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.

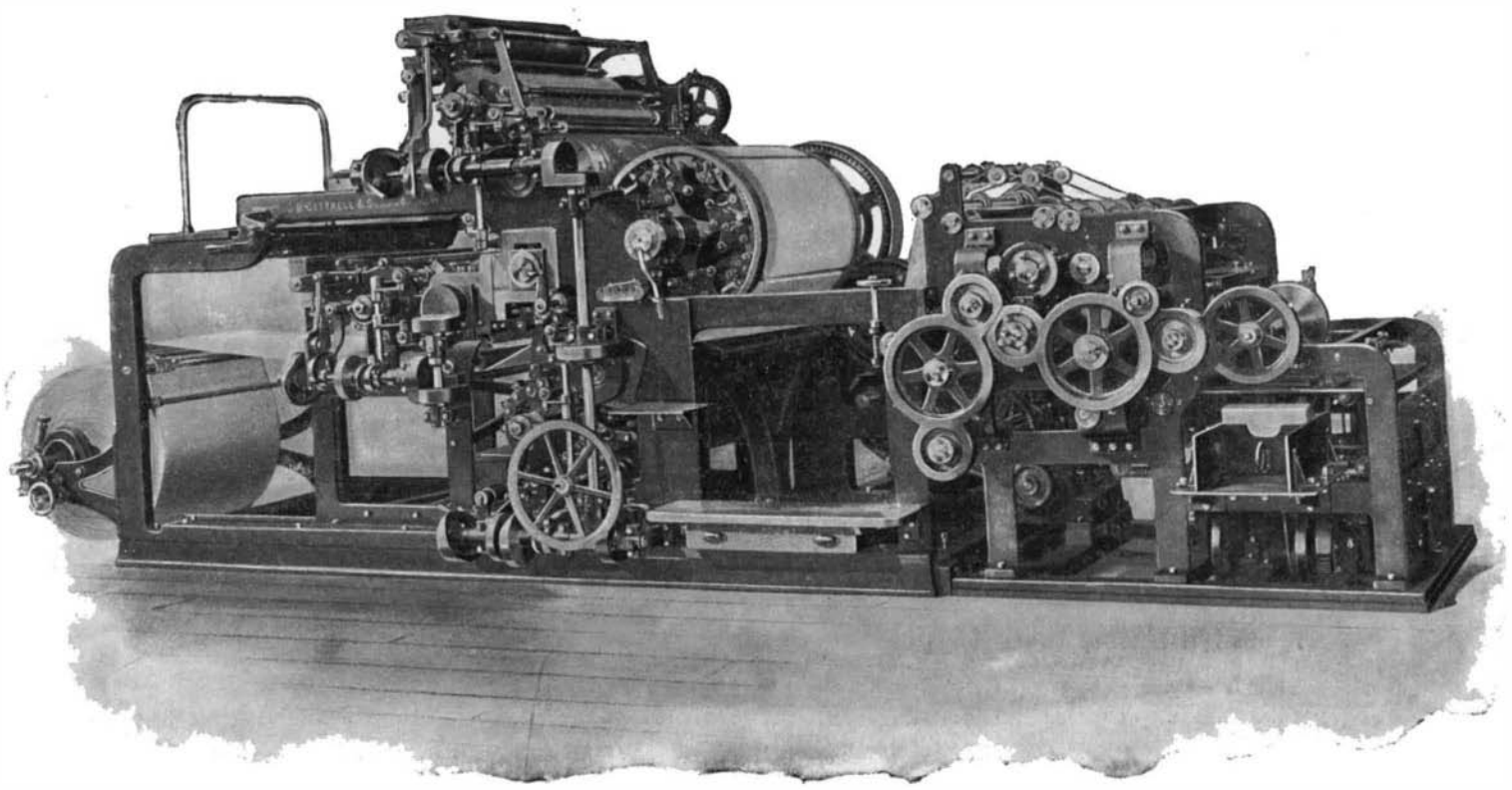
Great improvements have been made in job presses. One of the new automatic job presses has a speed of from 5,000 to 14,000 impressions per hour, the feeding being done automatically. Paper feeders have come into very general use. We illustrated one in the SCIENTIFIC AMERICAN for August 29, 1903, and 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

this entire new tympan as often as required. Going over these points of the invention again, the entire tympan changes itself, so that you have a brand-new tympan in an instant. It does this between impressions, while the press is running at a high rate of speed, and it will do it as often as you wish.

