second slug. So accurate is the machine that not even an expert will notice the difference between a proof from the two slugs and from a foundry type.

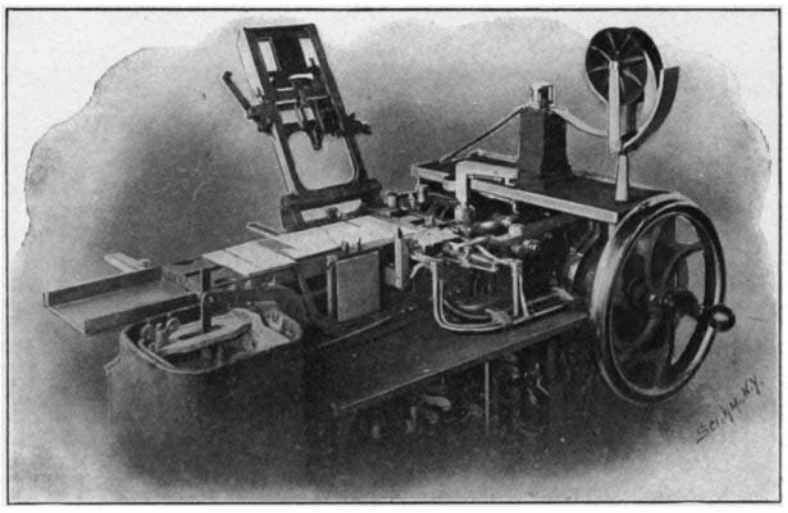
The average product of a good operator is 4,000 ems per hour, the measurement of type being based on the width of the character "m." Many operators, however, can set from 5,000 to 6,000 ems per hour and a speed of 13,000 is on record. About 1,000 new machines are put in operation each year, and they are in general use in the large newspaper offices in the United States, and are also largely used in Europe. The Lanston monotype machine has already been illustrated in the SUPPLEMENT, No. 1089, and the Dow composing machine in the issue of the SCIENTIFIC AMERICAN No. 3, vol. lxxxv. The Goodson graphotype is described below.

THE GRAPHOTYPE.

The use of electricity in individual type-casting and composing machines originated with the "Graphotype;" and the reader bearing in mind that there is no known power-producing agent that performs its work with such quickness so easily as electricity, can more readily understand why the graphotype can produce its work in such a small space and with such rapidity. Throughout the entire machine, wherever it is possible, instead of using heavy, cumbersome levers, cams, or other means of conveying power, the graphotype uses small wire cables, which give the quickest results. The work is produced in two operations. The first is done on the keyboard or composing machine, which makes perforations in paper tape that represent the characters or spaces struck by the operator; and when run through the second operation or casting machine, produces the type.

