

## MACHINERY FOR BOOK AND GENERAL PRINTING.

---

BY MR. WILLIAM POWRIE, *Member*, OF LONDON.

---

Until a comparatively recent period Typography was almost the only process employed in the production of books and other readable matter ; but it is now largely supplemented by lithography, collotype, &c., each requiring special machinery and appliances for their effective development. In fact the operations in a modern printing factory are specialized and carried on in departments, in a similar way to work in an engineering establishment ; and a simple list of the various machines employed would fill several pages. As an excellent detailed description of a rotary newspaper-printing machine, and the method of producing a daily paper, has been given by Mr. John Jameson in the Proceedings of this Institution for 1881 (page 511), the author purposes dealing at present with the leading classes of Machines employed for Book and Job Printing.

Although the art and method of printing from movable types was invented about the beginning of the fifteenth century, it was not until the early part of the present century that printers' engineers and tool-makers began to produce power-driven machinery. Since then the improvement and development of printing machinery has been continuous, and more especially during the last thirty years, until the modern printing machine bears about the same comparison with the early ones that a first-class express locomotive does with the historic "Rocket ;" and printers' engineering is now an important department of mechanical work. There is great diversity of details in the presses and machines used by typographic printers : some are of the "platen" kind, printing the whole surface of the sheet at once ; and others are of the "cylinder" class, printing one line at a time, but

revolving so rapidly that their production exceeds that of the platens. Some have one cylinder for printing one side of the paper only ; while others have two or more, and print both sides at one operation, either from rolls or in sheets as may be desired. But a few leading principles are common to them all.

The aim of the printer is to produce on paper in one or more colours a correct representation of a given arrangement of type, or combination of engraved blocks or ornamental designs, which, while being printed from, are usually wedged fast or "locked up" securely in iron frames called "chases," the whole collection being called a "forme." To this end it is necessary to provide apparatus for covering the printing surface of the forme with a thin even coat of the colour in which the work is to be printed ; and other apparatus by which the colour is transferred to the paper, so as to be always in the same position on a sheet of given size. When these operations are performed separately by the workman, the apparatus is usually in this country called a "press" ; and when they are performed automatically by apparatus actuated by the turning of a single shaft, the combination is termed a "machine" ; but in some other countries every such apparatus is termed a press and the maker a press builder, while here we have both press and machine makers, usually termed printers' engineers.

Most newspapers and magazines of large circulation are printed from webs of paper brought to the machine in large rolls, printed on both sides and delivered in sheets ; but the bulk of book and job printing is done on machines which print one side of the paper only at a single operation, the sheets being taken singly from a pile. In platen machines the paper is usually fed or laid on and taken off by hand. In cylinder machines the sheets are usually delivered automatically : some are also self-feeding, but hand-feeding is still a common practice.

*Hand Press.*—For general proving or for printing small editions the hand press is still largely used. The general arrangement is as represented in Fig. 1, Plate 24, and Figs. 3 and 4, Plate 25, where B is a sliding bed or carriage for supporting the type

forme; P is a platen for taking the impression, set down by a combination of levers L; and T is the tympan, and F the frisket frame, for holding the sheet in position while being printed. The forme is inked over by a hand roller, the sheet to be printed placed between the frisket and tympan, which are then folded down over the type; the carriage is slid under the platen, which is then pressed down on the paper by the levers with a force equal to about twelve tons in an average-size press, printing 36 inches by 24 inches.

Steam-driven machines were made on this principle thirty years ago, and largely used for book printing; but although they did good work they were slow, and the demand for greater speed has led to the development of cylinder machines, which, owing to the improvement in engineering tools and methods, can now be relied on to do quite as good work as the platens and a great deal more of it: so that platens have almost disappeared for large work, although the smaller varieties are used in increasing numbers for job printing.

*Single-Cylinder Machines.*—Wharfedale or single stop-cylinder machines have been for many years the most popular for book and job printing; their general arrangement is as shown in Figs. 5 to 11, Plates 26 to 29. In designing a machine of this class, the first thing to decide is the size of sheet it is to be capable of printing, and then how many inking rollers shall clear or pass over a full-size forme; these data determine the travel of the carriage, size of cylinder, and total length and width of the machine. The forme must clear the cylinder grippers at one end and the last inking roller at the other, while the circumference of the cylinder must coincide with the stroke or travel of the carriage, and the length of the forme over the chase settles the width of the machine. As it is usual to put the crank-pin in the driving wheels, the length of stroke required determines their diameter; and they in turn fix the height of the carriage, the ink-table having to pass over the top of them. The other working parts are arranged as the experience of the designer may suggest, and the frame is made to suit his arrangements. The frame is on the box principle, with two sides,

two ends, and one or more cross stays in the centre: all securely held together by tight-fitting bolts.

The carriage which supports the forme and ink-table, Plate 27, runs forward and backward on two, and in large machines on four, sets of anti-friction live rollers or bowls R, running on rails or tracks, which are usually planed after being bolted in position, in order to ensure accuracy. These rollers are kept at regular distances apart by coupling-bars on each side of them, Plate 28, and are compelled to run at the proper speed by being coupled to the rack-wheel shaft. The carriage is propelled by the rack or traverse wheels W, which are fitted with smooth flanges to run on rails fixed securely to the frame, and gear simultaneously into racks both top and bottom; the bottom racks are fastened to the rails, while those on the top are secured to the underside of the carriage. The rack-wheel shaft is coupled by a connecting-rod to a crank-pin in the main driving-wheels, and with its wheels runs forward and backward as the driving wheels revolve; the racks on the carriage compel the latter to move in the same direction through twice the distance. The printing cylinder is driven by the carriage, which has a toothed rack at each side, driving spur wheels on the cylinder ends. One of these wheels is securely fastened to the cylinder, while the other runs loose when the cylinder is at rest, the fast wheel having a portion of its teeth planed off at the underside to clear the carriage rack on the return stroke. The loose wheel is coupled to the cylinder by a pawl clutch, Figs. 8 and 9, Plate 29, so arranged that it allows the wheel to run either loose or securely attached to the cylinder as required; and an automatic cylinder-check and double-rolling motion D are fitted, which when required prevent the pawl from dropping into position to take the cylinder through each alternate revolution, so that the forme then gets twice the usual amount of inking. Moreover, by touching a small lever, the attendant can at will prevent the cylinder from revolving. At each end of the cylinder surface, a belt of about  $1\frac{1}{2}$  inch width is made exactly the diameter of the pitch line of the cylinder wheels: so that these belts will roll without slip upon the bearers which are secured on the carriage. The centre part of the cylinder, being the printing surface, is made 1-16th inch smaller in diameter than the end belts, in order

to allow space for a few sheets of paper and a calico covering, for holding the overlays or patchwork "make-ready"; the latter is required to make up for the uneven surface of the forme, and to bring up the printing properly on the paper. The cylinder surface is ground dead true after turning.

The strain of the pressure required in printing comes principally upon the cylinder and the frame cross-stay S immediately under it, as the carriage and forme are like a fine wedge driven in between these to separate them. The cylinder is stiffened by ribs cast inside, and has a strong steel shaft right through, Plate 28; while the centre cross-stay is stiffened by a heavy bottom flange, Plate 27, and rests, as do the other stays, on planed seatings projecting inwards from the frame sides. The bolts are thus relieved from pressure, and have only to hold the parts together.

The ink, which is usually made of lampblack or other colouring matter, is ground up in boiled or blazed linseed oil, contained in a narrow trough, called the ink-box, duct, or fountain, Plate 27, placed across the back end of the machine; one side of the box is formed by a cast-iron roller called the ink-cylinder, and the other by a triangular piece of cast-iron called the duct-knife, which is really a scraper. The ends of the ink-box are plates, fastened by screws to the ends of the knife, and lapping over shoulders turned on each end of the ink-cylinder to prevent the colour from escaping. The duct-knife is adjustable by screws in its back edge, and can be set close to the ink-cylinder or at any required distance from it, so that the latter may be coated with colour to any thickness desired. The colour is taken off the ink-cylinder by a small vibrating composition-roller, and is laid on the ink-table or distributing-drum according to the class of machine. An adjustable ratchet-motion causes the ink-cylinder to revolve when the duct roller is in contact with it, whereby a portion of its coat of colour is transferred to the duct roller, and over more or less of its surface as required. The distributing drum revolves in contact with two or three composition-rollers placed on the top side of its circumference, and is compelled to move endways a few inches to and fro by a lever and cam or by a worm-wheel and crank; the result of this lateral movement

combined with its rotation is to spread the colour in an even thin film all over its surface. Underneath the drum is another vibrating roller, which takes colour from the drum and deposits it on the ink-table or "slab." The latter is an iron plate secured upon the end of the carriage; its top surface is finished quite smooth, and is set to the same height as the face of the forme. In machines for the commoner sorts of printing, the colour is transferred from the ink-cylinder to the ink-table direct, without passing over a distributing-drum, which is omitted from such machines. The ink-table moves forward and backward under the rollers, and has the colour equalised over its surface by the distributing rollers or "distributors," which are caused to traverse laterally over its surface by being placed diagonally across the machine. The forme rollers or "inkers" take up a coating of colour from the ink-table as it passes under them; and this coating is further distributed or equalized by the "traversing riders," Plates 27 and 29, which are made of steel tube accurately turned and polished, and are compelled to move endways to and fro by a suitable crank-motion. The colour is ultimately deposited by the inkers on the face of the forme; and finally by the pressure of the cylinder is transferred to the paper to be printed. The whole of the inking and distributing rollers are made of steel tube, with ends welded in, and covered outside along the centre portion with a composition made of a mixture of glue and treacle or glycerine, cast hot in accurately bored and polished moulds.

In order to produce good printing, especially if the design is in several colours, it is necessary that the cylinder and carriage should always come into contact in exactly the same relative position, and that the cylinder start and stop at exactly the same place in each revolution. When the carriage is made a good sliding fit in the frame, and the cylinder fits its bearings so that there is no end play, and the teeth of the wheels and racks are of correct size and shape, and when also the bearers are the proper height and in contact with the cylinder belts when in motion, then the carriage and cylinder will move so accurately that the cylinder may be run repeatedly over the forme without showing more than a single impression. When the sheets to be printed are laid against stops on the "grippers," the above is sufficient

to ensure good "register;" but in the machines now described the stops or "lays" are usually attached to the feed-board, and are quite unconnected with the cylinder, so that any variation in the position of the cylinder, when the grippers close on the sheet, spoils the register. To prevent such an occurrence, these machines are fitted with a pushing motion, which presses the cylinder back to a dead stop before the grippers close on the sheet, Plate 28, and Figs. 10 and 11, Plate 29. On the inner side of the brake-wheel rim is cast or fastened a projecting lug A, which is fitted to fill the space between two movable levers B and C, so arranged that, when the cylinder revolves in the direction of the arrow, the projection A on the brake wheel depresses the front lever B, Fig. 11, and passes clear over it, allowing the lever to rise up to its previous position. When the cylinder stops, the other lever C, which has been drawn back for allowing the wheel to pass, Fig. 11, is pressed forward by a cam and lever arrangement, and pushes the brake wheel and cylinder back, until the projection A on the wheel is hard up against the front lever B, Fig. 10.

The sheets to be printed are laid in a pile on the front part of the feed-table. They are removed by the operator singly to the back portion, and laid in contact with the "lays" at the gripper edge and at one side. This portion of the table is hinged at its front edge, and the back edge is raised by a cam and lever arrangement until the sheet is in contact with the gripper edge of the cylinder; the grippers then close on it, the cylinder revolves, and the printing is completed.

