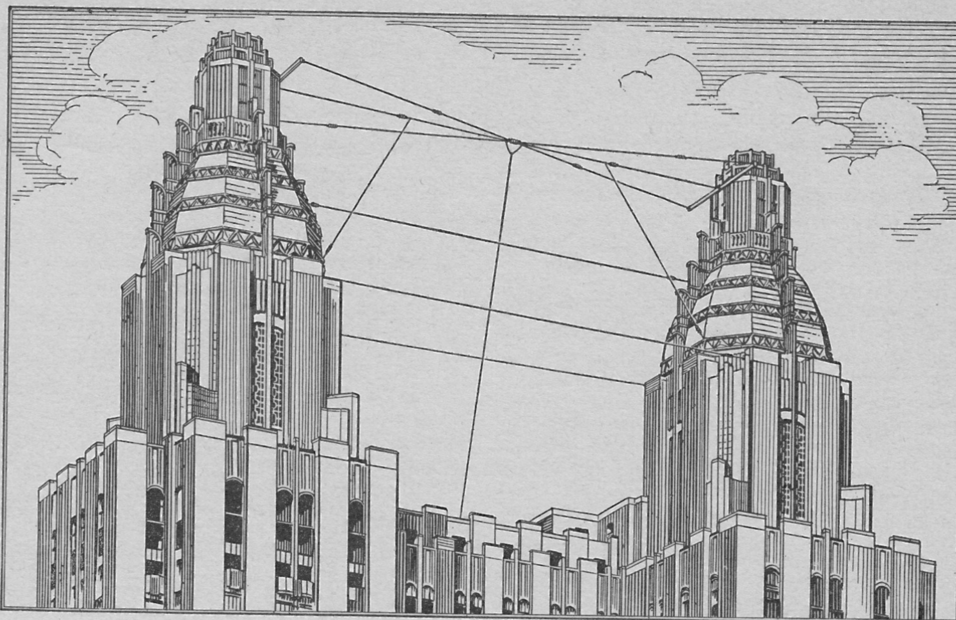
Short Wave Programs for Waldorf Guests



By H. T. BUDENBOM

Member of Technical Staff, Bell Telephone Labs.

SINCE its opening some four years ago, the new Waldorf-Astoria Hotel has provided radio broadcast programs for its guests in over two thousand rooms. A horizontal antenna, suspended between towers forty-seven stories above the street, is connected to high-quality Western Electric receivers on the sixth floor, from which point the programs are distributed over a building-wide network developed by the Laboratories. Since the Waldorf enjoys an international reputation, and attracts many foreign guests, the management felt it would be desirable to make available to them radio programs broadcast on short waves from their own countries, in addition to our local broadcasts. Moreover, the increasing general interest in short-wave reception would make the availability of short-wave programs an attractive feature for American patrons. To receive such programs the Waldorf has now installed a Western Electric short-wave receiver which can be connected to any of the circuits of the present distributing system.

Most of the short-wave programs are broadcast at frequencies from 6 to 25 megacycles, corresponding to wave lengths from fifty down to twelve meters, and it was decided that the Western Electric 13A Radio Receiver would provide the best quality of signal and most general satisfaction over this range. This receiver was designed for various applications in the short-wave field, including aviation, point-to-point, and ship-to-shore. It was first applied to the Caribbean radio telephone project, as already described in our September, 1933 issue, but has since been widely used both at home and abroad. As shown in Figure 1, all the apparatus is housed in a seven-foot cabinet about twenty inches wide. The cabinet itself forms the back, sides, and top for a number of units, each of which has its own function and carries its own front panel. The scope of the receiver may be broadened, after purchase, by the addition of other units as desired.

