The Marvelous Voice Typewriter

Talk to It and It Writes

By Lloyd Darling

CONCEIVE an ordinary machine resembling the machines in common office use—full of the customary cog-wheels and crooked levers and variegated springs. It might be an adding machine so far as one can judge by external appearances or a dictaphone or a new-fangled cash-register. But——

Speak to it!

It becomes alive. It *hears* you. It vibrates with action. Somewhere inside, typewriter bars go "clickety-click-click." At the top of the machine a sheet of paper unwinds from a roller.


The largest camera in the world, used by Mr. Flowers in experiments for recording rapid sound vibrations

The machine has written down what you have spoken!

If you said "cat" it wrote down "cat". If you said "Dear Sir: Your favor of recent date received and——," as though you were starting out an ordinary, time-worn business letter, it wrote that same thing down.

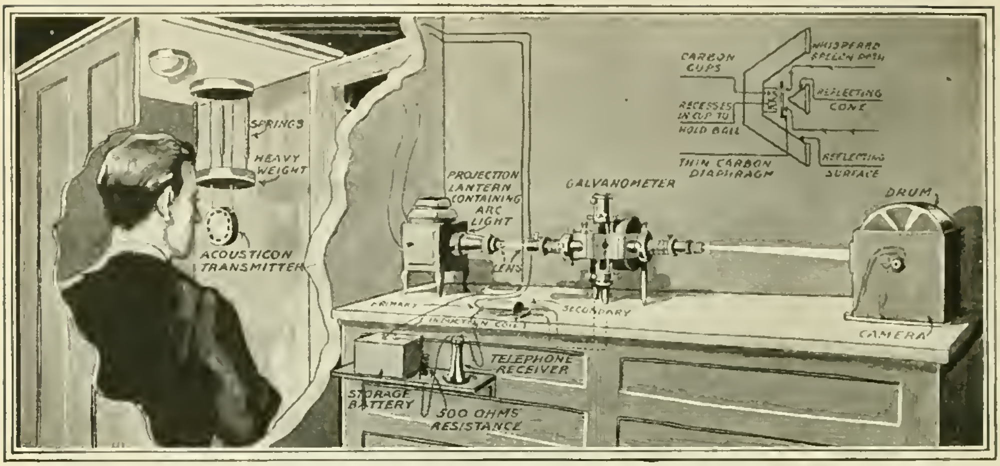
An odd feature about the machine is that it spells words as they sound and not according to some fat dictionary. Indeed it would have to be a phonetic speller. How else could it distinguish "dough" and "tough?" But if you are considerate, and mindful of its feelings enough to spell out words correctly in cases where it might be likely to err, the machine will very obediently follow you and make the resultant letter strictly orthodox so far as spelling is concerned. It faithfully tries to do its best.

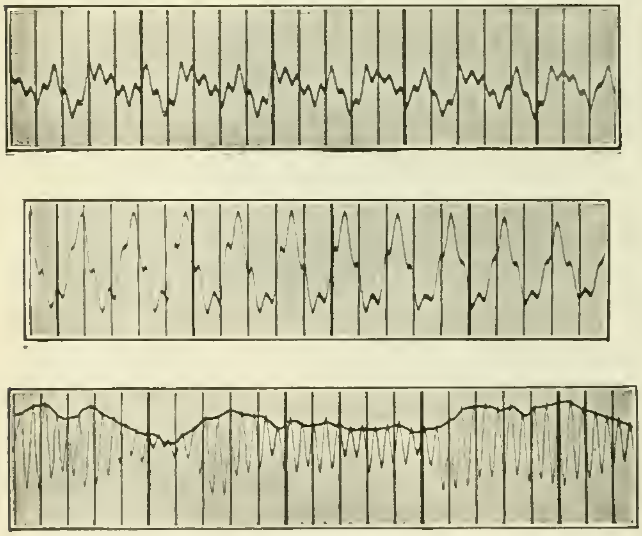
Does the machine think, as well as hear? How else can it perform all these feats if it doesn't reason?

Unfortunately, the machine doesn't think, however much it may appear to approach that desirable attribute. One reason is that at present the machine is brainless. But, even if it had a brain, that organ would be of no use in controlling parts completely separated. Thus far the inventor of this contrivance, Mr. John B. Flowers of Brooklyn, N. Y., has succeeded only in getting the various parts to operate, alone and by themselves—in itself no mean achievement. The machine as we have depicted it is the conception toward which he is working. It opens up a wide vista for the imagination. Think what it means for the office of the future to have an almost human machine at hand to perform the routine drudgery of typewriting and letter-writing!

