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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

PRIZES FOR DESIGNS FOR FURNITURE.

The Council of the Society of Arts hold a sum of £400, the balance of the subscriptions to the Owen Jones Memorial Fund, presented to them by the Memorial Committee, on condition of their spending the interest thereof in prizes to "Students of the Schools of Art, who in annual competition produce the best designs for household furniture, carpets, wall-papers, and hangings, damasks, chintzes, &c., regulated by the principles laid down by Owen Jones."

The prizes will be awarded on the results of the annual competition of the Science and Art Department. Competing designs must be marked "In competition for the Owen Jones Prizes."

No candidate who has gained one of the above prizes can again take part in the competition.

The next award will be made in 1895, when six prizes are offered for competition, each prize to consist of a bound copy of Owen Jones' "Principles of Design," and the Society's Bronze Medal.

Proceedings of the Society.

CANTOR LECTURES.

TYPE-WRITING MACHINES.

By Henry Charles Jenkins, A.M.Inst.C.E.

Lecture I.—Delivered April 30, 1894.

The subject before us to-night occupies a somewhat peculiar position, in that, although possessing much importance and interest, it is but a development in a particular direction of something much greater. It is generally agreed that the most wide-reaching invention in the present era has been that of printing. Until about five centuries ago, the records of the world, and duplicate copies of them, were, with very few exceptions, all obtained by means of the laborious operation of writing. The exceptions were to be found in the use of engraved seals, which could be impressed upon the surface of a plastic material that subsequently could be hardened, and in the use of engraved wooden blocks, from which an ink impression could be made upon a sheet of paper. The use of the wooden blocks was, however, confined to a single part of the world, and for the rest, the scribe had not only to make the first, but every other copy of his work.

The invention and use of moveable types created what was nothing short of a social revolution, the beneficial effect, and even the residual agitation of which we feel at the present day. It must have occurred to many a printer since that time that the use of a set of types for the production of a first copy, without the need of "composing," would be advantageous; indeed, the bookbinders of to-day perform wonderful feats in lettering by such aid. It would ultimately be the opinion of some one versed in the mechanical arts, that the operation could be performed by a suitable machine; and we find that, in 1714, a Mr. Mills—born in London in 1680—and at that time engineer in chief to the New River Water Company, devised some such machine, and obtained letters patent for it. He seems never to have developed his invention; indeed, his duties would probably leave him little leisure, and the "typewriter" was left for a later day.

There are a few fragmentary records of machines that may have been typewriters, including those of an embossing machine, invented in France in 1784; but we have nothing very definite until nearly a century and a half had elapsed.

In the year 1844,* the Rev. W. Taylor, F.R.S., exhibited at the meeting of the British Association, at York, a type-writing machine, the invention of Mr. Littledale, a resident of that city. It was designed for the especial purpose of giving aid to the blind. It is possible that earlier attempts may still be discovered, for ever since the beginning of this

* British Assoc. Report, York meeting, 1844, p. 99

century, and for long previously, benevolent minds had been hard at work to ameliorate the condition of those who are not so fortunate as to enjoy the possession of sight, and it is difficult to suppose that a half century had been occupied with inventions by which to aid them in writing and in reading, without some such attempts having been made. No drawings of this machine are to be found, but we have a description indicating that the apparatus consisted of a set of types arranged in a single row, and means by which any one of the set could be brought beneath a hammer. There was also some arrangement by which a sheet of paper was held in place beneath the hammer and moved the width of a letter at every stroke of the machine. Finally, although Mr. Littledale endeavoured to produce embossed printing, he also employed blackened or "manifolding" paper, which, placed between the hammer and the sheet, caused a black mark to be left upon the embossed sheet. Wooden type was employed, and to avoid damage to its face the inventor of the machine used a piece of cloth between the type and the impressing hammer. He contemplated, however, the use of metal type.

It will thus be evident that Mr. Littledale's machine was a veritable typewriter, which we may, for all ordinary purposes, define as being a machine for producing printed matter without the preliminary "setting up" of type.

All the practical typewriters of the present day are printing machines, but they need not necessarily be so, we might have true writing machines, or we could have stencilling machines.* Many present will recall the late Professor Cowper's arrangement of cams, by which two motions, at right angles to each other, could be given simultaneously to a pencil, and thus cause the pencil to trace out written letters.

The following figure (Fig. 1, p. 841) shows a machine in which a similar attempt, but on a much bolder scale, was made. This machine was patented in this country in 1846 (No. 11492) by Vickers, of Sheffield, as a communication from a foreigner residing abroad. Fig. 1 is from the patent specification, and, as it has been a little simplified for the sake of clearness, only shows the arrangements for writing three letters of the alphabet instead of twenty-six letters, besides figures. There is a shaft, *a*, upon which is mounted a series of cams, one set of which is lettered *b*. A similar set is provided for every letter that the machine is adapted to write. The set of cams consists of two surfaces, one of which is what is technically known as a "face" cam giving motion, in the direction of the axis of the shaft, *a*, to a piece, *d*, attached to a sliding frame carrying the pencil, *e*. The other part of the set of cams consists of a surface, giving motion in the vertical direction to the piece, *c*, upon which the horizontally sliding piece, *d*, is mounted. The pencil, *e*, is thus made to partake of both movements, and by giving suitable shapes to these two surfaces the movements of the pencil, due to one revolution of the set of cams, correspond to that necessary to form a single letter upon the temporarily fixed sheet of paper, *g*. The pencil, *e*, is also pivotted on the frame that carries it, so that it is only in actual contact with the paper when writing is being performed. There are several ways in which the revolution of the cams may be brought about, either a lever, *f*, may, by its depression, cause the rotation of the system by means of a cord wrapped around a drum, *h*, mounted upon the same shaft as the cams, and engaging with them in one direction only, by means of a suitable arrangement of ratchets; or the shaft may be kept continually rotating by independent means, and the cams brought into connection with it for the period of one revolution at a time, by means of some suitable clutch contained in drum, *h*, whenever the lever, *f*, is depressed. The inventor provides in the patent for the adoption of either method, but illustrates the latter.

We now will consider a notable feature in the machine, in which it was much in advance of many later and, in all other respects, better instruments—its writing was properly spaced.

The paper was held in its flat frame immediately opposite the pencils, and this frame was capable of sliding vertically in a second frame, *l*. The frame, *l*, could, moreover, slide longitudinally in between the guides, *m m*. A rod, *n*, was provided parallel to *m m*, and, allowed a screw, or worm, mounted on the back of *l*, to slide over it, but compelled the worm to partake of its rotatory motion. This rod was connected also, by means of a train of wheels and a cord, with the treadle, *k*. The treadle, which was mounted on two pivotted arms, extended right along the machine, and rested beneath the levers, *f*, so that whenever one of these was depressed, the bar, *k*, was also depressed a pre-arranged distance, varying with the width of the letter to be written, and adjusted by means of a set screw on *f*.

* Very few stencilling machines have been made. One was patented by Forbes (3235, of 1876) of England.

