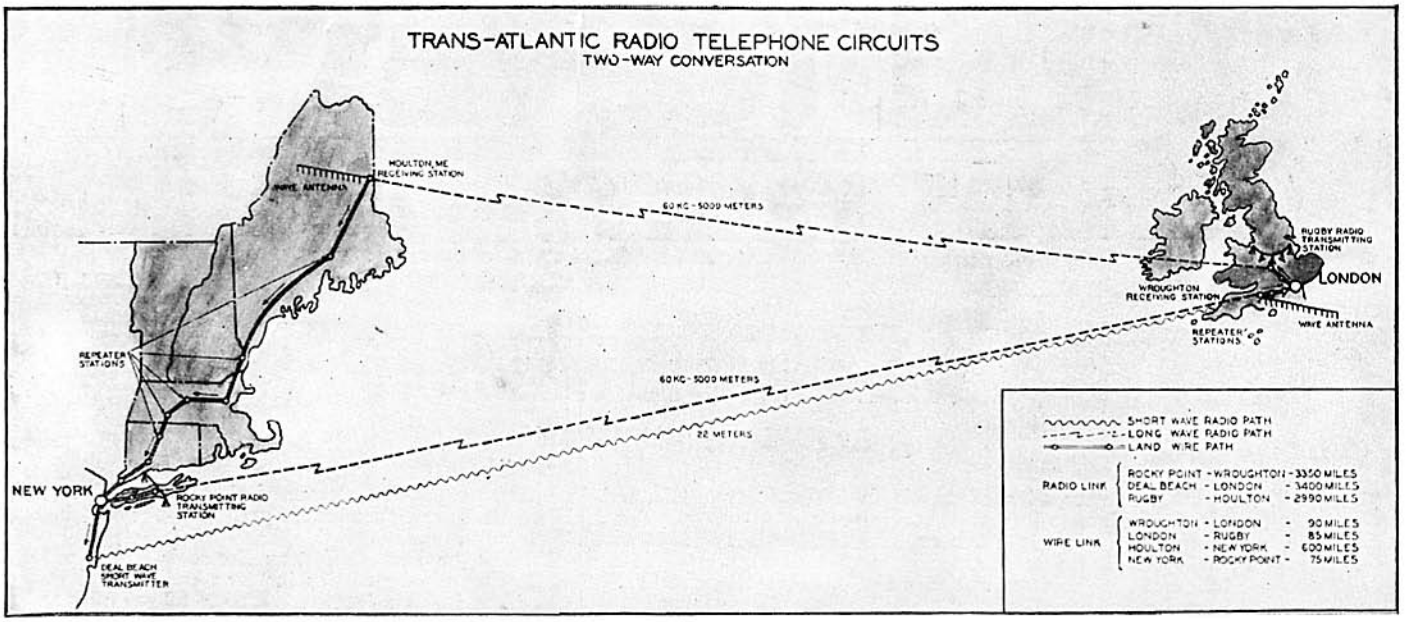


Transoceanic radiotelephony follows the paths indicated in the map. The distances between the points are given in the accompanying table.

"Hello, London!" "Are You There, New York?"

Describing the Transatlantic Radiotelephone System and Apparatus

By G. C. B. ROWE

ON Friday, the seventh of January, 1927, in New York and London, simultaneously, the first commercial transatlantic radiotelephone service was made available to the public. At 8:30 a. m., President Walter Gifford, of the American Telephone and Telegraph Co., spoke the words, "Hello, London!" into a telephone transmitter in the offices of the company on lower Broadway, New York. Almost instantaneously came back the reply of Sir Evelyn P. Murray, the secretary of the British post office. From then until late in the afternoon, messages of all kinds were flashing back and forth between the two greatest cities of the world.

Apparently the toll of $25 a minute was low enough, for the operators at both ends of the line were besieged with applications for connections; and in order to accommodate even the major portion of the calls, it was necessary to extend the time of communication beyond the intended closing hour of 1:30 A. M., New York time.