Unlike most projected inventions of the kind this machine was not conceived as an idle dream. It is based upon sound technical reasoning and researches as

How the Voice Typewriter Works



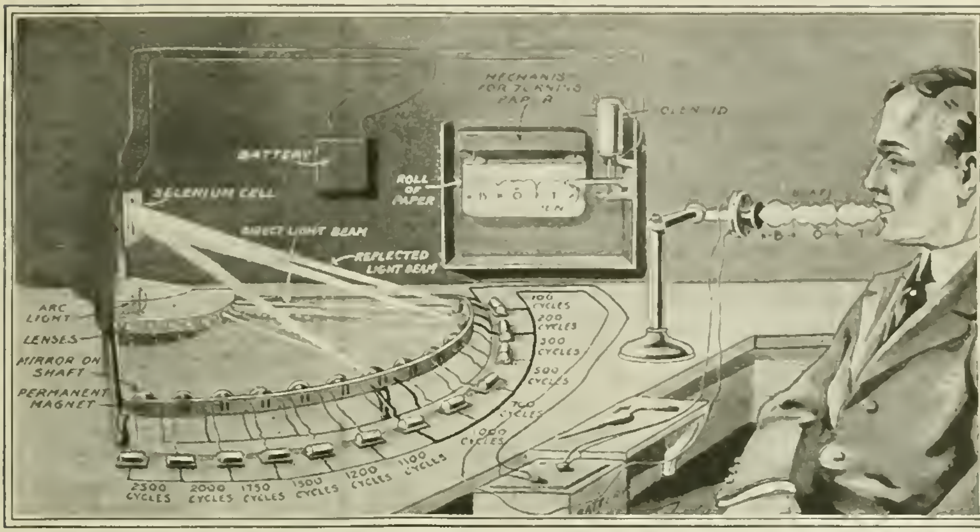


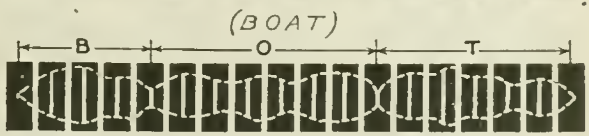
This is the machine used to evolve the natural alphabet. The man at the left is whispering into an acousticon or loud-speaking transmitter, which is attached to a heavy weight, in turn suspended by springs. The inertia of the weight and the resiliency of its spring supports, prevent exterior vibrations of any kind from jarring the extremely sensitive transmitter. Connected with its circuit is a string galvanometer. The whole arrangement is so sensitive that faint whispers readily cause the "string" to vibrate. Light from the arc light throws a shadow of this vibrating string on to the camera at right. A revolving drum carries a strip of photographic film and makes a permanent record of the vibrations. Sample records are given at left, together with an explanation below of what those particular curves signify.

These strange curves are records of the whispered and spoken vowel "U"

The strange curves shown above are records obtained from the apparatus. Upper Curve: Man's voice pronouncing the letter "U" bringing out in striking fashion the fact that any underlying curve is obscured by extra humps due to the peculiar nature of the particular speaker's voice. Middle Curve: Woman's voice pronouncing the same letter "U." Note differences from same letter pronounced by man's voice. Lowermost Curve is obtained when the letter "U" is whispered. Whispering is the most elemental way one can transmit speech, since it does not require use of the vocal cords. Contrast this curve with the two preceding. Note that instead of a series of repeating diagrams peculiar to a particular speaker's voice, a definite undulation or wave-shape now appears. In the two upper curves this underlying wave-shape was blotted out by extra curves or humps known as "higher harmonics" which arose from the use of vocal cords and were different for different men's and women's voices. This underlying wave-shape was none the less present in the two upper curves, because a sound shaped in this precise manner is necessary before the brain recognizes the letter "U" as such. Mr. Flowers' feat consists in recognizing this principle, and in demonstrating it. He whispers the whole alphabet into the transmitter of the apparatus shown above, and secures accurate photographs of the undulations, or "letter patterns" resulting. A complete set of these is shown on Page 68. Mr. Flowers found that it makes no difference who does the whispering; the same wave form for the same letter always results. Scientists recognize this as an immense step in advance, because heretofore men attempting to get at the real nature of speech have always been frustrated because the higher harmonics blurred out the true wave present. They could not deal with whispered speech because no apparatus sensitive enough to record whispered speech existed, and the curves they obtained with spoken speech varied hopelessly with each different speaker's voice.

