SOUND RECORDED ON STEEL TAPE

The Mirrophone—a new magnetic sound recorder and reproducer perfected by the engineers of the Bell Telephone Labs. will find many uses in the training of public speakers, singers, school students, etc. It records the voice on a steel tape and the sound may be reproduced at any desired time.

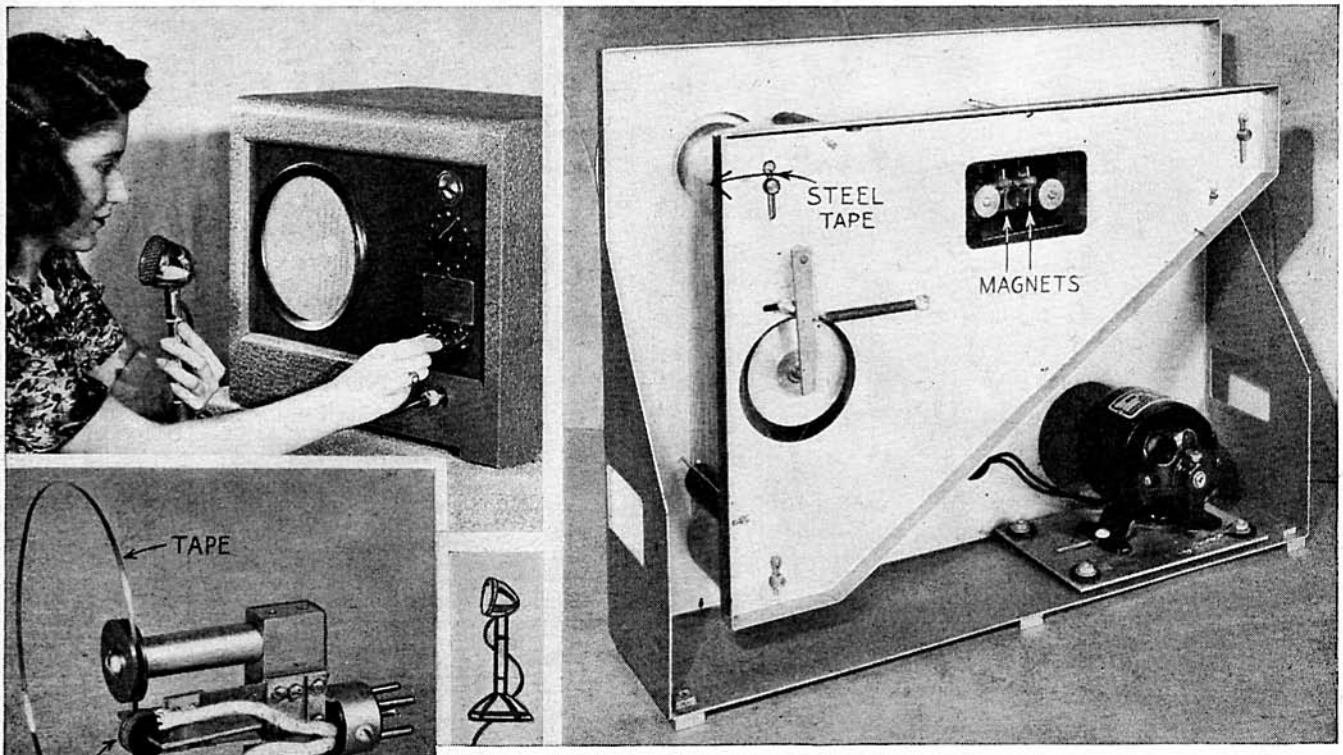

Photo above at left, shows a person about to record her voice on the steel-tape Microphone. Lower left photo shows the magnetic recording-reproducing element of the Mirrophone; the upper magnet is the polarizer and the lower one the recorder and reproducer. Right-hand photo shows the continuous steel tape, recording and reproducer magnets and tape driving motor.

Photos—Courtesy Bell Telephone Laboratories

FOR many years telephone engineers have been experimenting with sound recording, because it is a most useful tool in studying the characteristics of speech. Reproducibility of a recorded sound, and its permanency, make possible detailed analysis of a particular word or phrase. There are three methods of recording sound: mechanically on wax, photographically on film, and magnetically on a steel wire or tape. The first method has found wide commercial application in phonographs and the second in sound pictures; but the third has until recently been used only in experimental apparatus. Recent developments, however, have made it a practical means of high-quality sound recording and reproducing. These new developments have been incorporated in the Western Electric "Mirrophone." It handles higher frequencies than previous magnetic sound recorders and is freer from distortions. These improvements largely account for its faithful reproduction of speech and music.

That sound could be recorded on a steel wire drawn at a uniform rate past the poles of an electromagnet, which carried voice currents from a microphone, was discovered by Poulsen, a Danish physicist, about forty years ago. This method has the advantage that the records are ready for immediate reproduction, since no processing is required as with sound recordings on wax or film. Moreover, recordings can be retained practically indefinitely without appreciable deterioration; but if wanted only temporarily they can be erased and used immediately for other records.

Attempts to commercialize the magnetic method of sound recording met with little success, however, until the improvements of recent years in which Bell Telephone Laboratories have been largely concerned. These improvements include the use of better magnetic materials and thin, narrow tape instead of round wire. Round wire twists and the magnetic elements have to be recorded along it instead of transversely across so as to maintain in reproduction the same direction of polarity. This result was achieved by offsetting the pole pieces of the recording magnets along the wire. The highest frequency that could be reproduced depended on the length of the longitudinal magnetic elements and high wire speeds were necessary to obtain faithful reproduction by this method. These high speeds not only required long recording wires but they wore the pole pieces excessively.

