

*Miss Dorothy Peterson
Route 1
East Ripley,
Minn.*

The Magic of Radio Transmission



Simply told by the
COLUMBIA BROADCASTING SYSTEM
and Station WCCO, Minneapolis, Minn.

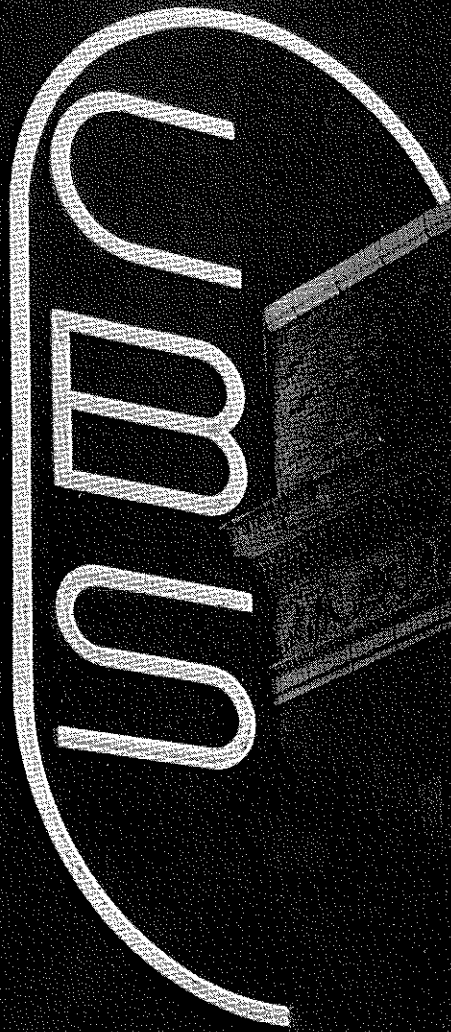


You sit at your radio, laughing with America's greatest comedians... or tapping your feet in time to America's best dance orchestras. It all seems simple. Just a snap of the radio switch, a twist of the dial or a press of the automatic tuning button and the world's best humor and entertainment are there, with you, in your living-room. But at the other end of radio—the broadcasting end—it's not quite as simple as all that. There are many jobs to be done, in order that the program may reach you exactly as it is being performed. Each job must be handled by an expert, with years of study and training in his own field.

First of all, there is the studio from which the program originates. In the case of some radio programs, this may be a small studio, properly equipped for a small cast of performers. Or it may be a large, specially designed theater, with a stage for a full orchestra and many performers, as well as hundreds of seats for the spectators.

Columbia Network radio programs originate in New York, Chicago, Hollywood, and many other major American cities. There, on the stages of special theaters, programs are performed each week before capacity audiences. But the hundreds of spectators who fill the theater are actually only a tiny part of the audience. For these programs are

Tense moment in "Supply and Demand," radio drama performed by the Columbia Workshop.



CBS

THE COLUMBIA
RADIO PLAYHOUSE

broadcast from coast to coast over scores of stations of the Columbia Broadcasting System. Through the magic of modern-day radio, that same performance actually has an audience of *many millions!*

What's more, those millions of listeners—even those who are at the opposite end of the continent, 3,000 miles away—hear the program even *before* the spectators seated in the back seats of the theater. That sounds unbelievable, but the reason for it is very simple.

SOUND WAVES AND RADIO WAVES

Just think, for a moment, of some time when you saw and heard a gun, or firecracker, go off at a considerable distance from you. Do you remember how you saw the flash of the explosion some time before you heard the sound of it? If the gun was about a mile away from you, the sound of the shot didn't reach you until almost *five* seconds after it had been fired. This is because sound travels only 1,120 *feet* per second, under normal conditions. But the flash of light from the gun travels at 186,000 *miles* per second—so that you see it long before you hear the boom of the gun.

Electricity, and radio waves, travel through the air at the *speed of*



light:—186,000 miles per second! Thus, in the time it takes the actor's voice (traveling in *sound* waves) to reach the rear of the theater in which he is broadcasting, radio has already carried his voice (on *electrical* waves) half-way around the world, and into millions of living-rooms, with the speed of light. Later we will tell you about the CBS broadcasts from Europe, which often report news to you at the very second it is happening—thousands of miles across the seas!