The tympan mechanism consists of rolls of this manila paper located just inside of the openings in the cylinder. The paper comes out through these openings, passes across the quarter sections of the impression surface of the cylinder, and is drawn in through another opening in the cylinder onto other rolls. It winds itself automatically from one roll to another, across the impression surface of the cylinder, but instead of moving slowly it travels across the entire surface of the cylinder in one quick movement between impressions, giving an entirely new tympan surface.

The tympan mechanism can be set to shift in this way once every 10, 20, 30, and up to 150 impressions as the form may require, and thus it goes on automatically, requiring no attention as long as the press itself is kept in operation.

A roll of tympan paper lasts a day on fine work, or on common work for a longer period; it can then be used again and again—allowing time to dry. The shifting tympan or the tympan sheet acts in place of a blotter to take up from the freshly-printed surfaces or surface such portion of the ink as is not impressed in the paper surface and is not necessary to make an absolutely black impression. The web after being printed is carried by its margins to the folder, where it is cut into sheets, folded without the use of folding rollers, and delivered without any portion of the printed surface coming in contact with any part of the mechanism.

The Miehle press for general work shown is of the flat-bed, two-revolution style and known to printers by this description. The bed carrying the type reciprocates under the cylinder, printing on one revolution of the cylinder and returning to its original position on the second revolution of the press, which also gives time for the handling of the sheet by fly or other delivery, and gives time also for the re-inking of the form, the distribution of the ink, etc. This style of press also permits the tripping of the cylinder in case the feeder should fail to present a sheet at the right time, thus saving the printing on the cylinder and the offset that ensues.

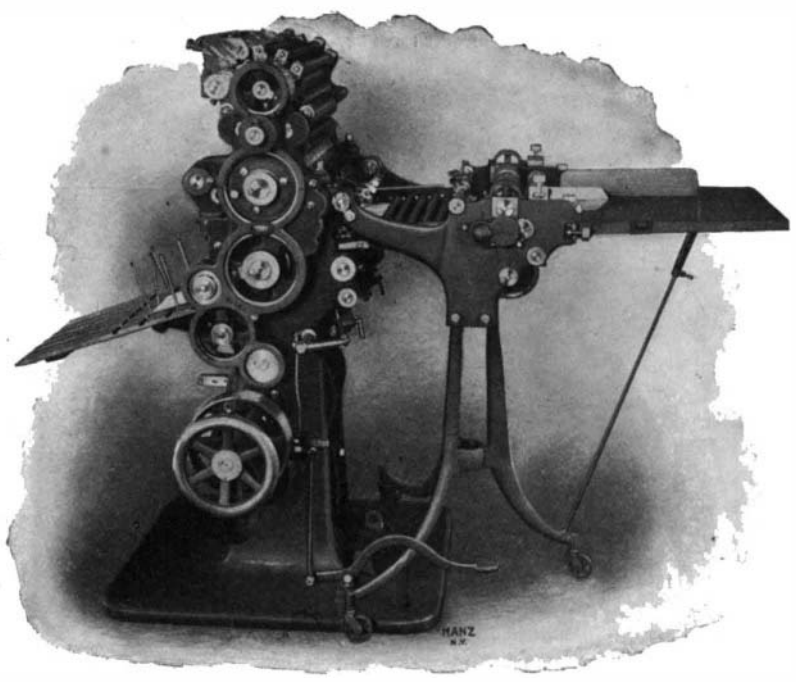
The special feature of this press is the new bed movement. Probably no part of the cylinder press has been the subject of so much experiment as the mechanism for propelling the type bed back and forth under the cylinder. Of the numerous devices invented, comparatively few have developed merit sufficient to attain any permanent adoption.

The movement of the bed under the cylinder is even throughout; the avoidance of any eccentric movement permits of an even quality of work throughout the line of impression, permits of its finest register work, like three-color or similar work requiring accuracy. The press prints at one time eight complete covers of a large magazine which are equal to thirty-two pages quarto book form, one impression carrying a sheet 48 x 68 inches, and it is at the Collier Press.

AUTOMATIC JOBBING PRESS.