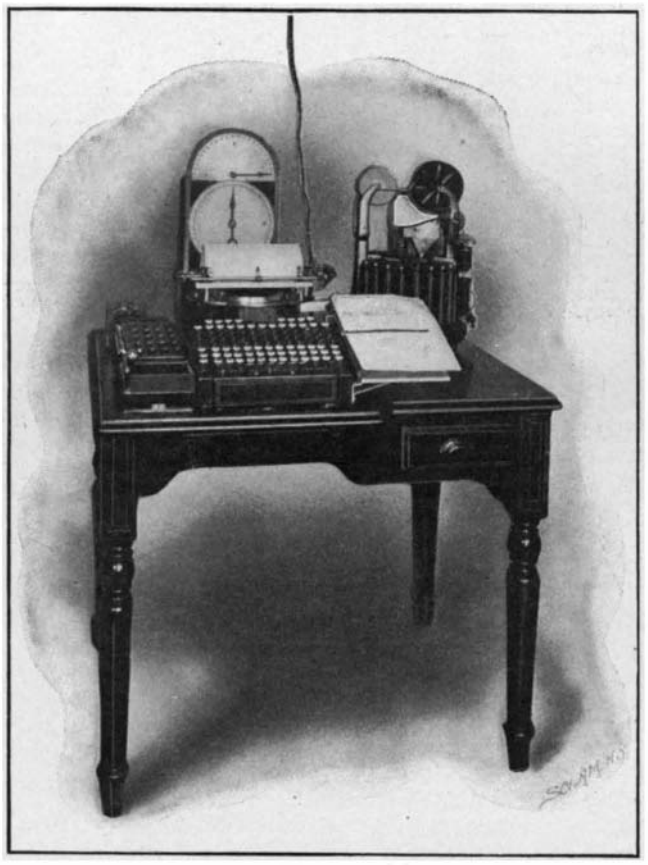
The keyboard is the part of the machine consisting of a typewriter electrically connected with perforating device and the counting or adding mechanism, all mounted on a neat table or stand to which is connected an ordinary flexible wire through which is fed a direct current at 110 volts. The typewriter is used to give a written copy as well as act as a keyboard for sending the message to the perforator device and counting mechanism. By actual use it is found that a typewritten copy is of great aid to the operator in case of interruption or tabulated work, as it enables him to see exactly what is done and what key has been struck last without looking at the tape or matrices, as in other machines. The perforator is a group of magnets, each of which is connected with a key or keys on the typewriter and operates small levers, which in turn operate the punches that perforate the paper, which, when taken to the caster after being automatically wound on a spool, produces from the perforations the exact character or space struck by the operator. The counting mechanism is nothing but a simple adjustable adding machine, with two dials one above the other (that can be set for any length of line within the scope of the machine), to notify the operator when the line is full and automatically give the justification, which is determined from the hand on the upper dial, this being set in motion when the line approaches completion. A strong feature in this machine is that, when the operator makes an error in a line, which often occurs on account of poor copy, interruptions, etc., he can, by pressing a certain key, make the casting machine automatically skip that line and begin where he wishes. The keyboard occupies about as much space and weighs about as much as a small typewriter desk, uses an ordinary manila paper about one inch wide, which requires no other preparation than to be cut in rolls of the required width, the feed or spur holes being cut as it passes through the perforator. The table can be moved around and used anywhere that the wires can be reached without being fastened in any way to the floor. The illustration shows this machine ready for use.

The caster is a small machine composed of the matrix, mold, metal pot, justifier, index head, and a number of magnets and a few cams and levers neatly mounted on an iron frame and driven by its own 1-6-horsepower motor. The paper tape is taken from the keyboard and passed through the index head, which has a number of index pins, each one of which drops through the proper perforation when it comes to it, making an electrical contact that transmits the current over a cable to a magnet or magnets, which operate pins that locate the matrix over the mold in the proper position for casting the character or space required, and at the same time set the mold for the size of the character or space called for. The mold and the matrix are then brought together, and a pump, which rests in the melting pot, is set in motion, forcing the metal through a small tube over a foot long into the mold, filling out the character or space in the matrix. The type being instantly chilled, the mold and matrix then separate, and the type is ejected into a slot. This operation is repeated until the line becomes the proper length, then this is moved forward into a galley; after this operation the type is handled in the ordinary way. The machine will set any size from 5½ to and including 12 point. In the caster there are many things that differ from all other machines. The tube through which the metal is conveyed from the melting pot to the mold is electrically heated, which enables the operator to regulate, by a rheostat, the temperature of the metal as it is delivered into the mold. It makes no difference what the condition of the metal in the pot is, as long as it is molten, the proper temperature is imparted to it as it passes through this tube. It obviates all trouble arising from the irregularities in gas pressure and change in temperature, caused by putting fresh pigs or type in the pot. The mold is water-jacketed in such a way as to insure the cooling of the largest type instantly.

