10TH SEPTEMBER, 1896.

MERGENTHALER LINOTYPE MACHINES.

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I esteem it a great honour in being asked by the Engineering Association to read an address upon the "Mergenthaler Linotype Machines"—it is the first attempt I have ever made; therefore, I ask your indulgence. I had the pleasure of attending the British Association, at Ipswich, England, in 1895, and Mr. John Southward, who read before the Mechanical Science section a paper on the "Production of Letterpress Printing Surfaces without the use of types," did me the honour of asking me to point out the various mechanical parts of the linotype machine, which were displayed on diagrams very similar to my own before you. To this gentleman and the proprietor of the *East Anglian Daily Times*, Ipswich, I am indebted for much of the information I place before you this evening. In my dealings with the linotype machine, as against hand composition, and type-setting machine, I will be as lenient as I can. It is no less strange than true, that in one of the two great branches into which the art of printing is divided there has been no alteration or progress during the last four centuries and a half. The compositor of to-day sets up his types in precisely the same manner and at the same rate of speed as his predecessors of the fifteenth century. The processes of impressing the type on paper, on the other hand, have been completely revolutionised. The fast rotary machines of the present day will print more a minute than the speediest press in use a century ago could print in an hour. Type composing has stood still, and up to a few years ago it seemed an article of general belief among printers that no acceleration of it was virtually possible.

TYPE-SETTING BY HAND.

As every schoolboy knows, or is supposed to know, types are small pieces of metal of various dimensions as regards thickness and body, but of uniform height. On one end they bear in relief the character or the point they are to impress on the paper when they are coated with printing ink. These types are assorted in the printing office into the compartments or boxes of the shallow wooden tray which the compositor calls his "case." He holds in his left hand a tool called a "composing stick," into which, with the right hand, he places successively the types which are required to set up the words of his copy. The composing stick has an adjustable flange, which confines the line to a prescribed length. All the lines must in this respect be uniform. They must not be of irregular lengths as in typewriting. Hence, when the letters do not quite fill up the line, the compositor suspends his work of picking up types to place additional spaces between the words, and so spreads them out. This is called "justifying." Letter after letter is thus put into the stick, and line after line laboriously composed. After the matter has been printed off it has to be returned to the cases, or "distributed." This process of de-composing is the opposite to that of composing, consisting of simply throwing the letters into their respective boxes one by one. By long practise compositors become wonderfully expert in these manipulations. An average rate of speed for several kinds of types is about 1500 composed letters per hour. When, however, the subsequent process of distribution is deducted from this output, the net produce is only about 1000 letters per hour. I mention these technical terms and these figures to make intelligible what follows

TYPE-SETTING BY MACHINE.

It would have been remarkable if modern inventiveness, especially in the direction of labour-saving machinery, should have overlooked the tardy process of picking up types by hand.

So far back as 1822, an apparatus for this purpose was patented. A machine for type-setting was actually in use in 1842. Some hundreds of patents have since been issued for composing and distributing machines. Yet at the present day very few type-setting machines of the kind are in use in the United Kingdom, or in America or Canada. It is no exaggeration to say that millions of money have been spent upon unsuccessful ventures of this kind. Thousands of machines have from time to time been built, tried, and rejected. Only in certain exceptional cases, and for peculiar work, have they ever been found economical. The opinion almost universally prevalent amongst printers is that ordinary type-setting can quite as cheaply—and more conveniently—be done by hand as by type-setting machine. There are almost insuperable difficulties in operating upon such minute, fragile, and light objects as small type with a machine. Their faces are apt to become damaged, their bodies perhaps broken. A machine, to deal satisfactorily with objects of this kind, must have many delicate parts and the most precise movements. Such a machine is very liable to stop suddenly or to break down altogether—a most serious fault for any apparatus used in a newspaper printing office. Machines of this kind must necessarily be very expensive, not only in regard to first cost, but to maintenance and working. For these, and many other reasons, type-setting machines of any kind are not to be found in actual work in more than 200 out of the 8000 printing offices established in different parts of Great Britain. A far less proportion are to be found working in America and Canada.

EFFORTS TO DISPENSE WITH TYPES.

There is, then, a general concensus of opinion to the effect that type-setting can be done as cheaply by hand as by any mechanical appliances. This has not, however, deterred inventors from devising schemes for reducing the cost of forming printing surfaces. A good many years ago, for instance, it

was proposed to form a mould by stamping the letters into it one by one, as the letters are stamped by the typewriter on the paper, and then taking a cast from this mould in the manner of stereotyping. This looks feasible; but it was defective in two essential requirements. The thin letters sank deeper than the thick ones, and the surface of the cast was irregular. There were no means of justifying the lines to make them of regular lengths. These were two fatal defects. Then the plan was tried of setting up a whole line of stamps, which, when justified, could be impressed in some plastic material, and a cast taken. This overcame the defects of the previous crude method, but it had new defects of its own, and the plan was given up as a complete failure.