THE MICROPHONE

Now to return to our studio, and the necessary steps in broadcasting a radio program. One piece of radio equipment that everybody has seen or heard about is the *microphone*. The artist, speaking or singing into the microphone, stands near it and uses his voice in a normal manner—just as though there were no microphone before him. It's as simple as talking into a telephone.

The sounds, entering the microphone, make it “shiver” inside, just as a breeze makes the leaves on a tree shake a little. Each sound causes a different type of “shiver” or vibration and, in music for example, each note makes a different vibration in the microphone.



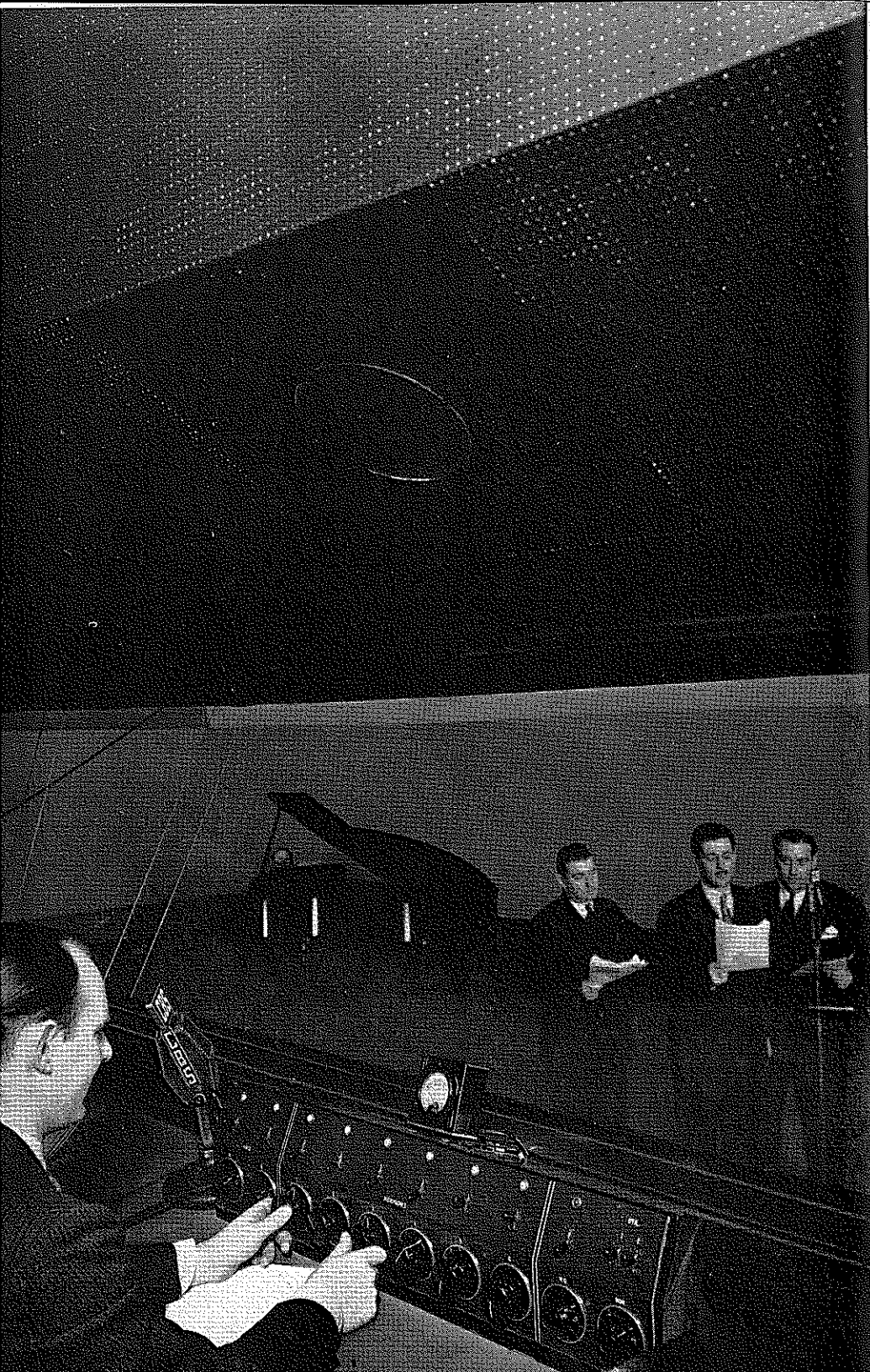
WHAT HAPPENS TO THE PROGRAM

This vibration is what starts our radio program on its way. The path it takes, from the studio to your home, can be outlined very briefly as follows:

