What Happens and Music

By JESSE

Above is Illustrated the Type of Microphone and Control Box Used for Announcing or Broadcasting from Remote Places. On the Right is the Double Microphone Used in the Studio.
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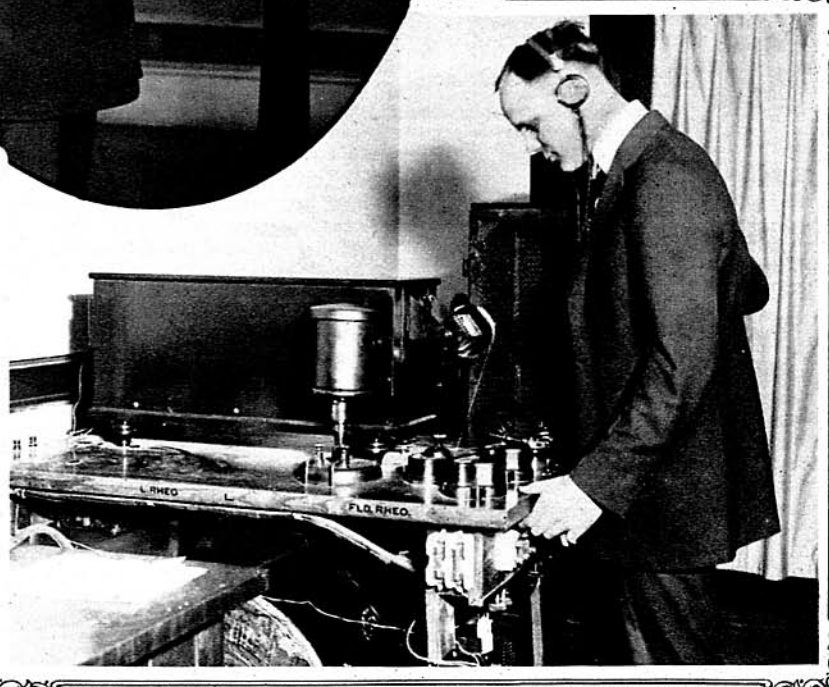
WHEN a speech or concert is broadcast from any given point, Newark for example, it reaches out over many, many miles all around it, and arrives at these distant points loud and clear in the receiving telephones. Did the reader ever stop to consider what an amazing feat this really is, that the voice of a singer can be thrown out hundreds of miles into space and heard distinctly? Stand on the corner of any street and try to talk to a person 10′ away. You must raise your voice perceptibly. Let that person stand one block away from you and it is almost impossible for him to hear you no matter how high you raise your voice. Yet a singer in Newark is heard in Chicago as clearly and distinctly as though the singer were there in Chicago. Imagine how much energy there is involved when you utter the sound "AH" in a normal tone of voice. Hardly enough to blow a thin sheet of paper placed in front of your mouth. Place a thin piece of paper in front of your mouth and say "Ah" steadily. The paper will not budge visibly. The energy involved is so small that it is almost inconceivable that it could be sent out into space hundreds, and sometimes thousands of miles. Consider the ordinary telephone which may now be resting on your desk and which you use daily. When you speak into this the energy of your speech is amplified by batteries which are connected to the telephone. Yet the energy output of that telephone is only about 0.1 watt. How much energy is this? Just about enough to move a weight of one ounce through a distance of 1′ in a second. Yet the voice of a singer which involves ever so much less energy than this is hurled out into space hundreds of miles. How is all this accomplished? Let us trace the path of the speech or the song as it leaves the speaker's or singer's mouth to find this out.

What applies to the singer applies equally to an orchestra or band or any other sound-producing mechanism.

Imagine a large room beautifully furnished and draped. It may contain a few chairs, a piano and a table. Apart from these there is no other furniture. The speaker or singer is in this room, perhaps with one of the broadcasting station officials. This room is not built like any other room in a building, but has been specially designed and constructed according to the best accoustical principles to avoid the production of echoes which might otherwise be transmitted with the original sounds. On the table there is what apparently looks like a neat piece of ornamental furniture, or it may be a long cylinder. Or this cylinder may be suspended or supported in mid-air. This is the so-called "microphone" which corresponds to the mouthpiece of the ordinary desk telephone. This microphone picks up the sounds as they leave the singer's or speaker's mouth and converts these sounds into electrical currents. The construction of the microphone is different from that of the desk telephone, although it accomplishes the same things. It is necessarily different for it has much harder work to do. It has to transform faithfully the most varied sounds from a deep bass to a high soprano, the queer sounds coming from a saxophone and those from a violin or piano, the complex sounds coming from a large orchestra or band. It must pick up each