In the early days of cylinder printing-machines, the sheets when printed were removed by hand from the cylinder, and deposited in a neat pile on the delivery table with the printed side up. The boy or girl attendant usually transported the sheet with a rapid movement through the air, which caused it to float down on to the pile upon the table. This came to be termed flying the sheet; and the mechanical apparatus which has now generally replaced the human attendant is called a "flyer," Plate 27, and Fig. 10, Plate 29. A cylinder of wood, half the diameter of the printing cylinder, and provided with grippers to alternate with those of the latter, is placed in a convenient position and geared with the printing cylinder; cams for actuating

both sets of grippers are so arranged that, when they are passing the plane in which lie the axes of both cylinders, the main grippers open and the flyer grippers close on the sheet, Fig. 10, which is then carried round the small cylinder until the latter stops and the grippers are opened, when the sheet is in position between two or more rubber-coated rollers, which are adjusted on a spindle to suit the unprinted margins of the paper. These rollers apply sufficient pressure to retain the sheet in position and compel it to move onwards when the flyer cylinder makes the next revolution; but, instead of going round with the cylinder, the paper passes off upon a series of carrying tapes, which are put in motion by the flyer cylinder, and at the proper time is lifted by the "fan," which may be likened to a large oblong hand, with wooden laths instead of fingers. The fan transfers the sheet to the pile on the delivery-table, turning it upside down on the way, and so delivering it with the printed side up. In order to facilitate "making ready," the flyer apparatus is so arranged that, by depressing a lever, it may be elevated bodily for giving ready access to the cylinder, as shown by the dotted lines in Plate 27. Automatic delivery is now the rule, but automatic feeding is still the exception; and although some highly ingenious apparatus has been tried, and in certain cases found to answer well, yet the great diversity of circumstances under which printing machines are used, and the variety of papers printed, make the production of a satisfactory feeder at a moderate price a difficult problem to solve. Considering the number of clever minds that have been and are devoting attention to it, and the stimulus of stringent factory regulations, the time is probably not far distant when automatic feeding will be as common as automatic flying; and a pile of plain paper deposited on the feeder table will be printed and deposited in a pile at the delivery end of the machine, without being touched by hand.

The class of machine just described, with various modifications of detail, has enjoyed a great popularity among British printers during the last twenty-five years, as a good all-round machine; but, for printing illustrations or work with solid masses of colour, the inking is not satisfactory. Although this has been remedied to some extent by double rolling, or placing inking apparatus



at both ends of the machine, these methods reduce the speed and rate of production.

*Fine-Art Machines.*—Within the last few years the preparation of printing blocks by photographic processes has so reduced their cost, that books and magazines are now more plentifully illustrated; and the demand for a better kind of printing machine has become imperative. Plates 30 to 32 represent some of the fine-art machines now coming into favour for this class of printing. These machines are substantially built. The defective inking of the Wharfedale machine, Plate 27, arises from the forme rollers receiving colour only when the ink-slab runs under them; and this intermittent supply, although sufficient for open type, soon gets exhausted when large surfaces have to be covered, and the rollers are almost bare before they have gone over the forme twice. In Plate 32 the flat distributing-slab or table is replaced by cylinders in contact with the forme rollers, ensuring a continuous and even supply of colour to the forme, which enables the machine to be worked to its utmost capacity. The sheets are fed in at the top of the cylinder to lays attached to it, as shown in Fig. 15, Plate 33; and the lays are adjustable by screws, which greatly facilitates obtaining correct register. By dispensing with the ink-table and placing the inking apparatus nearer to the cylinder, it is easier to put the forme into position on the carriage, and to get at it for cleaning and adjustment.

To facilitate changing and cleaning the inking rollers, they are divided into two sets, Plate 32; and by a rack and pinion arrangement the ink-box and distributing rollers can be moved backwards bodily on the frame, leaving the forme rollers more accessible to the operator, as shown in Plate 31.

The flyer apparatus can also be detached and moved away from the cylinder to facilitate "making ready," Plate 31; and the flyer drum, instead of being a hollow cylinder of wood, is a series of gun-metal rings with grippers attached, the rings being fixed on a shaft. This arrangement is less liable to get out of truth, and makes less noise in working, than the hollow wooden drum.

To ensure smooth running at the increased speed now required, these machines, as well as the best of those previously described, are fitted with air-buffers, which take up the momentum of the reciprocating carriage and give it an impulse to return, Plates 27 and 32. (*See also* page 120.)

*Two-Revolution Machines.*—In the last two machines, which are of the stop-cylinder class, the cylinder stops after each impression, and remains at rest until the carriage has returned to the original starting position. But the desire for increased speed has led to the introduction of two-revolution machines, in which the cylinder is continually in motion while the machine is at work, and makes two revolutions for each sheet printed, as shown in Plates 34 to 36. Although this class of machine was in use in this country over twenty-six years ago, it met with little favour until quite recently, when introduced in an improved form as a novelty from the United States.

The type carriage in these machines is propelled in several different ways; but the arrangement shown in Plate 36 seems to have found most favour up to the present with British printers. Instead of the rack-wheel travelling forward and backward while in gear simultaneously with both the top and bottom racks, as in the machines previously described, it revolves continuously in one direction, and being mounted on a sort of cradle-frame A has a small vertical movement, which allows it to engage alternately with the top and bottom rack. Attached to the under side of the type carriage is a rectangular frame B, carrying the driving racks; and near their ends are two vertical flaps or shutters C turning on vertical pivots, which are opened and shut transversely at the proper times by the bowls or rollers D D and cam plate E. As the end of the frame B nears the rack-wheel, the shutter C opens, and allows the bowl F, carried by the rack-wheel, to pass it and get into the slot formed by the end of the frame and the edge of the shutter, which has now closed. Then the rack-wheel moves away from the rack it is driving, and the bowl F takes charge until it comes round to the bottom of the slot, when the rack-wheel engages with the

other rack, the shutter opens, and the carriage proceeds on the return journey. These movements are repeated at each end of the stroke.

As this method of driving gives an even steady speed of travel, with only a short stay at the ends, the momentum of the carriage is considerable, and is taken up at each end of the frame by the air-buffers, Plate 36, which soften the shock at the ends of the stroke, and give the carriage an impulse for its return. The cylinder is not driven by the carriage, as in the machines previously described, but by independent gearing from the driving shaft, whereby a smooth steady motion is produced; and in order to ensure accurate register, a few teeth on the cylinder and type carriage engage with each other when the printing surface is about to meet the forme. The sheets are fed in to the top of the cylinder as in the fine-art machines; but the lays are attached to the frame, and are removed out of the way when the grippers seize the sheet, which is carried round by the cylinder, printed, and delivered by a flyer in the usual way.

The inking arrangements of these machines are generally similar to those of the stop-cylinder machines; but the distributors are arranged in pairs, with a polished steel-tube roller between, geared to run continuously, which materially assists the distribution of the colour. During the printing, the cylinder is pressed down and held in contact with the forme by a pair of toggles or eccentrics E, Fig. 16, Plate 33; and, when the forme has passed under it, the eccentrics are released, and the cylinder is raised about a quarter of an inch by helical springs at the top of the impression rods RR, in order to clear the forme during its return stroke. The bowl B, carried at the end of an arm A which turns loose upon the eccentric shaft E, runs in the groove of the impression cam C, which revolves in the direction of the arrow. On the spindle of the bowl is centred a quadrantal jaw-lever J, having on its underside a jaw engaging the impression arm I which is fixed upon the eccentric shaft E. In the jaw lever is fixed a pin P, which works in a quadrantal slot in the check lever K, keeping the jaw engaged with the arm I while both move together through nearly a quadrant of a circle and back during each revolution of the cam C, thereby rotating the eccentrics E through the same angle forwards and backwards for applying the

K

pressure upon the forme and relieving it again. When it is desired to miss printing without stopping the machine, the cylinder is retained in its highest position by disengaging the jaw lever J by means of the foot lever F, which is depressed by the treadle T at the feeder's stand. The check lever K and the jaw lever J are thereby raised into the positions shown by the dotted lines: so that, while the impression cam C continues to revolve, the jaw lever J works clear of the impression arm I, and the eccentrics E are not brought into action for depressing the cylinder. The treadle T is held down as long as required by the pin N catching underneath the foot board; when this is released by pushing it aside with the foot, the treadle and foot lever F are raised to their original position by the helical spring S. The jaw lever J then drops into gear again with the impression arm I.

*Two-Colour Machines.*—The machines previously described are designed as single-colour machines, although two or more colours may be printed on them at the same time with special appliances; but where much work in colours is done, such as posters, showcards, labels, &c., it is preferable to employ two-colour machines, as represented in Plate 37. These are designed on the same general principles as the single-colour machines represented in Plate 26, but are double-ended, and the cylinder revolves twice for each complete impression. The carriage is double, having space in the centre for two formes; and an ink-slab is fixed at each end. The inking arrangements are similar to those on the single-colour machine; there is a complete set at each end, and for each colour in the printing. The formes are inked up by passing under the inking rollers, as in the stop-cylinder machines; and the cylinder with the sheet of paper to be printed rolls over both formes before it stops; thus a two-colour impression is obtained at each travel of the carriage. The sheets are fed in and delivered as in the single-colour machine; and if more than two colours are required in the design, the sheets can be put through the machine as often as required, and completed as in the other machines, with the advantage of having two colours put on at each printing. If two-colour work falls off, such

a machine can be used as a single-colour machine; but the production will be less, because owing to its greater length it cannot be worked at the same speed.

*Perfecting Machines.*—The first successful cylinder printing machine, which printed the issue of "The Times" for 29th November 1814 for the first time by steam power, printed the paper only on one side in a single passage through it, being what is called a single-side machine, although it had two cylinders; but the necessities of newspaper and book printers soon led to the introduction of machines which "perfect" or print both sides of the sheet in each complete revolution, and are known as "perfectors."

These machines differ in their arrangements and details, but may be grouped generally in two classes: those with large cylinders making one revolution; and those with small cylinders making two revolutions for each sheet printed. They are used for book and magazine printing, where the editions are large and the sheets have to be printed on both sides. The machines mostly in favour with British printers for ordinary work are those with the large cylinders, of which Plate 38 shows the general arrangement, and Plate 39 is a sectional view showing the arrangement of the cylinders, and of the tapes which guide the sheets through. The type carriage is here driven by a horizontal pinion, Plate 39, secured to the top of a vertical spindle, and acting on a rack with two flat sides and round ends, which is secured to the type carriage, but is free to move transversely: so that the pinion may gear into each side of the rack alternately, and cause the carriage to move first to one end and then to the other. Each type-forme comes under its own cylinder, and the sheet of paper is printed first on one side and then on the other.

The cylinders run in fixed bearings adjustable vertically to suit the impression, and the registering drum is also adjustable vertically, so as to vary the length of the tapes between the inner and outer forme-cylinders, and also to alter the position of the sheet on the latter while being printed, in order to ensure the pages being exactly opposite each other on both sides of the paper. The printing surfaces of the cylinders are covered, as in the single-cylinder machines, with calico for the

“overlays” and a few sheets of paper or a blanket, according to the class of work and the result required; the remaining portion of their circumference is made about  $\frac{1}{4}$  inch less in radius, so as to clear the formes during their return. The sheets to be printed are laid in a pile on the feed-table, which is a fixture, and are fanned out at the front: so that the feeder has but a small distance to move them, and usually “strokes” them down to the front lay marks with a hard wood or bone stroker. The gripper drum, which is about one-third the diameter of the printing cylinders, opens its grippers each alternate revolution. These seize the sheet by the front edge, and draw it forward into the tapes; then the grippers open, and the sheet held between the two sets of tapes is carried round the cylinders until it is printed on both sides, and deposited on the receiving table. The inking arrangements are similar to those on the two-colour stop-cylinder machine, as there is an ink-box or duct, with ink-table, distributing, and inking rollers, at each end of the machine, one set for each forme.