THE MATRIX METHOD.

Not, however, until after a great deal of attention had been given to the subject by men who, recognising that all machines that were intended for setting types were more or less unsatisfactory, was it believed that some other plan for producing surfaces might possibly be practicable. One of these was Ottmar Mergenthaler, a native of Wurtenburg, Germany, who went over to the United States in 1872. He was originally a watch and clock maker. A Washington shorthand writer (James O. Clephane) had made for over twenty years a hobby of inventing writing and printing machines. Both of these gentlemen I have had the pleasure of meeting several times. In 1876 he employed the engineering firm of which Mr. Mergenthaler was a member, to work from drawings. Mr. Mergenthaler immediately manifested a singular aptitude for this kind of work. He began experimenting with various methods of casting type bars from matrices made by indentations in soft metal, but met with the difficulties with which all inventors had been confronted. He persevered, nevertheless, in his experiments, and in 1880 struck out an entirely new idea. This idea was to use separate, moveable, interchangeable

matrices, to compose or assemble them together, and to cast from them bars corresponding to stereotyped lines of type. In 1884 he produced a machine of the kind which at once attracted attention. As might be expected, it was in many respects defective. Still, it was seen that the new principle was a good and promising one. Improvements were soon made, and eventually the machine was shown to be a success. Different American newspaper proprietors adopted it and gave a favourable account of it. About five years ago the machine was introduced into England. It was known as the linotype because it produced lines of type. It is only, however, within the last two or three years that the machine has been to any considerable extent used in English offices. At the present time there are far more of the linotype machines at work than of all the various kinds of type-setting machines put together. Some 800 linotype machines are now at work in England. Nearly all the London *Daily Telegraph* is set up by linotype, and it is only a matter of time before all the principal newspaper offices are using these wonderful machines. In America and Canada no less than 5000 linotype machines are in constant use, very few offices being without them, and all the large publishing offices have also adopted them. In Australia we have (including those on the way out) some 100 machines, thus showing that our newspaper proprietors are now eager to follow the good and enterprising pluck displayed by Mr. Watkin Wynne, the manager of the Sydney *Daily Telegraph*, that proprietary being the first to introduce linotypes, and their shareholders do not regret it.

THE LINOTYPE MACHINE.

I will now attempt a brief description of the linotype system of composition. The part of the apparatus which usually first attracts attention is the key-board. This is placed in the lower part of the apparatus at a convenient height to be fingered by the operator sitting in front of it. There are

ninety keys, in six rows, one row rising above another. To the left are the keys of the lower-case letters, and to the right those of the capitals, between them being keys for points, figures, etc. The particular arrangement is peculiar to the linotype machine, and is the result of much study and experience. The letters on the extreme left are those which are considered to be most requently used, viz.:—the e, t, a, o, i, n. To the left is a key, which actuates the spacing arrangements. As each of these keys is touched it releases a matrix of the letter which is indicates upon it. The matrix is a piece of brass shaped as shown in the diagram; it is 1¾in. long by ⅜in. wide. Its thickness varies according to the thickness of the letter or point to which it corresponds, ranging from a full point to the widest capital—the several thicknesses being the same as that of the different types. At the side of it is a small cavity, and cut into this is the form of the letter to be produced. The molten metal is afterwards injected into this cavity by a pump, a line of matrices being cast together, not each matrix separately. The cast produced is, of course, in relief, or in cameo, like the surface of a common stereotype. About 1500 matrices of any one fount are supplied with each machine, the number of separate matrices for the several letters being proportionate to the respective frequency of their use in printing. The stock of matrices in the machine never becomes exhausted, in contrast to cases of moveable type, which are always, when being set from, in process of depletion. The general arrangement of the machine may be understood from the accompanying diagram. At the top is an inclined magazine containing channels in which the assorted matrices are stored. The matrices tend to slide downwards out of the magazine by reason of their gravity. Each time a key is depressed a matrix is permitted to fall out of the mouth of the magazine through a vertical channel. This brings it to the inclined travelling belt, which carries it into the assembling block. Here all the matrices are successively received, and set up side by side in a row, with

spaces between the words. After the line is thus composed, it is transferred to the face of a vertical mould wheel, seen on the left of the diagram. The line of matrices here receive the supply of molten metal and is cast from. The matrices now being done with are returned to the magazine, in the direction shown by the dotted lines, same being caught by an arm working automatically, and placing the matrices in the distributing bar; this is a very beautiful motion. The line bar is trimmed to proper height by being brought against a knife which shaves off the feet. Then it is pushed by a vertical blade which advances from the rear between parallel knives, which trim or plain the sides, and make it perfectly true with regard to depth of body. The linotypes are sent one after the other into the receptacle called the gallery, in which they are made up like ordinary lines of moveable type, but, of course, with much greater facility, being in one piece.