1. *Sound* waves in the studio become *electric* waves in the microphone.
2. From the microphone these electric waves go to the *studio control room*, where they are “checked” by an engineer before passing to the Network *master control room*.
3. From the master control room they go out *over wires* to all the radio stations carrying the broadcast.
4. The individual radio station takes these delicate electric waves from the wire and, by means of the station’s transmitter, shoots them into the air in the form of *radio* waves.

(During these several steps, the power of the vibrations has been increased 30,000,000,000,000 times between the microphone and the time they go on the air over a 50,000 watt transmitter.

5. These waves are picked up by your home radio—and are changed back in the radio set into *sound* waves, so that you can hear them just as they were in the studio.



And all this takes much less than a small part of a second to accomplish. That's the story in outline; it will help you to follow the more detailed description below.

I. Microphone to studio control booth

When, in the studio, sound waves are turned into electric waves by the microphone, they go directly to the *Studio Control Booth*. Here, in a sound-proof booth, an engineer controls the volume of sound coming from each microphone in the studio. Through the use of various instruments, it is possible for him to increase or decrease the power of a voice or musical instrument. He could make a hand-clap sound like a burst of thunder...or reduce an explosion to the sound of a pin dropping on the floor. More important than changing the intensity of sounds, however, is his job of keeping the "balance" of the program just right, so that it will be heard in your home exactly as intended.

II. Studio control booth to master control room

From the studio control booth, the program passes on to the *Master Control Room*. Here, additional engineers perform the task of sending the program to each station on the Network which is broadcasting it. To the average person, the master control room looks like a telephone exchange room. And it does serve somewhat the same purpose.

