Practical Communication on the 224-Mc. Band

The New Tube and Directive Antennas Reveal a World of Possibilities

By Ross A. Hull*

TWENTY-FOUR hours after we had obtained delivery of one of the new acorn type tubes, we had a duplex 35-mile communication circuit in operation using 56 mc. one way and 224 mc. the other. Directive antennas were used for both bands at the home station and plain antennas at the mobile station. Signals were maximum strength at both ends of the circuit. We thought we had had our full share of thrills during the recent work with directive antennas on 56 mc. But here was another one, fast on the heels of our recent fulsome dose. 224-mc. band signals that would just about burst the diaphragm of anybody's speaker—signals which appeared to have all the desirable characteristics of the 56-mc. ones (if not more).

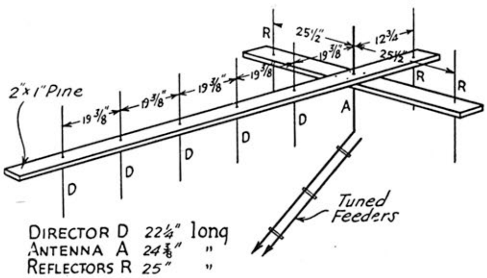

FIG. 1—THE YAGI DIRECTIVE ANTENNA OPERATED AT W1AL ON 130 CENTIMETERS (ABOUT 230 MC.)

The antenna, director and reflector are made of 1/8-inch brass rod pushed through holes in the wooden structure, the latter being thoroughly soaked with hot paraffin. The feeders are cut approximately to an odd number of quarter wavelengths and tuned with series condensers in the conventional Zepp fashion. The supporting structure can be arranged in any one of a hundred ways—our next one will be on a rotatable pole hitched up to a brass wheel alongside the operating table!

During the few days since then we have built a couple of extra receivers and made a very sketchy preliminary survey of the manner in which a 130-centimeter wave from a directive antenna pokes its way through the Connecticut hills. The data at hand are far too meagre to allow any emphatic statement comparing 56 and 224 mc. but it is our impression that the signals on the new band soak into valleys and generally cover the landscape more effectively than our 56-mc. signals have done. At the moment we are getting geared up for an attempt at contact between Hartford and Boston on 130 centimeters and enthusiasm in these parts is running very high. The reception of strong signals in an automobile over a 50-mile path blocked by hills 1200 feet high leads us to suspect very strongly that all sorts of surprising distances will be possible just as soon as we fit out the necessary directive antennas for reception and transmission at both ends of the circuit.

The tremendous advantage of operation on the extremely high frequencies is not in the novelty of the work but in the possibility of fitting out a highly effective directive antenna while still keeping it small enough to pick up and cart around. It takes a fair amount of space to fit out an antenna with a power gain of twenty on 56 mc. but there is no conceivable location in which there would not be room for a dozen such antenna systems suited for the 224-mc. band. The "signal squirter" with a brass wheel controlling its direc-

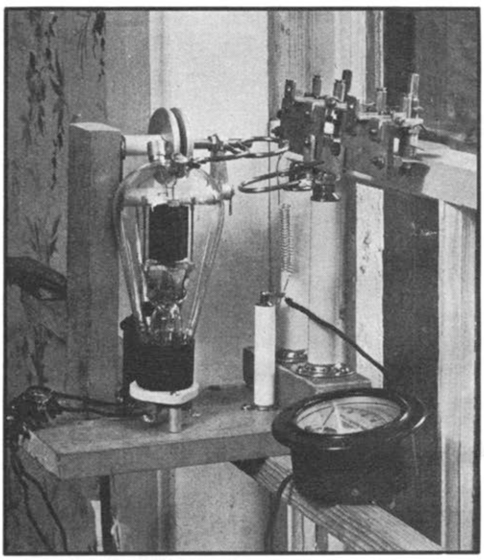

FIG. 2—THE LIGHT IN THE WINDOW—THE 130 CENTIMETER TRANSMITTER AT W1AL

Mounted right in the window frame, this simple transmitter pushes large chunks of juice to the directive antenna on the veranda roof The antenna, in turn, squirts this at the moment, in a northeasterly direction.

