ments, permitted of moulding pipes 8 and even 10 feet in diameter. Fig. 3 represents the removal of the core, after moulding, by means of a crane that served likewise for putting the moulded pipes upon cars.

The lowering of the pipes into the gallery is shown in Fig. 3, which also gives a view of the place of manufacture of the rings for joints.

The arrangement adopted for the assembling of two successive pipes includes a first internal joint composed of a sheet of rubber-coated asbestos fixed with white lead and covered with a lead ring soldered and driven upon the pipe so as to fit closely to the surface.

A second joint, designed to assure the tightness of the first, consists of a ring and cement.

Here and there the conduits are provided with compensation joints to permit of expansion. Fig. 6 represents the pipes in place constituting the gallery $3\frac{1}{4}$ feet in diameter that prolongs the siphons which pass under the Seine at Herblay. One will observe here the conspicuous joint rings of which we have just spoken. —La Nature.

HEAVY HYDRAULIC RIVETING MACHINE.

HYDRAULIC machine tools now play an important part in the work produced from engineering shops and shipbuilding yards.

Our illustration represents Smith's patent hydraulic boiler riveting machine, with plate-closing arrangement. These machines are suitable for every class of work, but have been more especially introduced for riveting heavy marine boilers, and are usually made to put a pressure of 15 tons to close the plates and

popular periodical was actually set up by machine. Up to the year 1860, about thirty machines and modifications of machines were patented. Many machines were made according to these specifications, and were tested in printing offices. They embodied every important principle to be found in the machines that have succeeded them. I fix the date 1860 because I do not find that after that any really new ideas have been enunciated. Indeed, inventors have ever since brought out machines which have been little more than variations or developments of the designs of their predecessors.

I should like, in the second place, to deal with some of the mechanical principles of composing machines. Hundreds of patents have been taken out during the last seventy years, but they may all be divided into well defined groups. There are first of all those in which ordinary types are used. Inventors have devised expedients for increasing the speed of hand composition from the usual cases of the hand compositor. They have suggested specially contrived cases. Others have brought forward inventions for dispensing with cases and providing machines which do nearly the whole of the mechanical part of the compositors' work. Others have gone much further than this, with proposals to do away altogether with movable types, and to produce plates directly, by casting either from punctured or stamped matrices, or from movable and interchangeable metal matrices.

Briefly, the two systems now adopted may be differentiated as typesetting and matrixsetting machines. As I shall be able to touch only the mere fringe of my subject, I must confine myself to an examination of the general features of these two systems. Even these,

his left hand. Letter after letter is set up in the same way. Composing consists not merely of thus assembling the types together, and putting the proper space between the words, but it includes spreading them out by additional spaces, may be, and making the line of the exact stipulated length. This is called "justifying."

The work of the compositor is, obviously, partly mental and partly mechanical. He has to decipher his copy, to spell the words of which it consists, to judge whether he shall use a capital letter or a small letter, and to punctuate the words. This is the mental part of his work; it cannot be facilitated by machinery. The lifting of the several types and the arranging of them in the stick is mechanical work. It would seem that it might well be done by some kind of mechanism. To provide mechanism for the purpose has been the aim of successive inventors of type composing machines.

At first sight, the designing of a machine for assembling types together and arranging them in orderly manner in lines might not seem to be a task requiring great ingenuity and skill. The difficulties are not apparent until the nature of the problem is somewhat closely considered. Let me point out some of those difficulties.

There is, first of all, the difficulty of operating on such small objects as printing types. Take, for instance, the letter l, in nonpareil. From one end to the other—its height to paper—it is only about $\frac{1}{8}$ of an inch. Its body is $\frac{1}{2}$ of an inch. Its thickness or width is $\frac{1}{8}$ of an inch. Some of the types are much smaller; their thickness is little more than that of an

HYDRAULIC BOILER RIVETING MACHINE FOR HEAVY WORK.

150 tons to form the rivet. The increase in the thickness of the plates in marine boilers, and the difficulty of getting these heavy plates thoroughly closed by service bolts, has created a necessity for a hydraulic plate-closing arrangement being fitted to the riveting machines. This machine first thoroughly closes the plate with the full power, and then staves and forms the rivet. The machines are made of great strength to stand the pressure, the hobs being made of the best Siemens cast steel, held with two large bolts of best forged steel. They are made of sizes from 6 up to 12 feet gap. We are indebted to the Steamship, of Leith, Scotland, for the cuts and particulars.