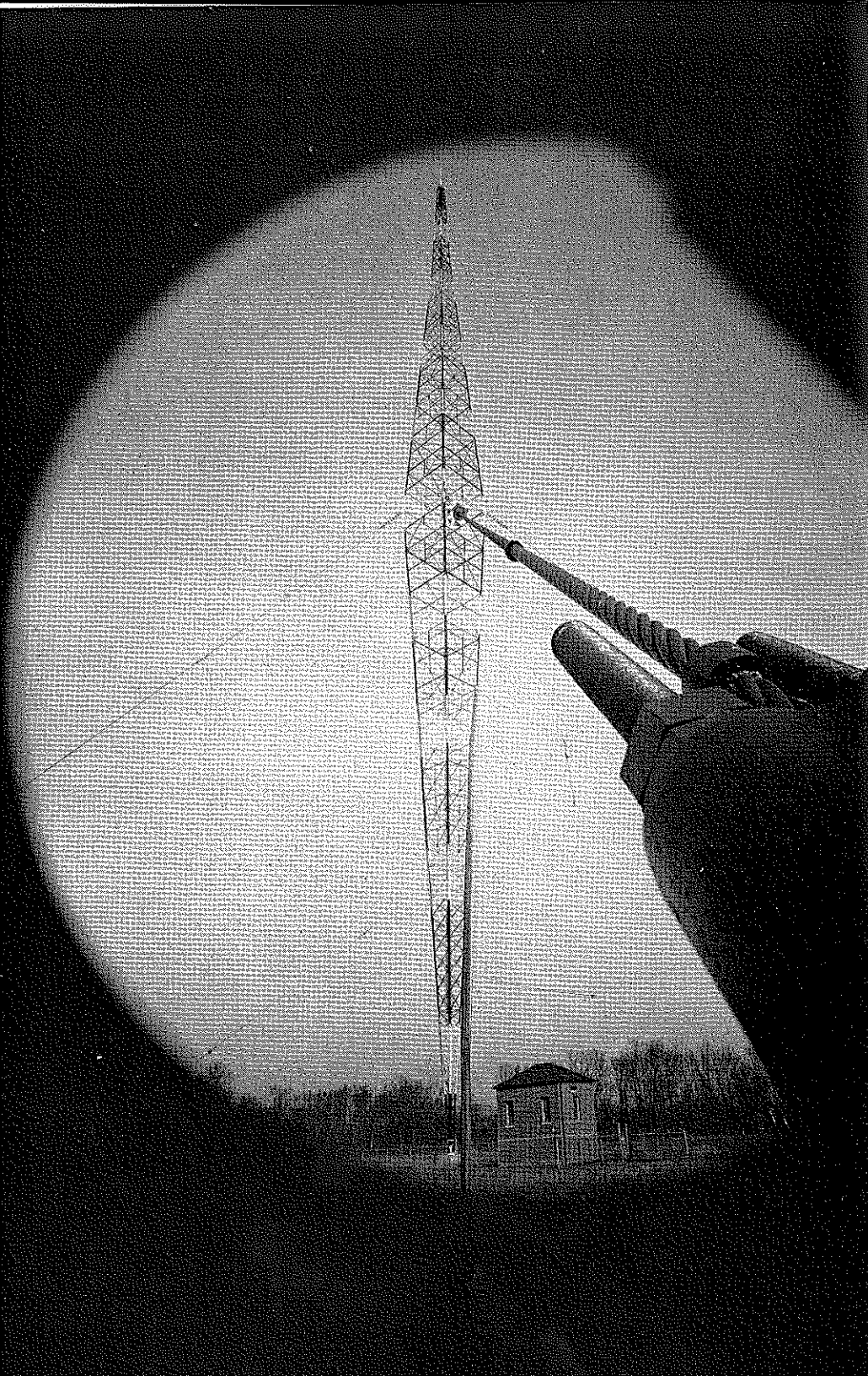


It is the responsibility of the engineer in this room to see that every program goes exactly where it is supposed to. One program may originate in New York. The next in London. The third in Hollywood. In each case it is up to the Master Control engineers to make the proper connections, and pick up each program with split-second accuracy, sending it to every station scheduled to carry that particular broadcast.

III. *Master control room to the network*

Contrary to popular belief, the program is not sent from the master control room "onto the air waves." It still continues on its way along wires. One wire circuit leads directly to the transmitter of the station in whose studio the program is originating. (This transmitter may be ten or fifteen miles, or even more, from the studios themselves.) Other sets of wires take it to every *other* station in the country which is broadcasting the program. Each of these stations in turn, continues it on its way to the transmitter connected with that station. You have seen these radio station *transmitters*, or pictures of them, at one time or another. In previous years, they consisted of a transmitter building and two tall metal towers, with aerial wire stretched between them (like many home radio "aerials" you see on people's roofs.)

However, continued research in radio broadcasting perfected a new



type of antenna. It is a single tall tower, instead of the older type with two towers. This new antenna is far more effective than the old kind. As an example of how large these towers are, the single, transmitting tower used by Station WABC, key station of the Columbia Network in New York City is *550 feet high and weighs 340 tons!*

IV. Network station transmitter to home radio

It is from the transmitter that the program first goes “on the air waves.” Here, the genius of engineering changes the electric waves in the wires to *radio waves* in the air. These waves travel away from the transmitter in all directions. Some of them follow the course of the earth, and are called “*ground waves.*” Others go up into the air, and are called “*sky waves.*”

During the *daytime*, your aerial will receive only the ground waves, because the sky waves shoot right out into space and are lost. At *night*, however, the sky waves do not get lost in space. About 70 miles above the surface of the earth they hit a “cloud” of electrical particles which does not let them pass through. (Scientists call this cloud the “*ionosphere*” because these electrical particles are known as “*ions*”). The sky waves bounce back towards the earth at about the same angle that they strike the “*ionosphere*”—just as a billiard ball bounces off



a cushion at the same angle that it hits the cushion. This is the reason why you can frequently hear distant stations at night which your radio will not bring in during the day.

The transmitter serves another purpose. A 50,000 watt transmitter, such as the one at WABC, magnifies the power of the program 10,000,000 times as it comes from the studio over the wire. This increase is supplied in order to give the program sufficient strength to be heard at great distances from the transmitter itself.

