Energy concentrated at lower angles reaches maximum range of about 2500 miles. Multiple "hop" reflection permits signals to cover the globe. Silent zones between the "hop" points may be noticed.

A beam antenna serves a double purpose for the Novice amateur. It enhances the strength of his signals and at the same time boosts the signals of the far-distant amateurs he is trying to contact. Without a doubt, every dollar invested in a beam antenna system will bring large dividends to the owner of a Novice station.

Designed particularly for the 21 *mc* amateur, the "Lazy Quad" antenna shown in figs. 2 and 3 is a 1959 version of the "W8JK" beam, orig-

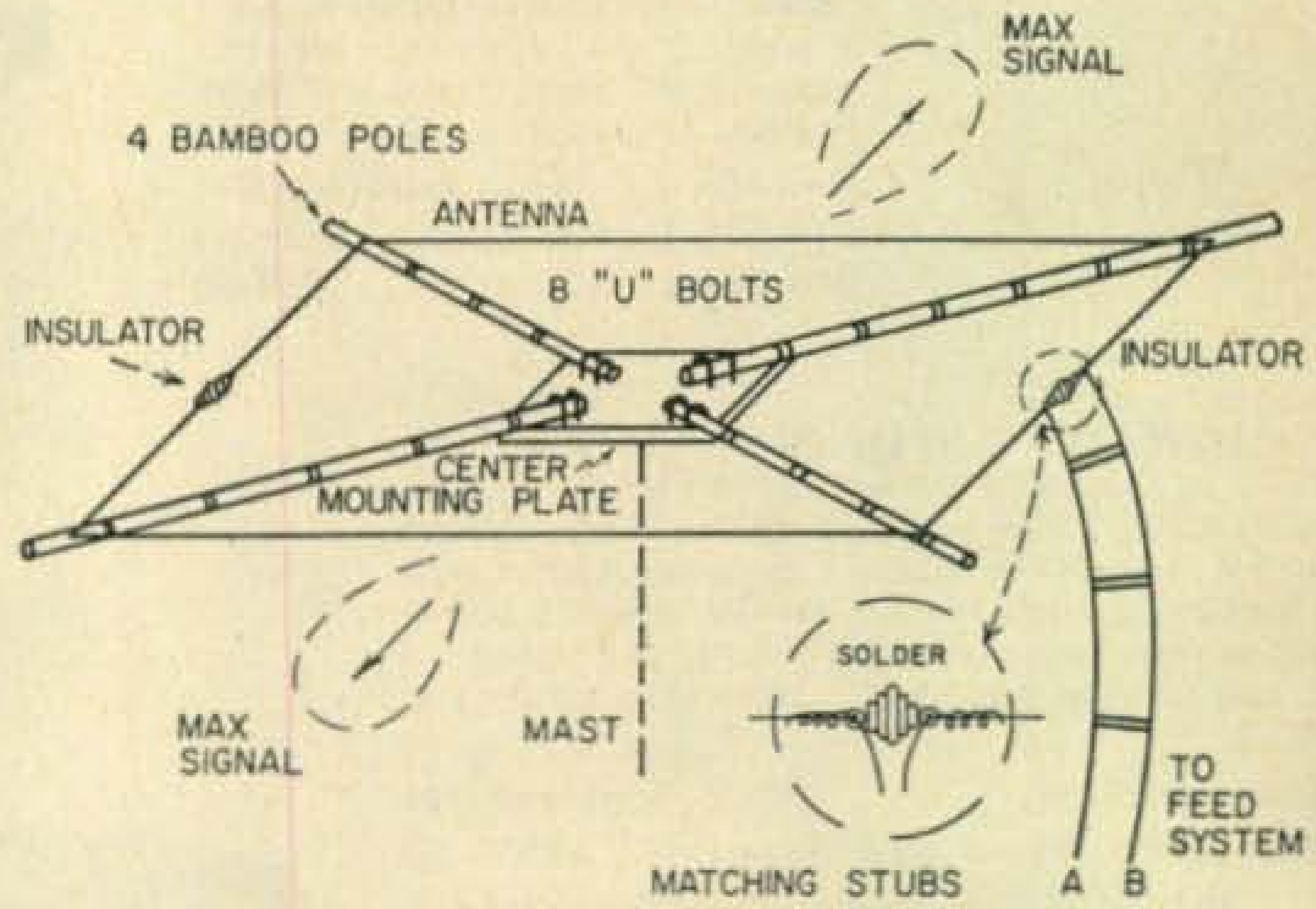

Fig. 2—The Lazy-Quad beam antenna for 21 megacycle Novice band consists of a horizontal loop of wire strung around the tips of a bamboo framework. The locp is 16'4" long and 6'6" wide, considerably smaller than any comparable beam antenna. It is made up of two pieces of wire, each 23'8" long. The excess wire is used to make connection to the insulators placed at centers of short sides. Impedance matching stub is made of thirteen foot length of "open wire" TV-line. Feed system is connected to points A-B on stub.

Bamboo poles are 10' long, and mounted to plywood center block with U-bolts. Center block measures 24"x10"x½". The center block may be affixed to the mast or supporting structure with metal angle brackets. Entire antenna should be mounted well in the clear, free of nearby metallic objects, such as gutters, drain pipes, TV antennas, etc.

