CYLINDER PRINTING PRESSES

TYPOGRAPHIC TECHNICAL SERIES FOR APPRENTICES — PART I, NO. 7

CYLINDER PRINTING MACHINES

BEING A STUDY OF THE MECHANISM AND OPERATION OF THE PRINCIPAL TYPES OF CYLINDER PRINTING MACHINES

BY

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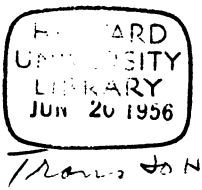
PUBLISHED BY THE COMMITTEE ON EDUCATION
UNITED TYPOTHETAE OF AMERICA
1918



The drawings from which the illustrations in this book were made were contributed by C. B. Cottrell & Sons Co., New York

PREFACE

THE modern printing press is peculiarly the product of American genius. While the cylinder press was first conceived and built in England, practically all the features which go to make up the modern machine, whether built here or abroad, were invented and perfected by American brain and skill. This was largely due to the American's freedom from the restraints of conventionality; "the blamed fool didn't know it couldn't be done, so he went ahead and did it," as one writer graphically puts it. Another reason was the willingness of the American printer to discard a machine when something better and faster was offered, whereas the disposition of the European was rather to retain the old machine so long as any usefulness remained in it. This naturally stimulated the American press builder to constant efforts to improve the machines he built since his greatest reward lay in that direction. The introduction of improved American presses into Europe was followed by the adoption of their valuable features by European builders and today there are very few presses built anywhere in the world which do not embody some American ideas and inventions. With so many minds at work to improve the American printing press, each limited by features on which others had secured a patent monopoly, many forms and varieties of machines were designed and built. Some of them never had much vogue; others had their successful day and then made way for more popular machines. As the country settled up and the frontier pushed ever farther west, there were always printers in the van with more ambition than money, and they made a market for old-style machines which were discarded by printers in settled sections where competition was a serious factor. Many of these old presses still exist somewhere; some of them look very queer now. A description of them

might have some interest for the antiquary, but would only be confusing in such a volume as this, which is practical rather than historical in its purpose. Therefore, the descriptions are confined to such styles of printing presses as are in general use today.

CONTENTS

A PRINTING PRESS

A PRINTING PRESS is a machine for impressing inked types or engravings upon paper, cloth, or other material, thereby transferring the ink to the material. The essential thing is the pressure, since the ink would not be transferred without pressure. Type varies in height as it becomes worn. A sheet of paper is uneven as to its surface and unequal as to its thickness. There must be pressure enough to force the ink into the uneven places in the surface of the paper; otherwise it will touch only the high places. The surface of the paper must be forced by a sufficient pressure against every minute inked part of the form; this is especially apparent when the paper is rough, spongy, and soft. After the paper has been forced down to its level still further pressure is required in order to transfer to the paper all the ink there is on the form. That is, the ink must be *set* into the fibrous structure of the paper in order to be perfectly transferred from the form. Everyone knows it is difficult to get a clear, sharp print from a rubber stamp. Instinctively one presses harder in order to transfer more of the ink from the stamp to the paper. One cannot give enough pressure because the rubber gives way under it. If the stamp were of metal it would stand up under the necessary pressure but to get the required amount of pressure calls for mechanical aid; and that is a printing press.

Make-ready

The actual number of pounds of pressure required varies with the character of the form which is being printed. Remembering that a certain effect is to be produced on the paper, a dent, a crushing of the fibre, it is apparent that the least touch of the edge of a very sharp knife would produce

such an effect; a dull knife edge would take perceptibly more pressure; the back of the blade would require considerable force; while the flat side of the blade would need many times as much pressure to secure the same effect. Where these variations occur in the same form such arrangements must be made as to secure the right amount of pressure for each variation; that is called "make-ready."

Until comparatively recent years all paper was dampened before printing. Dampened paper accommodated itself more readily to inequalities of pressure and took the ink with less squeeze. The finer modern half-tone engravings require paper with a smooth calendered or coated surface which surface dampness would destroy. To print such paper dry required a revolutionary change in printing methods; even a radical change in printing presses which needed to be much stronger and more accurate than before.

Printing cannot be done "metal to metal." Between the form and the impression surface there must be a certain resiliency. This is supplied by what is called the "packing," which is made up of various materials fastened around the cylinder. It may be "soft" or "hard." Soft packing is used for newspaper work, posters, cheap books, etc., and may be a rubber blanket, a felt blanket, or several sheets of soft paper. Hard packing is used for all good grades of printing and consists of one or more sheets of special cardboard, very hard and very even (called "hard packing"), together with sheets of paper. Sometimes thin sheets of rolled copper are used in place of the cardboard. In practice a great variety of packings are used, from very hard to very soft, depending upon the nature of the work. On cylinder presses the packing is covered with a "top sheet" which may be of muslin, cloth, or a manila paper made especially for the purpose. One end of this top sheet is caught on hooks under the gripper edge of the cylinder and is carried around the printing surface; the other end is wound about a rod under the rear edge of the cylinder and the rod is turned until the sheet is stretched smooth and taut. This holds the packing in place and prevents the possible slipping of the make-ready which is put on under the top sheet.

The Elements of the Printing Press

In order to print by machinery the following elements are essential; they are found in some form in all kinds of printing presses:

1. The thing containing the designs intended to be reproduced. This is called the "form" and may consist of type pages, engravings, electrotype or stereotype plates (either flat or curved), or a combination of any two or all of them.

2. A place to put this form while it is being printed. This is called the "bed" in the ordinary press, or the "plate cylinder" in a rotary press.

3. A storage place for the ink supply. This is called the "fountain."

4. Means for taking ink from the fountain, spreading it evenly, and applying it in a thin film to the form. This is called the "inking mechanism."

5. Means for applying pressure. This is called the "impression cylinder" on cylinder or rotary presses, or the "platen" on platen presses.

6. Means (on flat-bed presses) for driving the bed back and forth as successive impressions are made. This is called the "bed motion."

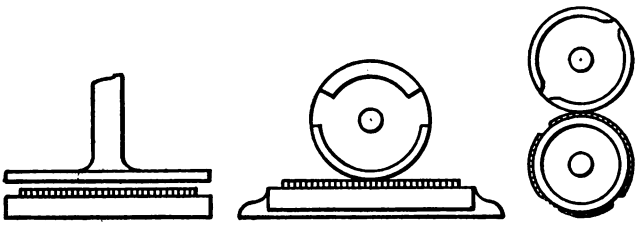
7. Means for holding the paper sheet while printing, and releasing it at the proper time. This is called the "gripper mechanism."

8. Means for taking away the printed sheet and depositing it in a convenient place. This is called the "delivery mechanism."