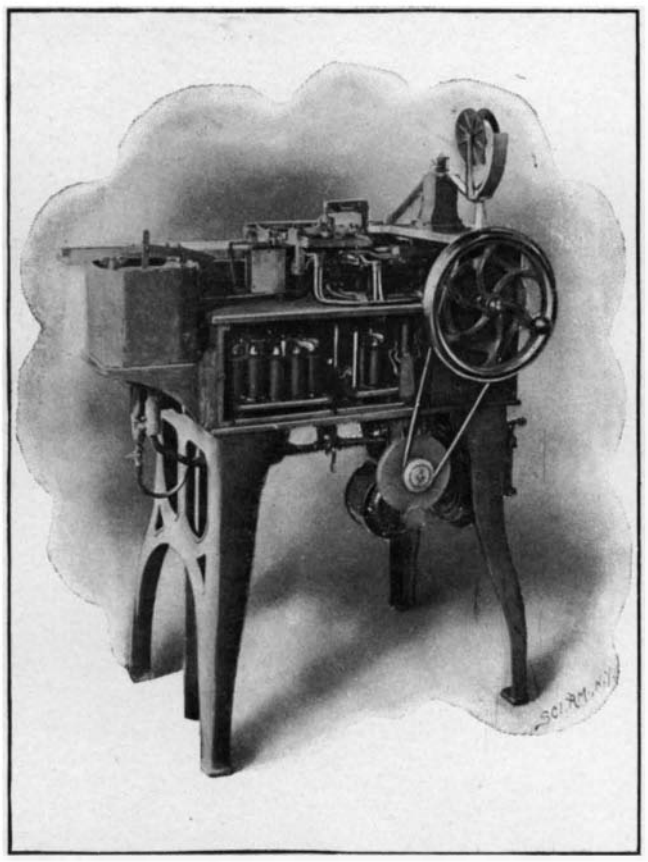


DETAIL VIEW OF CASTER WITH MATRIX UP.

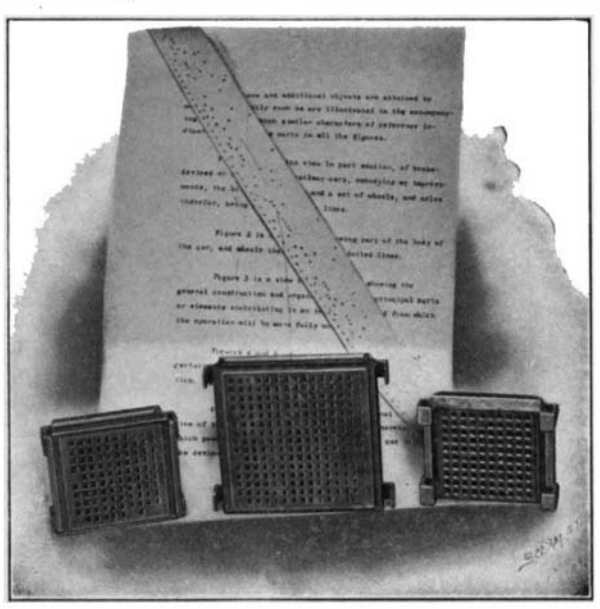
The matrix, which is practically indestructible, is made by a new process, which enables the company to make them at a phenomenally low price. It is as hard as steel, and at the same time not brittle enough to break. There are no knives or cutting edges in the mold to get dull, as the type is cast in such a peculiar way as to leave no gate or tail on the type. This feature alone makes the caster a very clean machine. The metal pot being such a long distance from the working parts, keeps the machine cool, and the fumes of the molten metal away from the operator. The justifier is a very simple electrical switch, which sends the current to a mold-size regulating pin to give the proper size space called for in the tape. This machine occupies 2 x 3 feet floor space, and weighs about 650 pounds. The illustration shows the machine in running order. There are no pulleys or belts to connect with it, as all the power is brought through the conduit, which is fastened on the back legs of the machine. This machine is so adjusted as to automatically stop on a line that is either a hair's space too long or short at the end of a tape, or an improper supply of metal. In fact, the machine is an automaton, that will cast, compose, and justify type. The detail engraving shows the matrix up, giving a view of the mold, type, and in fact nearly all the mechanical motions on the machine.



GRAPHOTYPE KEYBOARD.



GRAPHOTYPE CASTER.



TYPEWRITTEN SHEET, PERFORATED TAPE AND LARGE AND SMALL MATRICES.

The type has a very deep-cut face with deep counters or cups, which aid greatly in making plates and stereotypes and also keep the type from filling up when used directly on the press, and can be made either hard or soft by changing the properties of the metal. This deep-cut, sharp face is only obtained by using the new matrix process. As the type is made on the unit system and each type or space is a multiple of a certain part of a pica em, and only six different sizes are used, the corrections are easily made, as the compositor can readily determine the size of the space by sight, which nearly always does away with the changing of all spaces in the line whenever the rejustification is required; neither does he have to put it in a stick, and type used for corrections is made on the machine.