inated by Dr. John Kraus of Ohio State University. This beam antenna has a "figure-8" pattern much like a simple dipole but it will make the 75-watt Novice transmitter sound like a quarter kilowatt to the DX station! Reception will be improved a like amount when the beam is used with the receiver. Results obtained with this ten dollar antenna are well worth the few hours' construction and adjustment time required for top performance! The beam will work with any standard Novice transmitter or receiver.

Building the Lazy-Quad Antenna

The Lazy-Quad consists of a resonant wire loop broken at the centers of the short sides by insulators. The loop is supported parallel to the ground by a simple lightweight bamboo framework. Four ten foot bamboo poles are required, attached at their butt ends to a wooden mounting plate. Suitable poles may be obtained at a nursery, rug cleaning establishment, or bamboo shop. Clean, straight pieces having no splits are required, and the poles should be given several coats of clear varnish before they are fastened to the mounting plate by means of galvanized U-bolts. The center mounting plate is a piece of ½-inch plywood, well painted to protect the edges from weathering.

The bamboo and wood frame is assembled in the yard and two sections of copper antenna wire each 23'8" long are cut and temporarily laid over the bamboo poles in the approximate position they will finally assume. Scrape the enamel insulation from each end of the wires for about a foot, and temporarily pass the wire ends through the porcelain insulator holes to form a square loop having 22'3" of wire on each side of the insulators. Stretch the loop over the bamboo frame, holding it in position over the poles by means of small wooden pegs driven into the ground, acting as