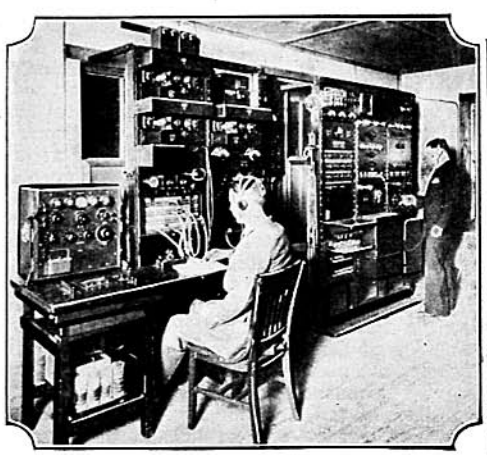
IN the December, 1925, issue of RADIO NEWS, there appeared an article entitled, "Transatlantic Radio Telephony," and under the title were these words, "Transatlantic telephony by radio will probably be opened to the public within the next twelvemonth, if present plans do not go awry." These plans have not gone awry; and today it is possible for a man to put in a call from his desk in New York City and, within a relatively few minutes, talk with someone in London by Radio.

Radio has made another giant stride forward and it does not seem unreasonable to predict that, within a short time, we shall be able to talk from any point in the United States to any point in western Europe, utilizing, of course, the radiotelephone, with practically no changes from the form in which it is used today. —EDITOR.

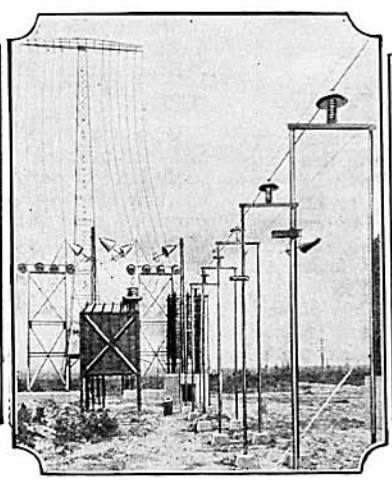
SINGLE-SIDE-BAND TRANSMISSION

The principle of the system of radiotelephony employed in the transatlantic service is that described in the December, 1925, issue of RADIO NEWS, and differs considerably from that employed in ordinary broadcast transmission and reception. The latter is effected through the medium of a "carrier wave," the modulation of which creates two attendant "side-bands." This is common knowledge to most radio fans. In order to conserve power, and for other reasons which will be explained, the transatlantic service employs but *one* side-band; the other, as well as the carrier wave itself, being suppressed by a suitable system of filters.

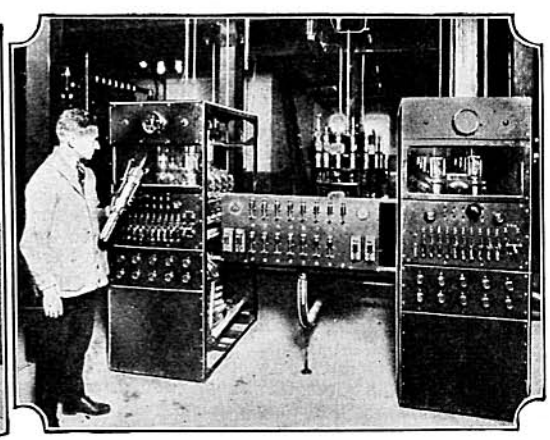
An important factor in the transatlantic transmission is the use of the piezo-electric crystal, such as governs standard-frequency broadcasts. This keeps the oscillator of the transmitter exactly on its fundamental wavelength, a most desirable precaution where speech is so costly; for even a slight variation in the frequency would make the speaker difficult to understand at the receiving end.



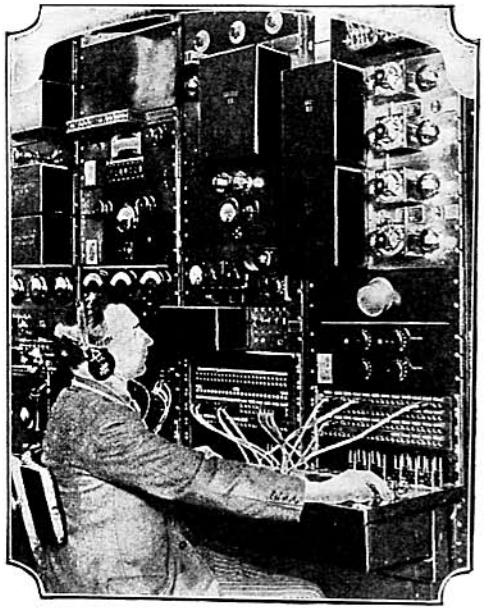
The radio receiving station at Houlton, Maine, which is connected by land-line with the New York exchange.
© *International Newsreel.*