9. The resilient surface against which the form presses the paper. This is called the "tympan" or "packing."

10. Various attachments are frequently used, such as "automatic feeders," which supply the paper sheet by sheet as required; "joggers," which jog or straighten the printed sheets into an even pile; "automatic folders," which take the sheets as they come from the press and fold them as desired. These folded sheets are called "signatures."

There are three general forms of printing press, distinguished by their method of securing the impression.



Platen Press Cylinder Press Rotary Press

1. The platen press, having the type or form on a flat bed, the impression being given by a flat platen.

2. The cylinder press, having the form on a flat bed, the impression being given by a cylinder.

3. The rotary press, having the form curved around a cylinder, the impression being between two cylinders.

The hand press on which all printing was done for nearly 400 years was a platen press. The first power machine built in America was simply the application of power to this hand press. This press came on the market about 1836 and was in active demand for about forty years.

The first cylinder press was built in London, 1811 to 1814, by a German mechanic named Frederick Koenig. It was first used by the London Times, November 28th, 1814, in its effort to supply the demand for news of the Napoleonic wars. Hand pressmen could print one side of the sheet at the rate of 250 copies per hour. If they printed continuously for twelve hours each day, the most they could produce was 3000 copies. If the type was set twice, and two crews of pressmen used, they produced 6000 copies in twelve hours. Koenig's new cylinder press gave them 1100 complete copies per hour from one form. The stereotype process was the result of a desire to get more presses at work without setting the type two or more times.

The first cylinder press in America was imported from England about 1826. Within six or eight years an improved

form of it was being produced in an American shop. For many years the cylinder press and the power platen press existed side by side, the former used chiefly for daily newspapers and the latter for book and periodical work of better grade. As improvements were made in the cylinder press it gradually displaced the platen machines.

As the platen machine squeezed the whole form at once there was a limit to the size sheet it would print. A form 25 x 40 inches contains 1000 square inches which requires great pressure to print at one squeeze. The same form on a cylinder press would print, at any one instant, only a narrow line about one-eighth inch wide by forty inches long, or a total of five square inches. (See illustration on page 11.)

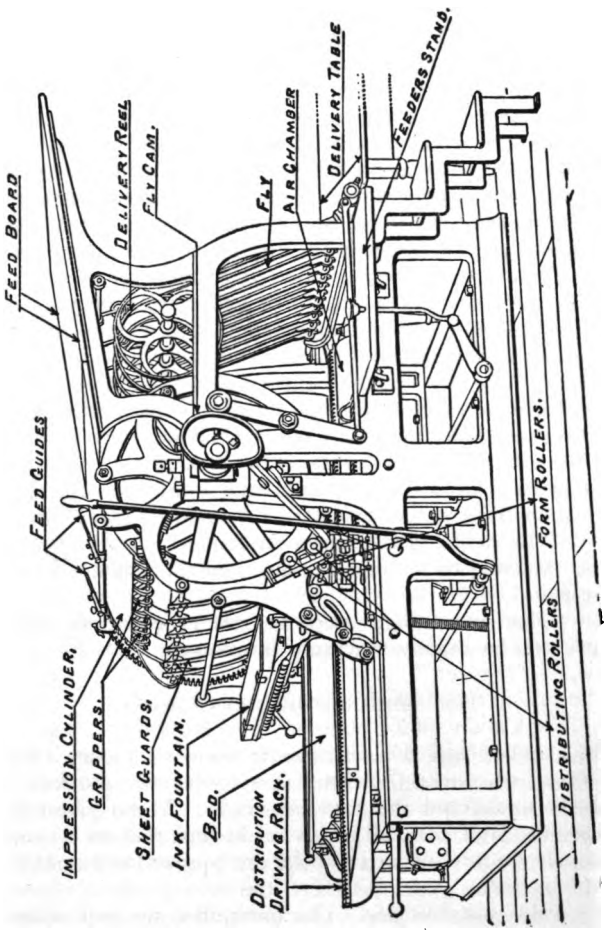
The limit on platen machines was twelve pages, and most books were in duodecimo signatures. When cylinder machines were built big enough to print sixteen or twenty or twenty-four pages, with satisfactory quality, they rapidly gained the ascendancy in the trade. The platen press survives now only in small machines for job printing.

The cylinder press has been built in many forms but most of them are no longer used much in this country. To-day, there are practically only two forms in general use:

1. The single revolution or so-called "drum cylinder" press, the cylinder of which makes one revolution for each impression.
2. The two-revolution press, the cylinder of which makes two revolutions for each impression.

The Single Revolution Press

This style of press has a large impression cylinder which revolves once for each printed sheet delivered. A sheet of paper is moved down to the feed guides. These guides are adjustable to all sizes of paper sheets and rest on tongues fastened to the feed board. At the proper time grippers on the cylinder grasp the sheet, the feed guides are raised to allow the paper to pass under them, then the guides drop into place ready for the next sheet. To prevent the paper from falling away from the surface of the cylinder or coming



A Single Revolution Press

in contact with the rollers, sheet guards or iron straps are provided, curved to the arc of the cylinder, and adjustable with set screws.

Meanwhile the type on the bed of the press has been inked by passing under the form rollers. The cylinder and bed move forward in unison with the paper between them, giving the necessary impression. When the impression is completed the grippers carrying the sheet have come up under the feed board again; these grippers open and release the sheet at the same moment that it is taken by another set of grippers and carried over the delivery reel. These grippers let go after starting the sheet down on the fly and rubber friction rollers carry it the rest of the way. As soon as the whole sheet is free the fly describes the arc of a circle and thereby deposits the printed sheet on the delivery table. The fly is actuated by the fly cam which is easily adjusted so as to fly a narrow sheet or a wide one.

After one impression is finished the cylinder continues right on in the same direction, but the bed and form reverse their motion and go back to take the next impression. To make room for the form to pass back under the cylinder without touching it, that half of the cylinder is made lower than the side which gives the impression.

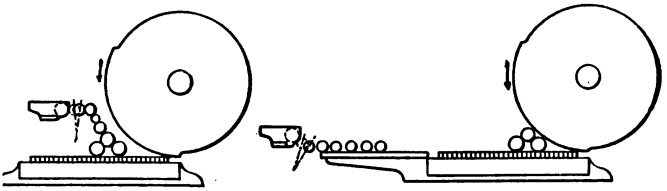
The register rack engages with a similar rack on the impression half of the cylinder, to ensure that the bed and cylinder shall begin their travel in unison, and thus place the printing in exactly the same position on each sheet—that is, "in register."

The inking mechanism is made in two forms:

1. Rack and cam distribution. The fountain is set close to the cylinder and the distributing done by means of a "pyramid" of rollers. This makes a short press and leaves the form uncovered and easy of access. Metal vibrators increase the lateral spread of ink. This distribution is used principally on newspaper or poster printing and work of the commoner sort.