And now, there is only one step left. So far, we have traced the program from the time it begins at the microphone up to the time it is broadcast into the air. What happens when *you* turn on your radio and tune in a station?

V. What happens in your radio set

The story we have just told you is reversed. Your aerial picks up the vibrations of the radio waves from the air and carries them into your set. The incoming power of these vibrations is usually very small, but your radio set can multiply it by a million!

First, the tiny stream of *radio* waves passes through the "*radio amplifier*." Then, much strengthened, it goes on to the *detector*, which allows only those *electrical* vibrations which have been produced by



THE MAGIC OF RADIO • SIMPLY TOLD BY CBS

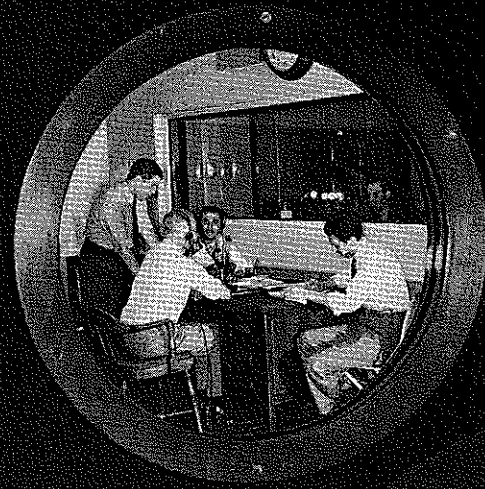
the program to go on to the second amplifier, known as the “*audio-amplifier*.” This further increases the power of the vibrations, and they then enter the loud speaker. Because of the differing vibrations of the electric waves, the loud speaker vibrates accordingly. It is this vibrating of the loud speaker which again changes the *electric waves* back to *sound waves* in your own home, just as they were in the studio, and enables you to hear the program.

It does sound very complicated, doesn't it? Yet, an interesting thing to remember is that every one of these steps occurs with such speed that the programs broadcast from Hollywood or New York or London or Shanghai reach your living-room—no matter where you are in the United States—in the smallest part of a second. When radio artists sing, play, and act in the studio, you hear them—at almost the same instant—though you may be thousands of miles away from the microphone!

EUROPEAN BROADCASTS

Perhaps the most interesting part of radio's “magic” is revealed when you sit at your radio and hear CBS news reporters and analysts in Europe's capitals, talking as clearly as if they were in the next room.

STUDIO
ON THE AIR



THE MAGIC OF RADIO • SIMPLY TOLD BY CBS

To help you understand this achievement, we'll have to go back a few steps and explain some other things about radio.

I. **Frequency**

First of all, there is something which radio engineers call the "frequency" of a radio station. This simply means the number of radio waves sent out by that station in a given length of time. The stations you ordinarily hear in the United States send out their radio waves at a rate from 550,000 waves per second to 1,600,000 waves per second. If we drew a diagram of these waves, we would have something like this:



At 550 on your dial (*550,000 waves per second*)