This caused the rod, *n*, and the worm to rotate and advance the paper the proper distance for the letter to be written at the same time as cams were thrown into gear. The same movement also advanced the point of the pencil up to the paper, and writing would commence. The treadle, *k*, would rise as soon as the lever, *f*, was liberated, but would not affect the position of the paper, owing to the interpolation of a suitable ratchet in the train of wheels. Then when the shaft, *a*, had completed its revolution, the pencil, *e*, would drop

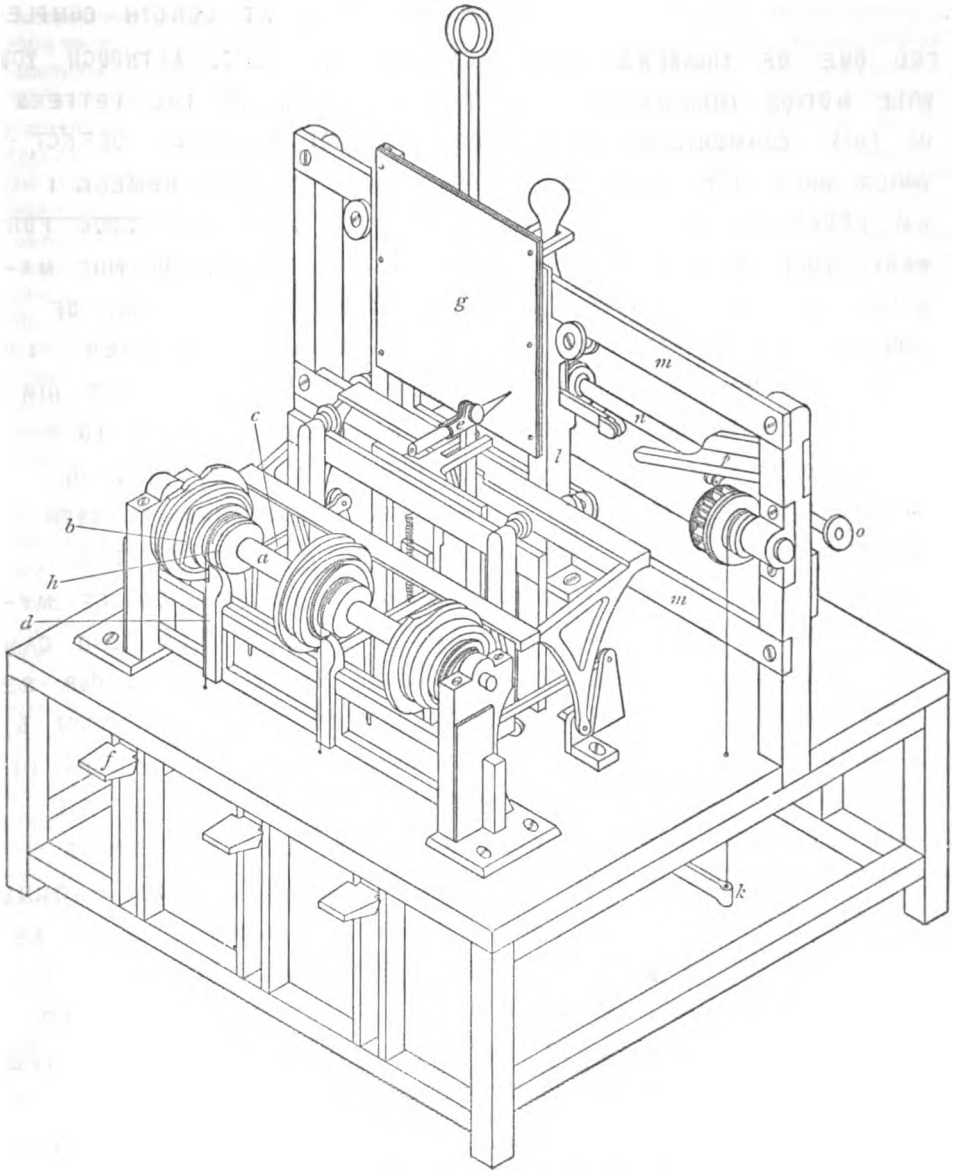

FIG. 1.—VICKERS' SPECIFICATION, 1846.

away from the paper, and at the same time the cams, *b*, would drop out of gear, and everything would be ready for the writing of another character. At the end of the line the shaft, *n*, and the treadle, *k*, were disconnected by means of a catch, *p*, and the shaft rotated backwards by means of a milled head, *o*, this also caused the sheet, *g*, to be lifted up the distance of a line in the frame, *l*. The catch, *p*, was replaced, and writing could be recommenced. The means employed for the adjustment of the spaces that each letter

NORWICH CT. FEBRUARY 1846

GENT.

WE HAVE, AT LENGTH COMPLETED ONE OF THURBERS MECHANICAL CHIROGRAPHERS. ALTHOUGH YOU WILL NOTICE IMPERFECTIONS IN THE FORMATION OF THE LETTERS IN THIS COMMUNICATION, YET THERE IS NOT A SINGLE DEFECT WHICH DOES NOT ADMIT OF AN EASY AND PERFECT REMEDY. I AM PERFECTLY SATISFIED WITH IT BECAUSE I DID NOT LOOK FOR PERFECTION IN THIS FIRST MACHINE. THE DIFFICULTY IN THIS MACHINE IS THAT THE CAMS ARE NOT LARGE ENOUGH. THIS, OF COURSE, CAN BE AVOIDED. I THINK MR. KELLAR TOLD WHEN I LAST SAW HIM THAT IF I WOULD WRITE TO HIM INFORMING HIM WHEN I SHOULD BE IN WASHINGTON HE MIGHT BE ABLE TO MAKE SOME SUGGESTIONS ABOUT A HOME DURING MY STAY IN WASHINGTON. I SHALL WISH TO EXHIBIT THE MACHINE. TO SUCH GENTLEMEN AS MIGHT TAKE INTEREST IN A THING OF THIS KIND. I DO NOT WISH TO MAKE A PUBLIC SHOW OF MYSELF OR MY MACHINE. I WANT TO SHOW IT TO MEN WHO CAN APPRECIATE AND UNDERSTAND MACHINERY. MR. ROCKWELL. OUR REPRESENTATIVE IN CONGRESS VOLUNTEERED TO GET ME A ROOM & I HAVE WRITTEN TO HIM ON THE SUBJECT. STILL I THOUGHT IN CONSEQUENCE OF YOUR MORE THOROUGH ACQUAINTANCE IN THE CITY THAT YOU MIGHT BE ABLE TO MAKE SOME SUGGESTIONS WHICH MIGHT BE BENEFICIAL TO ME IN EXHIBITING HE MACHINE. I WANT A ROOM LARGE ENOUGH TO RECEIVE SUCH COMPANY AS MAY WISH TO SEE THE MACHINE. I WANT A ROOM WHERE I CAN SAFELY LEAVE IT WHEN I AM ABSENT AND WHERE NO ONE WOULD BE LIABLE TO GO IN AND INJURE IT. EXCUSE THE LIBERTY I HAVE TAKEN, AND BELEVE ME

YOURS, TRULY. CHARLES THURBER.

MESSRS. KELLER & CREGNOUCH
PATENT ATTORNIES.
WASHINGTON. D. C.

FIG. 2.—WRITING FROM THURBER'S "CHIROGRAPHER," 1845.

should occupy, are open to criticism, they were very faulty, but the end sought to be attained was excellent, and it was many years before better means was provided. In the meantime we have almost become accustomed to the hideous uniformity of width of character (whether w, or a, or i, or m), imposed on us by the earlier marketable machines, but fortunately now no longer necessary, as will subsequently be seen.

This machine of Newton's so nearly resembles a writing-machine patented in the United States, in 1845, by Thurber, of Worcester, Mass. (No. 4271), that it has been described at length somewhat out of its place. A drawing is not preserved in the records we have in this country of the early American patents, but an examination of Thurber's claims lead to the conviction that his machine is identical with Newton's. We have fair proof, moreover, that the machine was made, as Fig. 2 will show. This has been photographed from what is evidently a lithograph* of writing actually produced in the machine itself, and we owe this cut to the courtesy of Mr. Allison, the librarian of our own Patent-office, in whose custody the sheet is to be found.

