ELEKTRO—THE MOTO-MAN

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never hope to compete with human intelligence and muscular control. There are 292 different muscles in the human body, capable in combination of producing unestimated thousands of different movements beyond the 500 most elementary motions. On the basis of Elektro's 260-pound weight and 26 tricks, he requires about 10 pounds for every motion. Theoretically he would have to weigh about 5,000 pounds in order to accomplish the most rudimentary human movements.

Elektro's "brain" weighs approximately 60 pounds and occupies more than 4 cubic feet of space outside the robot's body. The "brain" or control unit includes an "electric eye," 48 electric relays and signal lights. He is "bossed" by human commands spoken softly into a microphone, jumps to obey, although there is no visible connection between the microphone and the robot.

VOICE CONTROL

Spoken words set up vibrations which are converted into electrical waves by a grid-glow tube. The electric impulse then lifts a shutter in front of an electric lamp and sends a flash of light across the room to a photoelectric tube or "electric eye" in the control unit (not shown) which serves as Elektro's brain.

The "electric eye" acts as a sensory nerve. It receives the light command, translates it into a feeble electric current which is amplified and sent on to the bank of relays. The relays, which operate on the same magnetic principle that makes the front door bell ring, close and open electric circuits to start Elektro's motors turning.

Talking to Elektro is like dialing an automatic telephone, using light impulses instead of numbers to cause the relays to act. It makes no difference what words are used to give the command so long as the proper number of light impulses are produced.

One word or impulse places a series of relays in position to act. Two words close the electrical circuit and release current to the motors employed in any particular movement of the robot. Three words activate relays to stop Elektro, and 4 words bring all of the relays back to their normal position of rest.

Signal lights on the control panel inform the operator which movement of the robot is next in sequence. By speaking single words or a series of words properly spaced, the operator can cause the relays to skip over any number of these "points of motion." When the light flashes over the desired "point of motion" on the control panel, a 2-word command will start the proper relay.

Just as the "electric eye" converts light waves into electric currents to put life into the robot, two other "electric eyes" enable it to discern colors. These photoelectric cells are placed directly back of Elektro's glass eyes. A filter in front of one tube lets only the relatively hot rays from red light through to the cell. A filter in front of the other tube permits only the relatively cool heat waves of green light to reach the tube. When the proper lights are flashed in Elektro's eyes, one or the other of these "electric eyes" energizes a relay to start a record revolving on a turntable to produce the word "red" or "green."

WALKING AND TALKING

Elektro's walking is accomplished by means of 4 rubber rollers under each foot which are driven by chains and shafts connected to a motor in the middle of the automaton. Nine motors are required to operate the fingers, arms, head and turntables for talking. Another small motor works the bellows for Elektro's smoking.

Like some radio programs, Elektro does his talking by means of transcriptions. His speech usually lasts about 1 minute and uses only 75 words. He has 8 turntables, each of which could be used to give 10-minute talks. Actually, except for an opening talk of about a minute, his other speeches will be only a few seconds long. A solenoid (a tubular coil) activated by electrical impulses in proportion to the harshness or softness of spoken words makes Elektro's aluminum lips move in rhythm to his speech-making.

Automatons have indeed come a long way since Aristotle speculated upon the possibility of making mechanical men. Elektro's direct forebear is Willie Vocalite, a robot developed a few years ago in the Westinghouse research laboratories. Willie is voice-operated and can stand up and sit down, but he can't walk. Their common ancestor was named Televox, but he responded only to sounds transmitted by telephone wires and went through life without an "electric eye."

These are actors on the stage of electrical living. The scientific principles which they dramatize are already quietly at work in industry. The Televox has now supplemented supervisory control in power transmission systems, enabling the system dispatcher to reroute the supply of electricity when a power line has been damaged. The "electric eye" and relays are employed in countless tasks of sorting, counting, and regulating, freeing human hands from monotonous and dangerous tasks. The sole reason for making Elektro was to dramatize the action of these sensitive electrical devices.

THE "VOSYN"—A ROBOT

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and quality which vary as the stream proceeds. During most of the speech only one of these 2 streams is active at one time.

THE BUZZ-AND-HISS SOUND STREAMS

Mr. Dudley proceeded to demonstrate the first-mentioned sound stream which he designated as "the *buzz*". It was a rich full note, something like a muted automobile horn. From this note, electrical filters picked out 10 different ranges of overtones covering the gamut of the human voice. The same filters then broke down the second stream—a *hissing* sound—into 10 ranges. These different sounds in their proper proportion form all the sounds of speech.

The Voder, astonishing telephone robot at the two World's Fairs, mixes sounds by finger controls. What Mr. Dudley was demonstrating was a circuit which analyzes a voice into 20 parts and then uses the results to control the proper amount of each of the sounds before they reach the loudspeaker. A shift in relative amounts was shown to change one vowel into another.

After letting his audience hear a test sentence before and after it had been broken down and put together, Mr. Dudley showed how it would sound when the buzzer alone was used and its pitch was held constant: a flat monotone like a chant. By releasing the pitch, so it could follow the speaker's voice, more naturalness was secured. Normal speech was converted into a whisper when the hiss was substituted for the buzz. While the hiss is relatively faint, it is essential in discriminating between "church" and "shirts", as was then demonstrated.

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