This machine is owned and manufactured by the United States Graphotype Company, who have their main offices at 13-21 Park Row, New York. They also have an exhibit in New York, where a battery of eight machines has been running for over a year on commercial, book, magazine, and general work with very satisfactory results. This plan was adopted to give

the machine a thorough test before putting it on the market, and save the purchaser a thousand and one annoyances that have heretofore come out with new machines. The present machine contains one hundred characters on the matrix, but has also auxiliary matrices for casting italic, small caps, heavy face, and all other "sorts" needed. The ordinary work, such as novel, magazine, catalogue, and tabulating, can be done to advantage on this machine, and it is small and rapid. A new and larger machine, containing all the above-named characters on one matrix, is being built, and in a short time that too will be on the market. One of our engravings shows the large and small matrices, typewritten copy, and a piece of the paper tape after being perforated.

THE INVENTION OF THE MODERN PRESS.

An extended account of the splendid achievements of Gutenberg must be relegated to such works as De Vinne's "Invention of Printing," where it more properly belongs. The primitive press was used from the time of the *incunabula* until the eighteenth century, when William Nicholson practically discovered modern printing machinery. He was an impractical person, but withal an inventor. To say that he was 75 years beyond his time would be no exaggeration. The invention of movable types is credited to the year 1436; the first really practical press, that of Blaew of Amsterdam. Benjamin Franklin worked on a hand press in London in 1725 and practically the same press is in use to-day by all photo-engravers for a proof-press. At the beginning of the nineteenth century Lord Stanhope invented a press composed of cast iron and provided with a toggle joint which facilitated the work. Taking the subject broadly, however, we are inclined to give the credit of the modern printing press to William Nicholson, for his English patent certainly foreshadows many of the modern improvements. We may regard him as a Watt, although it took a Stephenson half a century later to develop his ideas.

The cylinder press was introduced in 1812. Various improvements were invented, and in 1814 the first press was driven by steam. In the same year the London Times put in a press the pieces of which were carried in by stealth to an adjoining building, owing to the avowed hostility of the workmen. At six o'clock, while the pressmen were waiting for the forms, Mr. Walter entered the pressroom and astonished its occupants by telling them that the Times was already printed by steam, and that if they attempted violence he had an adequate force to suppress it, but if they were peaceable they would be retained. The speed was 1,100 an hour! The curved stereotype was invented in 1816 and the improvements all tended to produce the modern press which is an evolution rather than a concrete invention. In 1848 Col. Hoe introduced his huge ten-feeder press, which in point of size was equal to the great modern double-sextuple newspaper presses. The capacity of the earlier machines was 2,000 per hour, while those of to-day print and fold 150 000 eight-page papers an hour.

Prior to 1870 printing presses were largely of two types—the platen job press, in which the impression was made by direct pressure, and the cylinder press, consisting of a flat bed which held the type form in a horizontal position, and was carried back and forth mechanically beneath a large revolving drum carrying upon a segment of its surface the sheet to be printed. There are four kinds of cylinder presses in use—the drum cylinder, the double cylinder, the stop cylinder, and the two-revolution cylinder. The last is now regarded with the greatest favor as far as speed is concerned. The double cylinder was evolved from the old-fashioned drum cylinder. By a duplication of the cylinders the capacity of the press was doubled; they worked alternately. The stop-cylinder press was so called because the cylinder stops at a certain point in its revolution, thus permitting of great accuracy in feeding and in the amount of color that can be carried. This press is especially adapted for color and art work requiring perfect registry. It has now been to some extent supplanted by the two-revolution press, where the cylinder is smaller and revolves twice at each impression, once in contact with the type and again in a slightly elevated position, while the sheet is being released and the form returned to its proper position. The details of presses, such as adjustment and ink distribution, have received special attention from inventors of printing machinery. The web perfecting press has now been improved so that it can be used for very fine work. In these presses a roll or web of paper passes into the press, and is printed or "perfected" on both sides before being cut and folded. We refer below to very large perfecting presses for newspaper work; but they are used for magazine and book work as well. It requires more time to make ready with a perfecting press, but there is, of course, a great gain in speed when the press is started. One of the large illustrated weeklies is now installing a battery of presses to take the place of perfecting presses. In these new machines feeding is done automatically. The cylinder is of very large size, and half of it is devoted to the printing plates, which are secured to its surface. The remainder of it is used as a distributing table for the ink. The great extent of ink surface makes it possible for the rollers, which are brought in contact with it, to obtain a perfect distribution of ink. It is expected that presses of this type will supplant the perfecting presses for very fine work. They are called art presses.