In these machines as usually constructed, only two inking rollers clear a full-size forme, which is not sufficient for good illustrated work; but the inking may be improved by applying a continuous inking arrangement similar to that shown on the fine-art machine, Plate 32. Flyers are now also frequently attached for delivering the printed sheets, and air-buffers for softening the shock of the type carriage at the end of each stroke.

In the small-cylinder two-revolution class of “perfectors” the cylinder bearings are fixed at both sides to slides, which move vertically for raising the cylinders above the formes during the return of the type carriage. The slides are held down by powerful knee-joints while the cylinder is in contact with the forme printing the sheet, and are raised by springs, as in the single-cylinder machine. The cylinders are placed close together, and both are fitted with grippers; those on the first or “inner” cylinder take charge of the sheet until after it is printed on the first side, when the “outer” cylinder grippers take charge until the second side is printed; after which the sheet is shot out upon the receiving table or delivered by a flyer, according as the machine may be arranged.

The type carriage is propelled sometimes by an upright spindle and horizontal rack, similar to the arrangement in the single-revolution perfectors, Plate 39 ; but more frequently by a vertical rack securely fastened to its under side, and driven by a pinion on a horizontal shaft with a universal joint, so arranged that the pinion gears into the top side of the rack-teeth during the travel one way, and into the under side during the return : this arrangement is usually termed the "mangle motion," owing to its early use in propelling horizontal mangles for smoothing cloth. Other methods are also in use, such as that for driving the carriage of the two-revolution single-cylinder machine shown in Plate 36 ; but the vertical rack in some form is in most favour, because the carriage can then be better supported near the centre to resist the pressure of the cylinder on the forme.

These machines have inking arrangements generally similar to the others, but are usually made with four inkers or forme rollers to clear a full-size forme ; this, together with the greater stiffness of the carriage in the centre, makes them better suited for printing illustrated work. They are usually not run at so high a speed as the large-cylinder single-revolution machines ; and they are so arranged that "set off" sheets can be fed in, to prevent the ink on the first side printed from "setting off" upon the second cylinder or adhering to it and smearing the next sheet.

*Platen Machines.*—Most of the small job printing is now done on platen machines, of which there is a great variety, although the leading principles are common to all ; and Fig. 2, Plate 24, may be taken as representative of the class. The body of the machine is a strong box-casting, as shown in the section, Fig. 23, Plate 40, with bearings for the shafts, and seatings for the brackets carrying the outstanding parts. The forme is secured by a spring clip in a recess V, which has been finished to a smooth accurate surface ; and, instead of its moving horizontally under the inking rollers as in the cylinder machines, the rollers pass down and up over it. The colour is put into the ink-box I, which is adjustable by screws ; and is transferred by the roller D to the circular ink-plate S. The latter is moved round

a little at each impression by a ratchet and pawl motion, so as to distribute the colour equally over its surface. The three rollers R act both as distributors and as forme rollers; for when they pass over the ink-plate they equalize the coat of colour on its surface, as well as take on themselves a coat to be transferred to the face of the forme. Below the forme there is an extra distributor plate P, which receives colour from the same rollers R, distributes it by a traversing movement, and restores it to the rollers, so that they can give a fresh touch to the bare places of the forme on their way up again.

In the working of platen machines the sheets of paper are usually both laid on and taken off by hand. The operator takes a blank sheet from the pile on the table with his right hand, and lays it up to the gauge-pins or "lays" while the platen is at rest in the position shown; and removes the printed sheet with his left hand, after the platen has brought it into contact with the forme and has returned to its first position.

The platen, which is finished to an accurately smooth surface, rests on wedges B fitted into the platen back. The wedges are adjustable by screws, as shown in Fig. 24, so that any side or corner of the platen can be advanced as may be required, in order to give an equal impression all over the surface of the forme. The face of the platen is covered with a thin cloth or a few sheets of paper, or both, as is the printing surface of the cylinders of the other machines; and is "made ready" in the same way, by pasting pieces of paper opposite the low places of the forme, so that the impression may be of equal depth all over. The sheets are strained tight, and held in position by clips C at each side of the platen. The lays are attached to the platen covering; and the sheet to be printed is held in position and removed from the face of the forme by two thin pieces of steel F, called frisket fingers. When the platen is moving forward, these come down and press on the end margins of the sheet; and when the platen is returning to the feeding position, they are raised to release the sheet. The platen is balanced by long helical springs; and the pressure upon it while taking the impression is intensified by a toggle-lever arrangement T, so that in an average size machine,



printing sheets 18 inches by 12 inches, the pressure will amount to about 20 tons when printing solid formes.

In platen as in cylinder machines it is sometimes desirable to prevent printing without stopping the machine. For this purpose, instead of compelling the platen to remain at rest, as the cylinders do, a "throw-off" arrangement is provided, Fig. 24, which sets back the wedges, and allows the platen to recede about a quarter of an inch, thus preventing the paper from coming in contact with the forme. This throw-off arrangement is used to prevent spoiling a sheet when not laid correctly, or to give double rolling when required; but when the bulk of the work is heavy, it is much better to provide machines with ample rolling power, so as to keep up the rate of production.

*Printing on Dry Paper.*—The strength of machines has been increased, in consequence of the change from printing on damp paper, which was customary twenty years ago, to printing on dry paper without leaving any marks of impression on the back, which is more general now. Also the profusion of illustrations produced from flat-surface process-blocks demands greater accuracy in the surfaces and adjustments of the printing machines than was previously considered necessary. The older presses and machines, designed to print with a blanket between the cylinder or platen surface and the paper, produced with careful management fairly good printing; but it was frequently so much embossed as to resemble books for the blind, and the sheets had to be pressed or rolled afterwards to make them flat. The modern machines, using a few sheets of hard paper instead of a blanket, turn out flat work without any sign of impression on the back.

*Working Pressure.*—A common working pressure in a lithographic printing-machine, working stones or flat metal plates, is about 200 lbs. per inch width of impression, and the line of pressure is not more than  $\frac{1}{4}$  inch broad. The pressure per square inch of surface printed is therefore about 800 lbs. In typographic formes with illustrations, from a quarter to half the surface in contact with the cylinder or platen will be under pressure at the same time: so that, in order to obtain

the same result, the pressure will be 200 to 400 lbs. per square inch. The old "Albion" press, with a leverage of 200 to 1, and a maximum pull on the handle of 200 lbs., subject to an allowance of one-fifth for friction of parts and resistance of spring, gave only 53 lbs. pressure per square inch on the forme, which is inadequate for present requirements. Many of the older platen and cylinder machines gave similar results. One popular job platen, with a leverage of 150 to 1 and a maximum pull at the fly-wheel rim of 50 lbs., gives only 58 lbs. per square inch effective pressure on the forme. The job platens described in this paper with a leverage of 400 or 480 to 1, according to size, and a maximum pull at the fly-wheel rim of 80 to 90 lbs., give an effective pressure on the forme of 200 to 400 lbs. per square inch; and both these and the cylinder machines are quite equal to a pressure of twice that amount if required, for exceptionally heavy work.

*Grinding of Surfaces.*—The grinding of the cylinder surface dead true, as also of the bowls or live rollers under the type carriage of cylinder machines, which is now done where first-rate work is turned out, is found to be a great improvement for printing from fine process-blocks, where a single thickness of tissue paper may make all the difference between first and second-class printing.

*Air Buffers.*—As previously described, high-speed reciprocating flat-bed machines are frequently fitted with some provision for cushioning the momentum of the type-carriage and its connections at each end of the stroke. Springs having been found unreliable for this purpose, air-buffers are now coming more into favour, Plates 27, 32, and 36. With these it is easy to adjust the resistance to the speed and moving weight; they are not liable to get out of order, and they effect a notable improvement in smoothness of running, especially in machines having the carriage propelled at a uniform speed and turning the ends quickly. A quad demy two-revolution machine, running at 1,500 impressions per hour, may serve as an example of the need for cushioning. The type carriage, with its apparatus and a type forme, weighs about 14 cwts., and travels at about  $4\frac{1}{2}$  feet per second: so that the momentum at the end of the stroke is about equal to 3 tons moving at one foot per second,

which, if not cushioned, would produce a blow on the propelling gear and framing at each end of the stroke or travel. In the machine under consideration the shock is taken up by two air-buffers at each end, 5 inches in diameter, with cylinders 15 inches deep, into which the pistons enter 12 inches, and produce a maximum air-pressure of 50 to 60 lbs. per square inch, equal to a resistance of about 2,000 lbs. at each end. As this is an increasing resistance through the last 12 inches of travel, the carriage is stopped smoothly, and receives considerable impulse for the return.

As the variety of work and the size of the editions, or the numbers of similar sheets printed, have greatly increased during the last twenty years, there is now more scope for special machines designed for special work. But the principal demand is still for generally useful all-round machines; and those now described may be taken as fairly representing the machinery employed for book and general or job printing in British factories at the present time.

#### *Discussion.*

Mr. POWRIE exhibited one of the platen job-printing machines, Fig. 2, Plate 24, and showed its action in working. Also specimens of the composition used for covering the inking and distributing rollers (page 108); and of the accurately bored and polished moulds for covering with the composition the steel tube forming the body of the rollers; and of the rollers so covered. Also specimens of printing from the following machines:—platen, Wharfedale stop-cylinder, fine-art stop-cylinder, two-revolution single-cylinder, and Wharfedale two-colour.

Mr. JOHN SOUTHWARD said that, as a printer and not an engineer, he had listened to the paper with the greatest interest, and had derived a great deal of instruction from it. Apart from its value as a comprehensive and accurate review of the best kinds of printing

(Mr. John Southward.)

machines which printed from types on a flat bed, he thought it would be of service to the printing industry by bringing this subject before a body of mechanical engineers, because he believed there were few industries which had been so much overlooked by engineers as that of printing. For a great many years so few practical improvements had been made in printing machines in this country that foreign manufacturers had got ahead of English makers in many ways. Naturally printing-machine manufacturers would say that they provided as good machines as were called for, and that they must conduct their business on a commercial basis, and that better machines had not been provided because they were not in demand. Similarly printers also might say that there was not a public demand for such high-class work as would require improved machinery ; and it must be confessed that the general kind of printing which was done by the machines described in the paper had always been in a backward state in this country. On looking back at the report of the jurors of the Great Exhibition in 1851, it would be found that an international jury had then been compelled to call attention to the inferiority of English printing. At the next Exhibition in 1862 a Frenchman, M. J. C. Derriey, came over to London with some remarkable specimens of type founding, and showed that there were many possibilities in plain and ornamental type-founding which were really not believed or realised at that time. His improvements found little acceptance in England then, perhaps hardly any ; but they were taken up abroad. The extraordinary effects which he had produced were imitated in Germany, and still more largely in America ; and they laid the foundation of the superiority of American type-founding, which some printers thought was maintained to the present day. At any rate English printers did not avail themselves then of the Derriey types, and did not improve their class of printing. Coming sixteen years later to the Paris Exhibition in 1878, it was found that the Americans had meanwhile made marvellous strides forward, in regard both to type-founding and to printing machinery. A model printing office was put up in the 1878 Exhibition, which no doubt had surprised many of the visitors. In 1883 there was an exhibition of printing in the Agricultural Hall, Islington, London, at which he had been

one of the jury; and the inferiority of English printing was demonstrated. Perhaps the only piece of really fine printing in that exhibition was the one which gained the first prize. It was done in fifty-three workings; every sheet of print had to go through the press fifty-three times. In 1889 an international exhibition of printing was held at Stationers' Hall in London; and the English specimens of general printing were still inferior, as was acknowledged by the Lord Mayor, who presided, and by Mr. now Sir Henry Bemrose. In 1889 there was again another exhibition, showing that English printers had not even yet made much progress in fine printing. Within the last ten years however improvements had been made in machinery, which printers had really been compelled to adopt. The method of making photographic blocks had largely affected the modes of printing, and had necessitated extensive modifications in many of the machines. The fine-art platen and cylinder machines described in the paper would hardly have been adopted, if half-tone blocks had not been invented; because half-tone blocks required better inking and heavier pressure. As had been plainly shown by the author, one of the great faults of earlier printing machines was that they did not exert pressure enough; and in some of the fine-art machines the inking had since been greatly improved. Having himself been engaged for so many years in connection with the art of printing, he had no idea of depreciating it, but only of suggesting that mechanical engineers in general, as distinguished from printing-machine manufacturers, should pay more attention to the subject. There were many excellent printers' engineering firms, who could turn out unexceptionable printing machinery to meet the general demand as it arose; but he did not know of any trade whose improvement had been less completely promoted than that of printers. In London there was an important and influential Association of Master Printers and Kindred Trades, comprising some of the most eminent firms, which in its corporate capacity had sent out on 29th May 1897 the following appeal:—  
“The Committee have observed with regret the great increase in the amount of foreign-made machinery used in connection with the printing trades; and they have decided to draw the attention of

(Mr. John Southward.)

