Making the Most of Directive Antennas

Practical Pointers on Operating a Number of Antennas in Limited Space

By Don C. Wallace,* W6AM

DIRECTIVE antennas have been used consistently at W6AM for a number of years. The present lay-out has been up for approximately three, and although other antennas are planned for the near future we shall confine the present description to those now in use. As to what can be done with them:

Often five continents will be worked on 'phone during the course of a single evening, sometimes in as short a period as two hours; all six continents were worked on three different nights during the 'phone portion of the last DX contest. Schedules have been maintained with CE1BC at Chañaral, Chile, for over a year without a miss, except for three times when he had to be absent for business reasons. Over a period of five months, weekly schedules were maintained with Manila on 20-meter 'phone without a break. Europe was worked on 'phone every night the station was in operation for a period of three weeks, and over a period of four months there were only three misses on any night Europe was called on 'phone. For two and one-half years schedules have been maintained with W2NB in New Jersey with never a complete miss during that time. These things are mentioned to show that with effective antennas 20-meter 'phone becomes more than a hit-or-miss skip proposition but takes on the characteristics of a consistent communication circuit—and we are all interested in two-way communication.

The beam antennas are universally used for reception as well as for transmission; to do this a changeover relay transfers the antenna in use (the various antennas are selected by manual switches) from the transmitter to the receiver. This gives an equivalent power gain on the other fellow in receiving and eliminates the necessity for requesting checks on various antennas when the direction of the station contacted is doubtful. It is surprising how accurate the operator can become in determining just where a station is long before it signs off. A quick trial of the various antennas soon indicates the direction, and the characteristics and frequency of the station usually will furnish the balance of the data necessary. On an average, the direction from which the station comes and its approximate location can be guessed nine out of ten times and often as high as nineteen out of twenty times. This is always interesting to visitors at the station.

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14-MC. ANTENNAS

The 20-meter 'phone antennas number five. Four of these come off one pole like the spokes of a wheel and the fifth originates at another pole. Two poles only are used for the entire seven antennas (two are on 7 Mc.). Trees, swings and any other convenient points of attachment are used for the far ends of the arrays.

The first honest-to-goodness 20-meter beam was designed by W2NB when he was visiting here and it was put up so that W2NB and W6AM could have a weekly schedule at some time convenient to both of us. The antenna is an adaptation of the Sterba curtain, mounted horizontally to get the benefit of horizontal polarization in reducing local-noise pickup. It consists basically of eight half-waves in two tiers of four each. The radiating elements are all 95% of a half wave in space [1] and the feed-line portions are all an actual half-wave long. The total impedance at the feed point appears to be something like the total of all of the half-wave sections; that is, considering each half-wave section as having a resistance of seventy-two ohms, the termination at the end is something like 8 times 72, or 576 ohms. It happens that No. 14 wire spaced four inches (a standard spreader length) has a computed impedance of 576 ohms, which to all intents and purposes is a natural match and makes matching transformers unnecessary.

If the feed lines are properly terminated it will be found that there is little if any inter-action between the various antennas. Once in a while a little inter-action creeps in, which is not surprising since four are attached to one pole and at the other end of the lot there are three more. This means a lot of antennas in a small space, some of them crossing over others. In addition, the feed lines converge to one spot and for the most part go through the same window.

In order to check the results obtained by using different types of feed lines, a line of approximately 800 ohms was used on the same antenna with noticeably poorer results.

THE COMPLETE ANTENNA SYSTEM

Using this antenna as a basis, the construction of other antennas followed whenever an opportunity offered. They are all bi-directional, and we have gradually come to entitle them:

14 Mc.:

1. New York, Australia

[1] I.e., length in feet = 468/freq. (Mc.).

2. London, New Zealand
3. South Africa, Cuba, Hawaii, South Africa
4. Alaska, Seattle
5. Buenos Aires, Chile—Japan, China, Manila

7 Mc.:

1. Manila, Orient—Mexico, South America
2. New York, Chicago—Australia

In addition, the forty-meter Manila antenna (two half-waves in phase) is used as a half-wave antenna on eighty meters. For ten-meter operation, a vertical antenna consisting of two half-waves in phase is used. And on top of one of the 90-foot telephone poles (there are two on the lot) is a Johnson Q antenna used for five-meter work. This makes nine antennas in use, all of which have their lead-ins brought directly into the station. Sometimes two or three antennas are used at once, although this procedure usually pulls energy out of the direction desired so it is not done except on rare occasions.