MACHINES FOR COMPOSING LETTERPRESS PRINTING SURFACES.*

By JOHN SOUTHWARD.

THE subject of Machines for Composing Letterpress Printing Surfaces is a wide and a comprehensive one. If time permitted, I should like, in the first place, to refer to the history of inventions of this kind. Such a review would begin with the first patent granted for a composing machine, in 1822, and for a distributing machine, in 1840. It is a remarkable fact that the specifications of these two inventions foreshadow, as it were, the principles of all the composing machines that have since been constructed. As far back as 1842 a

however, involve many more considerations than could be adequately dealt with this evening, and a further limitation will be necessary. Hence, I shall not attempt more than an inquiry into the economic results of the two systems, and an answer to the question which of them produces letterpress printing surfaces with the greater cheapness. This may seem a somewhat ignoble narrowing down of such a subject, but it is, in reality, the aspect of it which is of greatest present importance and of greatest general interest.

Accordingly, I intend to avoid entering into mechanical details, except when they appear to be necessary to illustrate the points I propose to submit to you. My very cursory examination will not involve a criticism of the merits or demerits of any particular machine. I shall merely contrast the principles of the two main classes of machines with a view, as I have said, to estimate their respective economic advantages.

As probably every one present is aware, an original letterpress surface, to print alphabetical characters and punctuation marks, one that produces the plain reading matter, or text, of books and newspapers, is formed, according to the ordinary method of typography, by combining together, or composing, one by one by hand, movable interchangeable types.

The compositor has these types assorted into little heaps each contained in one of the compartments of his case. According to the wording of the copy he is engaged upon, he first "sights" the type he requires. He picks it up with his thumb and fingers and conveys it to the tool called a composing stick, which he holds in

ordinary visiting card. Such objects are of course very light. Of the little pieces of metal which print the l, 1,760 weigh only one pound. Such objects are not only small and light, but fragile. They require the most delicate treatment. A very slight strain upon them in one direction will break them. Add to this that they are extremely delicate. The hair lines of their faces would be destroyed by slight friction frequently repeated, and the type would be rendered useless for printing purposes. To deal satisfactorily with objects of this character, a machine must have very delicate parts; and delicate machines are ill adapted to the conditions of the printing office.

This is the smallest of the difficulties involved. The types are not only small, but they are of various sizes, as regards their width. The machine must provide for the thick m and the thin full point. Few people realize how much types vary in thickness. It is not generally known that among the 244 sorts which comprise some fonts of roman and italic there are 190 different widths. It might be easy to set a machine to pick up any one width for a time, and then to set it for another width. But these widths happen, as it were, promiscuously. In the word "width" there are letters of four different dimensions, and the next word that may present itself will comprise a different order of letters. To meet this difficulty, much complexity is rendered necessary.

There is still a greater initial difficulty. It would be much easier to make an apparatus for dealing with such objects, however small, light, delicate, and vari-

* Paper read before the Society of Arts.

ously sized, than one which will provide for every combination of letters to be found in the copy to be set up. The hand compositor, as I have mentioned, has types arranged in separate compartments of his case. The instant he sees a certain letter is wanted, he throws out his hand to the particular box in which it is contained, and picks it up. A pair of cases—that is, for an assortment of one face of letter—measures about 2½ ft. one way, and 2 ft. 9 in. the other way. The types are assorted into about 150 boxes. The intelligence and dexterity of the compositor enable him to extract the different types with a certain degree of rapidity and accuracy. To do this by machinery is quite another matter. It cannot possibly be done altogether by mechanism. The selection of the types must be done by the brain of the compositor. What the inventor has to do is to enable us, by mechanism, to assemble together any possible combination of letters found in the words of the copy. This is quite another thing to providing for any one letter, however small, being brought instantly out of its receptacle.

Now, no machine could pick the letters out of an ordinary case and form them into lines of reading matter. The reason is, that they lie in these boxes higgledy-piggledy. The compositor has not only to sight the right type, but he has to put it in the right position in his stick. Accordingly, the types must be arranged in order, the faces all one way, and the nicks all one way. This is the first requirement. The next is that, however the types are located, each one must be accurately brought, as required, to one place—the place corresponding to the composing stick of the hand compositor. This requirement involves the provision of channels, along which the types can be brought to their destination. It also involves means for pushing, or impelling, the types along those channels.