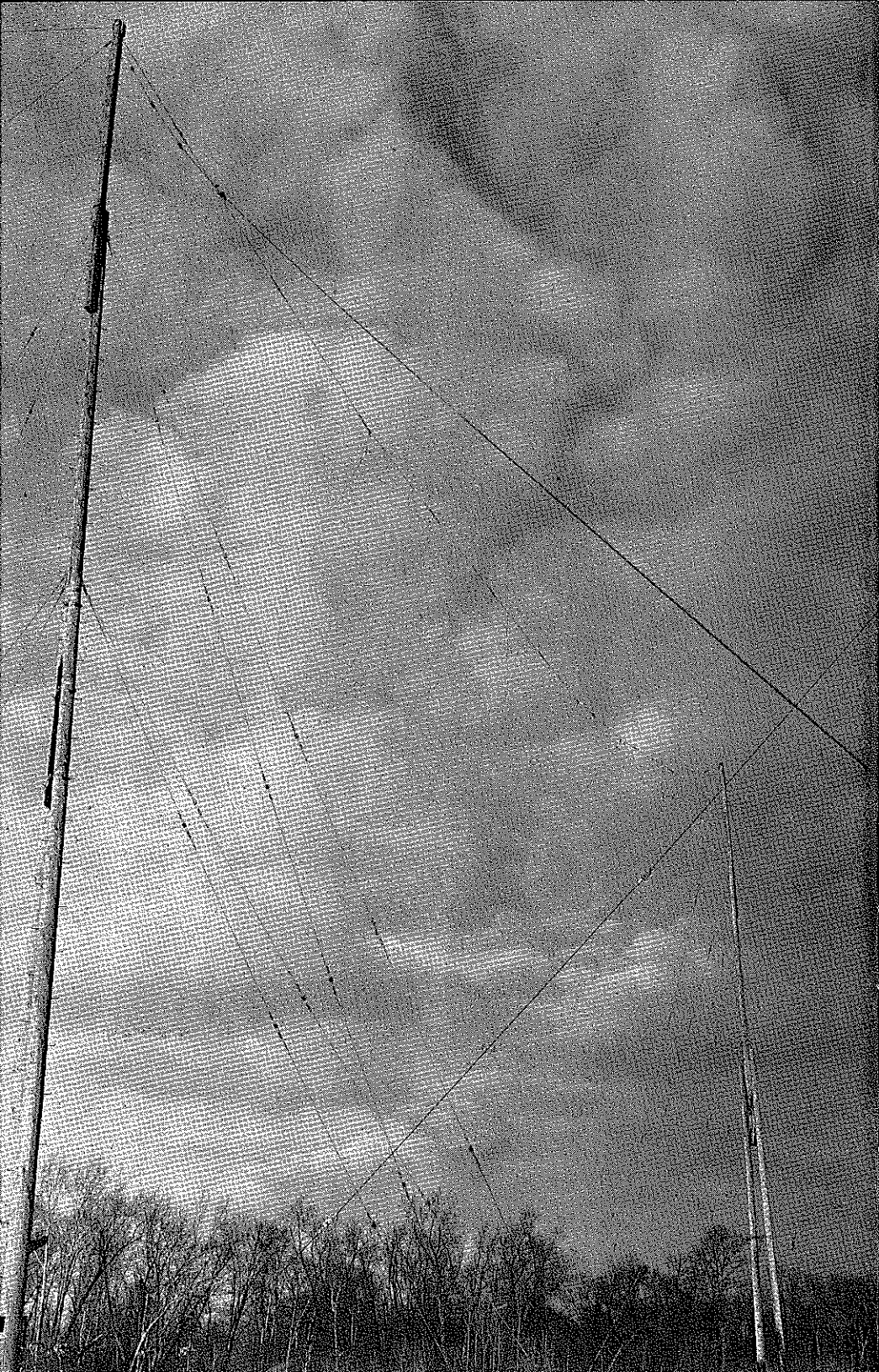


At 800 on your dial (*800,000 waves per second*)



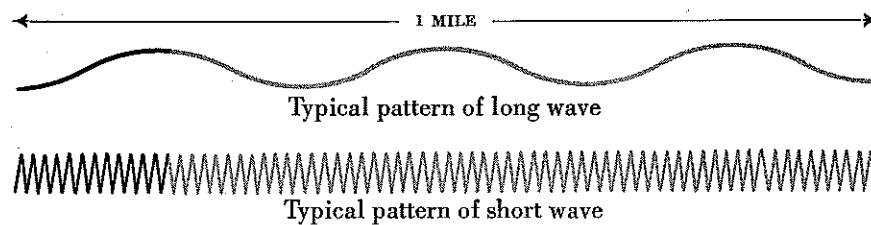
At 1600 on your dial (*1,600,000 waves per second*)

A station sending out waves at a rate of 550,000 per second is said to have a "frequency" of 550 kilocycles. It is found on your dial at 550-- (or on some dials at 55, which means exactly the same thing in radio).



II. *Short Waves and Long Waves*

The radio stations in the United States that broadcast on frequencies of from 550,000 to 1,600,000 waves per second are called “long wave” broadcasting stations. The waves these stations transmit really are very long. At a frequency of 550,000 waves per second, the actual distance between the “crest” of the succeeding waves is 1,800 feet, while the distance in what we call “short wave” broadcasting is only 50 to 150 feet. Or compare them in another way: In “short wave broadcasting,” the waves are sent out so fast that the stations broadcast from 6,000,000 waves per second to 25,000,000 waves per second. A “long wave” station broadcasts only 550,000 to 1,600,000 waves per second.