2. Table distribution. The fountain is set back some distance from the cylinder. The bed of the press has an extension called the ink table with surface 9/10 inch higher

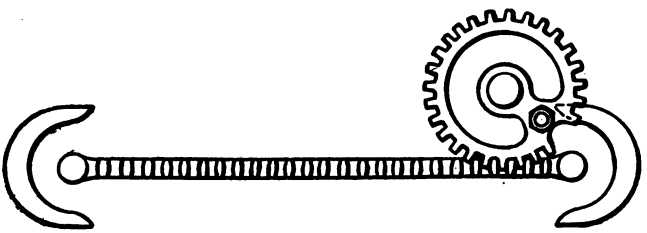
than the surface of bed. The distributing rollers are so placed as to bear on this ink table and be frictionally



Rack and Cam Distribution

Table Distribution

operated thereby. These rollers are set at an angle across the press so that they vibrate back and forth. This form of distribution makes a longer and less convenient press but is preferred for the better classes of printing as the distribution is better.

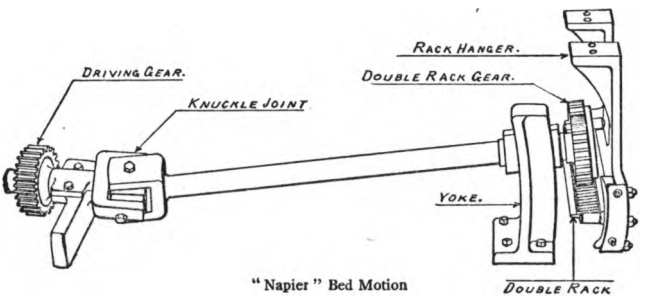


Showing the Principle of the Napier Bed Motion

Bed Motion

In order to drive the bed back and forth while the power continues to go constantly in the same direction, a number of methods have been used. However, on single revolution presses in this country the methods universally used today are all modifications of the movement originally designed by Napier. One form of it is shown on the following page.

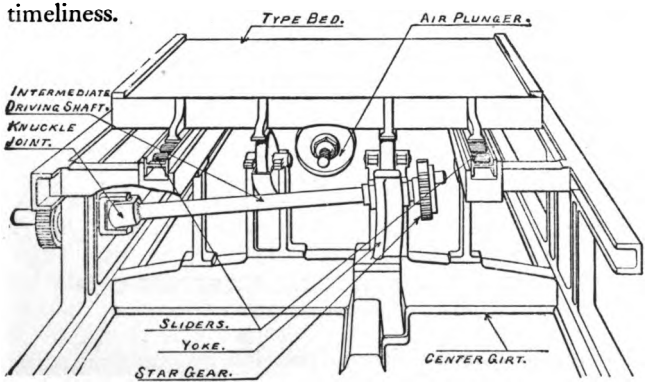
The rack hanger is bolted to the under side of the bed. It carries the rack which is so made that it may be driven either from above or below. It is driven by a gear which



"Napier" Bed Motion

moves constantly in the same direction. When this gear is driving the rack from above the bed goes forward; at the end of the rack the gear drops below the rack and carries the bed back. It is possible to drive this gear in both positions because of a universal joint, or knuckle-joint arrangement, connecting the driving shaft of the press with the shaft driving the gear, called the intermediate driving shaft.

The gear which drives the cylinder is on the same shaft that drives the bed in order to insure uniform speed and timeliness.

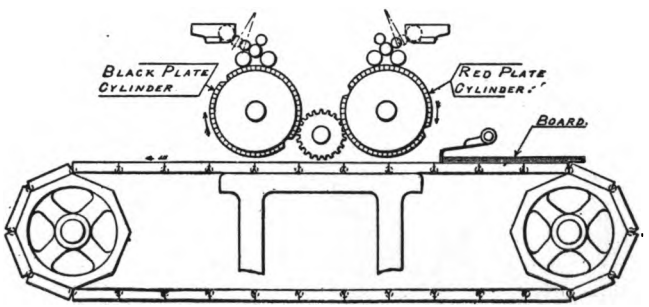


There are 3600 seconds in one hour. In order to run a press at the rate of 1200 impressions per hour there are only

three seconds to run the bed back and forth, stopping it and starting it at each end. In one and a half seconds the bed must make its full travel one way, stop, and start back. This would be impossible without some means to stop the bed easily at each reverse and give it an initial impulse back. This is done with air springs. At each end of the bed, fastened beneath in the center, is a plunger which enters an air chamber bolted to the press frame at each end. This forms a cushion of air which absorbs the thrust of the heavy bed and form, stopping it quickly and without strain on the driving mechanism.

The bed runs on sliders, a form of roller bearing, which lessens the power required and reduces the wear which would otherwise ensue. These sliders are geared to prevent their sliding out of place, too far forward or back.

Under the line of impression are placed extra supports, mounted on the center girt, to stiffen the bed while under printing pressure. On these supports heavy wheels are mounted; each in contact with a track under the bed and part of it. Each side of the bed is supplied with adjustable gibs to prevent any sidewise motion.



Board Printing Press

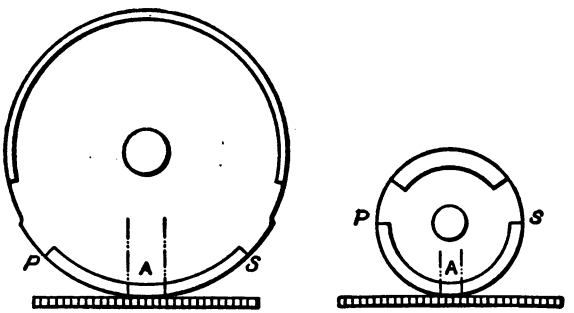
Above illustration shows the principle of one of the many special styles of single revolution press developed for special purposes. It is used for printing one or two colors on wood boards, corrugated strawboard, or other heavy

material which must stay flat while printing. The printing is done from plates fastened on the cylinders, while the material printed is carried under the cylinders on the bed.

Two-Revolution Press

The two-revolution press grew out of the demand for a faster machine which would print larger forms. As only half the cylinder surface of a single revolution press can be used to print, every inch added to the width of the form added two inches to the cylinder's circumference. Therefore cylinders became very large and clumsy as builders tried to meet printers' demands for larger sheet capacity. These great cylinders required much power, were not easily controlled, and necessarily were slower than the smaller sizes.

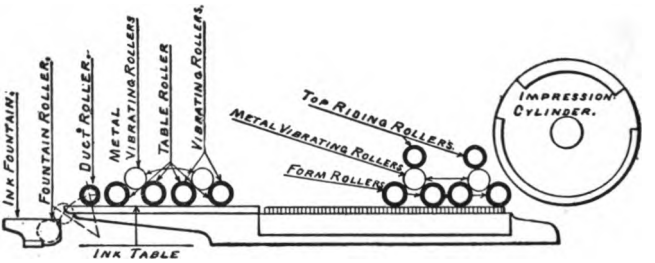
In a two-revolution press the cylinder prints while making one revolution and is lifted during the second revolution so as to clear the form during its return journey. This makes it possible to print the same size sheet with a cylinder only half the circumference of the one required on a single revolution press; and a cylinder half the circumference is only one-fourth as heavy. A smaller cylinder has a sharper curve and is therefore printing a narrower surface at any one instant during the printing operation.



