

ENGINEERING

Now a Machine That Talks With the Voice of Man

Voder Combines Electrical Currents to Produce Synthetic Speech; Converses at Signal From Keys

See Front Cover

NATURE took hundreds of thousands of years to teach man how to speak.

In two years, scientists have taught a machine how to talk, translating into real words and sentences signals punched into its controlling keyboard.

Controlled by a skilled operator who has learned how to mix the sounds the device's two electric discharge tubes produce, it combines varying electric currents that an amplifier turns into real speech. No phonograph records of any kind are ever used. It is the first device that actually creates human speech.

The name of this new robot is the Voder.

"Practice makes perfect," it told its first enthusiastic hearers at its debut before the Franklin Institute. It isn't perfect yet. But the Voder was good enough to convince its audience that the Fourth of July orators and, perhaps, even opera singers may some day have to look to their laurels.

This new synthetic orator will "lecture" with his "electrical accent" at the New York and San Francisco world fairs.

It is a compact machine resting on a small table, plus as many loudspeakers as are necessary to reach the audience. It has a pair of keyboard units, more than a dozen other controls and an electrical circuit featuring a vacuum tube and a gas-filled discharge tube.

It builds up speech from 22 fundamental sounds from which speech organs also create spoken words. The operator, in using the device, analyzes phonetically the words the machine is to speak, then duplicates the sounds, and therefore the words, by pressing the proper keys and controls.

The Voder proved itself to be quite an able talker at the hands of Mrs. Helen Harper of New York, first of 24 telephone operators to be trained in its use, and S. S. A. Watkins, Bell Telephone Laboratories scientist who taught it to speak. When members of the audience suggested even such difficult foreign phrases as "Hasenpfeffer" and "Com-

ment allez-vous?" it repeated "Hasenpfeffer" and "Comment allez-vous?" with perfect aplomb.

The machine resulted from efforts of Bell scientists H. W. Dudley and R. R. Riesz in fundamental telephone research. They developed an electrical speech analyzer and a speech synthesizer, both of which were demonstrated at the Harvard Tercentenary. The former machine fed an electrical control pattern into the synthesizer. With the exception of the organ-like keyboard, all its parts are in regular telephone use.

When the subject of the Bell exhibit at the New York and San Francisco fairs came up, it was suggested that the machine that talked, when the analyzer fed it the proper pattern, would be a fit display—particularly if it could be made to speak when an operator punched a keyboard instead of merely seeing that the analyzer continued feeding it the proper signals.

Two fundamental types of sound are involved in human speech—the relatively musical note of the vocal cords, and a sibilant hiss which can be recognized most easily in a whisper. These sounds the machine imitates. The vocal sound comes from a vacuum tube, while the sibilant is produced in a gas-filled tube. The tubes themselves do not actually produce the sounds; what they do is produce an electric wave whose pattern corresponds to the sounds in question and which is converted into sound in an amplifier, just as occurs in a radio receiver.

These two fundamental sounds are given proper pitch by punching the right one or ones of 10 keys which control electric filters. Changes in intonation, as in asking a question, are made by raising or lowering a foot pedal. Three special tabs provide the "stop" consonants, "t", "p", etc.

The Voder is actually the superior of any human being alive in one respect, for it can speak in tones ranging from lowest bass to highest soprano, as determined by the flick of a knob. Ordinarily, however, it speaks in a firmly masculine baritone.



THE VODER

The young lady striking keys is creating a man-like voice. This and the cover picture are from the Bell Telephone Laboratories.

Mr. Riesz is also known for his work in connection with the development of the artificial larynx. He and his associates are accustomed to calling the Voder "Pedro" after the Brazilian emperor, Dom Pedro. Dom Pedro, when he listened to a demonstration telephone, then newly invented, at the Centennial Exposition in 1876, exclaimed, "My God! It talks!"

Heart of the device is a "relaxation oscillator," which produces a saw-toothed wave from the discharge tubes, instead of the rounded wave of a pure musical note. The machine has considerable difficulty with the so-called transitional consonants, such as "l" and "r", but otherwise its speech is clear.

Science News Letter, January 14, 1939

GEOLOGY—PHYSICS

Research By-Product Saved \$500,000 During Depression

THERE is nothing much more fundamental than the constitution of the earth itself and the rocks that lie beneath our collective feet. In Washington there is a modest building full of laboratories where a handful of scientists are struggling with this problem.

During the World War the scientists at the Carnegie Institution's Geophysical Laboratory interrupted their program long enough to help create an American optical glass industry without which our

military forces would be blind. Then they went back to fundamental research.