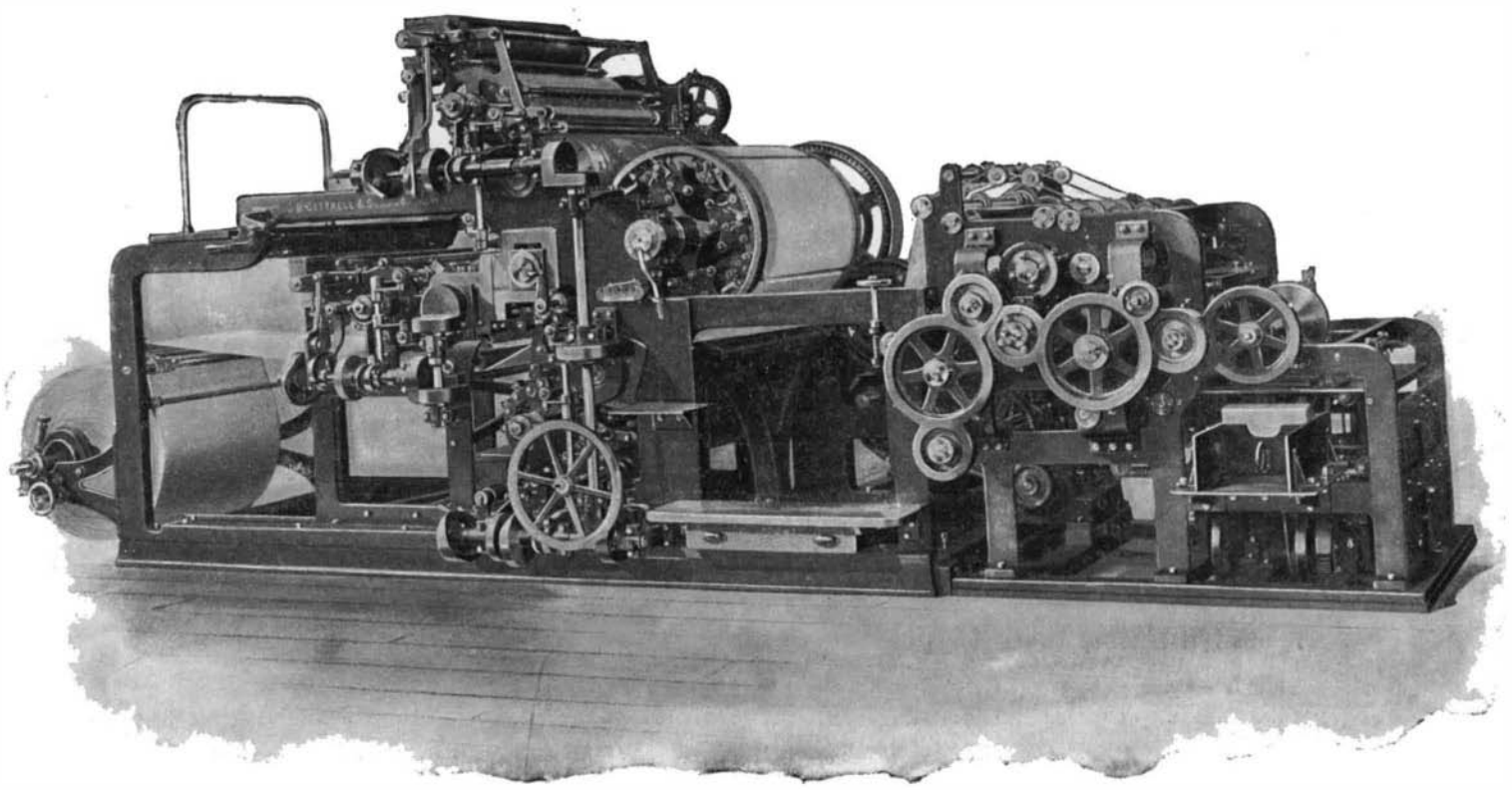
Great improvements have been made in job presses. One of the new automatic job presses has a speed of from 5,000 to 14,000 impressions per hour, the feeding being done automatically. Paper feeders have come into very general use. We illustrated one in the SCIENTIFIC AMERICAN for August 29, 1903, and two of our illustrations show the same feeder in place on printing machinery. Press manufacturers built their machines faster and faster, so that in time the feeder was unable to cope with the press. This opened a field for the automatic supply of paper, thus increasing the output from 30 to 40 per cent. The use of paper feeders has minimized the liability of strikes. The continuous use of the press adds greatly to the increase in the output. The feeder can be loaded with paper at any time, and the capacity of the paper truck is very large, 20,000 sheets not being unusual. The mechanism is described in detail in the article already cited.