It is an entirely automatic machine. The stock being dropped by handfuls into the hopper, the press delivers it admirably well printed, in such a convenient form for ready removal that one hand can operate the machine entirely unassisted on all speeds up to twelve thousand per hour. Indeed, there are many operators competent to handle the press at fourteen thousand per hour. The press is automatic to such an extent that if left alone it will stop itself when it has printed all the stock in the hopper. If for any cause a piece of stock fails to feed, the press throws off its impression automatically, so that the tympan receives no ink to offset the next piece of stock that goes through. At the same time the press stops itself. To start it again is practically an instantaneous process. The Harris press is a small machine, occupying a floor space of 3½ x 5 feet. It ordinarily takes but one-half horse power to run it.

It is possible to make 250 changes of type forms a day, and still run off 50,000 impressions where it is not necessary to "make-ready." It feeds cut sheets of paper in all sizes of stock from 4 x 6 inches up to and including 15 x 18 inches. It prints in one or two colors at once a curved electrotype or stereotype form in all sizes from a single letter up to and including 14 x 17 inches, and one or two type forms in turtles, each holding a form up to 4⅞ x 8⅝ inches.



THE HARRIS AUTOMATIC PRESS FOR PRINTING CIRCULARS, NOTICES, ETC.—FEEDS ITSELF FROM A HOPPER.

The normal running speed on a full form is 6,500 impressions per hour. The maximum speed is 10,000 an hour.

The feeder is accurate and reliable, involving no use of air, no electricity, and no buckling, crimping or doubling of the paper. The sheets are not pushed forward from the top of the pile, but are pulled out by the front edge from underneath the pile. It requires very little adjusting for various weights of paper or for changes in the size of stock. The separating mechanism is rotary. The stock being fed from the bottom, the pile is replenished without stopping or in any way delaying the machine.

The feeder is provided with a choke to prevent more than one sheet at a time reaching the form, and a trip, or automatic throw-off, which stops the press and separates the two cylinders to prevent the form from smutting the tympan whenever a sheet fails to feed from any cause whatever. This makes the press practically "fool-proof;" so that after a good, competent pressman has made a form ready and started the job, the cheapest intelligent labor in the shop can perform the work of loading up the stock pile, watching the color and removing printed sheets.

Ink and Rollers.

Ink and rollers are two of the most important articles connected with printing. Printing ink is a pigment of the required color mixed with an oil or varnish. It must distribute freely and easily, work sharp and clear, and not be affected to any great extent by atmospheric conditions. It must dry almost immediately on the paper, but not dry at all on the type or rollers. The basis for the best black ink is lampblack and the vehicle is usually linseed oil. Many pigments are used to produce printing inks of different colors. Printers' rollers are diverse in their composition, each maker having his own formula. The following is a typical formula:

Best glue	10½ pounds
Black molasses or honey	2½ gallons
India rubber, dissolved in oil of turpentine	1 pound
Venice turpentine	2 ounces
Glycerine	12 ounces
Vinegar	4 ounces

The above formula is given for the mysterious black composition, so durable and elastic. Purified and unvulcanized India rubber only is used.

In a printing establishment in New York city two motors are in use, a 15-horsepower gas engine and a 25-horsepower electric motor. The average load carried is only about 10 horse power. Comparison has been made two months, when the gas engine alone was used, and two other months, when the electric motor alone was in service. Gas is taken from the city illuminating mains and costs $1.05 per 1,000 cubic feet. The engine was run a total of 697 hours, and the gas consumed cost $106.68, or an average of 15.3 cents per hour, which is about 1½ cents per horse-power hour. Electric current is taken from the Edison mains, and the amount used during the 686 hours of operation of the motor amounted to $250.30, or an average of 36.5 cents per hour, which is about 3½ cents per horse-power hour.