The illustrations above show proportions of printing surface to the whole cylinder. In each case P to S represents

the printing surface. It measures the same in both cylinders. By noting the width of the printing contact at "A" it will be clear why a smaller surface is printing at any one instant on a two-revolution press.

Comparative capacities might be stated roughly in this way: The power platen press found its limit in sheet size about 24 x 36 inches; the single revolution is practical up to twice that size, or 36 x 48 inches; the two-revolution will double that again successfully, or 48 x 72 inches. Two-revolution presses printing widths from 65 to 70 inches are numerous.

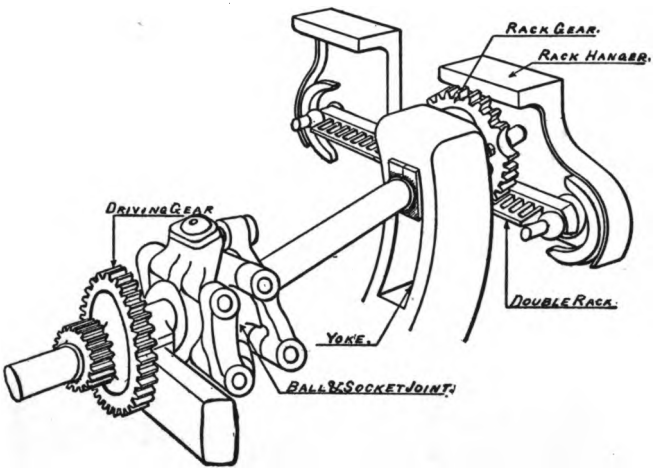


The above illustration shows the arrangement of rollers on a two-revolution press.

Bed Motions

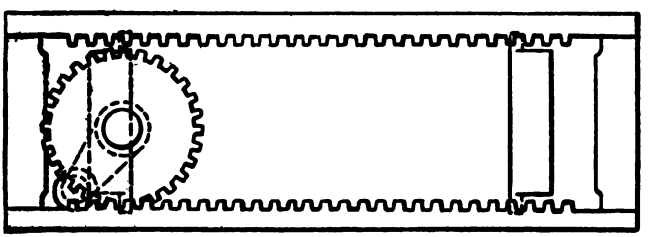
There are two general types of bed motion used in American two-revolution presses. One of them is a "ball and socket" universal joint drive; the other is called "direct drive."

The following illustration shows an improvement on the Napier movement used on single revolution presses but working on the same general principles. The "ball and socket" joint is more flexible, smoother in operation, and retains its center even when worn.



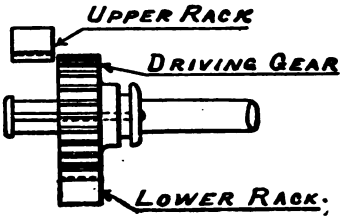
A Ball-and-Socket Universal Joint Bed Motion

The direct drive bed motion has an upper and lower bed rack, with a driving gear between them, running constantly in the same direction. When the gear is engaged with the lower rack the bed is carried forward; when it engages the

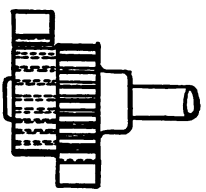


Showing the Principle of the Direct Drive Bed Motion

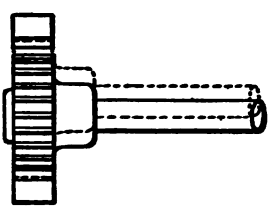
upper rack, the bed returns. This alternate engagement of the upper and lower racks may be accomplished in three ways:



1. The racks may be set in different planes vertically, the gear sliding on its shaft.



2. The driving gear may be double width, with the teeth cut away from certain portions of each half of the double width.



3. The driving gear may be alternately raised and lowered, with racks in same vertical plane.

To assist in arresting the bed at each reverse and transfer the power from one rack to the other, either sliding blocks or rolling studs are used.

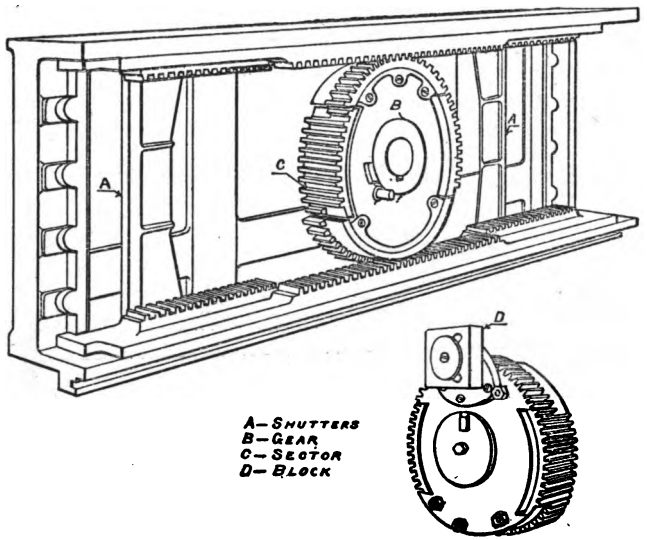
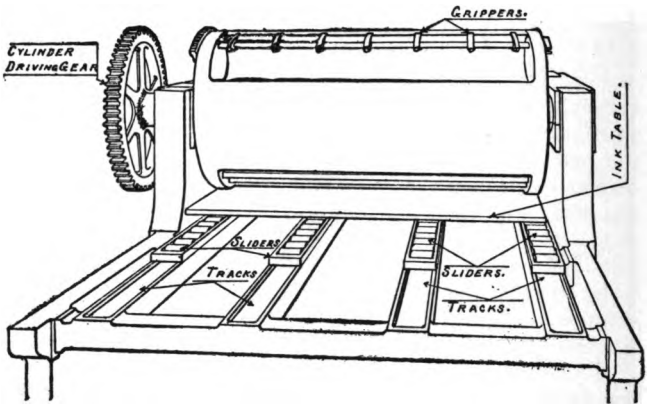
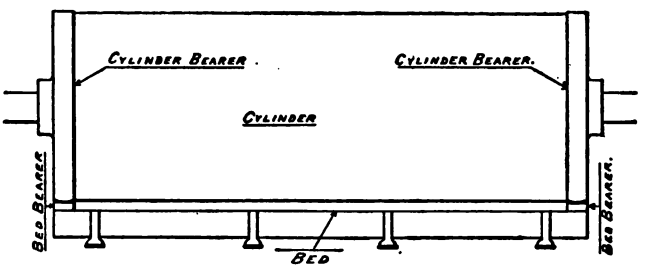


Illustration of a bed motion which consists of an upper and lower bed rack at each end of which is a lateral segment cast in one piece with the racks. The bed-driving gear running constantly in one direction engages these racks and segments. This gear is cut away or recessed for a portion of its circumference, into which recess is fitted a section of teeth, or sector, which alternately recedes from or projects to the gear's circumference to engage or avoid the racks as the bed is moved to and fro by the gear. The gear is cast double-width with teeth only on the part of the gear-face which engages the rack; the other part of the gear-face being left blank, excepting where the sector is. Attached to the gear is a block with a four or five inch face sliding in slides or shutters and assisting to arrest and start the bed movement.