The sheet tells its own tale to the mechanical expert—a tale of difficulty that can only be appreciated by one who has experience with novel and intricate machinery. Indeed, this type of machine can hardly be imagined to have any chance of competing even with the pen, whether as regards permanent legibility or speed, the slightest irregularity of its working parts being quite enough to spoil either quality. There are easier ways, moreover, of getting legible writing that, at the same time, are but little affected by wear. In this machine it will be noticed that two distinct operations were found to be necessary to get one written character. One of these operations was the movement of a shaft, *a*, and the second was the depression of the key, *f*. This is slow, if performed by the operator himself, but in the course of this lecture we shall see that one of a pair of such movements may be performed automatically, and the combination utilised to great advantage.

Dronin† says of Thurber's machine:—"It did not answer well, because it had not the perfection that was necessary to enable it to obtain an advantage over the pen." The machine was, in reality, much in advance of the state of the mechanical arts of the time.

* U.S. Patent-office Reports, vol. ix., 1845, p. 1,351.

† "Machines à Ecrire." Paris: 1890, p. 7.

The next machine to which we will direct our attention possesses unusual interest. It was designed for the use of the blind by a man who was blind himself. Pierre Foucault, the inventor, was a pupil of the Institution for the Blind, Paris, and had so far finished his machine in 1849 that he was able to exhibit it in Paris, and receive for it the award of a gold medal. His invention was so useful that, in 1850, the Board of Encouragement, Paris, also awarded him a medal. He brought the machine to London in 1851, to the Great Exhibition, and obtained another award.* A number of these machines appear to have been made; they cost about £20 each. As they were somewhat bulky, they were placed on a low stool, in front of which the operator stood. The Fig. 3 is taken from a view published in London at that time; K is a curved keyboard with two rows of keys. Each key is attached to one end of a slider that was fitted

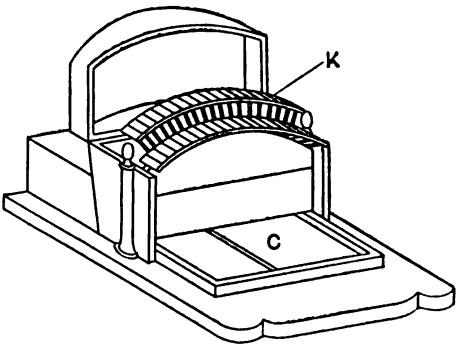

FIG. 3.—FOUCAULT'S MACHINE, 1850.

into one of a number of radial grooves in the machine. The opposite end of the slider carried a matrix that agreed with the key, and at the surface of the sheet of paper, *c*, the radial grooves all meet, and coincided, so that pressure upon any one of the keys would produce a embossed letter on the paper at one particular point. Means were provided by which the paper was advanced a step at every letter, and by which the paper could be shifted as required.

The jurors of the 1851 Exhibition had two other typographs to attract their attention, and they awarded medals to both.* One of the two machines, the invention of an Austrian named Marchesi, has disappeared; the other, which the jurors report to be the best in the Exhibition, is still with us. It is the invention of William Hughes, the governor of the Man-

* "Official Report Exhibition of 1851," p. 311; Cassell's "Illustrated Exhibitor." London: 1851, p. 53.

chester Blind Asylum, and one of the machines (Fig. 4) may still be seen in the magnificent collection of industrial machinery and models at South Kensington Museum. It is in working order, and the illustrations of it, as well as of several other of the historical machines, are from photographs, for which I am indebted to the able and courteous superintendent of that department, Mr. Last. There is a good description of the machine in the Official Report of the Jurors,* from which we might reconstruct the very simple piece of apparatus. It consists of a horizontal type-wheel, containing a number of vertical grooves in each of which is fitted a sliding type-bar, provided with a spring to keep it in its uppermost position. The type-wheel was provided with a wide rim that served as a dial-plate, and around this rim a row of raised letters, was placed, each corresponding to a type-bar, so that with the forefinger of the right hand the operator could feel which letter was to be pointed. With the left hand the operator then depressed a lever, *d*, that both locked the type-wheel into position, and pressed down the sliding type-bar on to a sheet of paper beneath it. Then upon raising the lever a detent moved the wheel, *e*, the space of a tooth, and this carried the type-wheel, and all attached to it, the space of one letter along the fixed screw, *f*. The detent could be released at the end of each line and the wheel pulled backwards, so as to start a fresh one. The paper was placed in a "manifolding" book so that the writing was not embossed but in black and white only, and the frame carrying the book could be

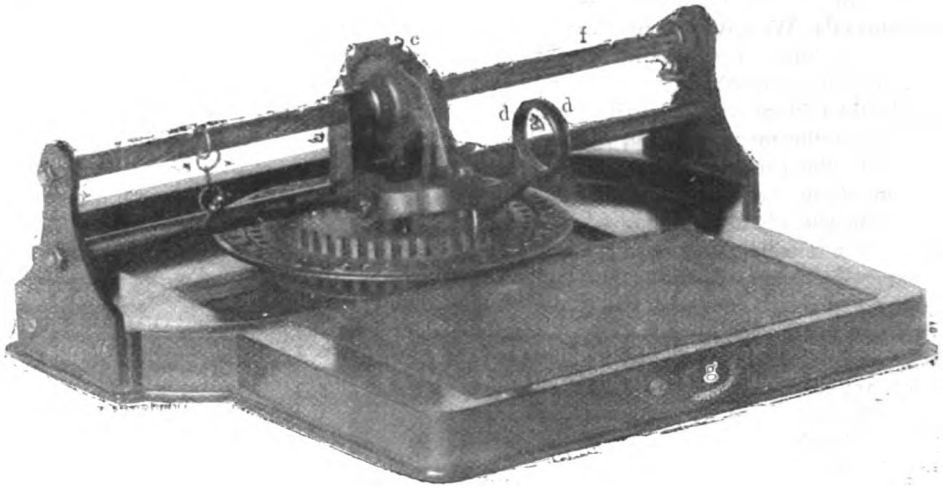

FIG. 4.—HUGHES' MACHINE, 1851.

advanced the space of a line, when required, by turning the screw-head seen in front of the machine at *g*. Hughes distinctly saw that his machine was capable of being applied to wider uses, and mentions the pointing of museum labels where neatness was desirable, as being a possible means of employment for it. But the public in general appear to have viewed these typographers, as they were called, in a most apathetic way, and severely left them to the use of those for whom they were primarily designed. Indeed, the official reporter, Mr. J. Glaisher, F.R.S., when giving his lecture in this room†, upon philosophical instruments (in which class these machines were placed) at the Exhibition, did not even refer to them, although they had received medals by his award. But Hughes's machine was of too useful a nature to be ignored by inventors, and we find that in 1852, only the next year, a patent* for a somewhat improved form was granted to a Mr. Jones. He retained the type-wheel with vertical type, but employed a cylinder beneath it upon which to secure the paper, and this seems to be the first time that the cylindrical impression surface is patented in connection with typewriters. About the "invention" itself, the "Official Examiner" is quite eloquent. He reports that "a patent was granted for a mechanical typographer by which, with the necessary

* "Official Report Exhibition of 1851," p. 311.

† "Lectures on the Results of the Great Exhibition of 1851." London, 1852, vol. i., p. 321.

* No. 8980, U.S.

practice to secure a skilful use of the machine, an author can print instead of writing his thoughts." One rather fears that his duties had kept him too closely occupied to have, at least, read the accounts of what was to be seen in Europe.