A part of the 7250-foot antenna at Rocky Point, L. I., where the telephone messages are put "on the air."
© *International Newsreel.*

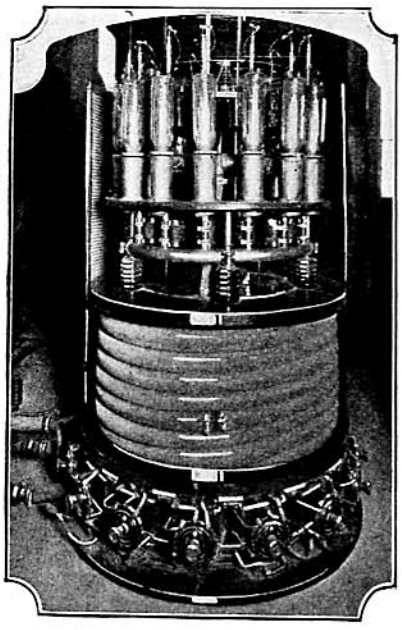


A few of the giant vacuum tubes, used in transmitting telephone messages from New York to London, seen in the amplifiers at Rocky Point.
© *Wide World.*



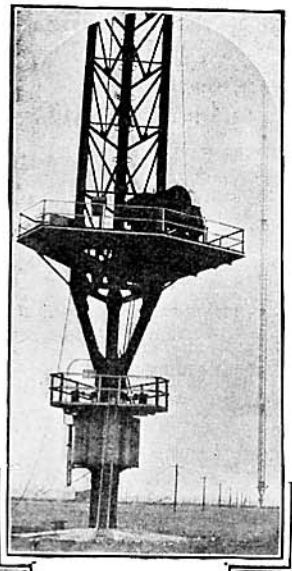
At the left is the English end of the trans-Atlantic telephone system. The operator is seated before the control panel with the various lines going to the London exchanges. At the right is shown a circular bank of fifteen 10-K.W. water-cooled vacuum tubes used in the final stage of amplification.

© *Wide World.*



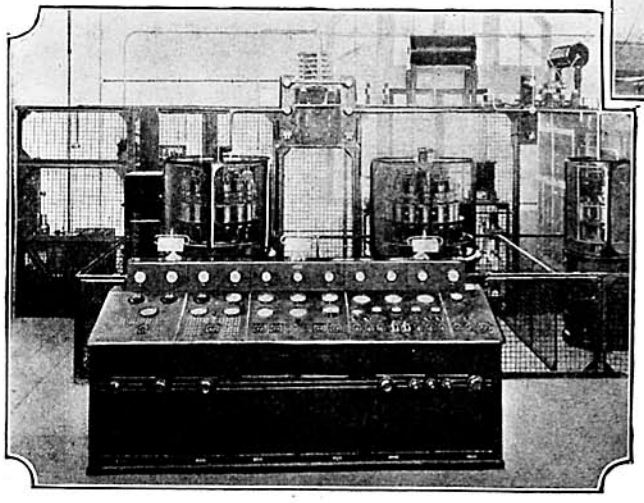
Below is the final stage of the high-power amplifier at the Rugby station. In the background are the banks of the 10-kw. tubes and in the foreground the instrument and signal panel.

Photo courtesy of Amer. Tel. & Tel. Co.