Two-revolution presses are usually provided with four tracks supporting the bed, sometimes with six tracks on wide presses.



Two-revolution presses are provided with a wide bearer at each side of the bed, of iron or steel. They run in contact with similar bearers around each end of the cylinder. Their purpose is to ensure a uniform speed of movement between cylinder and bed, to lock them together as it were, to carry the cylinder over the spaces between pages,

and to ensure that the surface of the cylinder will bear the same relation to the form at all times whether printing a light portion or heavy portion of the form. There is more or less "play" in gears; they become worn, and worn unevenly at times. In order to ensure exact, hair-line register, as required by modern printing (especially color work), the bed and cylinder must be locked together during the impression, at least to such an extent that variations in driving gears will not change their relation. A "register rack" is accordingly provided, which engages with a segment of like pitch on the impression half of the cylinder. These bring the bed and cylinder into correct relation just before impression begins and the bearers are depended upon to maintain the relation.

The correct relation between bed and cylinder depends upon whether the press is so packed as to be on the exact "printing line," that is the line where the surface of the packing and the surface of the form move at exactly the same speed. Every sheet of packing put on the cylinder increases the distance around it. If that distance becomes greater than the movement of the bed, and as it must make its revolution in just the same time, there is no escape from a slip or slur on the form. The same result occurs if the form is too high, and the packing is made thinner to meet it; only in that case the distance around the cylinder is lessened, making the cylinder surface movement correspondingly *less* than that of the bed, and the slip or slur the other way.

Sheet Delivery

Two-revolution presses are usually provided with means to deliver the printed sheet either side up. Sheets delivered printed side up can be more conveniently watched by the pressman, which is an advantage especially on very fine work in black or several colors. At times it is convenient to lay the sheet printed side down, ready to print the other side without turning it over.

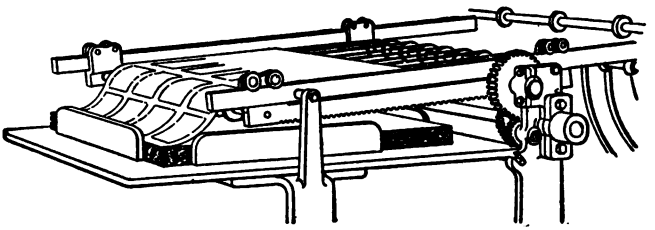


Illustration Showing Printed Side Up Delivery

The sheets run upon a carrier, or apron, which carries them forward over the delivery table, then leaves the sheet behind as it goes back for the next one.

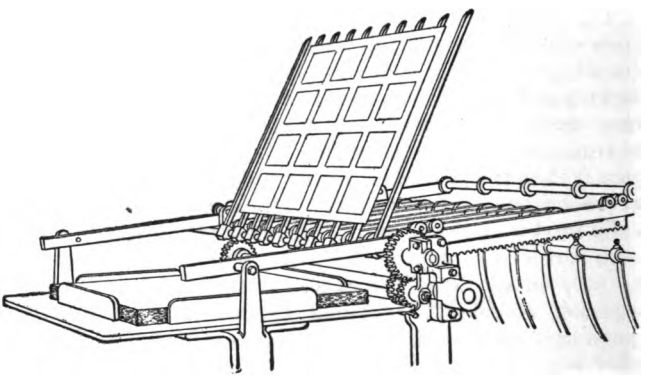
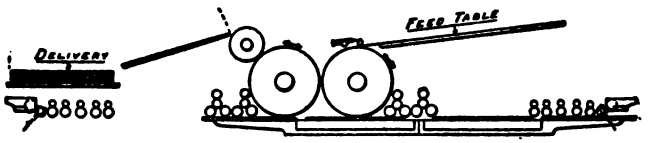


Illustration Showing Printed Side Down Delivery

The sheets run upon a fly, clean side down, while the carrier remains stationary. The fly then delivers the sheet on the table with the clean side up.

Two-Revolution Perfecting Press

This press prints both sides of the sheet at one operation. There are two beds, two forms, two inking mechanisms, one feed, and one delivery. One cylinder prints while the



Two-Revolution Perfecting Press

bed goes forward, the other while it goes back. The cylinders revolve in opposite directions and lift alternately. After the first side of the sheet is printed it is delivered, clean side out, to the other cylinder. This brings the freshly printed first side against the tympan of the second cylinder. More or less of the ink sets off on the tympan; soon so much ink will accumulate in this way that it will smut the coming sheets. To prevent this an automatically shifting tympan is provided which can be set to shift itself as often as necessary, every so many impressions, 25, 50, 100, 250, 500, etc. This consists of a small roll of thin manila paper placed inside the cylinder (as shown), the paper being led around the cylinder over the make-ready and wound up again upon another roll, also within the cylinder. The shift is made between impressions, presenting a clean tympan at every shift. The same tympan paper can be used over and over after the ink on it dries.

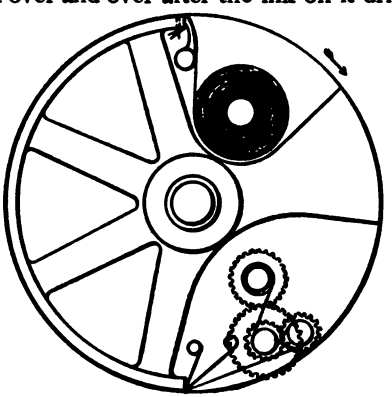
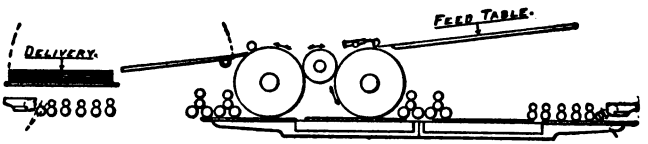


Illustration Showing Details of Automatic Shifting Tympan on Perfecting Press



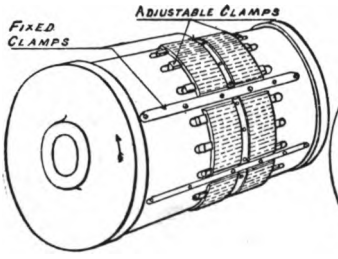
Two-Revolution Two-Color Press

This press is similar in principle to the perfecting press, except that both cylinders revolve in the same direction and print during the same movement of the bed. It prints two colors on the same side of the sheet and a shifting tympan is not necessary. In order to deliver the sheet from one cylinder to the other without turning it over, a transfer cylinder is provided. Each cylinder lifts at the end of its impression to allow the form to return without touching it.