Below is the Oscillograph Which Permits the Operator to See the Modulated Current and Adjust the Amplifier for Best Results.
(c) *U. & U.*

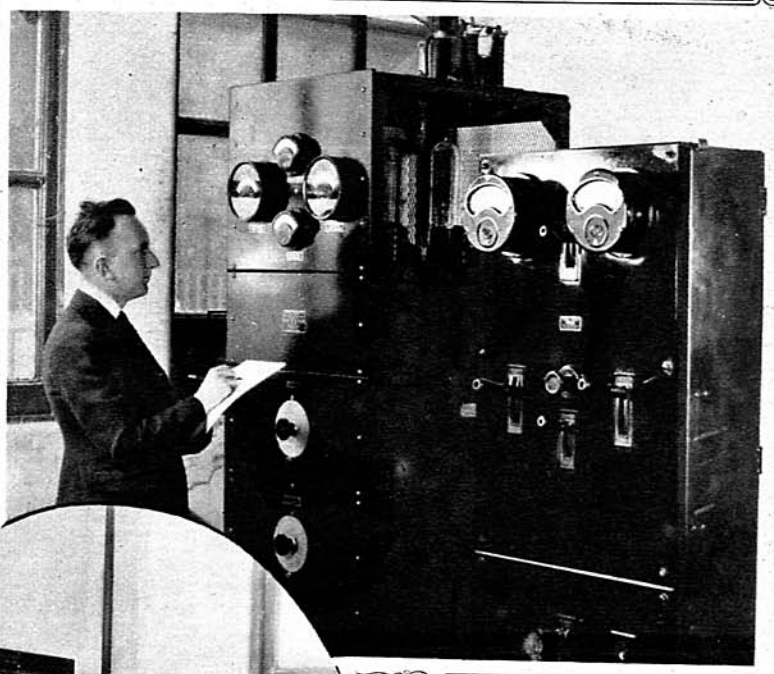
to the Speech When Broadcast

MARSTEN

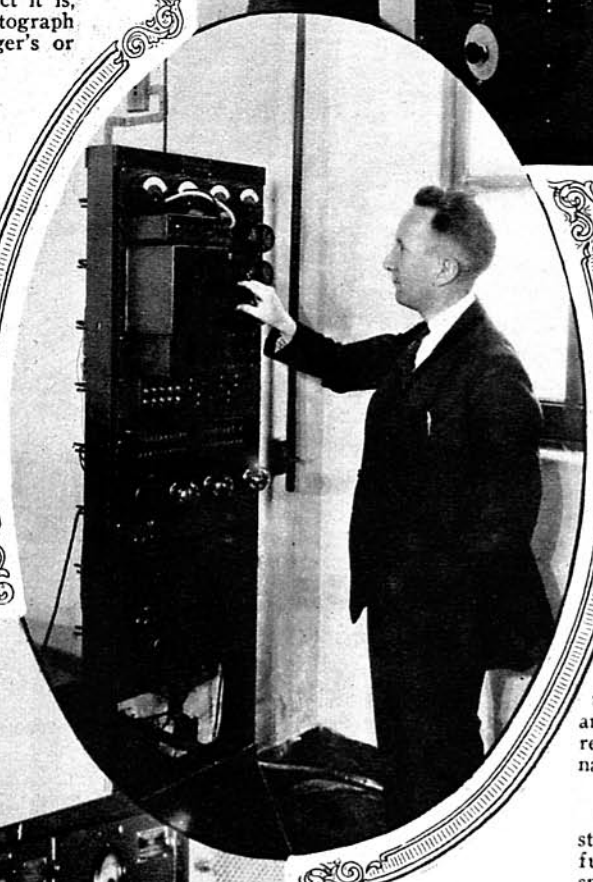
of these varied sounds faithfully without omitting any or detracting from the quality of any individual sound. The desk telephone is built essentially for human speech as ordinarily used. Hence the microphone used in broadcasting is a much better and more complex device.

As stated, when the sounds leave the singer's or speaker's mouth they strike the microphone which is connected in an electrical circuit. These sounds vary from moment to moment, sometimes low, sometimes high. They produce certain changes in the microphone which changes correspond faithfully to the changes in the speaker's voice. The electrical current in the microphone circuit is correspondingly varied so that the electric current may be considered, as in fact it is, an exact electrical duplicate or photograph of the sounds which leave the singer's or speaker's mouth. However, the energy contained in the original sounds is minute or microscopic and as a result the energy in the electrical duplicate of the microphone is also extremely small. In order to utilize this small energy for broadcasting purposes, it is necessary to magnify it many times.