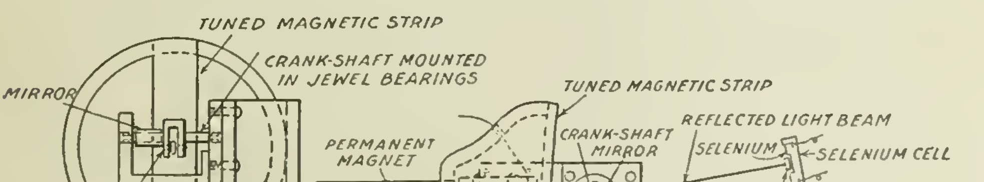
Experimenting with the Phonoscribe





This machine is sometimes referred to as a "phonoscribe." It is designed to take dictation, writing words down on paper in natural characters as fast as spoken. It is of interest here as a forerunner of the voice-operated typewriter. The man at the right is pronouncing the word "boat" as an example. The "a" in boat, being silent, produces no effect on the machine, since it must necessarily spell words phonetically, or as they sound. The "bot" sound vibrations proceed into the transmitter and affect an electric circuit in which are 12 vibrating-mirror mechanisms. Detail of these is given in the figure below. Each mechanism is tuned by the small coils back of it so that it will only respond to vibrations, or cycles, of a certain magnitude. See page 70 for further description.

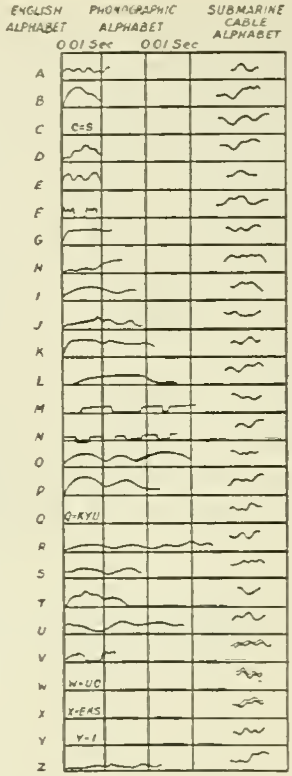
The black rectangles beneath the word "(Boat)" at right make clearer the workings of the selenium cell shown in the picture above. They may be considered a series of instantaneous views of the selenium cell while the light beams are varying in length over its surface. The white strips in the center of each view show how much the light beams happened to be vibrating at each particular instant. The white curves connecting the bottoms and tops of these strips of course have no real existence but were drawn in to show how the light-beam lengths follow the original shape of the word "boat" as sketched in, in front of the man's face. Note also how the curve traced by the solenoid and pen varied directly with the length of these light-beams, tracing the identical curve.



Detail of mirror-moving mechanism. Similar to a telephone receiver in general construction, the tuned magnetic strip taking the place of the usual diaphragm. Attached to the strip is a short lever working a tiny crank-shaft on which a little mirror is mounted. Vibrations from the strip rotate the crank slightly causing the mirror to move through a small arc and throw its beam of light up and down on a selenium cell in the manner shown in the illustration at the top of the page.

well as on experimentation, back of which were the resources of a great typewriter company.

The line of reasoning involved in designing the machine, though somewhat intricate, is exceedingly interesting. Getting any machine at all to respond to such an uncertain and variable director as the human voice, is a task beset with difficulties.



After all, what are spoken words but telegraph signals sent through the air, collected by the ear, and interpreted by your brain? Consider spoken words as sound signals and the voice-operated typewriter becomes possible

Alphabet of natural letter-patterns obtained with the apparatus shown at top of page 66. Note that the natural alphabet is not unlike that now used in submarine-cable telegraphy, though of course the two alphabets have no connection, theoretical or otherwise. The machine shown on page 67 spells out words in this natural alphabet.

This phonetic writing may some day be used in offices as a sort of short-hand system, the dictator talking into a machine similar in principle to that shown on page 67, and the stenographer afterward reading the wavy line from the roll of paper as easily as she would her own notes. The machine with its present design is entirely in laboratory form—interesting however, for the novelty of the idea on which it is based, and because it comes closest to tracing the true wave-form of speech of any machine yet devised.