Each 14-Mc. antenna covers at its best point a region varying from 3½ to 5 degrees either side of the direction toward which it is pointed. This gives a strong ten-degree beam in two directions. Each antenna is approximately thirty degrees from the next adjacent one, so in between is an area of reduced utility, although these areas are given a signal about equivalent to that from an ordinary half-wave antenna. Having ten directions at one's disposal, however, is productive of some interesting operation, as can well be imagined. Since putting up the complete layout there has only been a single 1½-hour period when the twenty-meter band was not good for DX—by which we mean something three thousand miles or over.

All of the antennas are not of the type described above; the drawings show seven in use.

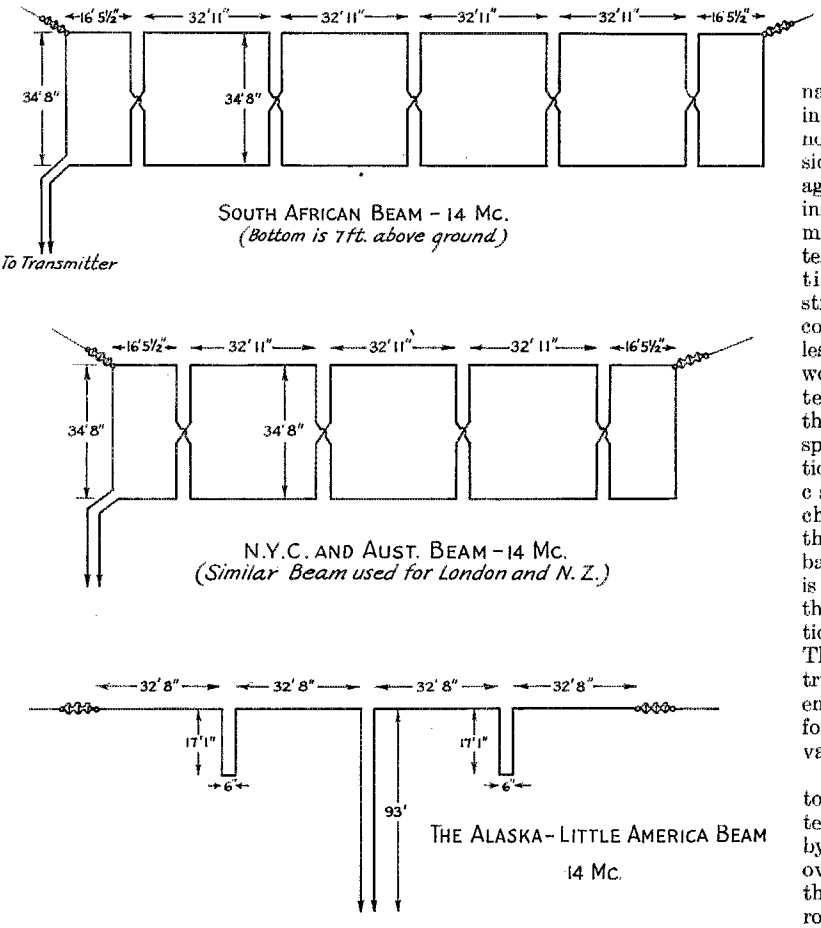


FIG. 1—THREE DIRECTIVE ANTENNA ARRANGEMENTS USED FOR 14-MC. WORK AT W6AM

All consist of phased elements, the line of maximum propagation being broadside to the line of the antenna.

REDUCING INTERFERENCE

Directive antennas have several interesting features not ordinarily considered by the average amateur. For instance, QRM is minimized. With ten separate directions available, strong QRM becomes considerably less than what it would be on one antenna. Although the antennas respond in two directions, usually, because of the characteristics of the twenty-meter band, one direction is skipping out while the opposite direction is at its best. This is not always true, but it is true enough of the time for us to take advantage of it.

It is far quicker to switch from antenna to antenna by means of switches over the receiver than it would be to rotate an antenna, consequently more stations can be spotted and called.

All stations naturally cannot be in the strongest part of the beam, but even at an angle of about fifteen degrees from the optimum direction the signal strength is comparable to that obtained with a half-wave antenna—and beyond that there is another antenna to switch in. Sometimes two antennas are used simultaneously when the desired station lies midway between the two, or one of the two will be chosen because of excessive QRM on the other. For instance, in working stations in South Carolina or Florida (one of the directions not optimum at W6AM), it is much more satisfactory to use the Cuban antenna for, although this antenna does not deliver a stronger signal to this area than does the New York antenna, it has relatively smaller QRM in reception. The New York line from Long Beach goes through such cities as Denver, Kansas City and Chicago, taking in about seventy percent of the population of the United States—and likewise probably 70% of the amateur stations. This is a busy region, and QRM conditions are almost as bad on that antenna as on a half wave.