Units available are three radio-frequency amplifiers, each with a different frequency range, an intermediate frequency amplifier, and an audio-frequency amplifier and power supply unit, as well as antenna tuning units, a patching panel, and an oscillator panel, which allows the set to be used for receiving telegraph signals. There is also available a panel, used chiefly for point-to point communication, which may be employed to disable the receiver either when no carrier is being received or when the transmitter associated with the receiver is on the air. Of these various panels available, the installation at the Waldorf includes only the audio and intermediate-frequency amplifiers and the three radio-frequency amplifiers, which are sufficient for broadcast reception over the frequency range from 2.2 to 25 megacycles. Such an arrangement will permit them to receive not only all the short-wave broadcasts, but many police, aviation, and amateur radio-telephone channels as well.

The use of three separate radio-frequency amplifiers makes it much easier to tune in on a given station promptly. Depending on the time of day, a broadcast station may employ any of several frequencies. If it were desired to get a station which used either 6, 9, or 15 megacycles, for example, one amplifier could be tuned to 6 megacycles, one to 9,

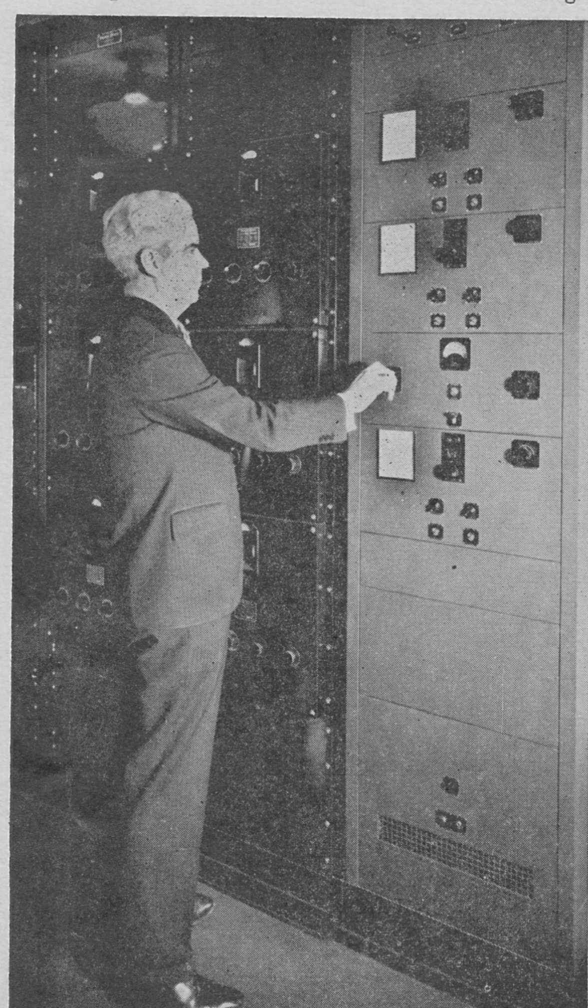


Fig. 1—H. R. Martin, Superintendent of Communication at the Waldorf, tunes the short-wave receiving unit

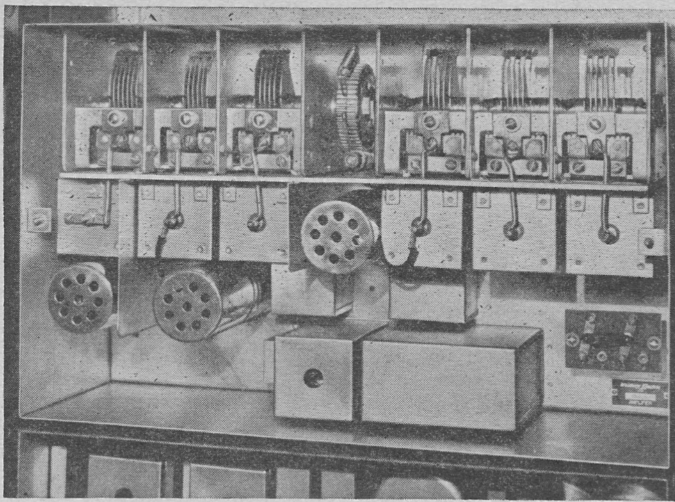


Fig. 2—The radio-frequency amplifiers incorporate accurate gang tuning through a worm drive with a double scale dial

and one to 15, and all three would be connected to the intermediate-frequency amplifier. If the station were on the air it would be immediately heard, and the two unnecessary amplifiers turned off. If it had not yet come on the air the operator would hear it the moment it did and would not lose the station announcement by having to tune successively to several frequencies.