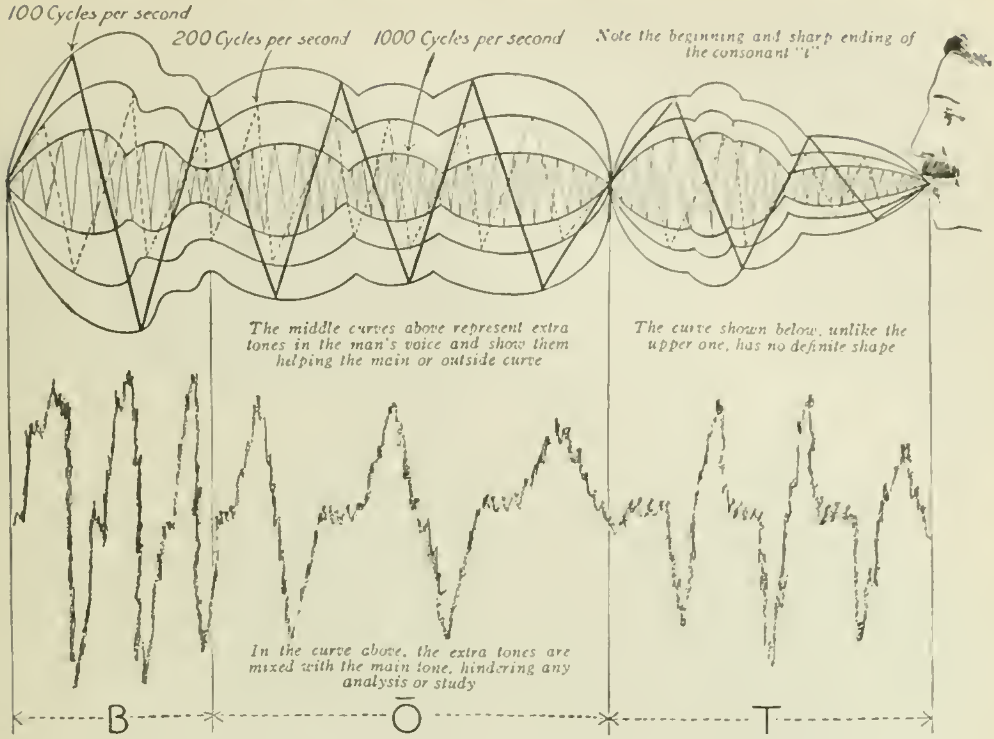
Speech Had First to Be Studied

In a recent paper which he read before the American Institute of Electrical Engineers, the inventor discussed researches lately completed into the true nature of speech, these having a great deal to do with the practical workings of the eventual machine. It was discovered that all speech can be represented by a sort of natural alphabet of sound patterns, which, no matter what the voice may be, always have the same shape. When a *man*, for instance, pronounces a given word he molds air waves in precisely the same way as does a woman. So far as sounds go, a Choctaw Indian is as well provided as a Harvard graduate; the only difference is that the sounds are grouped differently. This is a fundamental law. The mechanism of speech is the same in all of us. Heretofore physicists and workers with speech and sound have been troubled by the fact that they had nothing definite to work with. The consonant letters, when one person spoke them, would appear to have much the same wave shape as vowels enunciated by another speaker. In fact, even consonants and vowels produced by the same person sometimes seemed to have these indeterminate shapes when the scientists squinted at them through their sound-wave recording machines. Hence the task of ever getting spoken sounds analyzed and classified for study seemed hopeless. Until these letter-sounds were analyzed and classified so that somebody could reason out the real underlying law they obeyed, it was obviously impossible to go go far toward a voice-operated typewriter. One cannot simply say "Write!" to an inanimate collection of levers and expect them to respond.

Why Whispers Were Studied

The instruments which were used in determining the real nature of speech sounds are shown on Page 66. With this apparatus Mr. Flowers dealt only in whispers. Why? Because whispering is the most elemental way one can convey speech. When you whisper you make no use of the vocal cords or other complicated mouth and throat mechanisms. It may be said in passing that one of the principal reasons previous workers with speech sounds failed to get at true sound-wave shapes was that over-tones (extra tones that cause a given voice to have its peculiar and distinctive nature) caused the shape of the main tone or fundamental to be obliterated. Resonant or echoing tones arising in the

What the Word "Boat" Looks Like in Air Waves



The protuberance from the man's mouth in the upper picture is not an unnatural excresence. He is merely pronouncing the word "boat" and molding air waves in the manner shown

This shows detail of the word "boat" as pronounced by the man shown in the illustration at top of page 67. "Boat" spelled phonetically, or as it sounds, is of course "b-ō-t." Hence the curves for "b," "o," and "t," are all that need concern us here and the "a" can be left out of consideration.