English printing engineers to this, with a view to finding a remedy, if possible, for so unsatisfactory a state of affairs. In their opinion the increasing preponderance of foreign machines used in the printing trade is due to the greater inventive and administrative ability which foreign printers' engineers display; and as the interests of the English printers' engineers are identical with those of the master printers, the Committee desire to ask whether something cannot be done for enabling printers to place in this country their orders for first-class machinery up to date, instead of having unwillingly to send them abroad." This appeal would serve to show that printers had complained that engineers had not provided them with exactly the machines which were wanted; and also to show that it would be a fine field of enterprise if scientific engineers would devote their attention to printing machinery more than they had hitherto done.

Mr. ALEXANDER NORTH fully agreed with the statement in the last sentence of the paper, that the principal demand was still for generally useful all-round machines. There was no doubt that most printers needed a machine which could be used for any and every ordinary purpose. As to automatic feeding (page 110), if engineers could supply printers with a reliable self-feeding apparatus, there was no doubt that in the course of a few years it would be used all through the printing trade. To produce such an apparatus which would work efficiently, a great deal of time and attention would have to be bestowed upon it. Whenever it was successfully matured, there would be a great demand for it. As far as he was himself concerned with printing, he should be glad indeed to see such a contrivance; and as soon as ever an effective self-feeding apparatus was brought out, he would be one of the first to examine its merits.

Mr. POWRIE thought that, as regarded lack of enterprise (page 122) on the part of engineers in supplying printers with improved machinery, if it had been possible for printers to be a little less anxious about price and more anxious about quality, perhaps they might have been better served by engineers. It had given him great pleasure to prepare the paper, which might have been extended

to much greater length without by any means exhausting the subject. In its present form he should be very glad if it proved of service to those interested either in the printing industry or in the manufacture of printing machinery.

The PRESIDENT conveyed the thanks of the Institution to Mr. Powrie for the labour he had bestowed upon the paper, which gave so excellent a detailed description of the mechanism of several of the principal kinds of typographic printing machinery.

---

Mr. CECIL CLAY wrote that he thought there were many points upon which practical printers might derive great advantage from the wider experience of mechanical engineers. For instance, the two-revolution machines, described in page 112, in their improved and accepted forms are to all intents and purposes an American importation, and are being largely adopted by English printers. No doubt practical printers are able to form a fairly sound judgment as to the merits of these and other machines, in respect of their actual printing capabilities, that is, their capability to print true and to give an efficient ink-distribution, and their rigidity to withstand the constant and the varying pressures to which they are subjected. But a further consideration of great importance to the user is durability, inasmuch as the price of this American machinery is practically double that of machines of the same size of the ordinary English pattern. It is on this point that information is required by printers, and in the writer's opinion it is to be sought from mechanical engineers rather than from practical printers themselves. From a mechanical point of view the ultimate decision respecting a two-revolution press lies in the method adopted for driving the bed of the machine. There are at least three more or less distinct movements in use at the present time for accomplishing this object, and innovations are always in prospect. The three may be readily identified under the following descriptions:—first, the upright-spindle motion; second, the mangle motion; third, the motions of the

(Mr. Cecil Clay.)

Century and Miehle printing machines, which are two modifications of the mangle motion, dispensing with the universal joint. Presumably all three cannot be perfect alike, or there would seem to be no necessity for more than one of them; and it should surely not be outside the range of mechanical engineering to pronounce which one is mechanically better than the other two. Although the printer may be quite satisfied that every one of the American machines offered to him is ideally perfect, so far as printing is concerned, yet he may have serious doubts as to the perfection of its mechanism, and as to the durability of the latter. The problem is simply to drive the machine bed, weighing with its apparatus and type forme about 15 cwts., through a distance of five feet and back, some two thousand times in one hour. Of the three methods in use, which is the best from a mechanical point of view for performing its task smoothly, efficiently, and with least wear and tear?

The great difference between English and American printers' engineers appears to the writer to be that the latter seem to go into the details of printing, and to find out what it is that printers want, and then to make it for them. It can hardly, he thinks, be a question of price, in view of the fact that the increased price asked by American makers is immediately given, as soon as ever they produce the right machine. This applies not only to the printing machine itself, but also with equal force to all printers' machinery. Printers know what they want, but in most cases cannot experiment for themselves; they need the services of the printers' engineer to supply their requirements.

---



# TYPOGRAPHIC PRINTING MACHINERY.

Plate 24.

Fig. 1.  
"Albion"  
Hand Press.

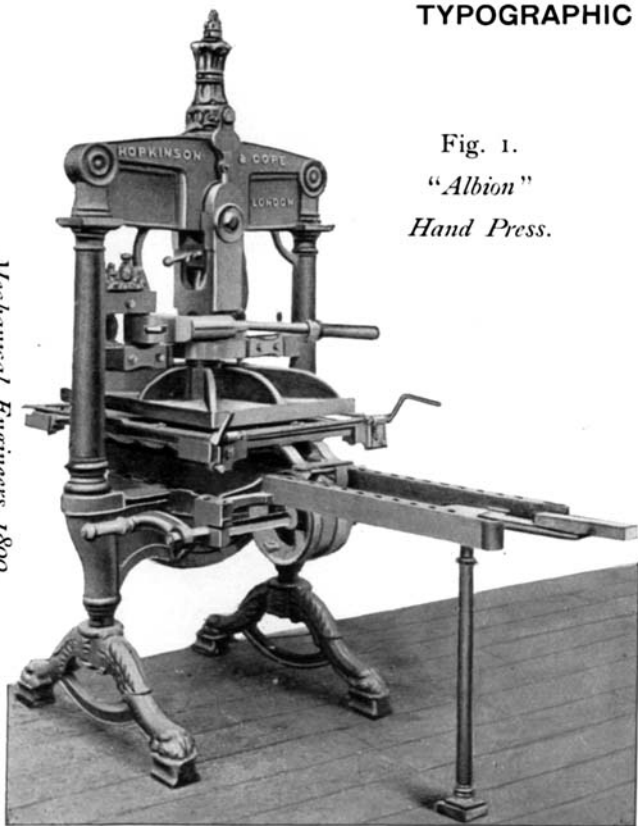
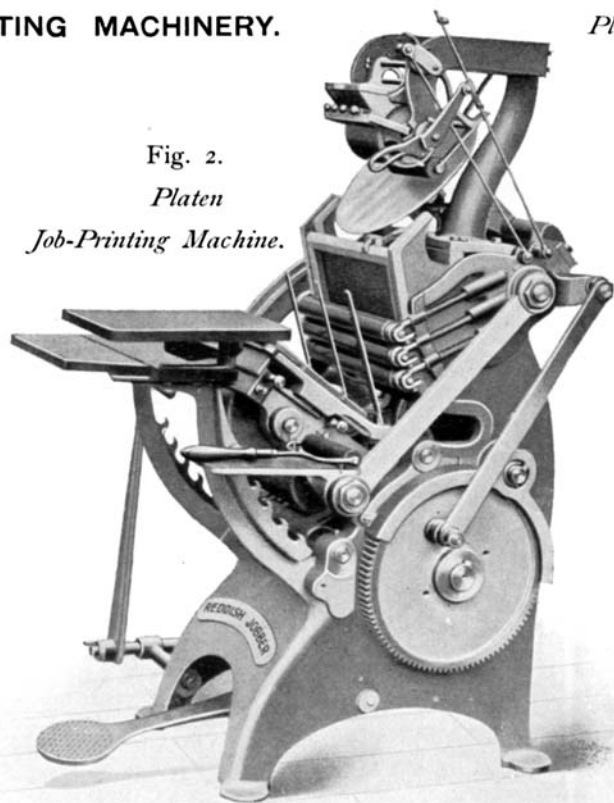


Fig. 2.  
Platen  
Job-Printing Machine.



# TYPOGRAPHIC PRINTING MACHINERY.

Plate 25.

*"Albion" Hand Press.*

Fig. 3.

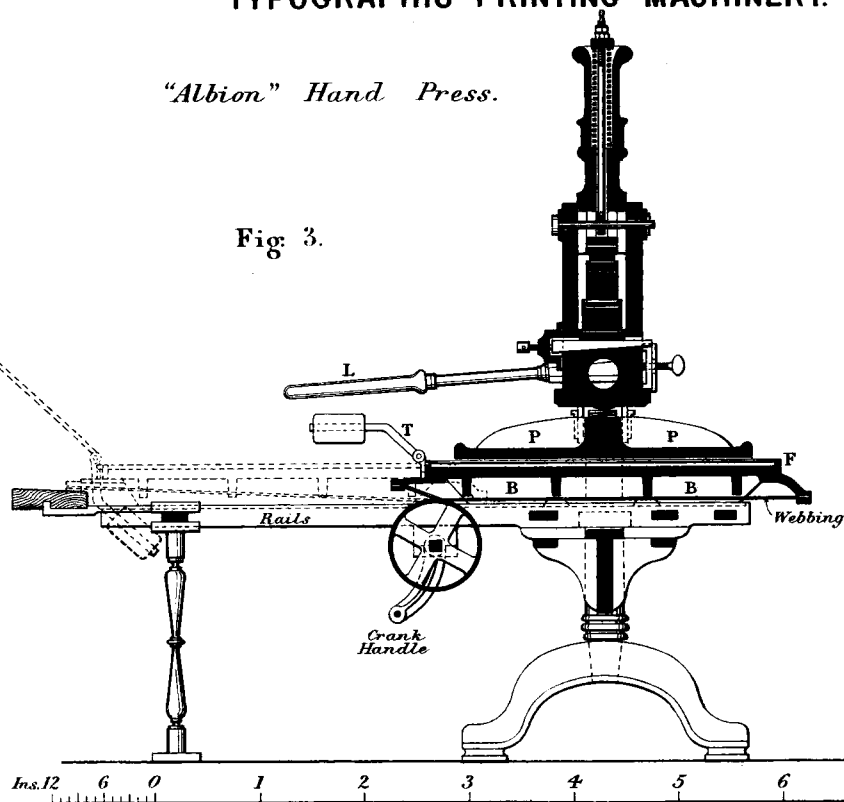
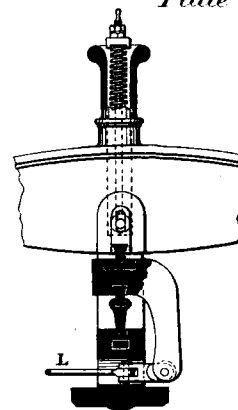