THE NEWSPAPER PRESS.

The Hoe double-sextuple printing presses are veritable triumphs of mechanical art. This machine is really composed of two separate complete printing mechanisms, each fed from three four-page-wide rolls of paper. The machinery for the gathering and folding of these webs of paper is in the center between the two sections of the machine. Each of the two portions of the machine is composed of six pairs of cylinders arranged with their axles parallel, in three tiers of two pairs each. They print on both sides of three webs of paper from separate rolls which are each four pages wide. One of these sections is so arranged that all six sets of cylinders will print upon a single web in colors and black, this web being associated with the three webs from the other portions in order to form a colored cover. Each section of the machine may be operated independently, if desired. There are twelve plate cylinders in the machine, each carrying eight plates the size of a newspaper page, and either stereotypes or electrotypes may be used. The ink is applied to the plates by four form rollers after having been thoroughly distributed by means of vibrating rollers and cylinders.

The immense press measures 35 feet long, is 9 feet wide, 17 feet high, and weighs about 225,000 pounds. The number of parts of which it is composed is approximately 50,000.

The capacity of the machine when printing all black from six rolls is equivalent to 150,000 four, six, or eight-page papers per hour. If the size of the paper is increased to twenty-four pages the press will still print 50,000 per hour. The three webs from each part of the machine are led to the top of the folder, where they are divided along their center line into webs two pages wide, and then run down each of the four formers by which they are folded along their centers. They are then led to cylinders which cut them into page lengths and give them a fold across the page to half-page size. This is one method of running a twenty-four-page paper. When running as a color press the maximum product is 50,000 sixteen-page papers per hour, the outside pages being printed in four colors and black, and the other pages in black only. It is most interesting to see one of these great presses at work. A number of men are required to operate it, and they communicate with each other by bells. The folded and counted papers are delivered so fast that it is almost impossible for the men to take them away fast enough. In the case of one large New York daily five miniature elevators are required to raise the papers to the street level for delivery to wagons and to the newsboys.



PRESS FOR MAGAZINE WORK.—THE SHIFTING TYMPAN PREVENTS OFFSETTING OF THE INK IMPRESSION.

MAGAZINE AND BOOK PRESSES.

The development of the web press and folder for printing and folding illustrated magazine work has been difficult, on account of the quality of printing on highly-finished papers and the necessarily accurate registry of the folding required, as well as the handling in the folder of the freshly-printed web without smutting. The incentive for the development of this class of web press is found in the growth of the illustrated monthly publications, improvement in the half-tone process, and the demand of publishers for a better quality of printing and folding at higher speeds than can be accomplished by a sheet-fed press and a sheet-fed folder. We illustrate one type—the Cottrell.

The tympan sheet is an extra sheet of paper stretched over the second impression cylinder, make-ready, or packing, to take the offset of extra ink from the first side of the web printed, and the automatic shifting tympan mechanism is adapted for the self-shifting of this tympan sheet.

This mechanism has first the ability to change the tympan in one second of time, while the press is running at a high speed, and secondly, the ability to have