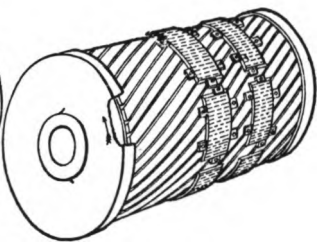
Rotary Presses

In rotary presses the printing is done by two cylinders; one of them carries the packing, or make-ready, and is called the impression cylinder; the other carries the form in the shape of curved plates and is called the plate cylinder.

On newspaper presses the plates are stereotypes, .25 or one quarter inch thick; on magazine and periodical rotaries they are usually electrotypes, .01875 or three-sixteenths inch thick. On rotary presses which are intended to print only one size of page the plate-holding clamps are stationary at the top and one side, while the clamps at bottom and one side are movable in order to tighten and loosen the plate. Where plates of various sizes are used the plate cylinder is usually spirally grooved and supplied with special clamps adapted to slide anywhere in these grooves as the adjustment of the plates may require.

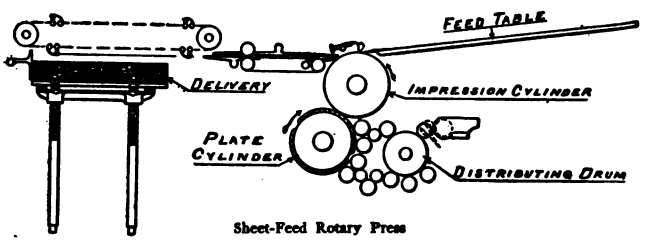


Cylinder With Fixed Clamps



Cylinder Spirally Grooved

The simplest form of rotary press is the sheet-feed rotary, which prints previously cut sheets of paper one side at a time. It does the work of a flat-bed press but much more rapidly because there is no heavy bed and form to reciprocate. It may be a two-revolution machine with the



Sheet-Feed Rotary Press

impression cylinder lifted for every other revolution; or it may print at every revolution. The two-revolution machine gets double ink-rolling for each impression. The ink table of a flat-bed press becomes a distributing drum on this machine. The printing plates are curved, and clamped to a spirally-grooved plate cylinder. (See cut above.) The paper is usually fed by an automatic feeder as the speed of the press is beyond the capacity of hand feeding. The printed sheets are deposited on a delivery board or table which slowly lowers as the pile of paper sheets increases, until it is finally deposited on a four wheel truck. (See cut p. 29.)

Web-Perfecting Rotary Press

Perfecting means to print both sides of the sheet, to perfect the work at one operation.

On a web-perfecting rotary, the *length* of the printed sheet is fixed; the machine at each revolution cuts off a sheet which is exactly the circumference of the plate cylinder. If the printing cylinder is 50 inches in circumference it pulls through 50 inches of paper at each revolution. The press may be so built as to vary the *width* of the web and consequently of the printed sheet.

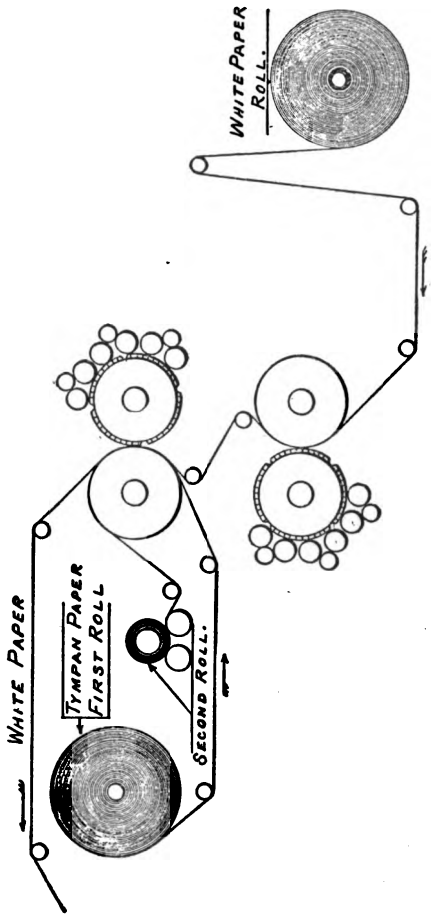
The web must be kept at an even tension at all times to get smooth operation, prevent wrinkles, and also prevent breaks which would occur in suddenly taking up any slack in the web.

Offset Mechanisms

Since the two sides of the web are printed in quick succession there is no time for the ink to "set" on the first side before the second side is printed. This is immaterial on newspaper and similar work because the paper is absorbent and the ink of a nature to be readily absorbed. On better paper the ink of the first impression sets off on the tympan of the second impression cylinder. After a few impressions enough ink has accumulated on the second tympan to smut the on-coming sheets. There are three means used to correct this condition.

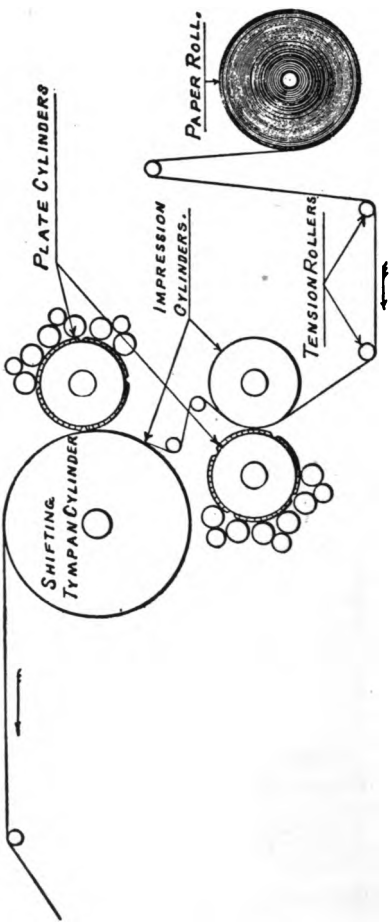
First—The oil wipe. An oily tympan resists the ink to some extent. A felt-clothed cylinder, soaked with oil, runs against the tympan. It is used for fairly absorbent stock on work that is not very particular.