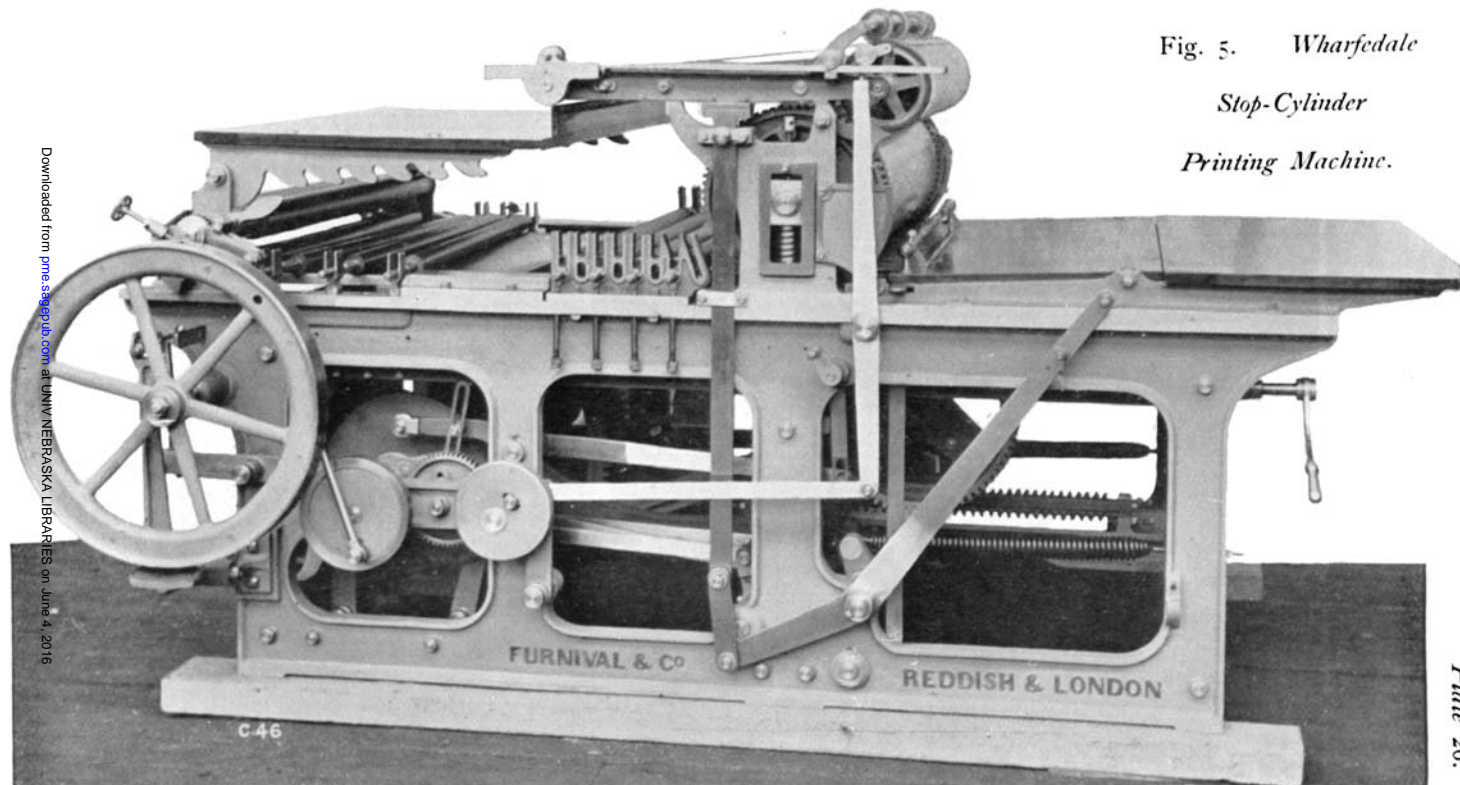
Fig. 4.



Mechanical  
Engineers 1899.

Plate 25.

Fig. 5. *Wharfedale*  
*Stop-Cylinder*  
*Printing Machine.*



# TYPOGRAPHIC PRINTING MACHINERY.

Plate 27.

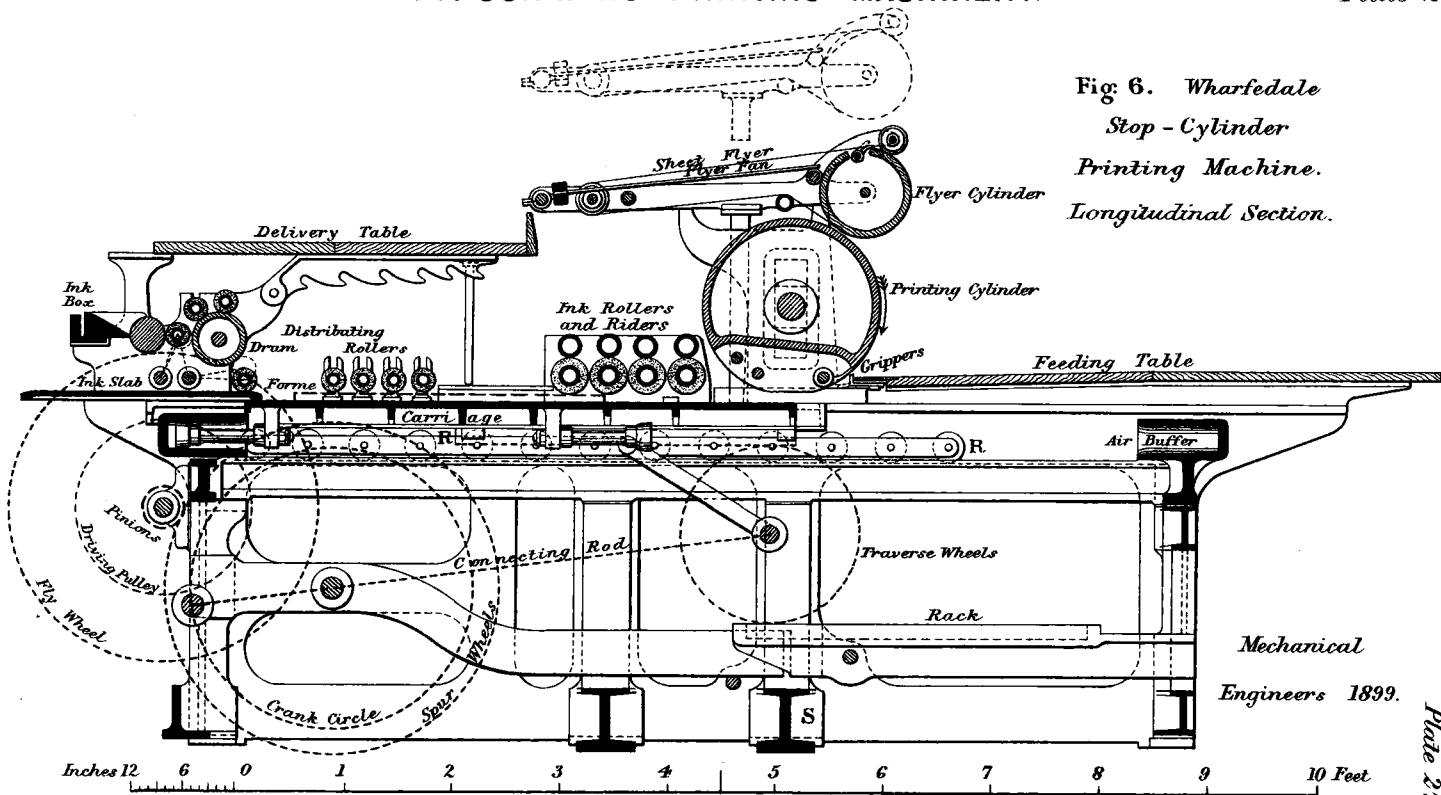


Fig. 6. *Wharfedale  
Stop - Cylinder  
Printing Machine.  
Longitudinal Section.*

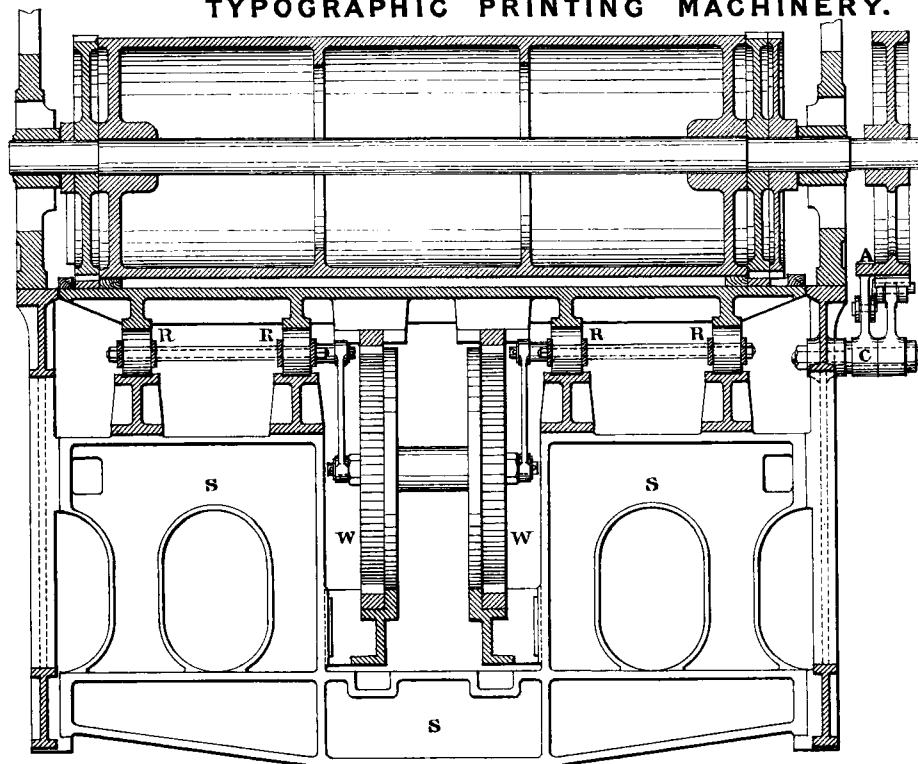
*Mechanical  
Engineers 1899.*

Plate 27.

# TYPOGRAPHIC PRINTING MACHINERY.

Plate 28.

Fig. 7.  
Wharfedale  
Stop-Cylinder  
Printing Machine.  
Cross Section.



Scale  $\frac{1}{16}^{th}$

Wharfedale Stop-Cylinder Printing Machine.

Fig. 8.  
Cylinder  
Check.

Loose wheel  
removed.

Inking Rollers  
and  
Steel Tube Riders.

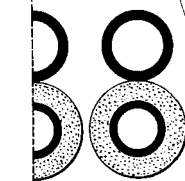
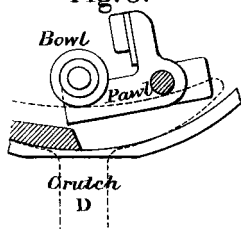


Fig. 9.



Crutch D

Scale  $\frac{1}{8}$  th

Fig. 10. Cylinder Lock  
and Brake Motion.