Nearly all inventors of typesetting machines, from the very first, have met this requirement in one way. They have had the types set up in rows, one sort in one row. These rows have been laid side by side, in grooves or tubes. The outlets of these tubes are ranged in a line. Mechanism is provided whereby the first letter in any one of the groups or tubes, or what not, shall be extracted on a key being depressed by the finger of the operator. When he strikes the key a letter in the groove is drawn or falls out. But when it drops out it has to be conveyed to the composing stick. It is led through channels. These channels begin at the mouths of the several tubes. It is necessary that the grooves all converge to a single point, over what I have termed the composing stick. The channels usually consist of grooves cut into a metal plate. This is called a guide plate.

This device is open to many objections, and, indeed, forms the weak part of nearly every machine in which it is adopted. I will mention a few of its drawbacks.

The converging grooves usually have to be adapted for types of different thicknesses being brought down one channel. These arrangements often consist of delicate springs, which, with rough handling of any kind, will get out of order. They are very susceptible to wear, and very liable to disarrangement. There are difficulties arising from the various weights of the letters, and their tendency to fall with unequal velocity. Sometimes they strike the receiver with great force and rebound; sometimes they turn round unexpectedly in their channels; sometimes they stick fast, and have to be released with a bodkin.

The dust and solid particles which often adhere to the grooves, as well as to the types, render their delivery uncertain. Hence the most perfect cleanliness of the guide plate and of the type is essential. Much time is required to properly clean the guide plate, and in the printing office unclean and "sticky" type cannot always be avoided.

In working type that is not entirely clean, the dirt is left on the plate in specks and little heaps. These cause obstructions, and the letters are turned in their course. The objection is of more importance than might at first sight be imagined. It is not felt so much on dry as on damp days. It has been said that typesetting machines work better in some parts of America than in England, because the atmosphere is drier. Possibly there is some truth in this. At any rate, the difficulty arising from such a small cause as insufficiently cleaned type, and a damp guide plate, illustrates the extreme delicacy of such machines, which is one of the chief drawbacks in them.

Again, the types are not always delivered in the receiver in the proper order. This may arise from the operator depressing the keys at a faster rate than the types can be conveyed through the guide plate. Sometimes, too, the types are brought down to the receiver faster than they can be cleared aside for successive letters. The claims of some makers as to their machines being capable of composing types at any speed at which the keys can be touched are certainly not corroborated by experience.

These drawbacks, it is right to state, have, to a certain extent, been remedied in the class of machines called rotary machines. In these the types are ejected in proper order upon a revolving horizontal disk, and are thereby carried to the receiver. These machines are capable of being worked at a much higher rate of speed than the guide plate machines. In several machines, also, the types have been transmitted from their place of storage to the receiver by traveling tapes. Machines of this kind have not proved satisfactory, and have almost gone out of use.

Here may be mentioned another objection to typesetting machines. Some of them cause a great deal of damage to type. In all, unless they are well designed, perfectly adjusted, kept in a proper state of repair and worked by careful, experienced and loyal operators, they may break a considerable weight of type. This item of breakage greatly detracts from the economic advantages of typesetting by machinery. Even if the type is not broken, it may be worn unduly. The edges are often rounded by frequent passage through the guide plate grooves. This wearing especially occurs to the feet of the type, and one result is that they go "off their feet," and all printers know the trouble this occasions.

It cannot be wondered at, I think, that machines of such delicacy and complexity are very expensive. Their expensiveness does not end with their first cost; it is increased by the percentage which has to be allowed for repairs. A typesetting machine with its ac-

companying distributor costs from £350 to £500 and upward. Only one size and face of type can be advantageously composed with it. I am aware that it is claimed for some machines that they set several sizes of bodies, but the question is, Do they do this at once efficiently and economically? If a considerable time is required to make the change, the advantage may be nullified. A book printer may use ten or more sizes or styles in his work. The cost of buying an equal number of machines would be very great, if not prohibitory. If a machine of this kind is to be even moderately remunerative, it must be kept constantly running. There are few offices, comparatively, in which machines could be kept going without a stoppage for copy or letter. When they are idle the loss is heavy, not only in regard to the capital sunk, but the waste of the time of the operator. In hand composing a man may have to work in a day from half a dozen different pairs of cases. No time is lost in changing from one to the other, but when machines are used every change is a loss.

The cost of running machines and the high rates of wages demanded by skilled operators is another important drawback to any machine which cannot be depended upon to compose a large quantity of type within a given space of time. A special apprenticeship to them is necessary; for some time the operator, even if he is a practical compositor, cannot produce as much composition as if he were working at the case. This deficiency has to be paid for by the employer, and, together with the time absorbed in learning the machine, becomes an important item of expense. Experienced operators, being comparatively few, naturally require higher wages than hand compositors.