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tion alongside the ham operating position is no dream of the distant future. If we can afford the brass wheel we will build one just as soon as we finish writing this article.

Before describing the equipment which has worked out so nicely in our case, we might mention the considerations involved in deciding upon 224 mc. as the band on which to start this ultra-ultra-high-frequency work. The acorn tube is thoroughly satisfactory for operation down to about half a meter. In other words, there would be no serious tube problem in reception on any of the wavelengths under consideration. Operation at wavelengths below about 125 centimeters, however, would mean that the only available tube for transmission (using conventional circuits) would be the "acorn." Since we wanted to be able to use higher powered transmitters than would be provided by the new tube, we decided that the band from 224 to 240 mc. (about 134 to 125 centimeters) would be the ideal spot. The W.E. 304A or the 800 are capable of splendid operation in that territory and provide all the steam one would want.[1] The 224-mc. band was selected in preference to the 112-mc. band for the very simple reason that the directive antenna could then be kept down to the point where even a highly directive system would be small enough to fit in any attic or on any porch roof.

The antenna chosen for our first work is of the "Yagi" type. In this system, a single half-wave antenna is used, backed by one or more reflectors and fitted with a series of directors strung out in

[1] Other circuit and tube combinations were discussed in "Firing Up on the Newly-Opened Ultra-High Frequencies," *QST*, September, 1934.

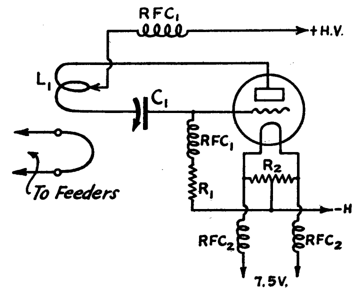

FIG. 3—CIRCUIT OF THE 130-CENTIMETER (224-MC. BAND) TRANSMITTER

C_1—National Type NC800 condenser.
L_1—Single turn tank coil of very small copper tubing or No. 12 gauge wire. Actual length of conductor is 7 inches—the turn 1-inch diameter.
R_1—20,000 10-watt resistor.
R_2—50- or 100-ohm center-tapped resistor.
RFC_1—15 turns of No. 18 wire wound on a pencil—the turns being pulled apart slightly.
RFC_2—About 10 turns of the filament leads wound on a pencil (see Fig. 2).
The new W.E. 304A is now used in this circuit at AL. The 800 shown in Fig. 2 was also satisfactory.

Five-Meter Performance Hits New Levels

Directive Antennas Permit Smashing All Records: Activities at High Pitch

WAS it freaky weather, never to be duplicated? Was the location just one in a million? Has anyone else been able to duplicate it?—These were the questions aired freely when Ross Hull revealed the amazing effectiveness of the directive antenna he had strung up at W1AL. Months of continuous communication, observation, and comparison are needed before the final answers can be made, but at this stage it certainly looks as though we can rule out all thoughts of freakiness. With Headquarters ops taking shifts, AL has been kept on the air every night (six weeks of it at this writing) and for schedules each morning. Ninety-seven out of an even hundred schedules with W1HRX have resulted in satisfactory communication. Every day since October *QST* went to press with Hull's story, Hartford-Boston contact has been had. Signals are, of course, not always the same strength. Dizzy cycles of good and bad weather follow each other at intervals of a few days with steady R9 signals one night and severe fading the next. But communication holds up just the same.

And that isn't all! AL was heard strongly by Mr. H. S. Shaw, of General Radio, 292 miles along the line of the beam at Mt. Desert Island, Me. Wow! Then, a four-hour continuous contact was had with W1XR at Mt. Washington (190 miles) using a second antenna pointed in that direction. Many excellent contacts have been had with Dr. G. W. Pickard, W1XZ, at Seabrook, N. H. (127 miles, with XZ located on the beach within a stone's-throw of the sea) and as many as 13 consecutive QSO's with Boston area hams have been had after a single CQ.

In short, an ultra-high frequency directive antenna does things!