We get our radio news from Europe and across the seas by “short wave broadcasting” because the short waves can travel over much greater distances than long waves . . . crossing the Atlantic Ocean from Europe to you in a split fraction of a second!



HOW WE LINK SHORT WAVES TO LONG WAVES TO BRING EUROPE TO YOU

You probably have listened to the many CBS programs brought directly to you from the chief European capitals—Paris, London, and Berlin—as well as from other far-off places... Japan, Australia, Africa, and even the South Pole. In certain respects, these broadcasts from Europe follow the same pattern as those originating in our own country.

I. *London to America*

Columbia's news reporters and analysts in London, for example, use the same kind of studios as we have here in America. They talk into the same kind of microphones. The studio control booth works in the same way and so does the master control. Identical, too, is the method of sending the broadcast from the studios over telephone wires, but instead of going to a regular transmitter, these programs are sent by wire directly to the English "short wave" stations to be sent across the seas to America.

II. *Paris to America*

In Paris, CBS likewise uses regular broadcasting studios, is served by the same kind of studio control and master control equipment and engineers. But Paris broadcasts are not sent to a French transmitter.



Land and undersea cables are leased by CBS, which carry the program from Paris to the French Coast, then under the English Channel and to the London studios. There they are received just as an American CBS station receives a program — on a “switchboard” — where Paris’ part of the European round-up is combined with London’s CBS program. Both parts of the program, blended together for uniform volume and tonal quality are sent by wire to the short wave transmitter in England.

III. *Berlin to America*

Berlin operates as does London. CBS uses a regular studio, with studio control booths and master control. The program is sent by telephone wire to a German transmitter for “short waving” to America.

IV. *America receives Europe*

Here in America are gigantic “short wave receiving stations.” These look something like the aerial you have on your roof, but instead of one aerial (which is called an antenna) there are many, and they occupy acres and acres of ground. These antenna systems face in every conceivable direction, and are so sensitive that they can receive every “short wave” program from anywhere in the world.