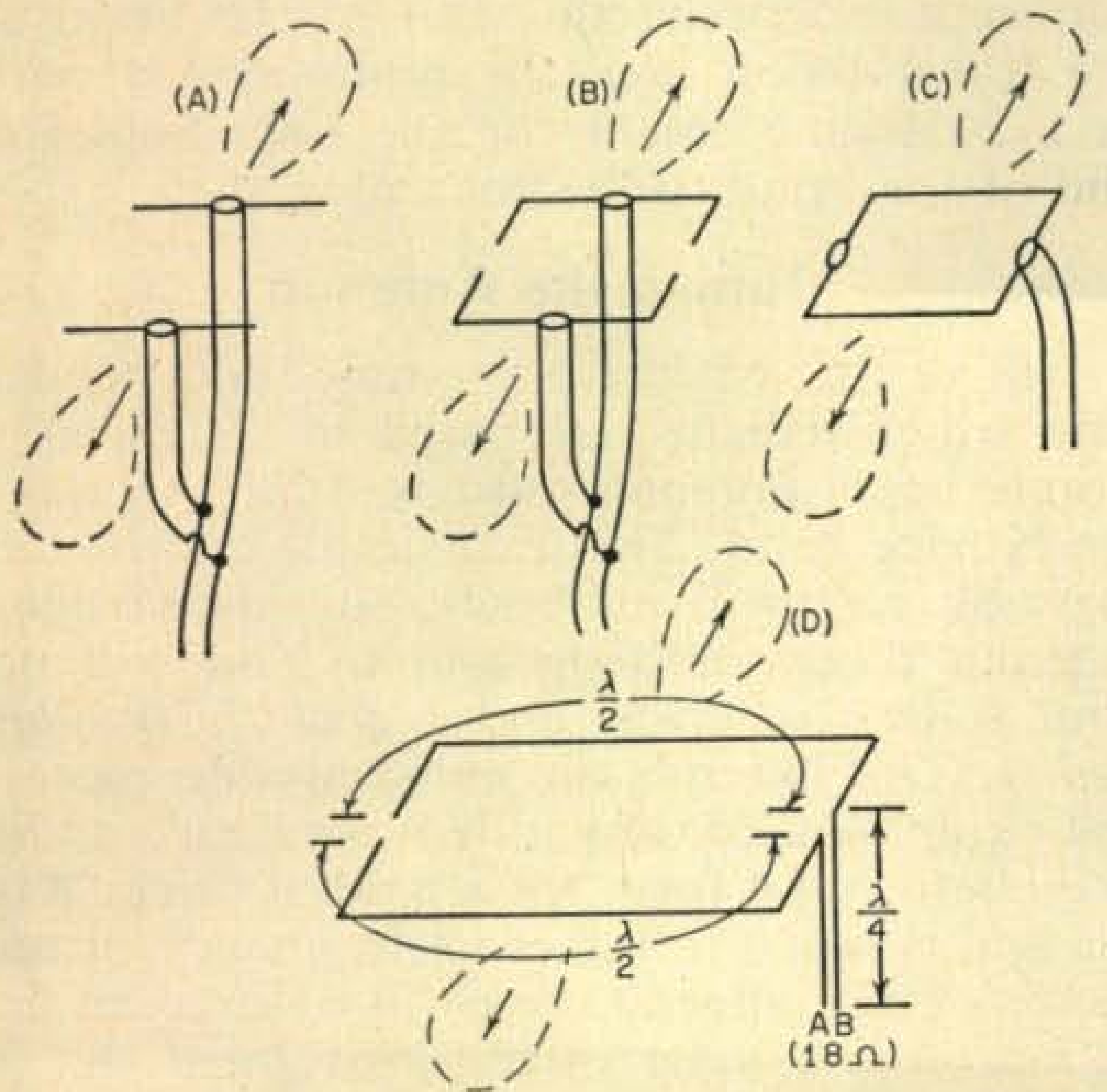

Figure 3 — Electrical diagrams of Lazy-Quad antenna.

A—Two half-wave antennas (dipoles) may be placed parallel to each other to form a simple beam antenna. Feed wires are cross-connected to provide proper energy distribution.

B—Ends of antennas may be folded back to conserve space without affecting antenna operation.

C—Single stub replaces dual feed system of A and B for ultimate in simplicity.

D—Complete Lazy-Quad beam is adjusted for optimum results by varying length of quarter-wave stub. Impedance of antenna at point A-B is approximately 18 ohms. Simple matching system is placed at A-B to permit use of 75 ohm "TV-type" balanced line with antenna. Matching system is shown in fig. 4.