The response to Hull's article has been perfectly swell. We gain the impression, from telegrams, radiograms and letters, that directive antennas are sprouting like mushrooms over the whole countryside. The first new one heard at AL was W1ZO at Medford, Mass. With a 200-volt plate supply, ZO handed us an R9 signal if ever there was one.

Watch the coming issues of *QST* for further dope on directive systems and for reports of the experiences at other stations.

—EDITOR

front of the antenna along the line of transmission. The antenna has the merits of being very simple to construct and infinitely simpler to adjust than any system in which several antennas have to be

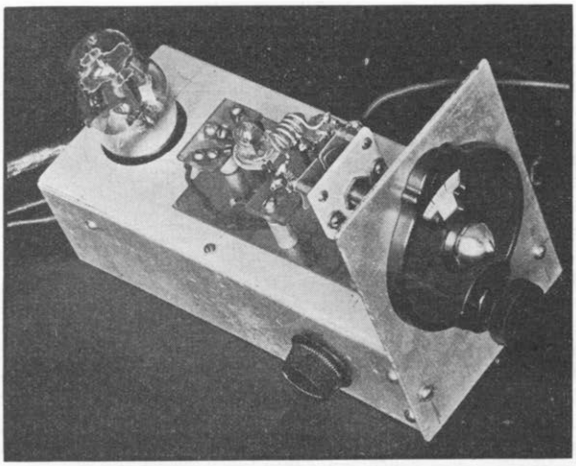

FIG. 4—THE LAST OF THREE 224-MC. BAND RECEIVERS

Though having the appearance of a permanent assembly, this receiver is nevertheless capable of easy modification. The detector equipment is mounted on its own small copper plate base and can be removed as a unit in quick time. The audio tube is "sunk-mounted" in order to conserve panel height

fed in phase or with some particular phase relationship. Fig. 1 gives full details of the antenna and the wooden frame upon which its elements were mounted. In the installation at W1AL this frame was in turn supported on a tripod arrangement made of 2″ x 1″ pieces. The wooden elements through which the antennas, directors, and reflectors were pushed, were well painted with hot paraffin.

TRANSMITTER

The transmitter used at AL employs the circuit given in Fig. 3. This is just about the simplest circuit one could imagine but, with a 304A or 800 tube, proved capable of delivering substantial power—enough, at least, to permit checking the operation of the antenna with a neon bulb. The input power was held down to about 40 watts (70 ma. at something under 600 volts). The transmitter was set on the desired frequency first by making a check with a Lecher wire system (to be described) and then by listening to the signal in a 56-mc. receiver. With the transmitter set on 130 centimeters, a harmonic of the 5-meter receiver provided a signal at approximately 57 mc. The Zepp feeders were then cut to approximately an odd number of quarter waves, hitched to the antenna of the Yagi system and tuned with the conventional series condensers at the station end. These condensers happened to be Cardwell neutralizing condensers. Any two or three-plate midgets would serve the purpose.

CHECKING FREQUENCY

Since some difficulties have been reported by ultra-high frequency enthusiasts using the Lecher wire arrangement for checking wavelength we will describe the actual layout used in our work. The wires themselves are of No. 18 bare copper wire strung two inches apart between stand-off insulators along an eight-foot length of board. One end of the wires remains free, the other ends being connected to a one-turn coupling coil located near the transmitter tank circuit. In operation, a sliding bridge—consisting of a piece of stiff bare wire on the end of a two-foot wooden dowel—is run slowly down the length of the wires until a point is reached where the oscillator plate current makes a sudden fluctuation. The point is marked. The bridge is then moved farther down the wires until a second node is located. This also is marked. The same procedure is then followed to locate a third node. At this stage, the distance between each pair of marks is measured. If the Lecher system is operating correctly and if it is mounted well clear of surrounding objects, the distances will all be the same and will represent quite accurately one half of the wavelength being measured. An alternative sliding bridge—useful when the oscillator has plenty of output—is a flashlamp bulb with wires soldered to its contacts. These wires are hooked over the wires of the Lecher system and the lamp