In 1854 a very simple and crude typographer was patented in America* by an inventor named Thomas. There was (Fig. 5) a type-wheel, T, with a horizontal axis carrying several rows of type, an aligning pin, P, by aid of which the roller is kept in position, and a cylinder, *c*, upon which the sheet of paper may be placed. This cylinder is mounted on a slide, F, by means of which the spaces between the lines may be made, and the cylinder itself is rotated a small amount after each letter. The ink is supplied by springs, M M, over which the type is first passed.

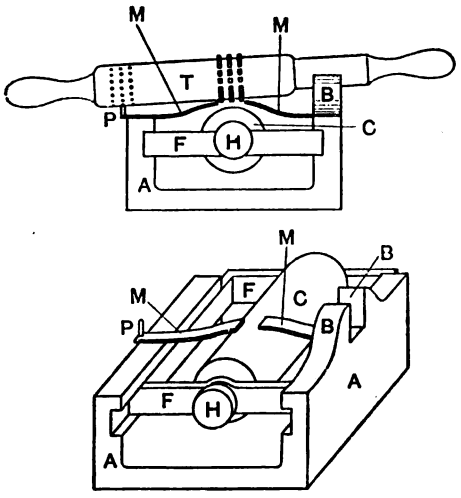

FIG. 5.—THOMAS' SPECIFICATION, 1851.

The printing machines with type-wheels in the above position are very numerous, but principally belong to the distinct class of printing telegraphs about which we are not concerned. The "Columbia" typewriter (1884) belonged however to this class, and reference will be made to it in the next lecture.

In 1856, another important combination was patented by an inventor named Cooper.† In this a wheel, with vertical axis and radial type was first brought into pointing position opposite a vertical sheet of paper; the wheel was then locked, and a hammer caused to strike the paper on to the type from behind. The instrument had a dial-plate on the same axis as the type-wheel, by the aid of which a letter was selected, and the same handle that was employed for this purpose was employed to lock the wheel (as in Hughes's machine) and to cause the hammer to deliver its blow. This last was effected by fitting the hammer on a bellcrank lever, one arm of which passed immediately beneath the axis of the shaft upon which both type-wheel and index-plate were mounted. A depression of the shaft, to which the handle was attached, thus caused the hammer to give the impression. This machine is capable of much improvement, and, fitted with a keyboard, will be recognised in the course of next lecture.

We must now retrace our steps a little, for the problem of producing a practical typewriter had been engaging the attention of one of the greatest practical scientists of the day, as well as that of his assistants. The late Sir Charles Wheatstone had, in 1841, invented and patented a dial telegraph. He seems to have soon recognised the convenience that a machine-written message for delivery would be; and there is evidence to show that prior to 1850 he had constructed a working type-writer, in which a small square metal plate, or comb carrying the letter, was employed in conjunction with a hammer, by means of which a selected letter could be impressed on to a strip of paper. Although not publicly exhibited, he had one complete machine at the time of the 1851 Exhibition, and then he let the matter rest for a while. Afterwards he took it up again, and between the years 1855 to 1860 he had (with Mr. Pickler, of Buda Pesth) completed no less than six different machines, of which three remained in a complete form. Although they would not by any means meet the requirements of the present day, yet they are marvels of ingenuity, and are still in more or less working order. The existence of these machines has long been known to a few persons, and was, indeed, mentioned by Sir Henry Wood some years ago.* They are now in the South Kensington collection.

All three machines possess keyboards, and this feature, as well as that of the comb, gives them a special interest to us. Fig. 6 (p. 846) is taken from a photograph of the machine, which there is good evidence to believe to be the result of the first of the attempts already mentioned. The separate types are

* No. 10995, U.S.

† No. 14907, U.S., 1856; also Jones' Spec., No. 14919, U.S.

* *Journal of the Society of Arts*, 1888, vol. xxxvi, p. 354.

all mounted upon the teeth of a comb, *a*. This comb carrying the letters is at the top of the machine, and is a segment of a circle, the teeth being radial to a common centre, about which the comb is pivotted. A tiny hammer, *b*, moves in a vertical plane above the comb, and over the printing point. Beneath the type-comb a segmental inking pad, *c*, covered with cloth, is made to vibrate as required; this at the printing of each letter dips into a well of ink, *d*, and passes between the face of the type

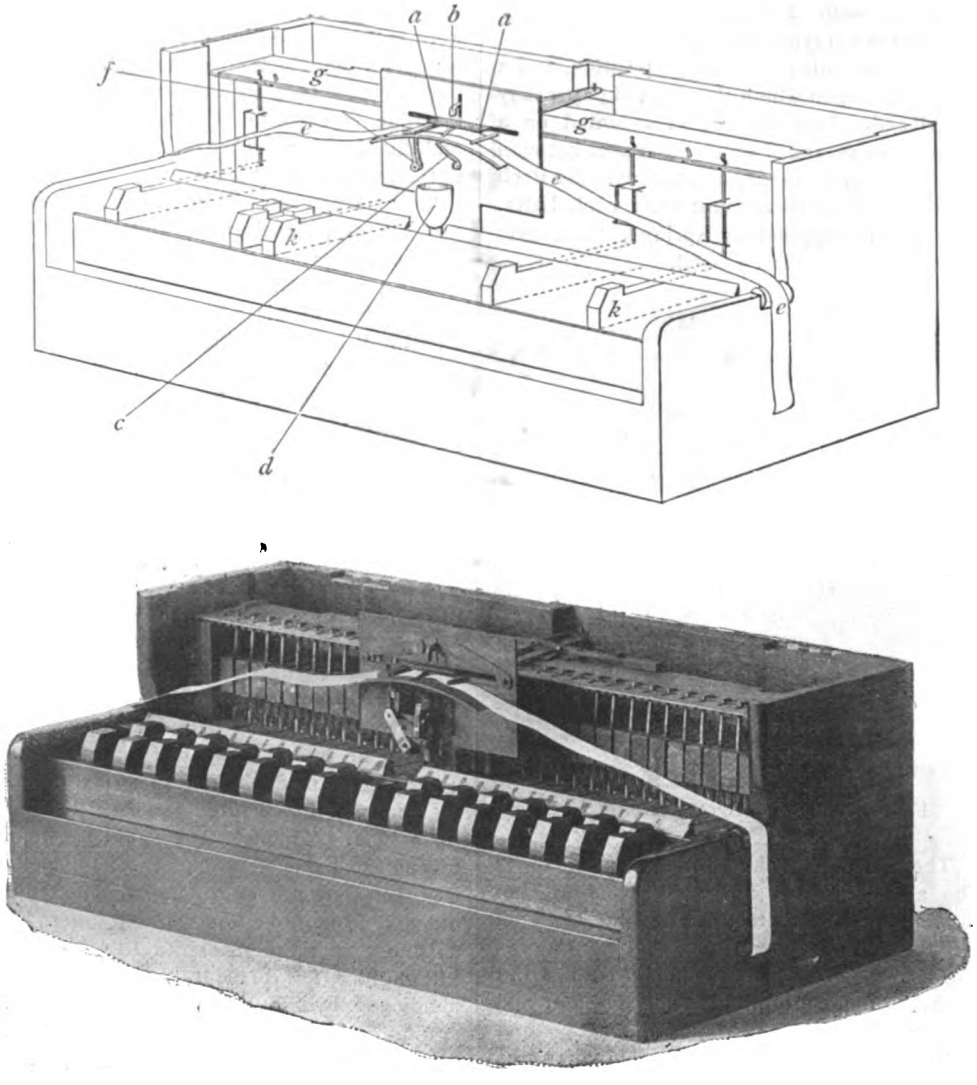

FIG. 6.—SIR C. WHEATSTONE'S EARLY MACHINE.

and the long strip of paper, *e*, upon which the matter was to be printed. It must be borne in mind, when looking at these instruments, that two springs, working in opposite ways against fixed stops, always bring the comb to a definite central position. If it be desired to point the letter that then is immediately beneath the hammer, a key, such as *k*, is depressed; this causes the inking pad to be withdrawn, then the hammer to descend, imprinting the letter on the paper, and then, as the key rises, an ingenious friction grip, *f*,

through which the strip of paper passes, takes hold of the latter, and draws it forward through the space for a letter at the same time the inking pad returns.