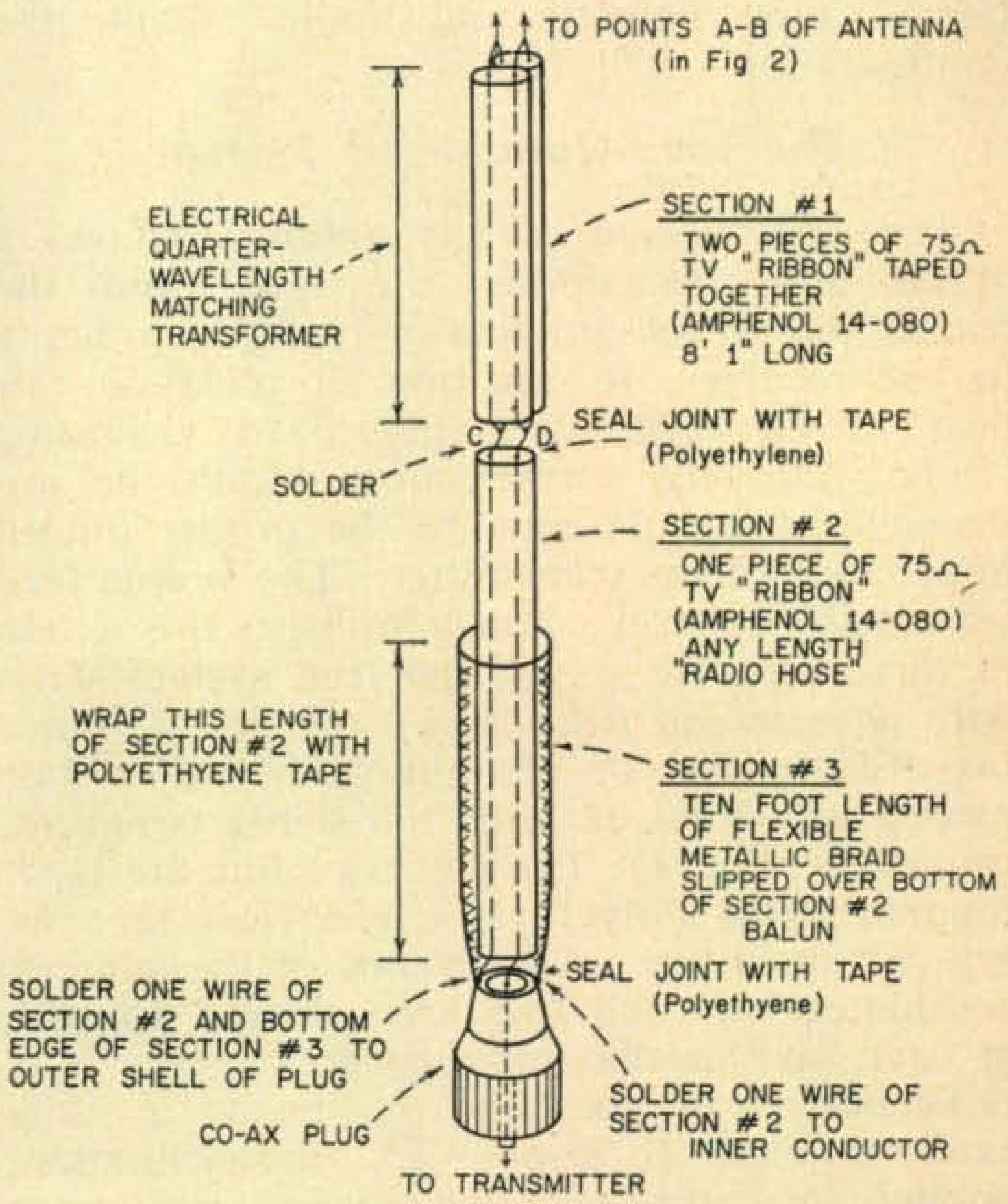

Fig. 4—The matching system for Lazy-Quad antenna. Impedance at point A-B of antenna (figs. 2 and 3) is 18 ohms. Section #1 of matching system is quarter wavelength transformer having impedance of 36 ohms. Impedance transformation resulting in termination of 72 at point C-D takes place in this section. Transformer is 8'1" long, made of two pieces of 75 ohm TV-"ribbon" line connected in parallel and taped together every few inches.

Section #2 is one piece of 75-ohm TV-"ribbon" long enough to reach from the antenna to the transmitter. Keep the line clear of nearby metallic objects.

Section #3 is a ten foot length of flexible, metallic braid slipped over the bottom of section #2, which is wrapped with polyethylene insulating tape before the braid is applied. Several wrappings of tape around the braid will hold it securely in place. Bottom end of braid is soldered to shell of coaxial antenna plug.

"corner posts". You will see that small holes must be drilled in the bamboo poles about nine feet from the center of the plywood plate to pass the antenna wires. Mark the position of the holes, remove the "corner pegs", drill the holes and "thread" the halves of the antenna through the holes. Reattach the wires permanently to the insulators and solder the joints. Finally, adjust the position of the bamboo poles in the U-bolts until the wires are taut.

The last step is to solder the *matching stub* across one insulator. The stub is made of a thirteen foot length of "UHF-VHF open line" of 400 ohms nominal impedance. Solder each wire of the stub to one side of the antenna, across a porcelain insulator as shown in the drawing. Scrape the insulation off the opposite ends of the wire for a foot or two. The antenna is now complete, and should resemble the configuration of fig. 2.