One of the researchers there was Dr. R. B. Sosman. About a decade ago he was persuaded to join the research laboratory of U. S. Steel Corporation then being organized under Dr. John Johnston, Director of Research, and former Sterling Professor of Chemistry at Yale. The steel industry as well as the pure science foundation, with steel-earned Carnegie funds, needed a man who knew about quartz and silica. For this is stuff that withstands the heat of furnaces. It is axiomatic in research that it is wisest to do a thorough, fundamental job of "pure science" knowledge manufacture. The by-products will pay industrial dividends in the near future and the pure science main product may produce a new industry a few decades hence.

One of the mere by-products earned the cost of Dr. Sosman's researches a

good many times over during the depression. You'll remember that steel production dropped then. That meant less need for coke and that caused a shut-down of by-product coke ovens. But it cost money to keep an oven shut down, or at least it used to. The ovens are lined with silica brick, which when cooled has a large volume change, so large that it wrecks the lining. The practice had been to preserve the ovens by firing them with gas, though they were idle and useless.

Dr. Sosman heard about this and remembered his researches on transition points in silica. He was able to predict that if the ovens were cooled very, very slowly in the range 400 to 500 degrees Fahrenheit the disastrous volume change could be avoided. The idea worked perfectly and while the ovens were shut down for three to four years about \$500,000 in gas bills was saved.

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A new visualization presented by Prof. George A. Baitsell, of Yale's department of zoology, bridges the gap between the living and the non-living with recent new knowledge of gigantic chemical molecules of viruses that act as though they were alive.

The difference between the living and the non-living is shown to be a matter of complexity. The same materials are used in both domains and they conform to the same elemental patterns. The natural world is fused so effectively that the procession of organic development flows uninterruptedly from atom to man. There is no need to worry as to just when and at exactly what stage life was infused into the evolving stuff of the natural world. In that ultra-Lilliputian borderland where the most powerful microscopes lose their sight, increasing complexity evolves into what has been labeled "life."

"From the simplest substances in the organic world to the most complex patterns of living substance there must be a graded series," Prof. Baitsell told the scientists. "Should evolution begin at the level of the living organism? The union of hydrogen and oxygen to form water, the union of carbon and oxygen to form carbon dioxide, the union of water and carbon dioxide to form sugar, the addition of other elements to the sugar molecule to form protein—were not all these stages in the evolutionary processes which have led to ever-increasing complexity, reaching their climax in the world of life?"

Viruses Living?

ONE of the major controversies of science today may be settled with the verdict: Everyone right.

The viruses that cause diseases like smallpox, infantile paralysis and other diseases are living? Correct. They are non-living? Correct. They are the beginnings of life? Yes. They are the last possible stage in parasitic degeneration? Also yes.

Contradictory as this may sound, it may be the explanation of the findings in this latest field of disease research, in which protein molecules, exceedingly minute for germs and exceedingly large chemically, are the puzzling actors.

One of the leading researchers in this field, Dr. Thomas M. Rivers of the Rockefeller Institute for Medical Research, believes that these viruses, much too small to see, are a very "mixed lot," having only their size and disease-causing ability in com- (Turn to Page 28)

BIOLOGY

Plant Tissues Shown to Have Potential Immortality

Plant Callus Grows and Grows in Laboratory, But Its Cells Remain Immortally Young and Undeveloped

YOUNG plant tissue has shown potential ability to stay young forever, in cultures prepared by Dr. Philip R. White of the Rockefeller Institute for Medical Research, Princeton, N. J. Dr. White, who was winner of the \$1,000 prize of the American Association for the Advancement of Science a year ago, reported his newest researches before the same organization, at the recent Richmond meeting.

The living material used in the experiments was taken from a hybrid ornamental Nicotiana plant, and consisted of stuff called callus. Plant callus is a mass of undifferentiated, unspecialized cells that form when the plant is wounded; it is essentially embryonic, or physiologically young tissue.

Dr. White kept his bits of callus in specially prepared nutrient solution consisting of a sugar, certain necessary mineral salts, together with vitamins and plant hormones which have been found essential to growth. The tissue grew and grew, but the cells showed almost no tendency to mature into any of the specialized forms found in plant organs. It was immortally young.

Each week Dr. White discarded part of the growth and kept the rest. At the end of the week new growth would have increased the pieces to three times their original size.

This kept up for forty weeks. By that time, he calculated, had he been able to keep all of the tissue as it grew, the original piece would have increased to 10 to the 19th power (10,000,000,000,000,000,000) times its original size.

For several years, Dr. White has kept cultures of roots going, unattached to any parent plant, but this is the first time that it has been possible for him to produce unspecialized tissue that is "just plant." The new material is analogous to the cultures of chick embryo, long since famous in the scientific world, first prepared many years ago by Dr. Alexis Carrel.

Evolution in Non-Living

EVOLUTION of man and all lesser living things gains scope and takes on new grandeur by being traced far below the world of life to the very chemical elements themselves.