The 13A Receiver is completely a-c. operated: the necessary transformers, rectifiers, and filters being incorporated in the voice-frequency amplifier unit. The signal gathered by the antenna first enters one of the radio-frequency amplifiers where it is amplified, passed through a series of selective circuits, and is then beat down to a frequency of 385 kc.—the frequency of the intermediate amplifier.* Here undesired frequencies are filtered out by sharply tuned circuits, further amplification is obtained, and the signal is detected. The resulting audio-frequency signal, which covers the band from 40 to 5000 cycles, is then further amplified in a suitable audio amplifier before distribution over the Waldorf system.

Outstanding features of this receiver are the high degree of selectivity, an electrical and mechanical design that insures dependable operation as well as high quality reception, and a sensitivity that permits good reception on signals as low as one microvolt. In the radio-frequency amplifiers there are five tuned circuits ahead of the modulator. These, together with the beating oscillator, are tuned by a six-gang condenser operated through a carefully constructed worm drive, shown in Figure 2, which gives very accurate selection. Frequencies separated less than one-tenth of one per cent may be readily tuned in. In the intermediate-frequency amplifier, Figure 5, there are eight additional tuned circuits. In this amplifier there is also a band-changing switch which, in the event of bad noise conditions, can be used to decrease the width of the audible frequency band and thus reduce the interference. Automatic gain control is provided, which is particularly important for short-wave reception, where the variation in signal strength with time may be considerable.

No matter how efficient a radio receiver may be, it must depend on the antenna to extract the maximum amount of energy from the arriving signal with the least amount of noise. Considerable attention was therefore given to the design of an antenna that would best secure these results, and at the same time would not mar the appearance of the building with tall ungainly structures. The multiple-doublet arrangement provided serves admirably to receive signals over a wide range of frequency and direction of arrival with a maximum of noise elimination.

When a horizontal wire is exposed to a high-frequency electro-magnetic field, it acts somewhat as a tuned circuit, and a current-measuring device placed at the mid-point would show maximum current when the length of the wire was approximately half the length of the radio wave. Such a wire differs in action from a tuned circuit, however, in responding not only to the fundamental frequency but to all odd multiples of this frequency. Thus a wire equal in extent to a half wave-length of a 3000 kilocycle signal, or 50 meters, would respond to frequencies of 3,000, 9,000, 15,000, and 21,000 kilocycles, and so on. If such a wire is broken at its mid-point and a tuned circuit or a transmission line leading to a tuned circuit is inserted, the resulting arrangement is known as a doublet. After the introduction of this associated circuit the tuning of the wire is only moderately sharp, and as a result it responds fairly well over a frequency range extending perhaps 20 per cent above and below the various frequencies corresponding to the length of the wire. By using several of these doublets, therefore, it is possible to secure good reception over a wide range of frequencies.