The electrical current in the microphone, which is the electrical counterpart of the original sounds leaving the performer's mouth, is therefore passed through a speech amplifier which consists essentially of the all-important vacuum tube amplifiers of which there may be three or four associated with specially designed elec-



A Typical Radiophone Transmitter. On the Right is the Control Panel and on the Left the Transmitter Proper.



These Two Pictures Show the Type of Amplifiers Through Which the Voice and Music Are Amplified Before Reaching the Transmitter. An Operator Listens Constantly to Check the Quality and Volume.
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trical circuits. The microscopic currents are here magnified hundreds of times so that they possess much more energy than they did previously.

In the process of this amplification there is always great danger that the original electrical impulses, which were faithful duplicates of the sounds which left the performer's mouth may suffer distortion, in which case the sounds reaching the receiving station will not be like those originally transmitted. The speech amplifier has been specially designed not only to magnify the weak speech impulses, but also to duplicate faithfully without distortion these impulses Coming out of this speech amplifier, then, are magnified electrical currents which correspond exactly to the original speech.

RADIO FREQUENCY TRANSMITTER

Let us leave the speech currents at this stage for a moment whilst we consider its function. What is required here is that the speech should be transmitted through the air over large distances. Now, speech currents cannot be transmitted alone, unmodified, through the air, no matter how much they are magnified. They have not the radiating power or ability because they do not vibrate rapidly enough. Only those currents can be radiated through space which vibrate very rapidly. Hence, even if we continued to use more and more speech amplifiers to magnify the original speech currents, we could not radiate this speech through space. What we require is something which does radiate in space and travel over far distances to carry these speech currents along with it. For this purpose we have a radio frequency transmitter connected to the antenna. The radio frequency transmitter generates those currents of extremely high frequency which are able to travel through space, and the antenna is the agency which hurls them into space. This radio frequency transmitter is likewise made up of those all-important instruments, vacuum tubes, only here more powerful ones are used than in the amplifier, for these tubes have to generate a strong enough current to radiate far out into space.

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What Happens to the Speech and Music When Broadcast

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The radio frequency currents which are generated by the vacuum tube transmitter are transferred to the antenna by means of electrical circuits. When these currents flow up and down in the antenna, radio waves are produced which then travel outward. However, in the state in which they then are, they cannot do anything as far as speech goes; they are merely in a position to carry along with them any speech signals which are impressed on them. The reader should remember that these waves, generated in the antenna by the radio frequency generator, are merely the agents for transporting the speech to distant points, for speech currents cannot travel alone through space. They are the speech carriers, or "carrier waves" as they are called.

So far, we have magnified faithfully the original speech or sounds which left the performer's mouth until the magnified current is many hundred times stronger than the original speech current, and we have generated the radio frequency waves which are waiting to transport the speech to distant points. In order that the radio frequency waves be able to carry these speech currents most efficiently, it is necessary that the speech currents be magnified and properly impressed on the radio frequency carrier waves. If the speech currents are not sufficiently magnified the carrier waves will not transport them as far as they would otherwise. Furthermore, unless the speech currents are properly impressed on the carrier waves they will not be transported and if they are, they may be very badly distorted, so that the person receiving the signals will hardly be able to recognize the sounds.

THE MODULATOR CIRCUIT

In order to properly impress the speech currents on the carrier waves, a special circuit must be employed called the "modulator circuit," which again employs that versatile instrument, the vacuum tube. This modulator circuit places the speech current on the carrier wave in the proper manner so that the latter will transport the speech most efficiently and without distortion. However, in order that this be properly done, the speech currents must be amplified a certain amount. The strength of the speech current when it emerges from the speech amplifier (where we last left it) is not sufficient for this. Hence another vacuum tube amplifier is employed called the "modulation amplifier." The speech currents which leave the speech amplifier are then passd through this modulation amplifier. The speech currents are now magnified to a sufficient value where they are able to be passed through the modulator tubes, of which there are as many as there are radio frequency oscillator tubes. When the speech current finally leaves these modulator tubes they are sufficiently strong to modify the radio carrier waves, which then transport them through space.

Throughout all these various operations through which the speech passes, one important thing must be avoided, namely, distortion. It is easily seen that there are many chances for the speech currents to be altered ever so little, so that they will deviate from their original true form. But if this happens, the music which we receive may be nothing more than discord. The various circuits are therefore most carefully designed so that nothing untoward may happen to these sound currents, and so that they are finally hurled out from the antenna into space in their original state.