The Lazy-Quad Feed System

The *feed system* of any antenna acts as a "radio hose" to conduct the signal from the transmitter to the antenna or from the antenna to the receiver. In addition, it must do this task in an efficient manner. (In electronic "lingo" the feed system must match the impedance of the antenna to the proper output impedance of the transmitter.) The simple feed system shown in fig. 4 accomplishes this action in three separate steps. The feed system starts with a *matching transformer* (section 1) made two 8′1″ lengths of 75-ohm "TV-type" ribbon placed side by side with the wires connected in parallel (fig. 4). The pieces of line are taped together with Polyethylene electrical tape every two inches or so. The ends of the adjacent conductors in each line are soldered together at each end of the transformer.

Section 2 of the feed system is a single random length of 75-ohm TV ribbon line long enough to reach from the antenna position to your radio equipment. It should be kept clear of metallic objects such as rain gutters, drain pipes and nearby television antennas. This section is the "radio hose" reaching from the antenna to the transmitter.

Section 3 is a simple *balancing transformer* (Balun) which permits the electrical balanced, two conductor "radio hose" to be efficiently connected to a transmitter having an unbalanced coaxial-type antenna output circuit. The balun is made of a ten foot length of tubular, flexible metallic braid passed over the lower section of the "radio hose". In preparation for this operation, the last ten feet of the transmission line (section 2) are wrapped with a spiral winding of Polyethylene electrical tape to protect the line against physical abrasion by the metallic braid which is carefully slid over the line. A coaxial plug is attached to the end of section 2, one wire of the line connecting to the center terminal of the plug and the outer wire being soldered to the outer shell of the plug. Do the soldering operation carefully so that you will not melt the plastic tape or the insulation of the transmission line.

The final step is to smooth out the braid towards the free end and to cut it off exactly ten feet from the coaxial plug. Tape the braid every foot or so to hold it in position over the line. At the open end carefully tape the braid to cover up the "whiskers" of wire. There is no connection between this end of the braid and the transmission line, the braid merely acting as a balancing shield for the line. Solder the end of the braid to the coax plug shell.

Tuning the Antenna

Unlike the expensive pre-tuned all metal arrays which can be purchased in kit form this simple beam antenna must be tuned to the 21 *mc* Novice band. This is a simple and interesting task and will increase your knowledge of antenna theory and operation. You will need your station receiver, and a *grid-dip oscillator* (*gdo*). The latter is an indispensable piece of test equipment for any ardent amateur and may be bought in kit form for a modest price. When the *gdo* is tuned to the exact frequency of resonance of the antenna, you will observe an indication on the meter of the instrument. As you make tuning adjustments to the antenna you can readily determine the new resonant frequency merely by holding the *gdo* in proximity to the antenna, varying the tuning dial of the instrument and watching the indicating meter. In order to couple the *gdo* to the antenna you must place a moveable shorting jumper at *point A-B* on the matching stub. The exact position of this jumper along the stub determines the frequency of resonance of the whole antenna. The jumper should be adjusted for antenna resonance near the middle of the Novice band (approximately 21.15 *mc*). This is how you do it:

Two long-nose "alligator" clips are connected back-to-back with a very short length of wire, forming a moveable jumper easily affixed to the two bottom wires of the antenna matching stub. Each clip is attached to one wire (fig. 5).

Parts List, Lazy Quad Antenna

- 50 feet #14 enameled, soft drawn copper wire
- 13 foot length open wire "400 ohm" TV-type transmission line
- 4—Bamboo poles, ten feet long, clear, with no splits
- 1—Plywood plate, 24″ x 10″ x ½″
- 8—U-bolts, with washers and hardware to clamp bamboo poles to center plate. Use only galvanized hardware to prevent rust.
- 2—Glass or porcelain antenna insulators, 3″ long
- 1—Length of 75 ohm balanced TV "ribbon" line (Amphenol 14-080) sufficiently long enough to construct sections #1 & #2, fig. 4.
- 10′ length of ½″ diameter flexible metallic braid, Belden 8661
- 1—Coaxial plug to match coaxial antenna receptacle of transmitter
- 1—Roll of Polyethylene electrical tape (Minnesota Mining & Mfg. Co. "Scotch #33")
- Small can of outdoor paint to coat center plate

The next step is to temporarily raise the antenna so that it is clear of nearby objects, yet low enough so that you can reach the moveable jumper from the ground or a short ladder. Place the coil of the *gdo* adjacent to the jumper and tune the dial of the instrument until an indication is observed on the meter. The *gdo* is now tuned to the resonant frequency of the antenna and you must now find the exact operating frequency of the *gdo*.