It will generally be necessary to shift the teeth of the comb until the particular letter comes beneath the hammer. This is done by fitting each finger key with a stiff vertical wire post (forming a right-angled lever with the key), and causing the top of this wire to lie in one of a series of slots made in a long horizontal metal plate extending right along the top of the instrument. This plate, *g*, is capable of sliding endwise, and is attached at the centre to the comb, whilst the slots in it are each so shaped as to just move the

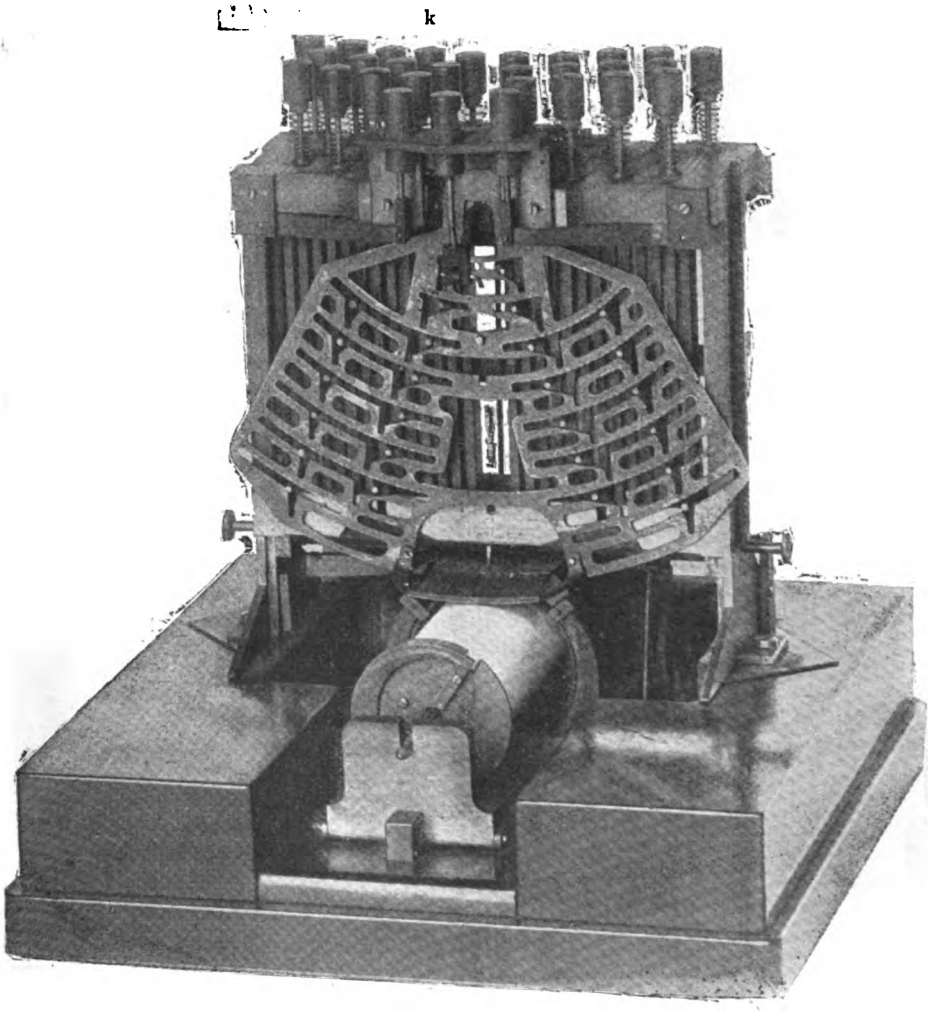

FIG. 7.—TYPEWRITER WITH "CHANGE OF CASE," BY SIR C. WHEATSTONE. SECOND PERIOD.

letter, corresponding to the key opposite the slot, into position under the hammer, when the key has nearly drawn its little post to its most forward position. The slot is then made so as to merely retain the comb in position whilst the hammer delivers its blow. This is a very simple method of connecting the keys with the type bars or "teeth;" but of course the letters at either end of the keyboard require the comb to be moved through a very considerable angle, and Wheatstone was compelled to use rather small letters on this account. The slots, too, become rather inconvenient, and occupy a good deal of room, as they approach the ends of the keyboard.

Figs. 7 and 8 are the front and back view

respectively of the earlier of the machines made in his second attempts, and therefore about the year 1856. In this machine the comb is still retained, but becomes the surface of a part of a cylinder whose axis is the centre of the curiously shaped segmental plate (*g*), Fig. 7. This plate corresponds to the long plate in the earlier machine, and the markings in it are the cam grooves, by means of which the types can be swung into position. But by causing the keys controlling such letters as need the greatest amount of movement from the mid-position, to act upon the plate near the centre on which it is pivotted, Wheatstone was able to have the grooves much more nearly alike, and to be of a shape much more favour-

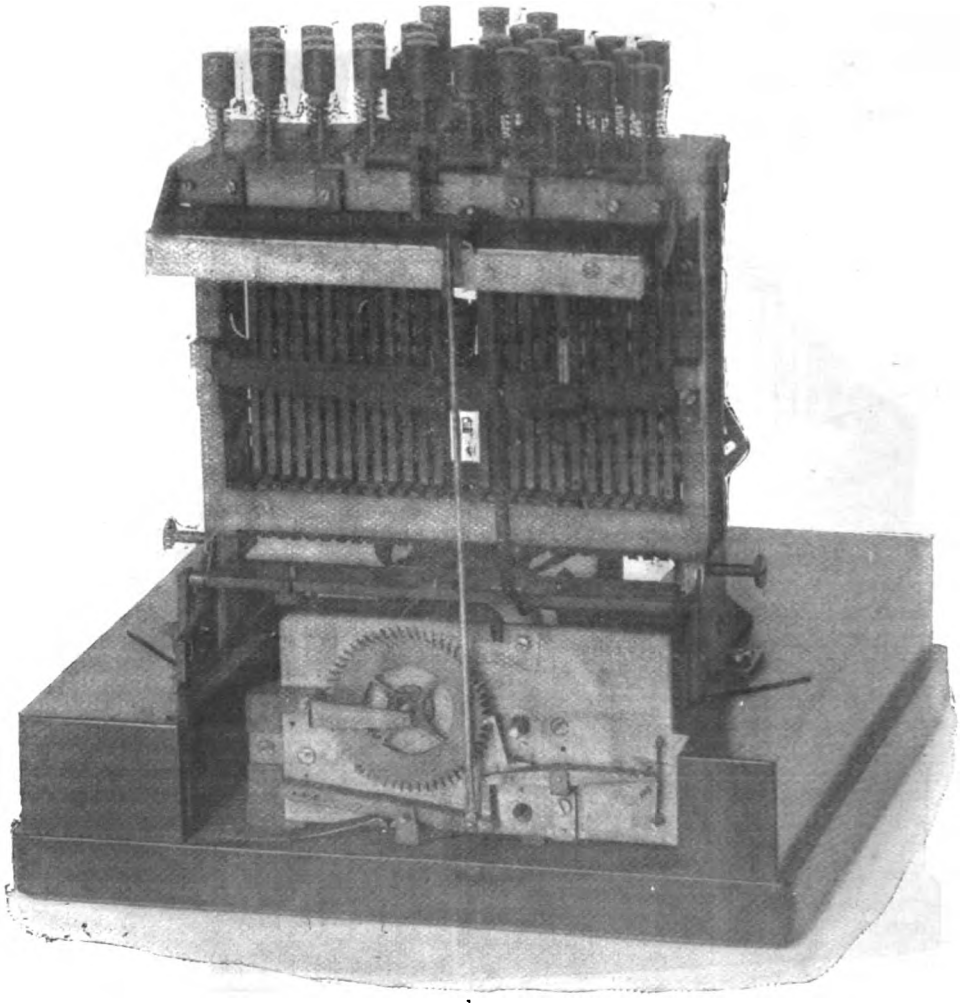

FIG. 8.—BACK VIEW OF WHEATSTONE'S TYPEWRITER.