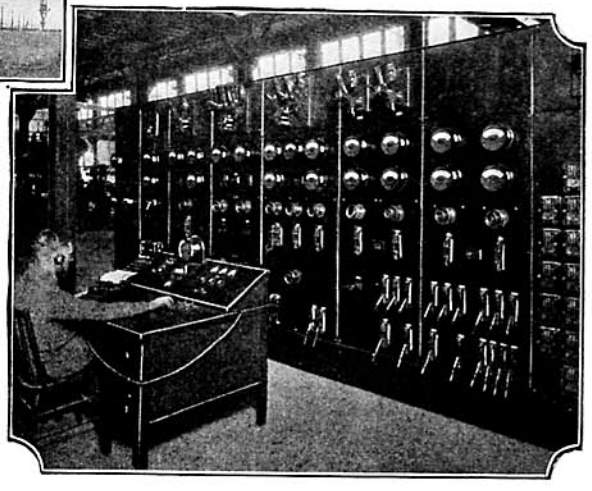
Below is the main power panel at Rocky Point for all circuits except the high-voltage. About fifty signal lights at the operator's left indicate failure in any of the circuits.

Photo by courtesy of Amer. Tel. & Tel. Co.



Above is part of the antenna system at Rugby, England. These masts are 820 feet in height.

© *Herbert Photos, Inc.*



NEW YORK SPEAKING

Let us trace the progress of a call from a telephone subscriber in New York to an Englishman with whom he desires to speak. The former calls the long-distance operator in New York and informs her that he wishes to speak with Mr. Londoner at Mayfair 4321. "Long Distance" communicates with the transatlantic operator, at the American *transmitting* station, Rocky Point, seventy-five miles out on Long Island. This operator, who must be a man skilled in technical radiotelephony and telegraphy, operates a buzzer working on 1,500 cycles, and places with the corresponding operator at Wroughton, in England, a call which is automatically registered on a tape, thus obviating mistakes in the understanding of numbers and names.

The Wroughton operator, who is at the English *receiving* station, then communicates through the trunk-wire (English long-distance) operator the call for Mayfair 4321 in London. When the necessary connection to the Englishman's phone has been completed, the London operator informs the New York operator (by voice) that all is ready, and the connection is made to the phone where the New Yorker is awaiting his call.

These operations will normally take but a few minutes, and the telephone subscribers can communicate with each other as readily as in the ordinary long-distance conversation over land-lines. At the conclusion of the call the replacement of the receivers on their hooks indicates, by the customary flashing of lights, to the station operators that the exchanges have been disconnected automatically from the radio station, and that another call may be put through.

All this sounds more or less easy and expeditious; but in order to make it so and span the Atlantic Ocean with the human voice, it has been necessary to design and construct stations and apparatus costing $5,000,000. All of this equipment is in use for a single conversation, as no "duplexing" methods are yet in use.

STEPPING UP THE SPEECH CURRENTS

Let us first consider the amplifiers. From the time the American subscriber speaks into the transmitter of his telephone in New York, until the signal has reached the Rocky Point station, the signals are carried at the ordinary low telephone voltage, as they would be to Philadelphia, for instance. At the transmitting station, however, the audio-frequency currents produced by the voice are led into a speech amplifier, and used to modify a carrier wave of 30 kilocycles (30,000 cycles = 10,000-meter wavelength).

Now, in order to make more clear the explanation of the method of eliminating the carrier wave and one side band, it may be noted that the ordinary frequencies used in sound reproduction over the telephone range from 200 to 5,000 cycles. It is not necessary to take into consideration the higher and the lower frequencies required to give an exact reproduction of some musical instruments. For the sake of clearness in describing procedure, we will assume that the band of voice frequencies is just 5,000 cycles in width. This band of frequencies, originating at the telephone in New York, has been transmitted unchanged to the station at Rocky Point, where it is amplified 2,000,000 times. Representing 250 watts of power (a third of a horsepower) it is then used to modulate the first, or 30-kilocycle carrier wave.

HETERODYNING THE CARRIERS

Now, when this carrier wave is heterodyned by the voice-frequency band, there are created two sets of beat notes, one ranging from 25 to 30 kilocycles and the other from 30 to 35 kilocycles. In other words, we have a "sum" and a "difference" band, one above and the other below the 30-kc. carrier. By means of proper filters any band of frequencies can be eliminated from a circuit; and in

(*Contnued on page* 1184)

monic, it will probably be found very near the estimated position. Tune in and plot this point on the curve. Work back on the new curve drawn to this point and find other points in the same way. Sometimes a point is found that does not fit the curve; disregard it, it is probably wrong. Mistakes may easily be made, as will be seen from the table; some of the harmonics are quite close together. However, if a nearby station is used, one can be quite sure of the harmonic, and the other points will serve as checks. Another satisfactory way of being sure is to listen on the main wave just when a station is about to sign off. Then shift to the harmonic and listen to see whether it disappears.