AUTOMATISM.

Reference has been made to the nature of the two processes which printers call justifying and distributing. In the linotype these are done automatically, and by singularly ingenius arrangements. No practical method of justifying ordinary moveable types has ever been devised. The matrices of the linotype system, however, can be justified with the utmost facility and at the same time the most complete precision. The spaces are composed of two steel wedges, and are so contrived that the longest member is about $3\frac{1}{2}$" long about one-sixth of an inch thick at the lower end, and tapered to a knife-edge at the upper. The spaces are inserted between the matrices of each word as set. They and the matrices are brought between two rigid uprights and pushed from beneath. They thus widen out the line to the required length. They not only space automatically, but with absolute regularity, which is almost impracticable in the manipulation of moveable type.

The method by which the automatic distribution of the matrices is effected is not less ingenious. The whole of the matrices necessary for the line having been cast from are lifted bodily in a vertical direction. The spaces now part company with their companions. From the diagram of a matrix, it will be seen that at the upper end there are teeth or notches. These teeth are different in the different matrices, and the difference effects the distribution—on the principle of a Yale lock. Extending horizontally above the upper ends of the magazine channels is a bar which has along its sides a series of ribs. The matrices key into these ribs in such a way that the matrices are held in suspension, but only to a certain extent. The ribs conform to the shape of the notches, which differ, as has been stated, in each matrix. In other words, the ribs vary in number and arrangement at different points in the length of the bar, so that a given matrix, which up to a certain point is suspended on the bar, is pushed forward by means of screws propelling it longitudinally up to a point at which it loses its support. It falls at once into the proper channel of the matrix magazine. The simplicity of the device is certainly remarkable.

LINOTYPE v. MOVEABLE TYPE.

The advantages of the linotype system of composition as compared with the type system are numerous and important. Composition by linotype may be done at a speed more than six times that of hand composition. I have said that the delay caused by the necessity of justifying, and the time occupied in distributing the type reduced the output of the hand compositor to about 1000 letters per hour. The linotype machine is generally worked at a speed of nine to 10,000 ens per hour, and experts have attained higher rates, even 15,000 and 20,000 ens per hour. The labour cost of composition is thereby reduced, according to the management of the office,

from forty to sixty per cent. Composing-room oversight is considerably simplified and cheapened by the reduction of the number of hands employed in proportion to the work done. Type-setting machines require almost invariably a separate distributing machine, which doubles their original cost and involves the expense of another operator. When types are not required there is a great saving in the cost of the plant of a printing office. A newspaper outfit will extend to thousands of pounds weight of type, averaging perhaps about 1s. per pound. The metal used for casting the matrices costs from 2½d. to 3d. per pound. The types produce only a certain superficial area of matter according to their quantity ; the matrices, supplied with sufficient metal, will produce an unlimited quantity of matter. Type is always in course of being worn out ; the linotype gives a new "face" every day. A linotype machine occupying about 15 square feet of floor space produces as much composition as can be got from six hand compositors, whose cases and stands occupy more than 100 square feet. There are other great economies possible by the use of the machine, but they are too technical to be appreciated by the general reader. Although these economies may not directly concern other than printers, all who may examine the machines must agree that they are really marvellous specimens of mechanical ingenuity and skill. And please bear in mind that the linotype machine is extensively used in many large publishing offices in America and Canada, as also in England—Kelly's great London Directory being set up by this machine; so it is therefore capable of setting up any class of book or Government publication.

FINAL.

Many may think that the introduction of linotype machinery will be a very serious blow to the compositor, and thus be the means of throwing many men out of employment. Certainly it will reduce the number of hands employed in the

composing room, but the using of this machinery will extend journalism and publications generally, and this has already been felt in England and America, where the linotype is mostly in use—more newspapers and publishing offices are being established in England and the United States than ever. This is bound to be the case where the means of production are so very considerably reduced, and the compositors in these colonies will soon realise that. Introduction of all labor-saving machinery has, no doubt, at first hurt the employees, but it is only a matter of time when matters equalise, and there is employment for the willing worker. The compositor can very easily earn more wages at the linotype machine than he can at the case, and his hours are shorter, as there is no distribution of types. Those men now working at the machine, I know, one and all, would prefer working the linotype than returning again to the old method of picking up types from the case.

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