able to smooth working. He had however to place his keys upon an elevated keyboard which was a distinct disadvantage. The keys, *k*, are upon vertical sliders, each carrying a small pin on its side that engages with its own proper cam groove in the swinging segment. But Wheatstone has also in this machine given us what is technically known as a change of case, by mounting upon the same segmental plate a second comb and set of types that could be brought beneath the printing hammer of the machine by sliding the segment with the two sets of types a short distance along the axis upon which it swung, so that as one set was brought into position the other set was taken out. He provided a key by which this

change could be effected, and this most important convenience to the operator was reinvented in the early marketable machines and retained in use ever since.

The paper was first folded and then slipped upon a cylinder, the cylinder being first removed from the machine for that purpose. Each letter as it was printed caused the cylinder to revolve a given amount by means of a positive feed gear, and when one revolution was completed, a springy end to the cylinder that had been compressed between the teeth of a coarse rack during the revolution, caused the cylinder to slide along its axis the space equal to that of a line. This was effected by providing an aperture, seen in Fig. 7, in the true end of the cylinder that allowed a tooth of the rack to pass when the latter was opposite the aperture. The rack itself was fixed and placed beneath, parallel to the axis of the cylinder. The ink was supplied to the type by means of a ring-shaped inking pad that completely encircled the paper roller, and which was slowly rotated by the action of the machine.

The third machine, Fig. 9 combined the good points of the other two already described. It had the "double case" of small and capital letters, with the small number of keys, and it had the cylindrical paper roller of the second

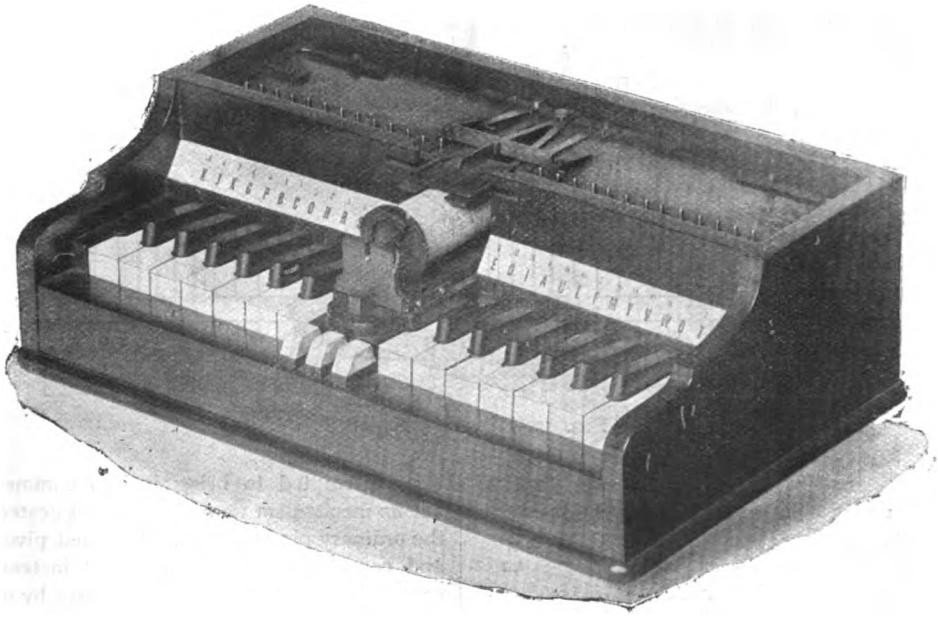

FIG. 9.—TYPEWRITER BY SIR C. WHEATSTONE. FINAL FORM. SECOND PERIOD. 1855-60.

machine with the convenient keyboard of the first. It is a very nicely finished and complete machine. The keys were, it must be confessed, somewhat heavy to manipulate, and the inking pad decidedly unsatisfactory, but in this respect no worse than machines made many years subsequently.

We must now look at what was being done in America at the same period in which Wheatstone was developing these machines, whose types were placed on separate springy bars, for such the teeth of his comb really were. A notable advance was in progress, for Beach, in 1856, patented* what appears to be the first machine in which this idea was carried to its full development. He mounted each letter on a separate pivotted bar, or lever, and connected the levers to a keyboard by a series of links. The patent is crudely drawn, but shows pivotted levers carrying type, so arranged in circular fashion that they converge to a common centre or printing point, beneath which a strip of paper was passed by means of independent clockwork, the escapement of which, however, was controlled by a cord, that, passing beneath the type-bars, received a pull whenever one of the latter was depressed, and allowed the clockwork to advance the paper the space required on which to print the next letter.

* Spec. No. 15164. U.S., 1856.

A strip of "manifold" paper was also employed, just as Littledale used a sheet of the same substance, but Beach moved his strip in much the same manner as the well-known ribbon is now used. This method of supplying ink in a tissue through which the blow of the type was received has, on account of its suitability, never been superseded, indeed, the only improvement, so far, has been to substitute silk for the paper, and a moister ink, for although serious attempts have of recent years been made to substitute inking pads for the ribbon, the practice is confined to a few machines, and opinion is much divided as to the benefit derived, except in the case of type *wheel* machines.

But Beach went further, and finally constructed a complete if somewhat unwieldly machine, in which two levers, *a*, *b*, Fig. 10, were made to approach one another for every character, and emboss the paper strip that was fed between their respective type surfaces at every depression of the key, *k*. The two type surfaces fitted one another, so that work was produced in raised characters, and could be read by a blind person. It was, however, only on a strip of paper; indeed, it is difficult to see how this machine could work upon any other than a very narrow sheet. The machine is said to be still in existence.*

* "Scientific American Supplement," Jan. 1st, 1887, p. 9163.

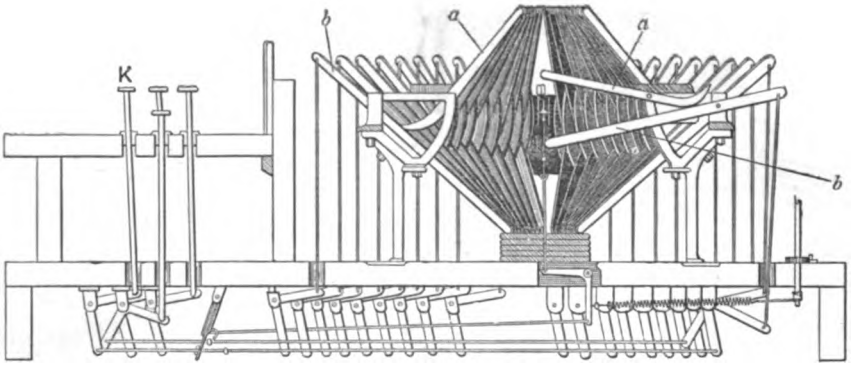

FIG. 10.—BEACH'S MACHINE.