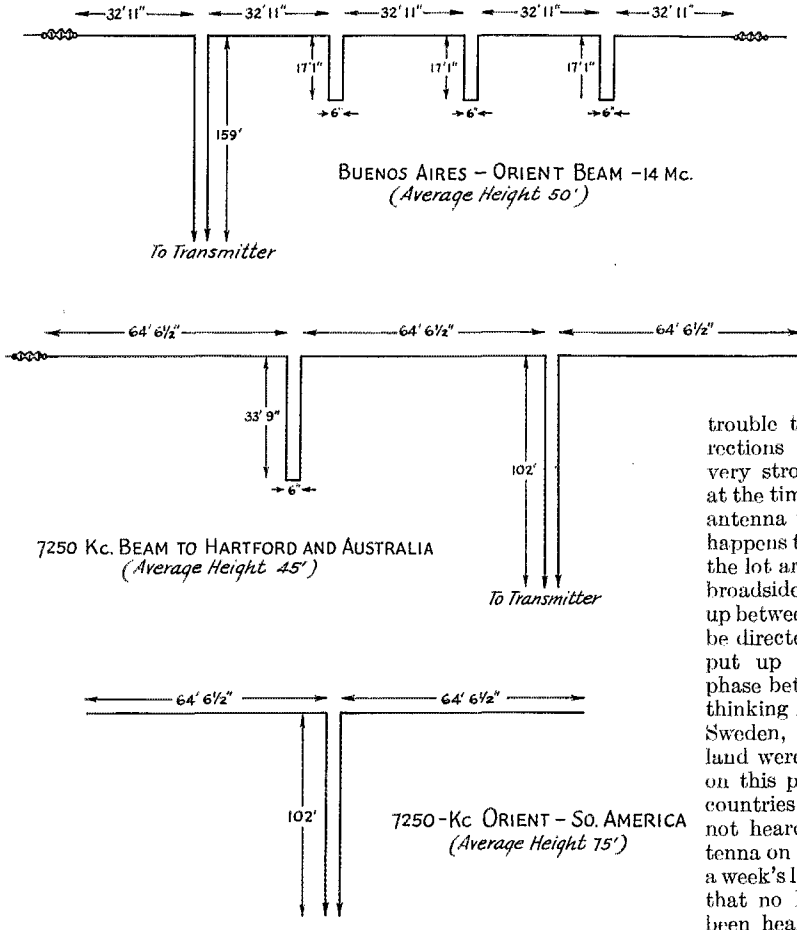


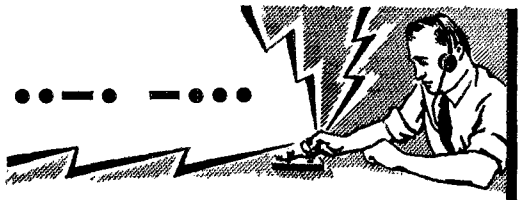
FIG. 2—14- AND 7-MC. ANTENNAS

The antenna in the lower drawing is also used for 3.5-Mc. work as a center-fed half wave.

GETTING DIRECTIONS RIGHT

Many amateurs who have put up directive antennas try them out and say, disgustedly, "Oh, it doesn't work as well as my old antenna." In every case that I have personally run down I have found that the particular amateur did not know the real direction in which the antenna was pointed. He laid it out by guess and by gosh, and simply had not gone to the trouble to determine his directions exactly. This was very strongly brought home at the time the first European antenna was put up here. It happens that the two poles on the lot are so placed that if a broadside antenna is strung up between them it appears to be directed toward Europe. I put up four half-waves in phase between the two poles, thinking I would get Europe. Sweden, Denmark and Finland were very easy to work on this particular antenna—countries that ordinarily were not heard on any other antenna on the place—but after a week's listening it was found that no London signals had been heard, nor any French nor German. A correction was made by running a long guy wire from the pole over to a tree so that one end of the antenna could be swung around approximately seven degrees, upon which it was found that London amateurs were plentiful, as well as French, German, and even some Italians and Swiss. However, since the antenna has been moved out no more Swedish or Danish stations have been heard. A seven-degree correction changed the European situation entirely. The present set-up is used because there are many more twenty-meter 'phones in the London area than in any other part of Europe.

