

thirty years of close observation and repeated experiments. I shall first describe the machine and then give an idea of the system of stenography employed, which is, perhaps, not as simple as it might be. It is necessary to premise, however, that Dr. Michela found, as the result of the careful decomposition of the phonetic elements of speech, that each syllable is composed of properly three parts at most—an initial consonant sound, a vowel sound, and a final consonant sound. The initial consonant on the other hand, is occasionally complicated by the introduction of a second sound. Thus, in the word "pace" we have three sounds, those of *p*, *a*, *e*, in "place" we have, according to Dr. Michela, four, the simple sound of *p*, being complicated by the additional *l*; he has therefore divided his signs in four series. The first contains all the consonant sounds; the second, all the sounds by which these consonants are ever doubled; the third, all the vowel sounds; and the fourth, once more all the consonants. This arrangement is of importance for the merely mechanical portion of the machine, for it is owing to it that the operator succeeds in tracing the letters in the required order. The types which produce the impression of the phonetic characters are arranged in the order of these four series; so that if there be an initial consonant it comes first, if this be a double sound the complimentary character in the second series comes next; the vowel third, and the final consonant last; were this not so there would be a difficulty in repeating the same sound in two different places in the same syllable. Again, each syllable forms a line by itself, so that no confusion can arise from the repetition of the same sound in the same word. The types being immovable, as far as the order in which they stand is concerned, there might in the word "apparent," for instance, be some difficulty in placing the second *a* if they were both written on the same line. As it is, the

word would be written thus: $\left. \begin{array}{l} \text{ap} \\ \text{a} \\ \text{rent,} \end{array} \right\}$ by which

means no confusion can arise. All this sounds, perhaps, complicated, but it is easy and rapid in practice from the nature of the mechanism which permits all the elements of each syllable to be produced on the paper by one movement of the hand.

The apparatus resembles a tiny piano with twenty keys, twelve white and eight black—disposed precisely like those of a keyboard. This keyboard is divided into halves by means of which the paper whereon the signs are printed is unrolled, and a row of little rods, at the top of each of which is cast, in relief, one of the phonetic signs—just like common type. These signs are disposed in the order indicated in my last paragraph, and do not occupy more space than about a couple of inches. A cover like that of a piano fits down over the keys, and when closed, the whole machine forms a box of about eighteen or twenty inches in length. It stands on three legs which can be dismantled.

It forms then a sufficiently handy package to be carried under the arm. When set up for work it reaches to the knees of the operator—I had almost written the performer—sitting before it.

Each note when touched, pushes down a vertical rod which acts on the end of a horizontal blade-shaped lever. This lever is attached to the other end to one of the slender rods on which are graven the phonetic signs, when therefore you press a note, one end of the lever goes down and the other up, and with it the type corresponding. It meets a band of paper passing just above the row of type and is printed on it, in colorless relief or in ink by means of another mechanism. On hearing a word, therefore, the operator, as in phonography, decomposes it into its phonetic syllables. He has under his fingers the keys requisite to represent, in writing, the first syllable. He touches them altogether, and the first syllable is printed; then the next in the same way, and so on. He operates in precisely the same way as a performer on the pianoforte striking a chord. Indeed the idea of his apparatus was evidently suggested to Dr. Michela by this musical instrument. As a skilful pianist, on seeing a group of notes, immediately finds the corresponding keys, so the mechanical reporter on hearing certain sounds, prints them with equal rapidity and ease. After each chord the paper moves forward, and thus the next syllable is printed a line below, and so on. The machinery by which this latter result is produced is no less ingenious than simple.

The paper is rolled around a cylinder in long strips of about two inches in width, it passes over the type and then between two other cylinders which grip it; one of the latter is governed by a small cog wheel which is pushed forward at every touch of a note, or of an assembly of notes by means of a small hook which catches in one of the cogs, and is worked by a rod in connection with all the keys. The movement takes place only when the notes, after having been struck, return to their natural position, that is after the impression has been produced. As the notes are struck this hook goes down, a slight turning motion, produced by a spring, preventing its catching in a cog as it descends. When the released note springs up again, the hook comes up and pushes the cog which it finds in its way, upwards. This little wheel sets the cylinders going at each movement, and having hold of the paper pulls it along with them a certain distance. The ink is applied by another little roll of blue inked paper, moved in the same way and passing over the white strip the moment the impression takes place.

In a machine of the nature of this one, the graphic system is quite of secondary importance—certainly not of such paramount importance as in the case of written shorthand. The objects to be obtained are economy of space, facility of transcription, and simplicity of study. The main object of a written system, namely, brevity, as an essential to speed, is of no consequence since, by the aid of a machine, a long