So far I have been dealing chiefly with the mechanical problem of setting type by machine and the mechanical difficulties in the way of its successful solu-

The only machines now actually offered for sale to the trade are two. One is made in America, as there is not sufficient demand for it to require a factory for its production here. The remaining one is the only English machine produced commercially. There is only one engineering works, and that not of very considerable magnitude, which is engaged in the production of typesetting machines. The really important patents connected with machines have now all expired, but engineers do not see fit to avail themselves of the fact, and cannot be induced to embark in the business of making such machines.

The reason is perfectly plain. There is not a demand for such machines. There is not a demand for an equally plain reason. The opinion of the great majority of printers—an opinion founded either on their own experience or on that of firms who have tried one of the systems of mechanical type composition—is distinctly unfavorable to them. Although under certain conditions and for certain classes of work, one or other of these machines may be to a certain extent economical in their results, it has been found that ordinary composition is done quite as cheaply—and more conveniently—by hand as by typesetting machines. When there is an economy effected by using appliances of this class, it is not sufficient to justify the heavy first cost of installing machines, of working and of keeping them in order.

Printers are, to say the least, business men, and in no business is it more essential than in theirs that economy should be practiced. If these machines were economical, nearly every office in the kingdom doing book or news work would now possess a composing machine—as every office possesses a printing machine. The fact cannot be got over that while the printing machine is, by reason of its economical working, regarded as indispensable, the typesetting machine is

DIRECT-ACTING CENTRIFUGAL SERIES PUMP AND ENGINES.

tion. I now turn to the economic aspect of the subject. The prices at which printing is done have been enormously reduced during the past half century. This has been rendered possible, not by reducing wages—for they have increased—but by the adoption of labor saving machinery. Up to almost the middle of the present century nearly all printing was done on the hand press. Now there is hardly an office in the kingdom in which presswork is not done by machine. Yet what do we find in the composing room? That types are set by hand as they were fifty, one hundred, four hundred years ago. I believe I may say confidently, as the result of careful inquiries, that typesetting machines are to be found in only about a hundred and fifty of the eight thousand printing offices existing in the United Kingdom. Not more than five hundred typesetting machines are, I believe, at present in actual operation.

This fact is the more significant when we remember that typesetting machines have been manufactured and used intermittently for nearly fifty years. During this space of time several hundred patents for typesetting machines have been taken out. Immense sums of money have been spent in carrying out these patents. Printers have spent large sums in buying these machines. One or two of our greatest printing firms have each spent thousands of pounds upon inventions now entirely discarded. Certainly, printers have shown themselves not to be averse on principle to the employment of machinery.

At the present time there are six different kinds of typesetting machines at work in this country. Perhaps it would be more correct to say five, as one of them has only been introduced within the last year or two, and is really a machine brought out in America about fifteen years ago, which has since been practically superseded by later machines. Of the other five, three are in use only in the offices of three firms—two of them book firms, one a great newspaper establishment. These, it is said, are doing good work, and doing it profitably.

done without, because its economy has never yet been satisfactorily demonstrated.

(To be continued.)

CENTRIFUGAL SERIES PUMP AND ENGINES.

The illustration shows a vertical double cylinder steam engine and two centrifugal pumps in series, all driven from one spindle and connected directly to the engine crank shaft. It is suitable for working against heads of 100 ft. and will be found to possess many advantages over pumps of reciprocating type. The construction of the pump is simplicity itself; it has no valves, air vessels, vibration, nor obstruction whatever, and the water passes through it in one continuous stream. It will be found to possess the merit of cheapness in first cost, and the annual charge for repairs is almost nil. By combining the pumps in series, the lift can be augmented to 150 ft. We need scarcely add that the workmanship and material leave nothing to be desired. We are indebted to London Engineer for the cut and copy.

For some time past several of the leading railway companies of Great Britain have been preparing for the forthcoming season's race to Scotland. The Caledonian were the first in the field, and the first of the six new "fliers" which they are building has been completed. The Dunlastair, as it has been named, is said to be the largest locomotive in England. Its pattern is similar to that of the Northeastern Company's, the large Greyhound type, and from buffer to buffer is 34 feet in length, her tank alone being 19 feet long. It has the ordinary size driving wheel, 6 feet 6 inches, and its total weight, when fully watered and coaled for a journey, is 134 tons, as compared with ninety-five tons for last summer's racer and eighty tons in the case of an ordinary passenger bogey locomotive.