It is easy to determine the frequency of your crystal controlled transmitter on the dial of the station receiver. In addition, the edge of the American phone band can easily be found at 21.25 *mc*. It is possible to plot a dial calibration curve so that the desired antenna resonant frequency of 21.15 *mc* can be "spotted" on the receiver. Once this frequency is noted, the *rf* gain control of the receiver is retarded, the beat oscillator is turned on and the signal of the *gdo* is tuned in. It can be heard quite a distance from the receiver. A good idea is to have a friend tune the receiver to the *gdo* while you are in the yard, adjusting the "alligator" clips and moving the antenna resonant point indicated by the *gdo*.

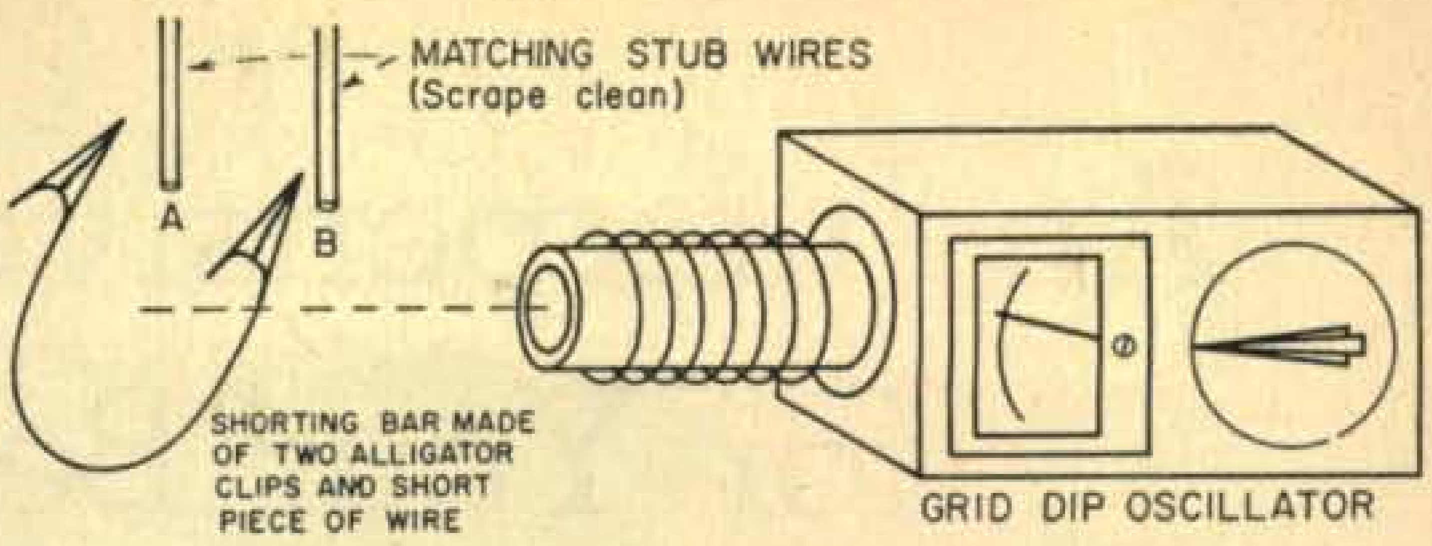

Fig. 5—Temporary shorting bar is placed across ends A-B of matching stub. Position of the stub determines the resonant frequency of the antenna. Measurement of the frequency may be made with a grid dip meter and station receiver as explained in the text.

[*Continued on page 115*]

Definition of Some Common Antenna Terms

"Balancing Transformer" —In many instances it is necessary to join a coaxial (unbalanced) line to a two-wire (balanced) line. Such a transition cannot be made directly since the junction of the dissimilar lines presents a discontinuity in the electrical characteristics of the system. Such a discontinuity would result in loss of radio energy and transmitter tuning problems. A balancing transformer is a special segment of transmission line that is placed between dissimilar lines to effect an efficient junction and to reduce unwanted effects to a minimum.

"Dipole Antenna"—The dipole is an antenna used for reception or transmission that is approximately one-half as long as the radio wave it is designed to receive. It is a simple resonant antenna.