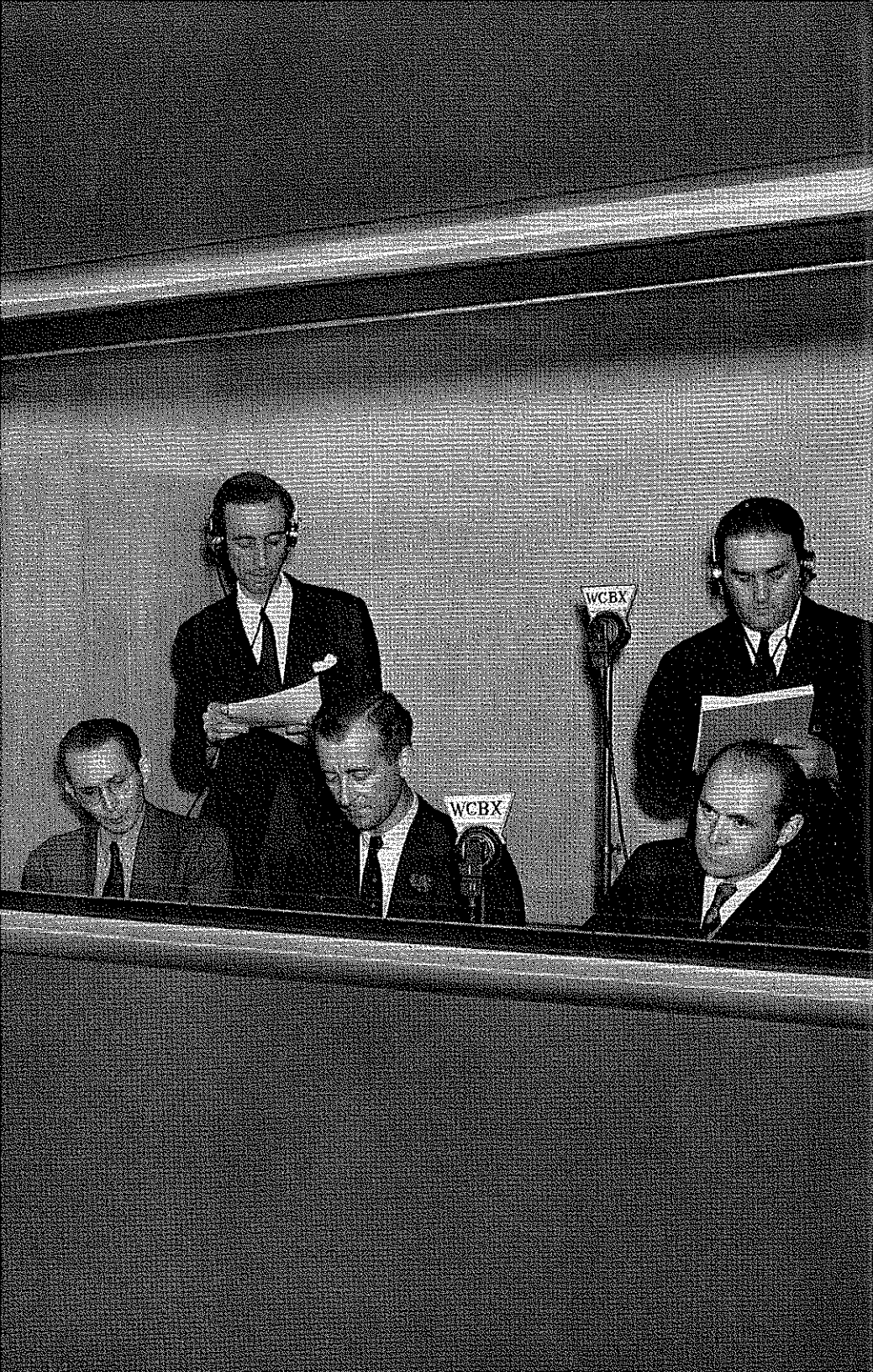
As soon as the programs are received in the United States on these highly sensitive short wave receiving systems, they are sent by wire to a



control point in New York. There—again by wire—they are relayed to CBS' big master-control board in New York City and from there, sent on to the entire network, just as any other program is transmitted. And it takes only *1/60th of a second* for a voice in Paris, London, or Berlin to reach *your* home!

V. **America to Europe**

You may wonder how these programs are so wonderfully timed, how it is that no matter how many thousands of miles one broadcasting point is from another, all parts of the program fit in with one another, as smoothly as if everyone was broadcasting from the same room. That's because, here at CBS in America, we sit with earphones clamped to our ears listening to these programs as they come in from Europe. We are in touch with our broadcasters in Europe by telephone all of the time, so that we can instantly notify them if everything is not being properly received in America. In addition to this, as soon as we receive the broadcasts from Europe, we short wave them back so that—in a tiny fraction of a second—the men broadcasting thousands of miles away hear their own voices . . . after the program has crossed the seas to America and then been returned, back across the seas, to Europe. Through this means of sending back the European programs, we signal



each foreign point with such phrases as “Go ahead, London” which you often have heard. These signals are what radio people call “cues”.

This wonderful CBS round-the-world series of broadcasts has made it possible for you to hear news of what is happening thousands of miles away as soon (and often, very much sooner) than those living right in the foreign countries from which the broadcasts come.

VI. **America to the World**

Here in America, Columbia operates short wave *sending* equipment, transmitting Columbia programs to the listeners in far-off countries all over the world. We use exactly the same technique as just described. Many distant lands which are *days* away by the fastest travel are brought in contact with America in *fractions of a second* through these short wave broadcasts over Columbia's WCBX and WCAB—which are the call letters for the CBS stations to which the outside world listens. Perhaps you too sometimes hear WCBX and WCAB on *your* set, if you have a short wave receiver. What you hear are the programs designed to reach our neighbors across the seas. They are “short wave” broadcasts that, when they reach foreign lands are picked up and sent along in each country by “long wave broadcasting” or are picked up by the individual listener directly on his short wave receiving set.

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This is ...

*The
Columbia
Broadcasting
System*

485 Madison Avenue, New York