Second—The traveling tympan. This is a roll of specially prepared manila paper which travels with the printing web over the second impression cylinder winding up again on another spindle. This is used over and over as it dries. A fresh offset surface is presented for every impression. When the first roll is exhausted and the tympan paper wound up on the second roll, the positions of the two rolls are exchanged and the paper run through again; this brings



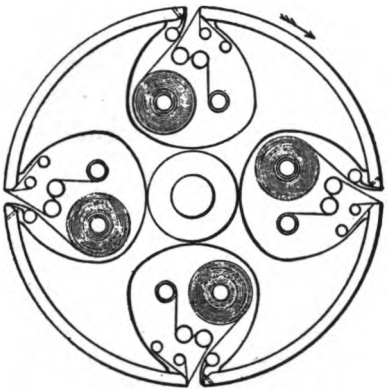
Showing Travel of White Paper and Traveling Tympan Paper

the reverse side of the web into use each time. In practice the tympan rolls have to be transferred about once an hour on an average.



Showing Automatic Shifting Tympan and Travel of White Paper

Third—The automatic shifting tympan. This is a patented device whereby the tympan of the second impression automatically shifts itself as often as desired presenting a clean surface at each shift.

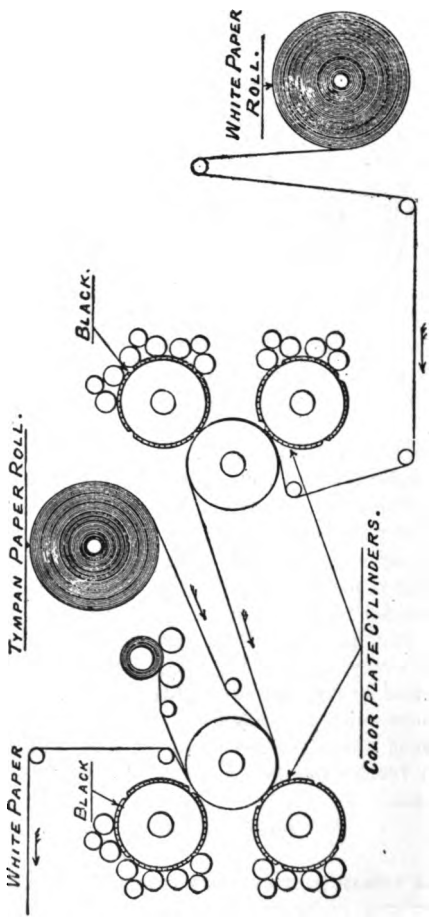


Details of Shifting Tympan Cylinder on Rotary Press

This is accomplished by dividing the surface of the second impression cylinder into four parts. Inside of the cylinder are four small rolls of tympan paper. The paper from each roll is led over the corresponding surface of the cylinder and wound up on a spindle also inside of the cylinder. This cylinder is made twice the size of the first impression cylinder in order to give space and time for the shift. By setting the mechanism, shifts can be made as often as desired, say every 12, 25, 50, 100, 200, 500 impressions. Fine work and heavy cuts on highly finished paper require more frequent shifts to keep the work clean and free from smut. These small rolls of tympan paper are usually replaced with fresh ones twice a day, less often when shifts are infrequent.

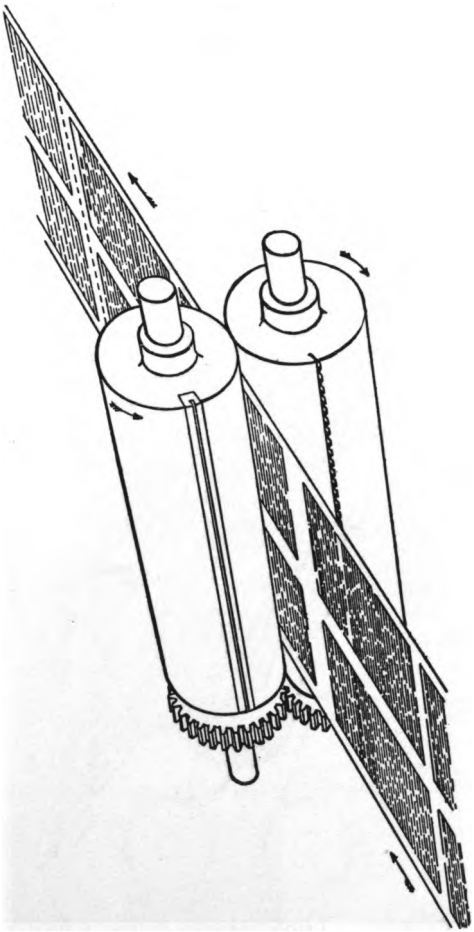
Extra Colors

On some rotary presses extra printing mechanisms are provided on one or both sides of the web. In such case both colors take their impression on one impression cylinder. To some extent this limits the character of the printing; two make-readys cannot be placed in the same place on the same cylinder; and therefore the two-color design must be



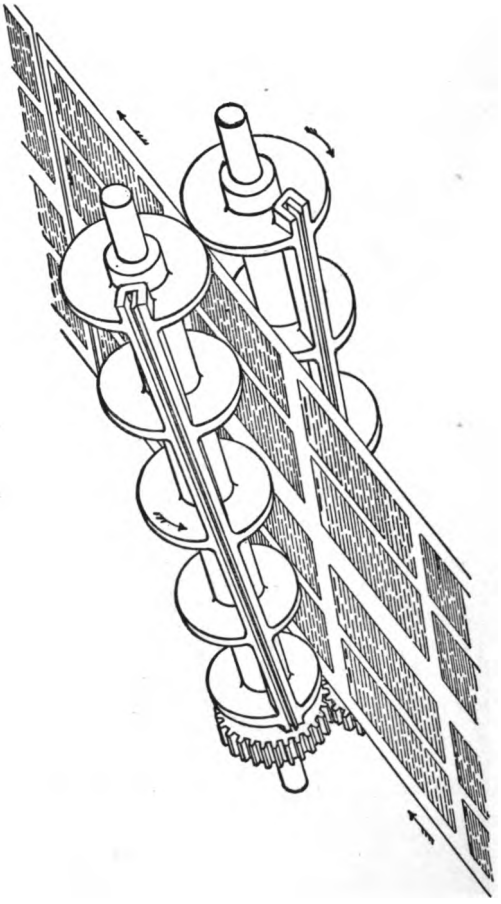
Printing Two Colors on Each Side of the Web

adapted to this method of printing. Such a machine may be used to print black only, by disconnecting the color cylinders.



Cutting the Sheet

On newspaper work and work of similar character the sheets are cut off by a blade with serrated edge mounted on



"Straight" Cutting

a skeleton cylinder. Opposite is a cylinder with a slot or groove and as the paper passes between the cylinders the serrated edge of the cutting blade makes a series of cuts across the paper; the sheet is then suddenly jerked away at increased speed and thus tears apart the little points left uncut.