Dr. Francis, of New York, appears to have been a very successful* worker of this same

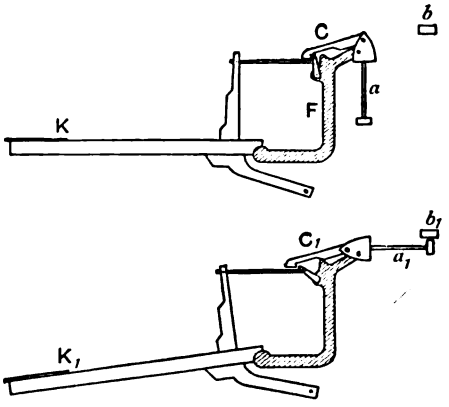

FIG. 11.—FRANCIS' MACHINE.

period. Like Wheatstone, he does not seem to have ever patented his invention, nor to have attempted to bring it into commerce, but its mechanism was no doubt suggested by the ordinary piano action. He used pivotted and converging type-bars, *a*, but instead of connecting the keys, *k*, with the bars by ordinary links, he interposed a sort of trip gear, *c*, that raised the bars by the action of the keys against an anvil, *b*, beneath which the paper could be placed, so that the type-bar would be released, and could drop down again if *k* were depressed to the position, K_1, and forcibly kept from returning; F represents the framework of the machine. The action is ingenious, but, on the small scale demanded by the mechanism of a typewriter, is rather complicated: a trip gear to every lever is terrible to contemplate, although this would effectually prevent fouling of the type bars in skilful use. Evidently Dr. Francis' machine was of good size, like Foucault's, and what knowledge we possess of its details would indicate it to have been made in wood. He used silk ribbons, by which to supply the ink, and altogether his machine was a very complete example.

* "Scientific American Supplement," Jan. 1st, 1887, page 9162, where a section of Dr. Francis' machine is given. The figure 11 is simplified for the sake of clearness, the original machine having been constructed in wood.

One other worker, who believed in the commercial aspect of the typewriter, must here be mentioned: I refer to Thomas Hall, of New York. He tried many forms of machine, and was so successful with one as to have been able, in 1861, to write 400 letters in a minute by its aid. These early attempts must not be confounded with the very simple little machine —now passing out of use—with which Hall's name is connected by the public; this latter

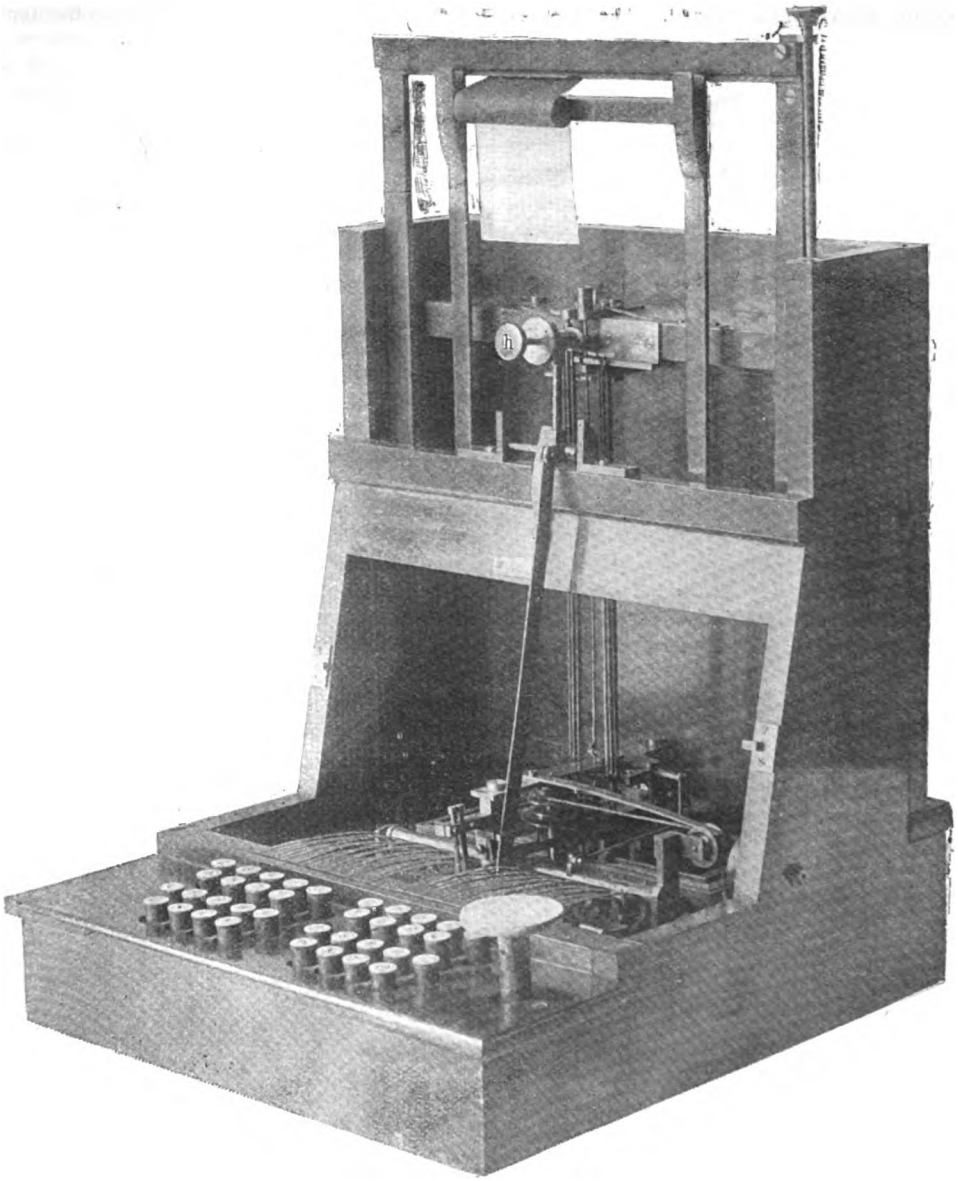

FIG. 12.—FINAL FORM OF PRATT'S MACHINE. FRONT VIEW.

belongs to a much later date, and met a want of the hour; a consideration of it belongs to our next lecture.

There is another historical machine, a short description of which will bring this lecture to a close. Pratt, an American inventor, of Alabama, U.S., patented in this country, in 1866,* a machine that he afterwards exhibited at a Wednesday evening lecture in this room.†

* No. 3163, Dec. 1st, 1866.