Scale  $\frac{1}{16}$  th

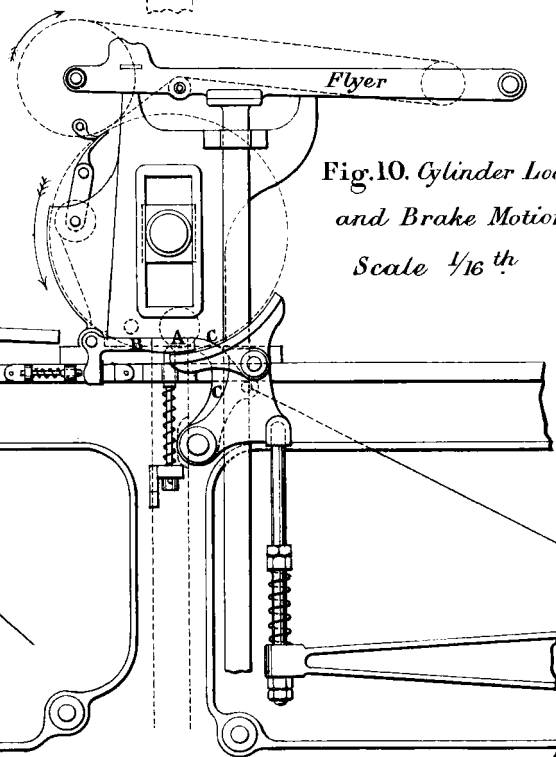
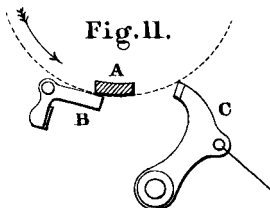


Fig. 11.



Mechanical  
Engineers 1899.

Fig. 12. *Fine-Art Stop-Cylinder Printing Machine.*

*In working position.*

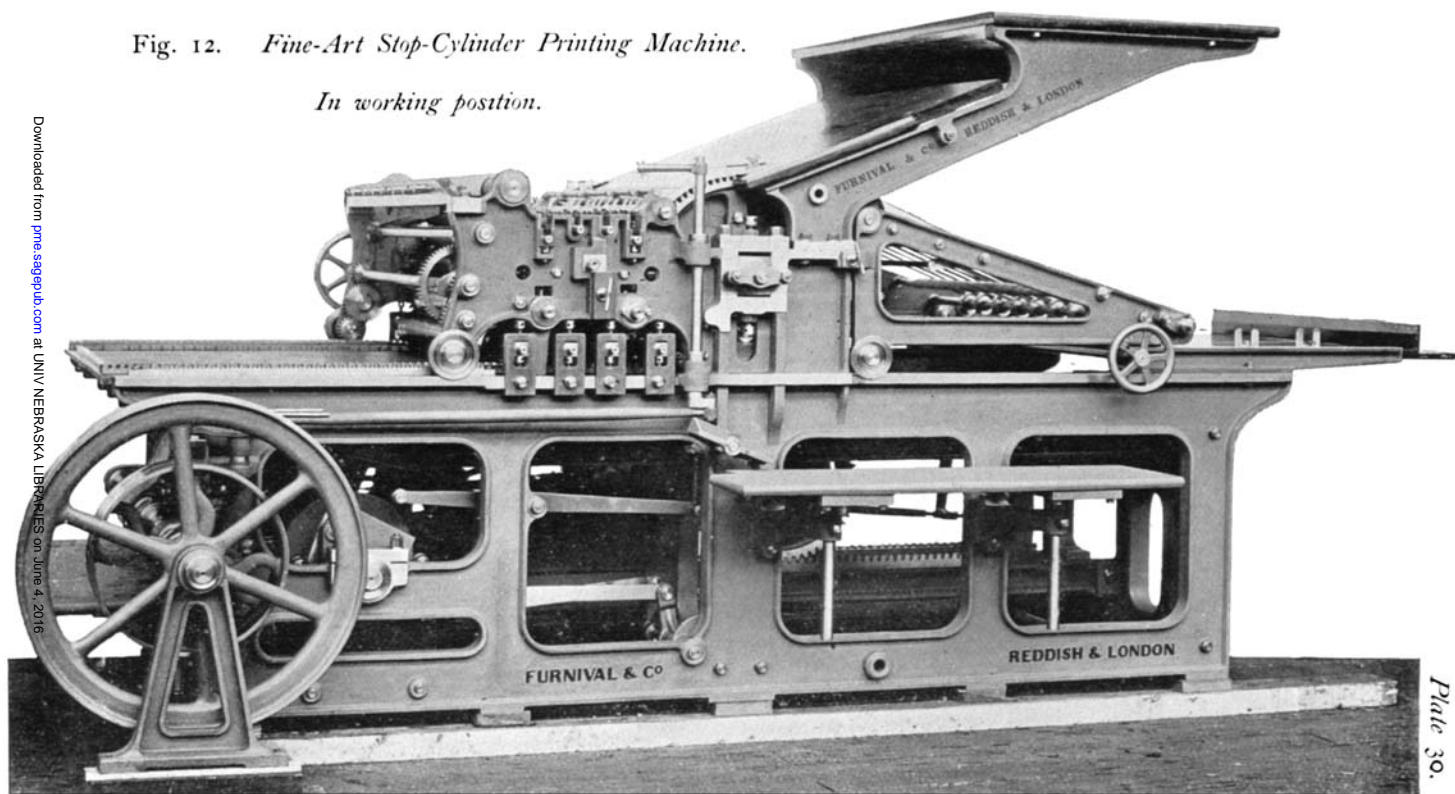


Fig. 13. *Fine-Art Stop-Cylinder Printing Machine.*

*In cleaning position.*





Fig. 14. *Fine-Art Stop-Cylinder Printing Machine.*

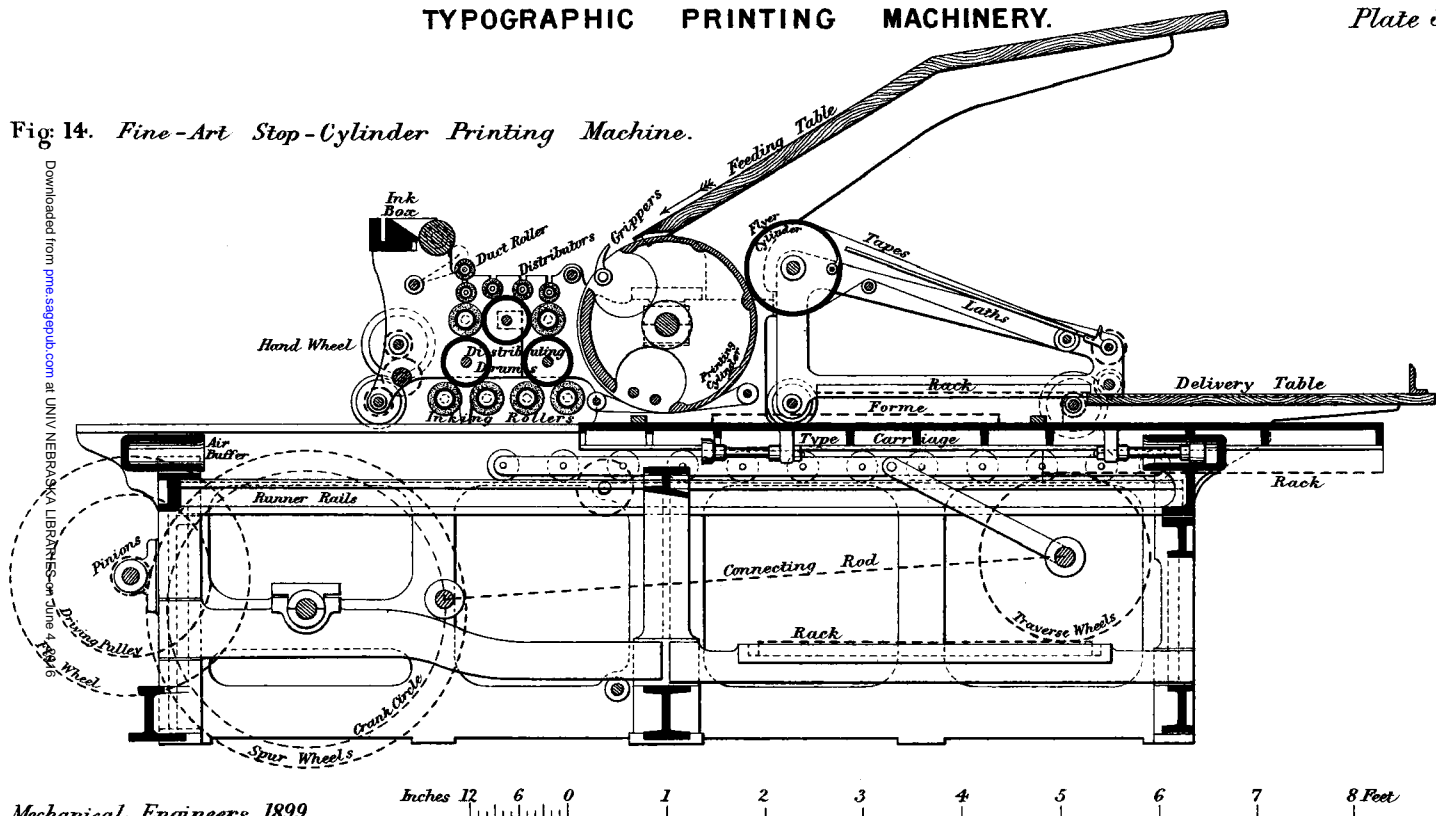


Fig. 15. Fine-Art Stop-Cylinder Printing Machine

Lay Attachment.

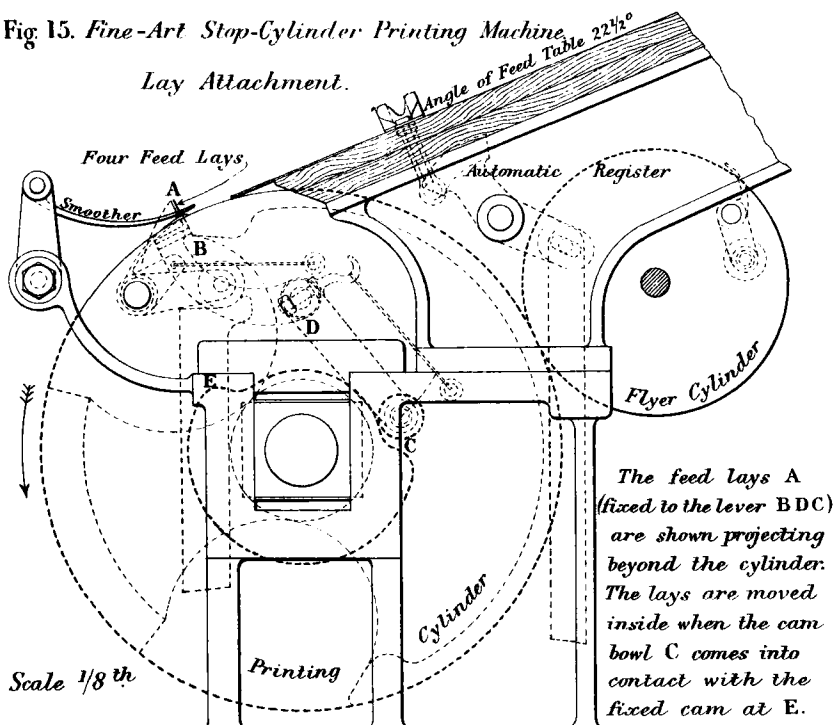


Fig. 16. Two-Revolution Single-Cylinder Printing Machine.