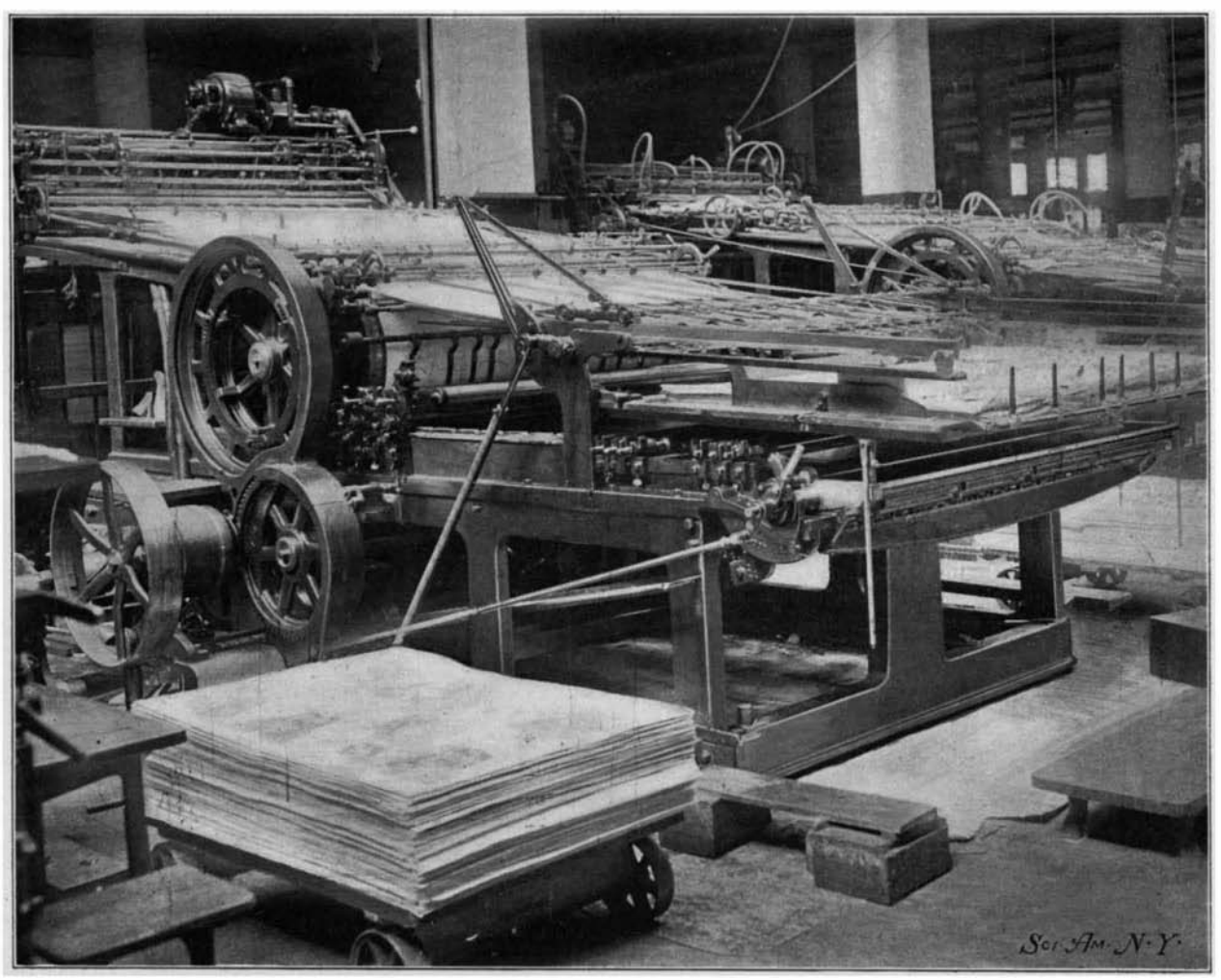
Lithographic Color Printing.

A widespread but unsuccessful attempt was made, about 1880, to substitute zinc for stone in lithographic work. After this failure, zinc was generally abandoned as a factor in the lithographic problem, but one firm has continued to make experiments along this line with considerable success.

In 1898 the great superiority of aluminium over lithographic stone was demonstrated. Aluminium is far lighter, requires less space for storage, is cheaper, is almost non-corrosive, can be used in sheets upon rotary presses, can be used for longer runs without reproduction of the design, and after some manipulation possesses all the desirable qualities of stone.

The methods of manipulation are two. By the first, the surface of a sheet of fine-rolled aluminium is ground off, producing a porous surface. The second method is the formation of an aluminium surface by electro-deposition.

The effect of the extraordinary activity in invention and improvement in the printing world since 1880, has been twofold. To the printer himself it has been injurious rather than helpful; to the public it has been of incalculable advantage and has been a potent factor in elevating the standards of good taste.



A TWO-REVOLUTION PRESS FOR WEEKLY OR MONTHLY MAGAZINE WORK.