"Feed System"—The feed system is a transmission line, or "radio hose" used for the conduction of radio energy with little loss. All antennas must be coupled to receivers and transmitters by means of transmission lines of one type or another. Balancing transformers may be included in the feed system.

"Great Circle Route"—Radio transmission between two points follows the shortest path consistent with its reflections back and forth between the earth and the ionosphere. This path is the shortest distance between two points on the surface of a sphere and is called the Great Circle Route, appearing as a curved line on regular maps, and as a straight line on a Great Circle Map.

"Grid-dip oscillator"—The g.d.o. is a miniature transmitter capable of being tuned across a large portion of the high frequency radio spectrum. It employs plug-in coils which are so arranged that they may be brought in close proximity to various radio circuits. When the g.d.o. is tuned to the resonant frequency of the radio circuit, an indication may be seen on the self-contained meter of the g.d.o. In this manner, radio circuits and antennas may be brought into alignment by varying the adjustments and noting the resonant frequency shown on the g.d.o.

"Impedance of an antenna or transmission line" —The transmission line has an inherent property termed impedance which is determined by the physical and electrical characteristics of the line. The size of the conductors, the spacing between them, the material used to hold the conductors apart determine the impedance of the line, expressed in ohms. Values between 52-300 ohms are common in amateur service.

The impedance or radiation resistance of any antenna may be defined as that value of ohmic resistance which, when substituted for the antenna, will dissipate the same amount of power as is radiated by the antenna. Values between 10—300 ohms are common in amateur service.

"Matching Transformer"—A matching transformer is a special segment of transmission line placed between two similar lines of different impedance values to prevent a discontinuity in the electrical characteristics of the line. A balancing transformer is one type of matching transformer.

"Resonant Antenna"—Resonance is a condition established in an antenna when the length of the antenna bears some specific relationship to the length of one cycle of the radio wave. In a simple antenna, a resonant condition may be found at multiples of one-quarter wavelength (¼, ½, ¾ wavelength, etc.). A maximum value of radio signal may be emitted or received when the antenna is in a resonant state. ■

quite surprising. (Perhaps it possesses some of the characteristics of the folded dipole which is noted for having better bandwidth.)

My Dipoler is oriented on the Eastcoast of the USA and I consistently receive good reports with only 40 to 50 watts input.

I am mighty satisfied with this antenna on 10, 15, 20, 40 and 80 meters. I am sure you will be too if you put it together as I have outlined here. Listen for F7FE, the signal will convince you! ■

FEEDER SYSTEM [*from page 40*]

System Measurements

Operation of the antenna system as a whole may be checked by placing a SWR meter in series with the 75 ohm coaxial line to the transmitter. The instrument must be capable of operation with a line having this nominal impedance value. In general, the matching system is capable of a better-than 2/1 SWR at the extremities of an amateur band, with better than 1.5/1 SWR at the resonant frequency of the antenna. The system has produced SWR values of 1.2/1 or so with the antenna at resonance when employed with various commercial antennas having split dipole elements. ■

21 MC BEAM [*from page 37*]

Once the antenna resonance is established near 21.15 *mc*, the shorting bar may be removed, the excess stub wire is cut off and the wires of the matching transformer are soldered to the stub at point A-B. The antenna is now properly tuned, and may be placed in the final operating position.

Using the Lazy-Quad Antenna

The radiation pattern of this simple beam antenna is at right angles to the long wires of the array. Since the pattern is bidirectional it is only necessary to turn the antenna through a half-circle to obtain world wide coverage. The actual direction to distant points is often deceptive, and the use of a "great circle map"[1] to plot antenna headings is highly desirable. For maximum results the antenna should be employed for reception as well as transmission, and the use of an "antenna change-over" relay or switch to disconnect the feed system from the transmitter and connect it to the receiver is highly recommended.

Erected well in the clear, this simple antenna will provide many hours of QRM-free contacts and is a worth-while addition to any 21 *mc* amateur station. ■

[1] Six great circle maps covering the entire world from the U. S. A. may be found in the "Better Shortwave Reception" Handbook, obtainable from Radio Publications, Inc., Wilton, Conn. ($2.85 plus 15¢ postage), or from your local radio dealer.