In securing data for the curves, as may be readily seen from the curves here, it is unnecessary to take a large number of points; when using an S.L.C. condenser take two or three values at the higher settings of the wavemeter, one at the center and two or three at the lower settings; these determine the curve quite nicely.

Broadcast harmonics have been heard as low as 30 meters and have been tuned in and identified; but ordinarily 50 meters is the lower limit when this method is used. With this method there is usually less chance for error in selecting harmonics than with the "driver-receiver" method (in which the harmonics become complicated sometimes), and no extra equipment is necessary. This work may be greatly simplified by using two stages of audio amplification.

The short-wave stations are usually much easier to calibrate from for the indication of the long-wave stations is sometimes quite broad. On nearby stations, the coupling should be reduced to a minimum; and in some regenerative receivers the tickler must be of the correct value.

The receiver dial itself may also be calibrated by using a curve; but different antennae and various adjustments of the receiver may change results.

For special ranges of the wavemeter, remember that to have a particular wavelength come in lower on the dial it is necessary to increase the inductance.

The wavemeter will only be as accurate as the calibration-curve; therefore use graph paper of sufficient size for the desired accuracy. The curves for the different ranges may be plotted on the same sheet for convenience; different "base-lines" for the different ranges will be necessary, as shown in Fig. 2.

Such a simple wavemeter is very convenient in determining the location of short-wave broadcast stations and, with calibrations for a few different coils, will have many uses; it will repay one many times over for the time spent in its construction. No owner of a modern receiver should be without one.

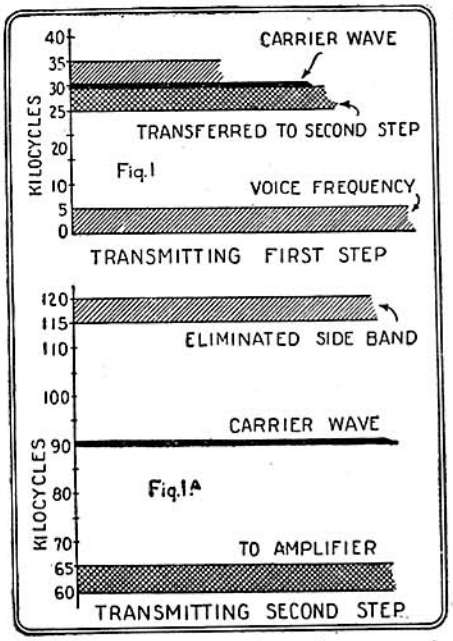
"Hello, London! Are You There, New York?"

(*Continued from page* 1087)

this case the carrier wave of 30-kc. and the "sum" band, reaching up to 35-kc., are suppressed. This leaves us a band of frequencies from 25 to 30 kc. (See Fig. 1).

This difference band is then heterodyned with a second carrier wave, this being of 90 kilocycles (3,331 meters—See Fig 1A). As before, there are set up sum and difference bands; they now range from 60 to 65 and from 115 to 120 kilocycles. Again the carrier wave and the sum band are eliminated; and we have a band of audio-modulated frequencies, ranging from 60 to 65 kilocycles, which are transmitted by radio across the Atlantic.

This 60-kc. band is selected because it is the designated one (5,000-meter wavelength)



This diagram illustrates the carrier waves and the two side-bands, and the way in which the carrier and one side-band are eliminated in transatlantic radiotelephony.

for transatlantic telephone communication. It is also much easier to separate by filters frequencies as far apart as 60, 90 and 120 kilocycles than those closer together, as in the 25- to 35-kc. band with which we started.

TRANSMISSION AND DETECTION

Further amplification is then carried out, first with a 10-kilowatt water-cooled tube, then with a stage of two such tubes, and finally with a third stage of twenty tubes. The voice impulse has now been magnified in volume more than two billion times. The power radiated into space from the antenna is about 70 kw., or about a hundred horsepower.