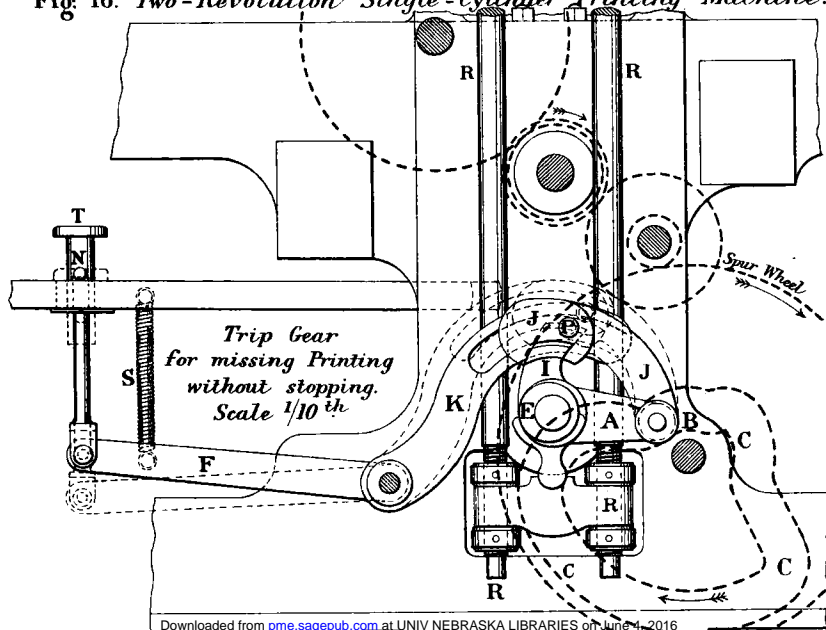


Fig. 17. *Two-Revolution Single-Cylinder Printing Machine.*

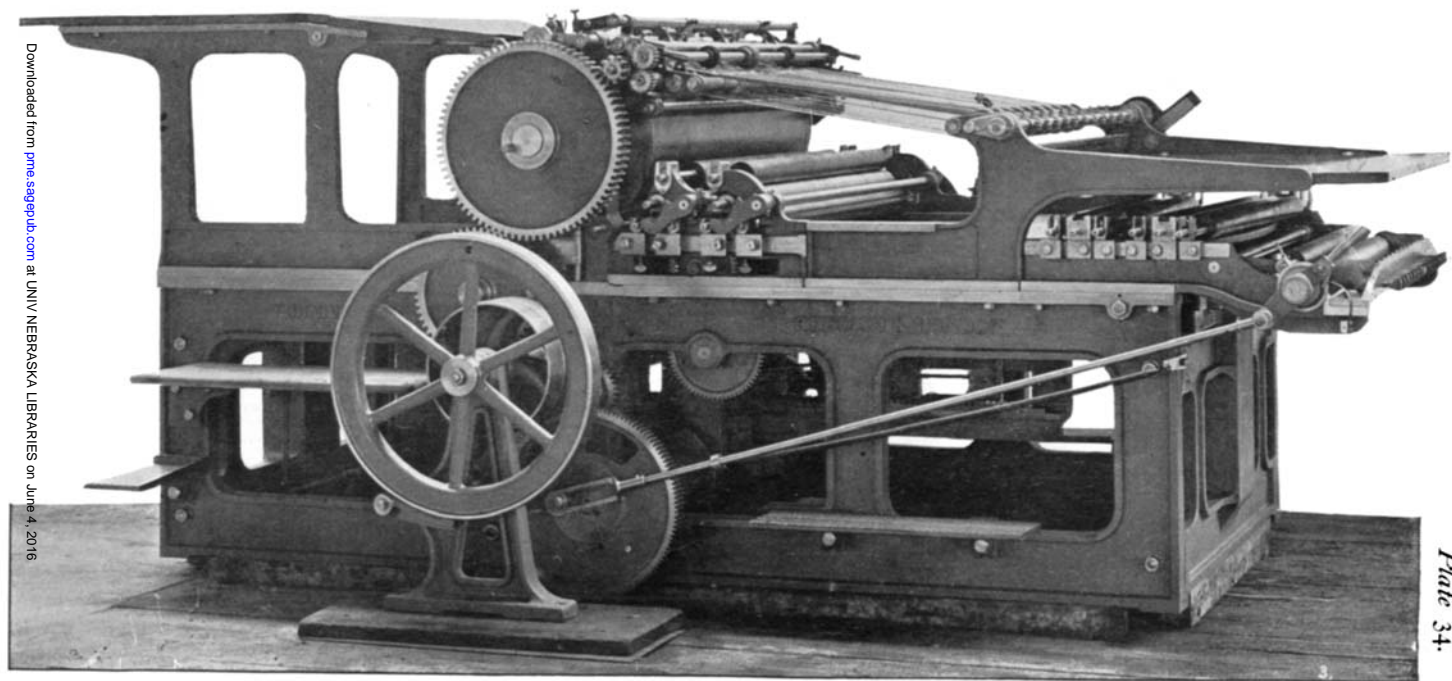
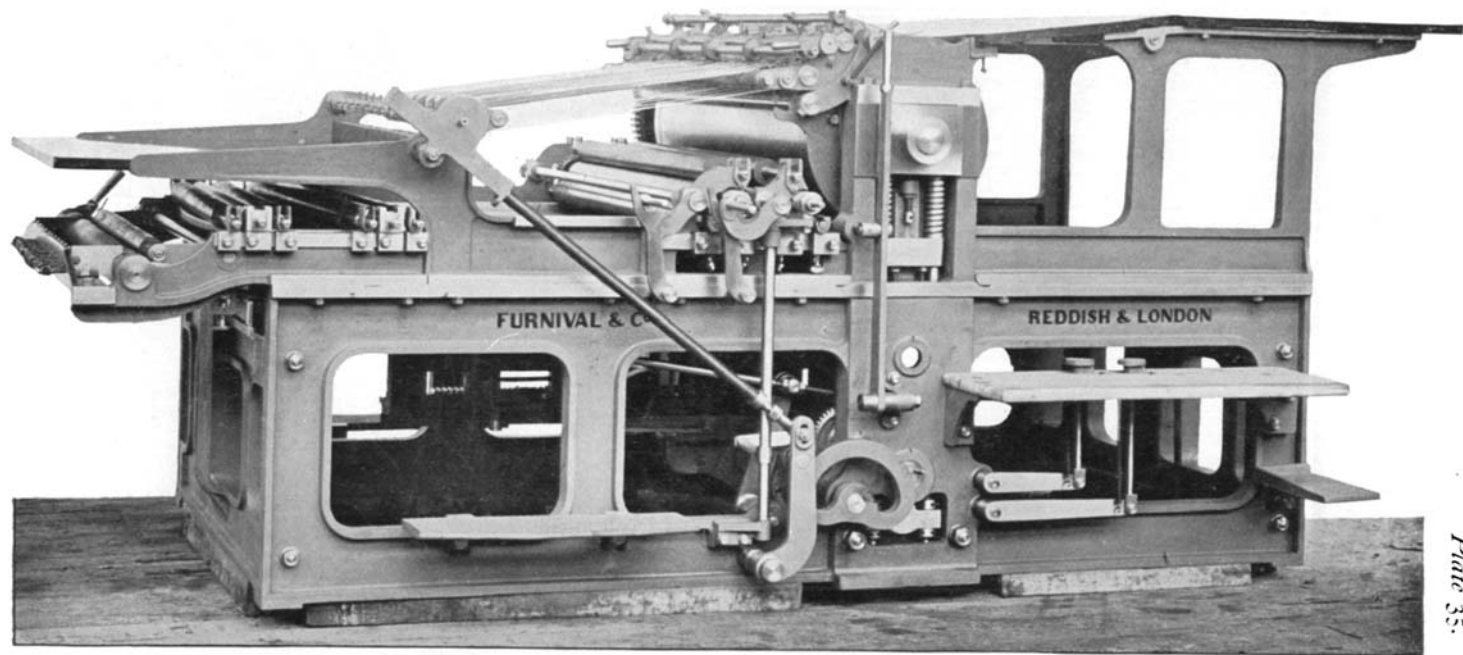
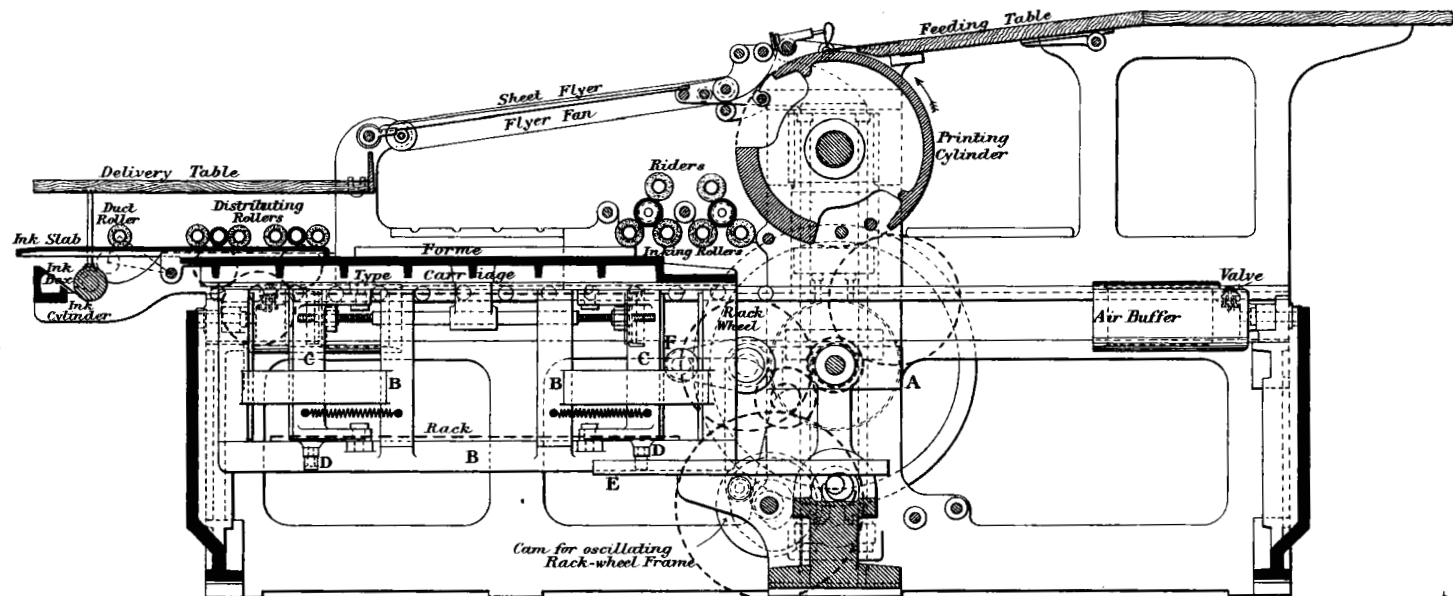