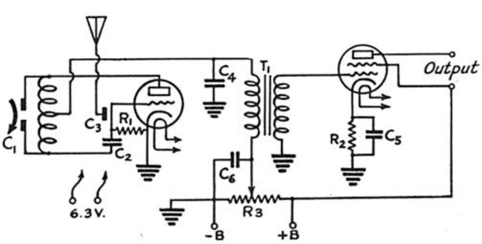

FIG. 5—CIRCUIT OF THE SIMPLE 224-MC. BAND RECEIVER

C_1—*Special split-stator tuning condenser (see text). Since the photographs were taken it has been found desirable to use two pairs of stator plates instead of one in order to give ample extra frequency coverage.*
C_2—*Very small grid condenser (see text).*
C_3—*Brass strip 3/16 inch wide mounted close to the exposed surface of C_2 (see Fig. 6).*
C_4—*.002 µfd. fixed condenser.*
C_5—*2 µfd. or more.*
C_6—*1 µfd.*
R_1—*1.5 megohm, half-watt resistor.*
R_2—*1200 ohm, one-watt resistor.*
R_3—*100,000 ohm potentiometer. Note that this resistor is across plate supply and that, if batteries are used, the supply should therefore be disconnected when switching off set.*

A 41 tube is used as the audio amplifier and allows speaker operation. A transformer or choke-condenser coupling unit must be used with this tube. For headphone work, a 37 audio tube would probably be more appropriate.

The coil is described in the text.

moved along until the various points are located at which the lamp lights brightest. The points will be extremely critical.

RECEIVERS

Three different receivers have been built for this experimental work during the last three days. The gadget illustrated in Figs. 4, 5 and 6 is No. 3 of the series. Its circuit arrangement, shown in Fig. 5, is the simplest of the lot. In operation, the set is just about as smooth as one could imagine. The first of our receivers was an elaborate affair in which the most profound precautions were taken in the layout of the detector circuit, in the provision of by-passing and in the fitting of some means of adjustment for almost everything in the circuit. Our experience with this receiver and with No. 2 of the series served to reveal many of the beautiful features of the new tube. We were afraid of it at first but we soon learned that, given half a chance, the tube will perform on, say, 130 centimeters, in just about the way one would expect a 37 to handle on 75 meters.

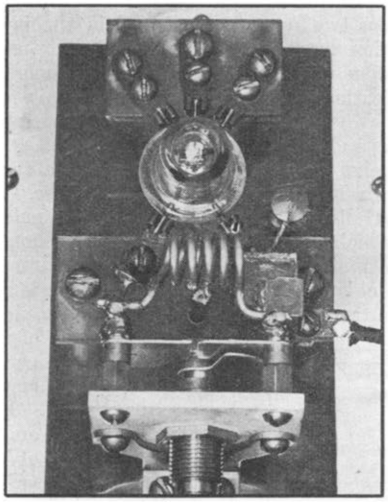

FIG. 6—THE "ACORN" DETECTOR TUBE AND ITS TUNING EQUIPMENT

The tuning condenser shown with two rotor plates and one pair of stator plates (a single stator plate split) has since been provided with another pair of stators to give ample tuning range on either side of the 224-mc. band. The grid condenser may be seen immediately to the right of the coil. The brass strip of the antenna coupling condenser can be seen apparently touching the right-hand coil connection.

The key unit in the new receiver is the detector assembly. It is built on a heavy copper plate, measuring two inches by four inches. The assembly includes the tube socket and the tuned circuit components and therefore constitutes a complete oscillator which could be fitted into almost any type of receiver or low-powered transmitter. In this particular instance, we attached the copper plate to the channel of a receiver chassis, hitched a pentode audio amplifier and—presto—acquired a complete super-regenerative receiver. The detector is, of course, of the self-quenching type. A separate interruption oscillator was used in the first two receivers but, for reasons yet to be discovered, it did not seem to justify its existence.