Flat tape does not twist and this permits magnetizing the recording medium transversely instead of length-wise. The magnetic elements can then be shorter and this allows the speed of the tape to be reduced without losing the higher frequencies in the recorded sounds.

Before a magnetic record is made, the tape is strongly magnetized in a direction opposite to that produced by the recording magnet. It is then partially demagnetized by a direct biasing current, which is applied through the recording magnet to condition the tape so that the record will not be distorted.

Voltages induced during reproduction are proportional to the rate of change of magnetization and hence, for a constant tape speed proportional to the frequency of the recorded sound. The response, in other words, increases directly with the frequency. This holds true, however, only at low frequencies. At higher frequencies the response diminishes because of the finite width of the pole pieces and because of hysteresis and eddy current effects. The frequency at which this decrease begins is higher in proportion to the speed of the tape. The response of a magnetic recorder thus rises steadily with the frequency to a maximum determined largely by the design of the pole pieces and the speed of the tape. Beyond that the response decreases progressively. In practice an equalizer is inserted in the circuit to make the response essentially constant for all frequencies.

These principles of magnetic recording are incorporated in compact practical form in the Mirrophone, shown in the photographs above. Housed in a small cabinet is the recording-reproducing unit, an amplifier and a loud speaker. Associated with this unit there is a high-fidelity crystal microphone. The thin narrow tape on which the recordings are made is mounted on drums as shown, which rotate to draw the tape between the poles of the recording magnet. To allow the tape to repeat without rewinding, its ends are welded together to form an endless belt. The material of the tape is a special magnetic alloy recently developed by the Laboratories which is superior to other materials for magnetic recording.

In reproduction the recording magnet serves as the pickup device. A photo shows the recording and the polarizing magnets; a short loop of tape illustrates the method of threading. These magnets are a removable unit with plug connections. The dynamic loud speaker is supplied by a two-stage amplifier which develops exceptionally high gain. An acoustic chamber encloses the back of the speaker. Its field coil also serves as a filter in the amplifier plate-circuit.

Alternating current from any 110- to 120-volt lighting circuit operates the Mirrophone. A volume control regulates the intensity of the recording or the reproducing currents; and an electronic volume indicator shows when the level is correct for recording. To indicate the length of the recording there is a moving pointer which makes one complete revolution per minute and can be reset at any time.

"Record" Can be Reproduced Many Times

A record once made can be reproduced as often as desired and kept indefinitely or until the switch is again thrown to the recording position. Doing so automatically clears the tape as it passes the polarizing magnet and prepares it for a new record. The switch also has a stand-by position which leaves the tape running but disconnects the erasing, recording and reproducing units. An output jack permits connection to an external loud speaker or another recording machine when permanent records are wanted.

Best quality recordings are obtained when the speaker is close to the microphone, but the results are entirely satisfactory from greater distances. Group conversation can be picked up when the speakers are several feet away. Intelligible recordings have been made in large auditoriums with the sound source many feet from the microphone. On the other hand whispered words can be reproduced loud enough to be heard by all present in a large audience.

A person who hears a recording of his own voice for the first time usually insists that it does not sound natural. His friends on the other hand assure him that the reproduction of the Mirrophone is faithful. This is because one's own voice is ordinarily heard not only through the air but also internally by conduction through the bones of the head. Thus its true quality is unfamiliar.

Excellent for Voice Training

In the Mirrophone, therefore, instructors in voice training have an effective new tool. Public-speaking classes and music schools find it helpful in developing good diction and correcting faulty technique in the rendition of vocal and instrumental music, for it has the great advantage of permitting a student to hear his own efforts as others hear them and to listen critically to the faults which his teacher wishes to correct. An experimental model has been in use at the Juilliard School of Music in New York City.

As a lecture demonstration for talks and at expositions and conferences, it has the advantage of being able to reproduce recorded speech immediately and of preparing itself automatically for a new record. The Mirrophone is also an effective aid in teaching the correct pronunciation of foreign languages. Large commercial organizations and retail establishments can use it to train their personnel in correct diction for contacts with their customers both face to face and over the telephone. For the first time those interested in cultivating the voice and studying instrumental music have in the Mirrophone the opportunity of immediately reviewing their renditions—a privilege long enjoyed by devotees of the literary and graphic arts.

HAM SERVES CHINA AS U.S. LISTENING POST

MR. CHARLES E. STUART, of Ventura, Calif., who received his first amateur license from the Department of Commerce when he was thirteen years old, has been assigned by the Central Chinese government in Chungking to act as the American listening post to short-wave broadcasts from China.

Dr. Stuart's work is to receive and translate daily English voice broadcasts emanating from XGOY and XGOX, Chinese International Broadcasting stations in Chungking. These broadcasts consist of military and general news and talks by distinguished Chinese and foreigners, and are made primarily for use by the Chinese News Agency in New York City and by United China Relief.

At present the broadcasts are made on 11.9 and 15.2 megacycles on acetate instantaneous disks and then are translated. Dr. Stuart is aided in his job by Mrs. Alicia Held, who probably is the only secretary in the world who takes dictation from a source 7,000 miles distant, through static and heterodynes, through "fading" and "hash."

Dr. Stuart uses uni-direction antennae (rhombic) which are also reversible. One of the antennae used for the Chungking receptions is a highly directive diamond rhombic with a full mile of wire in the system. This gives great signal strength from Chungking, according to Dr. Stuart, plus consistent reception when poor general conditions are confronted. The location of this vital station is ideal, according to Dr. Stuart, being on a flat stretch of beach land underlaid with salt water, which gives maximum reflection and ground conductivity. The low horizon, plus the absence of interfering hills or mountains shields the incoming signals.—*N. Y. Herald-Tribune*