We now have traveling through space at a tremendous speed, 186,000 miles per sec-

ond, a radio frequency wave which is carrying with it some song or concert or lecture. As it travels through space it gets weaker and weaker, the farther away it gets from the antenna. In its travels through space, the wave strikes a number of antennæ which are on the lookout for it, by being tuned to its frequency, and these antennæ snatch from the wave a portion of its energy, but only a very thin portion, for after the wave has passed through space it has not much energy left in it. Yet this tiny energy is sufficient to bring the sounds in loudly and clearly.

The radio wave carrying with it the speech currents flows down the receiving antenna and into the receiver. Probably with this wave there are a number of other waves also clamoring to get into the receiver. Unless these other waves are shut out, the signals will be a hodge-podge because all these waves are contributing their little speeches which together do not make much sense or music. By properly tuning the receiver we shut the door of the receiver in the face of these interfering waves, but permit the wave we want to sneak in, as it were, through a trap door.

We now have in our receiver the radio waves which have carried with them the speech or music currents which we want to hear. But the energy in these waves is now extremely minute for they have had to travel a long way and in their travel they have lost some in the atmosphere, some while traveling through houses and perhaps across mountains, and much of their energy has been stolen by other antennæ, which have been on the lookout for them. So that there may be as little energy left in them now as there was originally in the voice of the performer which was, as we saw, ridiculously small. We must, therefore, magnify the energy in the received wave so that we will be able to hear it. This is done by means of the "radio frequency amplifier," which employs the vacuum tube to increase the strength of the received energy. Here again, as in the case when the speech was being transmitted, we must be very careful not to alter or distort the speech. By using the proper kind of tubes and the proper kind of electrical circuits we are able to magnify the energy sufficiently without distorting the speech which has been carried along.

However, we cannot hear the music or speech yet because it is still in the grip, we might say, of the radio frequency carrier wave. All we wanted the radio frequency wave for was to carry the speech currents to the receiver. Now that it has carried the speech currents to the receiver we have no further use for it. We therefore pass these magnified waves through a "detector," which may be again a vacuum tube or sometimes a crystal mineral, which separates the speech currents from the radio currents, and passes these speech currents to the telephones. We now have our original speech currents which were transmitted from the broadcasting studio in the telephones and the original sounds are heard, just as a conversation is heard when the speech currents flow in the receiver of your desk telephone.

It is possible that the sounds heard in the telephones are weak, for the waves may have had to travel so far that less energy was left in them than we imagined. Or it may be that the sounds heard are loud enough to be heard by the person wearing the telephones, but not loud enough to be heard by other people in the same room. These received signals or sounds may be increased in volume by using an "audio frequency" amplifier to amplify the sounds so that they are stronger. This audio frequency amplifier corresponds exactly with the speech amplifier employed at the transmitter to increase the intensity of the speech currents. By amplifying the signals this way, they may be made loud enough to be passed through a special telephone called a "loud speaker" which will fill a room with the music or lecture.

The original sounds have had to pass over long distances, through many obstacles, and through many operations to reach their final destination, pure and undistorted, true and faithful to the original sounds which left the mouth of the performer. It may be said that eternal vigilance is the price of this achievement.

With the Sea-going Operators

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Board and by Gibbs Brothers, the Naval Architects who have charge of reconditioning the ship and all expressed themselves as entirely pleased with the installation and performance.

At sea, the operator who is assigned to this boat will have charge of the installation and probably will be required to send out test signals about once a week on both 300 and 600 meters. It will probably be interesting for amateurs to listen in for these test signals provided they are sent out at a prearranged time.

Calls Heard

(*Continued from page* 174)

WGY, WHA, WHAB, WHAH, WHAS, WHB, WHX, WHZ, WIAO, WIAS, WIAR, WJAB, WJAD, WJAH, WJAX, WKAA, WKAF, WKAL, WKY, WLAB, WLAG, WLAJ, WLAL, WLB, WLK, WLW, WMAK, WMB, WMC, WNAD, WNAS, NY, WOAA, WOAC, WOAI, WOAN, WOAO, WOAW, WOAZ, WOC, WOI, WOK, WOQ, WOS, WPA, WPE, WPAC, WPAD, WPAH, WRR, WRAP, WSAS, WSB, WSY, WTAW, WTK, WUZ, WWAC, WWAY, WWI, WWJ, PWX, and Frank H. Jones, somewhere in Cuba.

Also Canadian stations CHCQ, CPCG and CJCG.