† *Journal of the Society of Arts*, 1867, vol. xv. p. 384. The machine was illustrated in *Engineering*, 1867, vol. iii., p. 3

In this machine he employed a small plate of metal bearing the fount of letters arranged in rows upon it and placed behind a vertical sheet of paper. He adjusted this plate so as to bring any selected letter immediately behind a hammer that he had mounted in front of the paper and above the keyboard. The depression of any key of this board caused the plate to be adjusted, the hammer to strike its blow, and the paper to be subsequently shifted to afford space for the succeeding letter. The illustrations, Figs. 12 and 13, are from a later form of his machine, very greatly improved, and at present in the South Kensington collection;

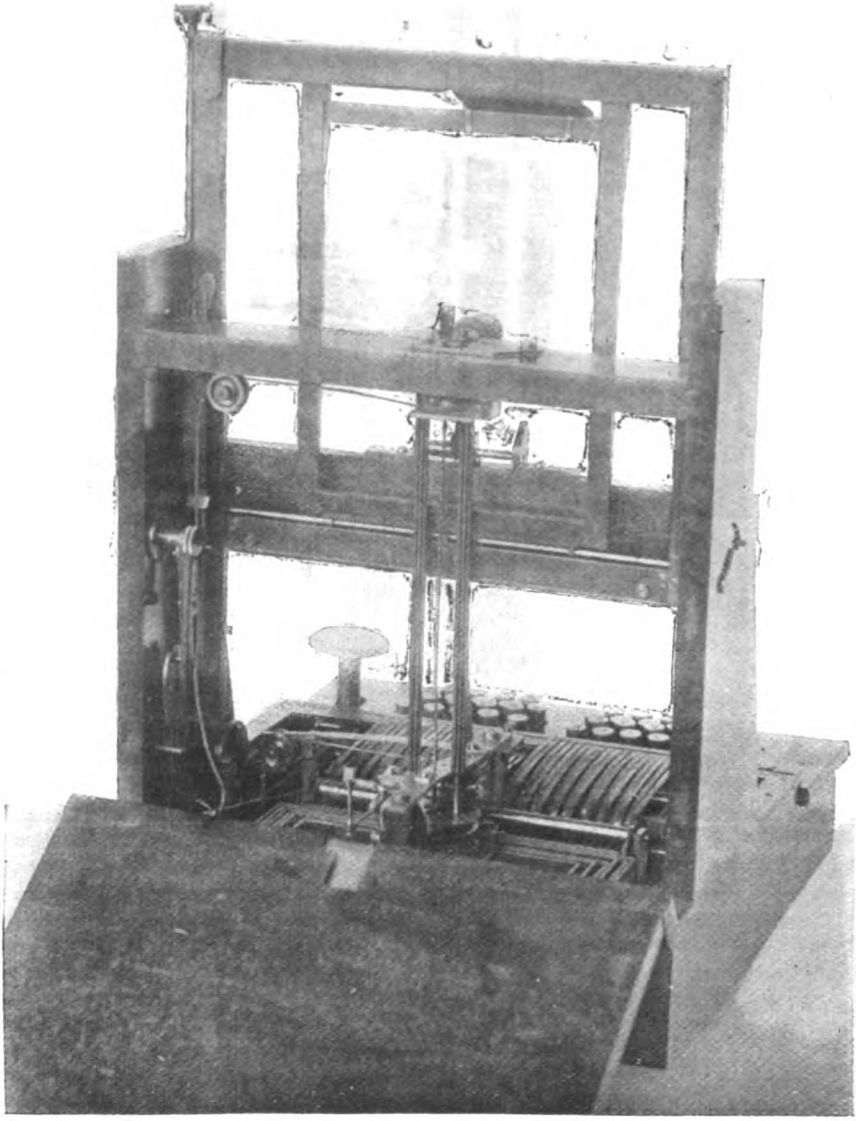

FIG. 13.—FINAL FORM OF PRATT'S MACHINE. BACK VIEW.

his earlier models appear to have been unfortunately lost to us. In it he retained the general form of his earlier machines, and the use of the hammer in front of the paper; but instead of placing the types in a plate, he mounted them in three horizontal and twelve vertical rows upon a small vertical type-wheel, placed immediately behind the hammer, *h*, Fig. 12.

This type-wheel is connected to a train of clockwork that always tends to rotate it, but is prevented from doing so by means of

a tooth mounted in a notched circular plate placed at the foot of the vertical shaft of the type-wheel. The shaft can thus be brought to rest at positions corresponding each to a single vertical row of letters by means of stops acting in the notched plate, and operated by the respective keys to which the letters belong. A second motion could also be given to the wheel in the direction of its axis, and thus the letter of any one of the three horizontal rows selected. Both these motions were controlled by one movement of the key, and the same movement, when continued, caused the hammer, *h*, to be struck. The return movement allowed a coiled spring, by the release of an escapement, to draw the paper carriage a step onwards for the next letter. There was a key, *m*, provided, by which the paper carrier was drawn back (and automatically lifted a line) so as to commence a new line; this action wound up the springs and clockwork employed to rotate the type-wheel and to advance the carriage. Pratt's machine was a practical and portable type-writer, and with it the experimental stage of type-writing machines as a class may be said to end.

Miscellaneous.

PRODUCTION OF MANGANESE ORE IN THE CAUCASUS.

The manganese ore industry of the district of Sharopan, in the government of Kutais, is one of the chief sources of Caucasian wealth. Consul Stevens, of Batoum, says that its significance even in its present early period of existence is a question of vital importance to the population of the government of Kutais, as also to the whole of the Russian Empire, for Russia, which annually furnishes over 150,000 tons of this ore to other European nations for the purpose of making steel, has become one of the largest exporting countries in the world. England takes more than half the quantity she requires for her foundries from the Caucasus, and is thus one of the largest consumers of this article. Many other first-rate European powers use considerable quantities of Trans-Caucasian manganese at their steel works. Within the last few years, the already existing large demand for this particular kind of ore has been increased, by the fact that America has likewise become a consumer, and there is every prospect that on the completion of the Chiatur branch of the Trans-Caucasian railway, a still further augmentation in the demand will take place. The manganese ore industry is also of importance to the population of the government of Kutais, inasmuch as it furnishes labour for the more or less poverty-stricken inhabitants of that province, where the insufficiency of the lands allotted them and the unproductiveness of the soil are more seriously felt than in other parts of the Caucasus. The industry has, therefore, become a most important factor in the existence of the inhabitants, and during the last few years the population of Imeritia alone has earned over £150,000 per annum for working the mines and transporting the ore to the railway station of Kvirili. The ore is obtained exclusively in the district of Sharopan near the village of Chiatur, about twenty-six miles from the village of Kvirili, the administrative and commercial centre of the district. The great mass of the mines are situated in this locality, and they extend over an area of thirteen square miles. According to the latest estimate they contain 66,500,000 tons of ore, and it is calculated that at the present rate of activity it will take over 200 years to exhaust them. Mining was commenced in the year 1879, when 871 tons of ore were produced; in 1880, 4,081 tons were obtained, and five years later the quantity exported was 20,370. In 1889, 137,097 tons were exported, and in the present year (1893), after the completion of the construction of the railway it is expected that the exports will reach the high figure of 322,580 tons. The Chiatur manganese ore fields are situated in a very mountainous and difficult country following the course of the River Kvirili, at a height of from 700 feet to 1,050 feet above the village itself. The mines are distributed in groups about two to three miles distant from the village, and are connected with the latter by narrow cattle tracks which wind in zig-zags over rocky ground, vertically-placed precipices, and projecting rocks, where obstructions are frequently met with. Access to them is, therefore, rendered dangerous, and the ore has to be transported in small quantities at a time on the backs of horses. In wet weather, when these tracks become almost impassable, many accidents occur, both with man and beast, during the transit of the ore. The industry is, therefore, entirely dependent on the elements; and in the autumn of the year 1891, which was exceptionally wet, a sensible decline, as compared with the same period of the previous year, was observed in the quantities of ore brought down from the mines to the railway station of Kvirili. Other drawbacks are experienced in the conditions under which the manganese ore industry of the Caucasus is carried on. Five mountains rise in an almost perpendicular slope from the bed of the river Kvirili, three of which—namely, Sedorgani-Rgani, Gwimewi, and Darquetti, are situated on its right bank, and two, namely, Shukrutti and Perewissi, on the left—contain, at almost equal distances from the level of the river, a layer of manganese ore, of considerable depth, which is alternately found between layers of chalk, earth, and other substances. The three mountains on the right and the two on the left banks are detached from each other by rivulets,

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