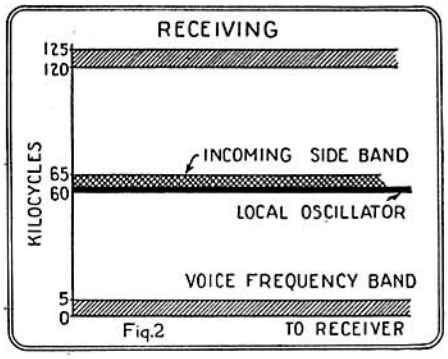
At the receiving end of the system in Wroughton, England, the incoming signals in the frequency band of 60 to 65 kc., are caused to beat with a locally-generated frequency of 60 kilocycles, thus resupplying the suppressed carrier wave. The difference-frequency thus created, 0 to 5 kilocycles, reproduces the original voice frequencies and causes an audible signal in the telephone circuit, as indicated in Fig. 2.

The same steps are carried out in the same order when the speech of the Londoner is being transmitted to America, except that the American receiving station at Houlton, Maine, reduces the receiving signal to audibility in two steps, by 90 and 30 kilocycle modulation, instead of by a single reconstituted carrier wave, as used at Wroughton.

AUTOMATIC VOICE RELAY

It has been discovered that, when talking by telephone over long distances, such as between New York and Chicago, where a certain type of cable is employed, all the energy produced by the transmitter, when energized, does not stop in the receiver. Some of it is reflected back over the line and is heard again in the first receiver. This "reflection" has been eliminated by an ingenious little "electrical valve," which permits the electrical energy to go in one direction only and therefore stops reflection.

Something of the same sort was experienced in the preliminary tests of the transatlantic radiotelephone. Whenever anyone spoke at the New York end he would hear a howl in his receiver. After due experimenting it was discovered that this was caused by similar reflection. By referring to the sketch showing the telephone lines used in this system, it will be seen that there is a line from the receiver at Houlton, Me., to New York and on the English side, one from



The "beating" of the incoming side band with a locally-generated wave of 60 kc. reduces the frequency to audibility.

Wroughton to London. These lines are, in their normal state, open; that is, ready for use.

Now it was discovered that, when one spoke into the microphone in New York and the signals were put on the air at Rocky Point, a portion of them went up to the receiving antenna at Houlton. They were detected there and carried down to the telephone in New York by the land line connecting these points, thus producing the howl. Therefore, in order to overcome this difficulty, a relay was placed in this line between Houlton and New York, which short-circuits it automatically when the microphone is energized in Manhattan. This short-circuiting device is a vacuum tube which operates an ordinary telephone relay. The same type of shorting is employed in the land line between Wroughton and London. Thus, when one person is speaking in New York the line between there and Houlton is shorted, while the London-Wroughton line is open; the opposite being the case when the man in London is talking.

The same type of relay is used also in the transmitting lines between New York and Rocky Point and in the line between London and Rugby, where the English transmitter is located. Therefore, when New York is talking the receiving line is shorted and the transmitter open, the reverse being true at the English side.

One of the first experiments with two-way radiotelephone conversation was undertaken at Catalina Island, California, several years ago, between the island and the mainland. This, however, was abandoned when a cable was laid between these two points. However, it would be possible for anyone to talk from Catalina to another, in Paris or Berlin, for instance, because there is a telephone cable between the Continent and England. So one might talk by air from Catalina to the mainland, by land line to Rocky Point, by air to London, and then by cable and land line to whatever point in Europe he desired. This is in the not-distant future, and surely the picture presented is not overdrawn.

One other development which the telephone engineers have yet to master, is that of secrecy in the air links between Rocky Point and Wroughton, Rugby and Houlton. Anyone who so desires may tune in with a receiving set on 5,000 meters and hear the conversation, providing he supplies the necessary local oscillations, which are needed to reduce the single side-band of approximately 60,000 cycles down to the audio-frequency range. The engineers say it is a relatively simple matter to counteract this, for the signals can be "scrambled" in such a manner at the transmitting end, that they will be unintelligible to anyone who has not the correct method of "unscrambling." This latter process is just as simple at the English end as the scrambling at the American side, and will doubtless be introduced in the near future.