In the Waldorf installation, three such doublets are employed, having ap-

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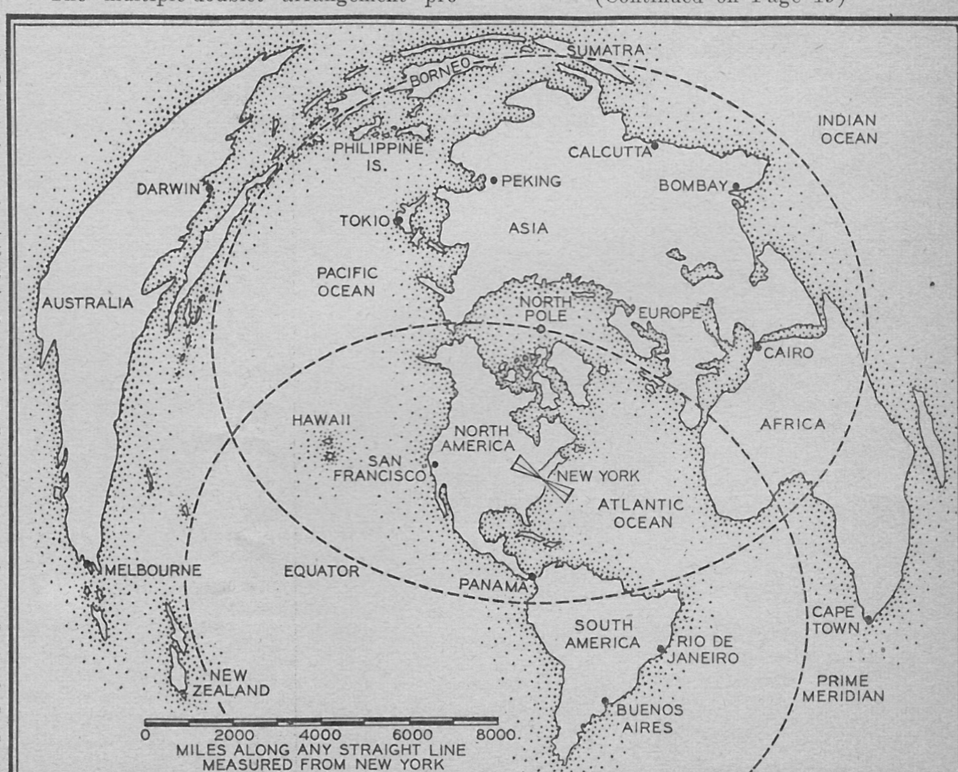
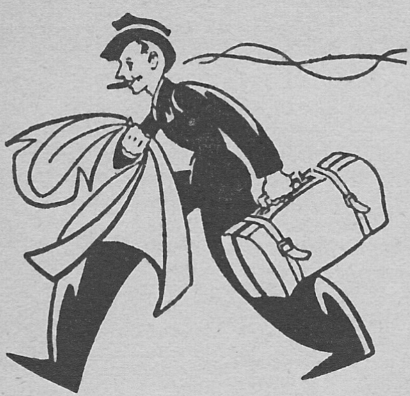


Fig. 4—A great-circle chart of the world centered at New York. The paths of radio waves coming to New York are straight lines on this chart.

*Suppressor grid modulation is employed.

ASSIGNMENTS



Radio officers assigned Mackay Radio, New York:

Yorba Linda—T. J. Burns
Shawnee—P. B. Kimball (Jr.)
San Jacinto—E. H. Cole (Chief)
Black Osprey—R. C Horscroft
Manhattan—F. W. Kent (4th)
Manhattan—W. E. Smith (5th)
Thos. P. Beal—J. J. Bamberg
Sage Brush—A. Adamson
Cherokee—T. J Cain (Jr.)
W. R Keever—C. R. Hamilton
Scanpenn—H. Weinstein (Chief)
Edouard Jeramec—H. McGoldrick (Ch.)
Edouard Jeramec—M. Gardiner (2nd)
Edouard Jeramec—R. C. Williams (3rd)
City of Fairbury—W. R. Weber
Shawnee—A. Sopko (Jr.)

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proximate lengths of 12.5, 25, and 50 meters, arranged as shown in the illustration at the head of this article. This arrangement permits reception of all frequencies from 2200 to 25,000 kilocycles except for a slightly lower response over the narrow range 3600 to 4800 kilocycles. This low frequency range is extended and re-enforced, however, by using the vertical lead-in wire from the horizontal doublets as a vertical antenna. Such an arrangement, with the lower end of the vertical antenna connected to ground through the coupling transformer, acts as a vertical doublet with its lower half buried in the ground, and responds to odd multiples of wave-lengths of four times its length. By suitable ''loading'' the effective length of this vertical section may be considerably modified and, as arranged at the Waldorf, the vertical section of about 100 feet which is ''loaded'' by the doublets responds to frequencies of 800, 2400, 4000, 5600 kilocycles, etc. By design, however, the response of this vertical section to frequencies above 6000 kilocycles is progressively nullified in the special coupling transformer to the radio-receiver transmission line.