These curves look complicated but are really simple and demonstrate most interesting points. In fact, they show us how we really speak, how we really mold air waves in pronouncing a given word. The upper set of curves are in the natural alphabet, as can be verified by comparing their shape with "b," "o," and "t" as given on page 68. The lower curve is the kind the old-time physics teacher would throw on a darkened screen as representing sound vibrations for such a word as "boat." It does represent such sound vibrations but they are in the crude, or unanalyzed state. The upper drawing shows the real multitude of curves whose jarring together, or "fighting," one might call it, caused the lower curve to be jagged and full of humps as it is. Mr. Flowers is the first to evolve this method of making clear the real nature of speech. Note how the machine shown on page 67 actually traces "b-o-t" on paper in natural characters, which ordinarily exist as ephemeral sound waves in front of a speaker, and which are difficult to capture and study.

mouth also aided in this. By dealing with whispers, however, the inventor at once eliminated all complications arising from the use of vocal cords and accompanying resonant vibrations. He could actually determine how it was that one's lips, teeth and tongue shaped letter-sounds and words into air waves.

As the figures on Page 66 explain, his apparatus was so sensitive that all sorts of whispered sounds could be recorded. The lower figure shows three sample records secured with the machine. Hundreds of others were obtained. It was found that each letter of the alphabet had a natural wave form of its own. This was the same no matter who the speaker was. In fact, it was found that these were the wave patterns, which, transmitted by the air, strike the ear and cause the brain to recognize a given letter as such. In other words, the letter patterns secured on photograph paper represented the actual wave shapes which everybody must use in conveying intelligence by means of speech. It was the first time they had ever been caught and recorded. Man has been molding sound waves into speech with his mouth and lips along lines represented by these curves for thousands of years; but he didn't know he was doing it. The chart on page 68 gives a complete set of these wave patterns. Just how a man molds sound waves into patterns such as these is shown graphically on page 69, the word "boat" serving as an example. "Boat" was chosen because its various letters, as explained in the figure, make use in succession of the lips, tongue, and teeth—three of the principal agents in shaping sounds. It is, therefore, a representative example.

Splitting Up a Spoken Word for the Voice Typewriter

Having discovered that a set of natural letter-patterns exists, the next thing is to make use of them. Accordingly the machine shown on page 67 was designed, and has in part been made to operate. It has been named the "phonoscribe," and is intended to write down speech in natural letter-patterns automatically. As is described in the figure, it makes use of a selenium cell* and a set of special vibrating-mirror mechanisms. These latter are each arranged or "tuned," to care for vibrations only of a certain magnitude. This is necessary, for this machine is intended to deal with spoken speech instead of whispers as did the recording machine shown on page 66. Since spoken speech, as has previously been outlined, is full of troublesome extra tones which obliterate true wave forms, it becomes imperative to have such tuned mechanisms as these to strain out the main or fundamental wave from its incumbrances. As shown in the figure on page 69 the main tone has a frequency, or vibration-rate, of 100 per second. The incumbrances have rates respectively of 200 and 1,000 vibrations per second. The three mirror-mechanisms which handle these rates are shown throwing their united light-beams on to the selenium cell, enlarging and diminishing the width of this light beam in unison, and so cause the cell correspondingly to vary the electric current through the solenoid and recording apparatus shown in the center of the figure. The width of the light beams at any one instant of course depends on how much the mirrors happen to be vibrating, and this in turn is controlled by the amount of current coming from the telephone transmitter at the right. The transmitter naturally shapes this electric current to correspond with the varying sound waves reaching its diaphragm from the speaker's lips. The whole apparatus therefore works in harmony, and a string of natural characters appears on the paper, recording whatever the speaker at the right has said—in this case the word "boat."

This phonoscribe is interesting mainly as a forerunner of the actual voice-operated typewriter itself. It embodies some principles, notably that of the selenium cell and accompanying vibrating-mirror mechanisms, which will be used in the ultimate speech-recording machine itself. But in this latter case of the typewriter, a whole collection of selenium cells will be necessary—one for each key on the machine.

The selenium cells are so distributed that only one letter of the alphabet can affect them. Down inside the voice-operated part of the machine these cells will be erected to receive waves coming from the vibrating mirrors when a person speaks. The selenium cells within the machine are arranged to correspond to the characters of the natural alphabet (see chart of these, page 68). If an ordinary rotating mirror be placed in the path of the light beams coming from the vibrating mirrors, it will automatically "spread out" these beams from the straight line (such as is shown on the selenium cell of the figure on page 67) to their natural wave shape (that shown on page 68) this on the same principle that physics teachers of old used to "spread out" sound vibrations on a screen, using a revolving mirror. The "spread-out" vibrations are intended to fall each on its own selenium cell in the base of the machine, and because of this falling on the proper selenium cell, to affect the corresponding typewriter key.

*Selenium is a metal the electrical conductivity of which varies directly with the amount of light falling on it at any given moment.