(*Continued on page 106*)



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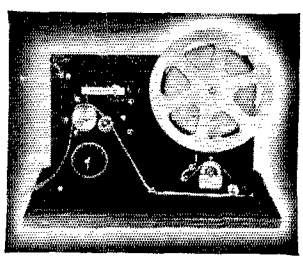

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Making the Most of Directive Antennas

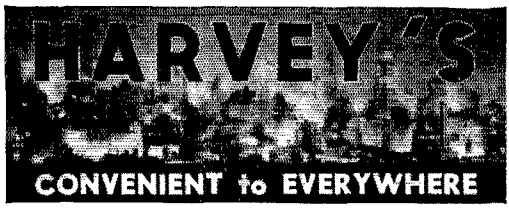
(Continued from page 37)

When first putting up these antennas the lot plot was used to determine true north; without correction, a compass is practically valueless.[2] With this as a basis, and using long straight sticks and protractors laid on the ground, the original antennas were put up. Although they were working satisfactorily, after about a year a registered civil engineer was employed to locate the poles with respect to true north and also to locate the trees, swing and other places where the antennas were fastened. A sight on the sun was also taken so that an exact base line could be established on the side of the lot. When the work was finished it was discovered that the New York antenna was 1½ degrees out of line. Originally intended to hit two degrees north of New York so it would also be effective in southern New England, it was actually 3½ degrees north of New York, so that the 5-degree part of the beam cut out some of the twenty-meter 'phones in the greater New York area. They simply were not as good as they were when the antenna was corrected for this degree and a half. Ever since it has functioned exactly as planned, and the survey was well worth while.

CROSSTALK

There are nine feed lines coming into the radio rooms—eighteen wires in all—accordingly there would be some coupling into the wrong antenna if certain precautions were not taken. These precau-

[2] Alternatively, a bearing may be taken on the Pole Star, or from the sun at noon as described elsewhere in this issue.



TAYLOR T-20, T-55

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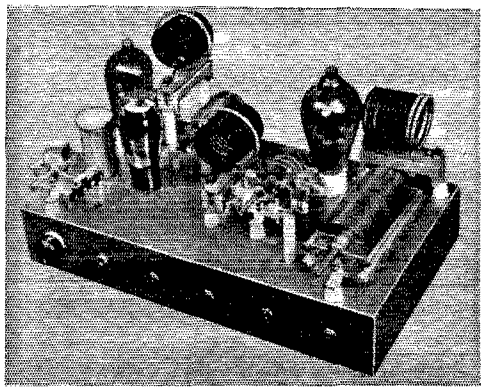

We furnish CARDWELL condensers, NATIONAL coil forms and sockets, UTC transformers, IRC insulated resistors, SANGAMO and CORNELL-DUBILIER condensers, a drilled and punched black crackle chassis (so that all the hard work is finished, and all that remains is a few hours of simple wiring.)

We also furnish a complete kit of coil forms and wire, exactly as shown on page 23 of the June, 1937, issue of QST. The power supply for the T-55 stage is made to deliver as high as 1300 volts at 300 ma. This allows for the addition of another T-55 at some future time. The power supply has a tapped arrangement for 850 volts, 1060 volts or 1300 volts. The smaller supply will deliver 500 volts at 200 ma.

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tions were lightly touched in the first part of this article and consist mainly of lengthening or shortening the feed line going to an antenna which continues to function when not connected. It is easy to tell whether an antenna is working or not because signals from that direction come in on the receiver, even though the antenna is not connected. In other words, if when listening on the New York antenna unduly strong signals are heard from Cuba, the length of the feed line going to the Cuban antenna is altered until the antenna resumes its normal oblivion. The slight inter-action which no doubt exists is just enough so that when listening on one antenna the most prominent amateurs in the other directions can be heard.

We pointed out above that eighteen wires come in, and this naturally brings up the question of what to do about lightning protection. A gap from each feed line to ground is placed at the window entrance. When lightning comes along the energy is drained through the gaps to ground and the antenna system acts as a lightning arrestor for the entire neighborhood. In an open field within two miles of the house a man was killed last year while hoeing in his garden, yet during a lightning storm W6AM keeps right on operating and the little gaps jump and look like a Christmas tree in the window. If it were necessary to throw eighteen lightning switches I am afraid the lightning would hit before we could get around to finishing the job.

The little gaps can be set up pretty close—about a sixteenth of an inch—since the feed lines have very little voltage on them at 600 ohms impedance. The ground wires are large—larger than the antenna lead-ins themselves.

We sincerely hope that this little story will encourage other amateurs to put up as many directive antennas as they possibly can. The single-wire feed-line type should not be used because of inter-action between antennas, but aside from this precaution we have come to the conclusion that just about as many antennas as a fellow cares to use can be put up on one lot. Several years ago there were fourteen originating from this one station. They were spread out a little more in those days, but made a very satisfactory array.

The more directive antennas that are put up the greater the enjoyment of amateur radio, the more reliable the communication and the less interference caused to stations not in the line of transmission. This means that the amateur with beam antennas is trying to be just as courteous as possible, for in addition to using only one frequency, he uses just the particular slice of air in which he is most interested at the moment.

Strays

We neglected to mention, in the story on page 45 of the September issue, that the 888 is an RCA tube. No doubt most readers guessed it from the number. Incidentally, the now-released operating data rate the tube at 550 watts output at 200 megacycles.