Since the most important part of the receiver is the input to the detector, we will discuss it in some detail. The tube socket is made from two strips of "Victron." These could be obtained from a sheet of the raw material or cut from a National Victron transposition insulator. Any other high-grade insulating material could, of course, be used. These two strips, fitted with the lugs that come with the tube, are supported slightly above the copper base in order to avoid the necessity for drilling the copper to accommodate the bottom of the tube. Our first receiver had a hole cut in the copper plate in the manner suggested in the instruction sheet for the 955. We deviated from that procedure in this case with the idea of avoiding structural complications. Since the smallest midget condenser did not appear to be satisfactory for the grid condenser C_2, we proceeded to build one from two pieces of brass, measuring ¾ by ⅜ inch. Each piece was folded in two and the pieces were then interleaved, the plates being kept apart by thin pieces of mica. The whole assembly was drenched with Duco cement and then squeezed in a vice. A lead was then soldered to each of the brass elements. Another item which had to be "homebrewed" was the tuning condenser. Believing that the normal midget condenser has an excessively large path between its terminals, we cooked up a special condenser shown clearly in Fig. 6. It consists of a three-plate Cardwell Trim-air midget with the one stator plate sawn down the middle. In this way a split stator condenser is obtained—one having an extremely low minimum capacity and a short path between one terminal and the other. It

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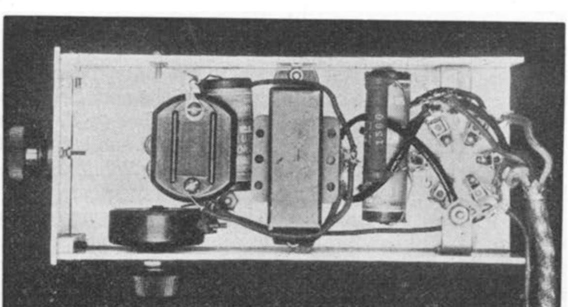

FIG. 7—UNDERNEATH THE 224-MC. BAND RECEIVER

All the gadgets not above the chassis channel can be spotted in this photograph. The location of the detector voltage control potentiometer is perhaps unconventional but certainly convenient in operation.

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is very important, with this type of condenser, to insulate the rotor from ground. The inductance, supported between the two lugs of the tuning condenser, consists of five turns of No. 18 wire, wound on an ordinary round pencil (about 5/16" diameter), the turns being spaced approximately the diameter of the wire. The tap is located on the third turn from the plate end of the coil.

The remaining features of the receiver are perfectly conventional and can be followed from the circuit and photographs. It might be mentioned that the channel on which the receiver is assembled measures 7½ inches by 3¼ inches by 2 inches deep. A Lecher system again could be used to check the frequency of the receiver and the check might well be followed by listening to the harmonic produced by small 5-meter transmitter or a 5-meter receiver oscillating but not super-regenerating. The harmonics so obtained will, of course, appear as dead spots in the 224-mc. receiver and in our case they were very well defined and permitted a splendid check of the calibration obtained with the Lecher system.

If a Lecher system has not been used to check the frequency of the receiver (or if the receiver has not been checked against a "Lecher-checked" transmitter) there is some danger of mistaking the third harmonic from a 56-mc. oscillator for the fourth. Any possible doubt can be cleared up by setting the "five-meter" oscillator on 60 mc., then finding what appears to be its fourth harmonic on the new receiver. If it really is the fourth harmonic, another harmonic (the fifth) will be obtained by tuning the "five-meter" oscillator to 48 mc. Since a suitable frequency meter may not be available for this test, we suggest dependence on the Lecher method.

The general procedure in tuning the transmitting antenna and in coupling the receiver to its antenna follow exactly along the lines observed in 56-mc. working.

The purpose of presenting this sketchy description of a transmitter and receiver for the new band is to provide some basis on which to start actual communication. Several stations in the New England area are all set to make new records on 224 mc. and we anticipate that activity on this band will soon be giving 56 mc. a tough run.

Plunk down your vest-pocket directive antennas, gang, and let's find out just how much fun we have been missing—it's plenty.

Strays

Poor quality from a velocity mike may be the result of using a mounting designed to "look pretty." These mikes should not be enclosed nor baffled under any circumstances, since the faithfulness of the response depends upon the free-