Fig. 18. *Two-Revolution Single-Cylinder Printing Machine.*



*Mechanical Engineers 1899.*

Fig 19. *Two - Revolution Single-Cylinder Printing Machine.*



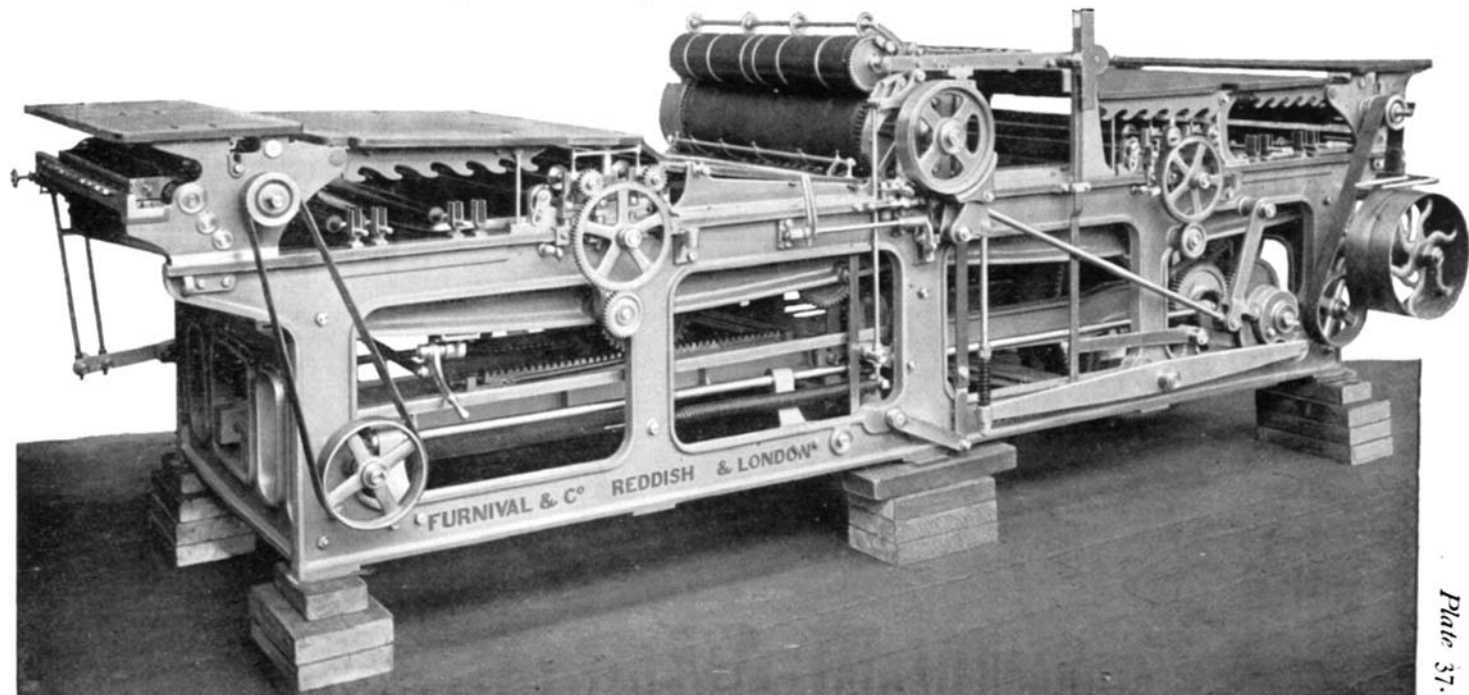
*Mechanical Engineers 1899.*

Inches 12 6 0 1 2 3 4 5 6 7 8 9 10 Feet

TYPOGRAPHIC PRINTING MACHINERY.

Plate 37.

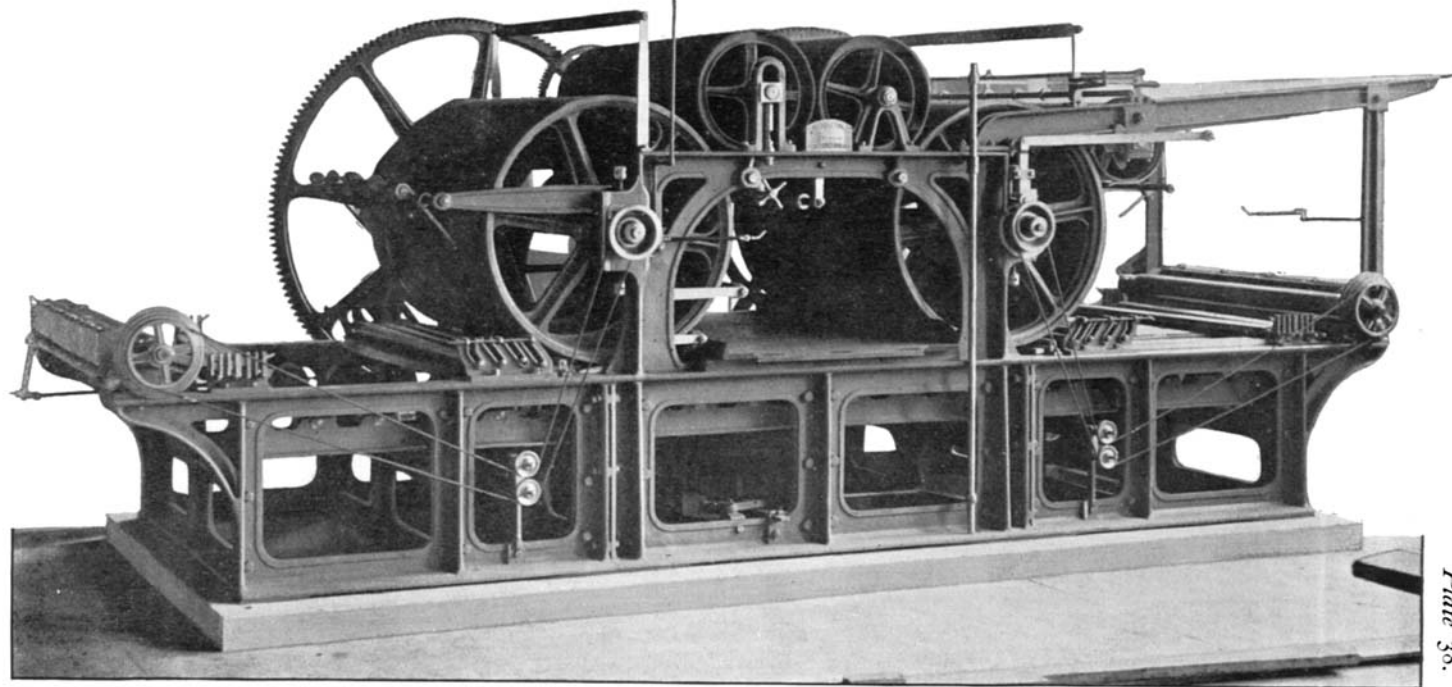
Fig. 20. *Wharfedale Two-Colour Printing Machine.*



*Mechanical Engineers 1899.*

Plate 37.

Fig. 21. *Single-Revolution "Perfector" Printing Machine.*

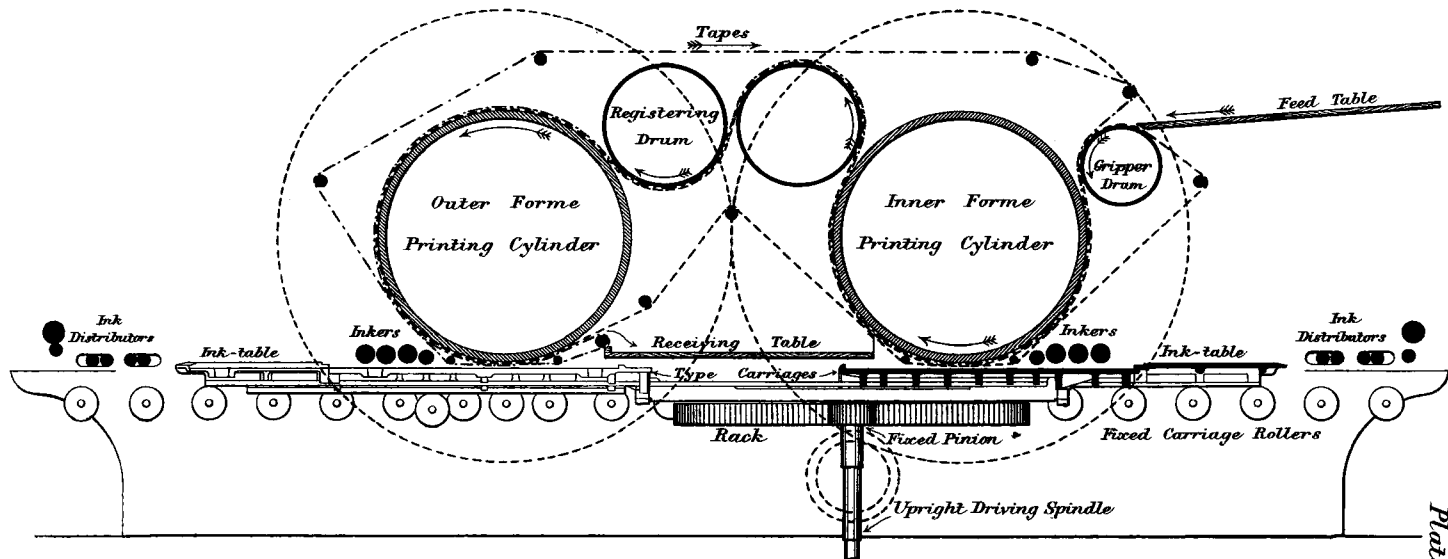


# TYPOGRAPHIC PRINTING MACHINERY.

Plate 39.

Fig. 22. *Single - Revolution "Perfection" Printing Machine.*

*Printing both sides.*



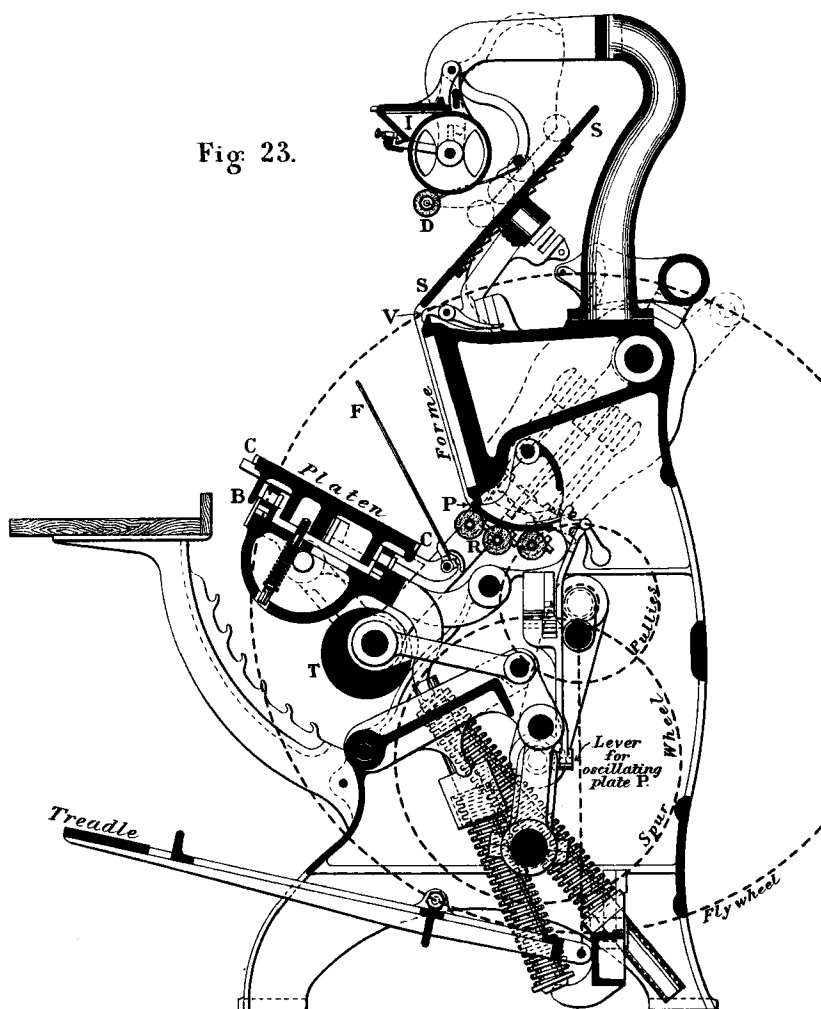
*Mechanical Engineers 1899.*

Plate 39.



*Platen Job-Printing Machine.*

Fig. 23.



*Front view of Platen showing arrangement of "Throw-off" and Impression Adjustment.*

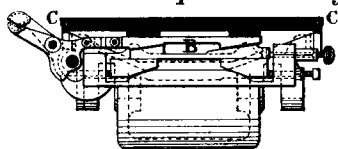


Fig. 24.

*Mechanical  
Engineers 1899.*