The manner of covering the wide frequency range by these horizontal doublets and the vertical half doublet is indicated in Figure 3. Here the odd-multiple response frequencies of the various antennas are indicated by the vertical lines, while the horizontal lines indicate the frequency range brought in, allowing a 20 per cent spread on each side of the multiple frequencies. The vertical lead-in consists of two wires twisted together—one wire being connected to each half of the horizontal doublets. The current from the horizontal antennas comes down one of these wires and up the other, thus traversing the vertical section in both directions. The current induced in the vertical section, however, travels in the same direction in both conductors. The special transformer at the foot of the vertical lead allows both of these currents to be fed to the radio apparatus, but shuts off the higher frequencies from the vertical part of the antenna.

Most transmitting antennas are effectively vertical rods, and the waves they emit are vertically polarized—providing the greatest effects on vertical receiving antennas. In traveling great distances, however, these waves undergo a series of reflections between the earth and the ionized regions of the upper atmosphere. By this multiple reflection their vertical polarization is changed to an elliptical polarization, with the result that they may produce even greater effects on a horizontal antenna than on a vertical one. For this reason the horizontal structure used at the Waldorf is very sensitive to waves coming from remote points, where because of the great distances involved the greatest sensitivity in reception is required. This form of antenna will also minimize interference by nearby stations, the waves of which are vertically polarized. It happens, moreover, that the waves from most man-made sources of interference affect a horizontal doublet much less than a vertical antenna. Most of this form of interference is at the higher frequencies and thus does not prove objectionable over the range from 2000 to 6000 kilocycles where the vertical section of the antenna becomes effective. Stations operating at these lower frequencies are for the most part local, representing mainly police, aviation, and amateur radio telephone channels. These waves retain sufficient of the vertically polarized component to be readily picked up by the vertical antenna.

Fig. 5—In the intermediate-frequency amplifier, shown undergoing inspection by F. Stevens, Radio Technician of the Waldorf, the power of the signal is increased a hundred thousand million fold

This multiple-antenna system is thus highly suited to picking up high-frequency signals coming from great distances and lower frequency signals from nearby stations, both with a large signal-to-noise ratio compared to vertical receiving antennas. The effectiveness of the antenna is further enhanced, however, by taking advantage of the directional characteristics of a horizontal doublet. Greatest sensitivity is obtained for waves arriving in a direction at right angles to the doublet. In Figure 4 is a map of the world in gnomonic projection centered at New York. The distinguishing feature of such a scheme of projection is that a line joining New York and any part of the world lies in the true direction over which radio waves would travel. The horizontal antenna system of the Waldorf—considerably enlarged in scale—is superimposed on this map at New York, and it is at once evident that waves from most of the international broadcast stations would reach the antenna from a favorable direction. The end-on directions of the antenna are toward the South Atlantic and North Pacific oceans where there are practically no stations, but even end-on, the antennas have some response because the short-wave signals arrive at a slight angle above the horizontal.

With these facilities the Waldorf is now in a position to offer its patrons short-wave radio broadcast programs of a high order of merit. Short-wave stations in London and Daventry, England, in Paris, France, in Madrid, Spain, in Koenigswusterhausen, Berlin, Germany, at Rome and in the Vatican, can be as readily heard as local broadcast stations under favorable conditions. Even the short-wave stations in remote locations such as Moscow, Tokyo, Rabat in Morocco, Melbourne in Australia, and the various South American stations will at times be available for instruction and amusement.