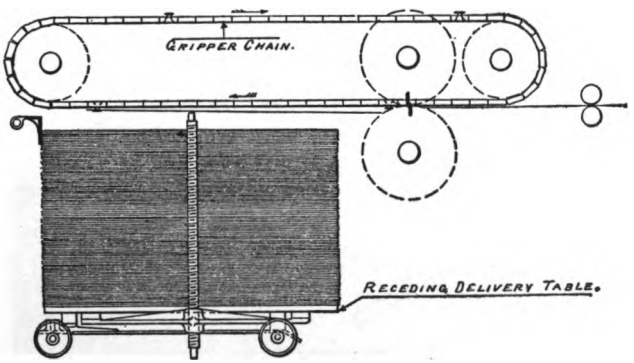
On fine work, a straight cut is desirable. This is accomplished by a patented method which acts like a pair of giant shears. The two blades have straight cutting edges. They are set in two skeleton cylinders which are built at an angle across the press. The web cannot be stopped while the cutting proceeds, so the blades are set at such an angle that the cutting point carries forward at the exact speed of the web. For instance, if the web moves forward six inches between the time the two blades begin cutting at one side of the web and finish cutting at the other side, the angle of the cutting mechanism is such as to carry forward their cutting point six inches during the cut. The result is to shear straight across the web without stopping it.

Delivery

Sheets are delivered either flat or folded, open on three sides or two, pasted or stitched, or as loose signatures.

Flat Delivery

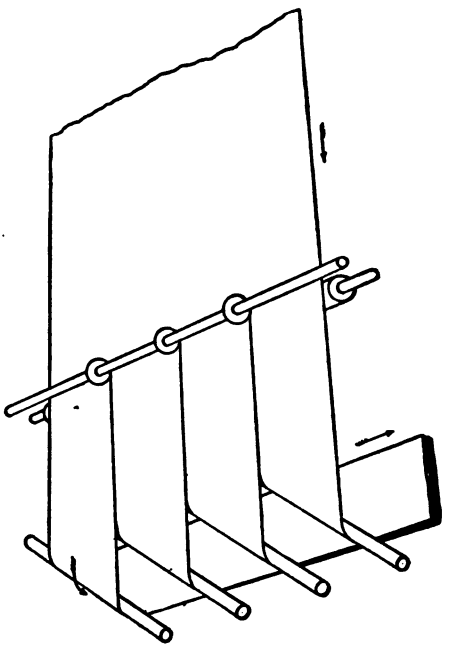
Sheets may be delivered flat by side grippers or end grippers. One method is to attach a series of grippers to an endless chain, each gripper opened by a cam at the right time to grasp the edge of the sheet, carry it forward the proper distance, and then release it.



In case end grippers are used they are mounted on a bar attached at each end to this endless chain. As they come around in place they grasp the front end of each sheet and carry it forward to its proper place. The rest of the sheet is supported by rolls running in the white margins so as not to smut the printing.

Turning-Bar Folding

By this method the sheet is slit into ribbons after printing, then these ribbons are given a half turn so as to come back to back. These ribbons, laid together, travel to the cutters, where one cut severs all the ribbons at once, delivering one



Turning-Bar Folding

complete periodical or signature. Pasters or wire stitchers are used to bind the paper or periodical when desired. The last operation is one fold at the back of the paper or signature after the pasting or stitching is done.

By certain adjustments part of the ribbons can be sent in one direction and the balance in another. Thus if four ribbons assemble together the product will be a 16-page paper or signature; but by assembling two ribbons in one place and two in another the product will be two 8-page papers or signatures.

Sometimes "formers" are used which result in giving one fold to the ribbon before it goes to the folding mechanism.

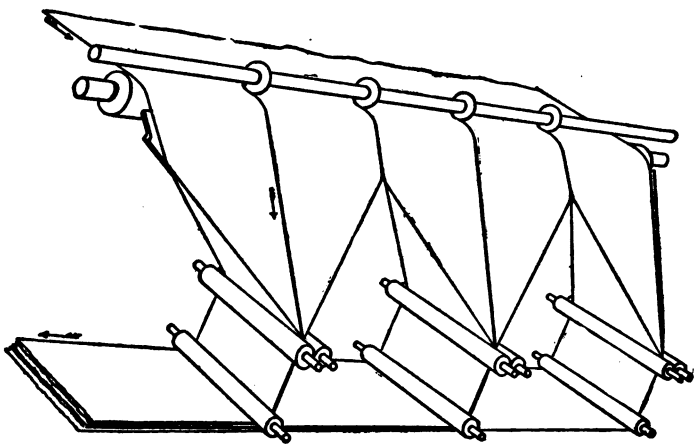


Illustration showing two formers and one half-former. Each former handles 8 pp., folded once; the half-former handles a single ribbon of 4 pp. The whole product of the machine is 20 pp. By leaving off one row of plates its product will be 16 pp. By separating the product of the two formers the mechanism will deliver two 8 pp. papers. By using the product of the half-former and one former, the press will deliver one 12 pp. paper.

"Double-deck" or "triple-deck" presses are simply two or three machines built up in tiers. It is done sometimes to save space but more frequently for the purpose of assembling more pages in a single periodical. The illustration shows a 20 pp. delivery; but the same formers will handle two ribbons as well as one. The same folder attached to a double-deck press would deliver a 40 pp. paper pasted or stitched. By diverting the various ribbons and changing the number of plates it could be made to deliver either two 8 pp., two 12 pp., two 16 pp., two 20 pp. or one 24 pp. or one 32 pp. or one 40 pp. as desired.

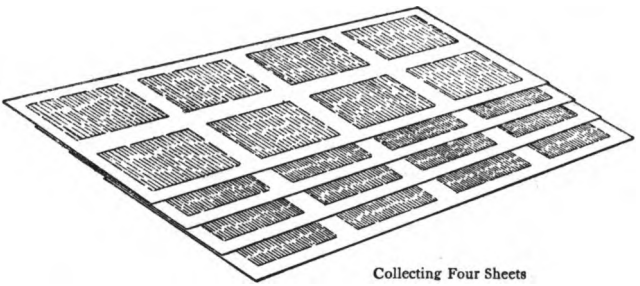
If the pages are small so that there are four around the cylinder two "cuts" are collected on a collecting cylinder and sent into the folder together. Otherwise the folder would have to run twice as fast as the press, which is impracticable. In this case the 20 pp. machine (shown in illustration) becomes a 40 pp. press and the double-deck becomes an 80 pp. press, with a great variety of combinations in number of pages.

Some rotary presses are built with an upper deck which runs at half speed, thereby delivering a two-page leaf at each revolution, instead of four pages. This makes it possible to turn out papers of 10 pp., 14 pp., 18 pp., 22 pp., and other combinations not multiples of four pages; or this half-speed mechanism may be used to print a cover on paper of different quality or color.

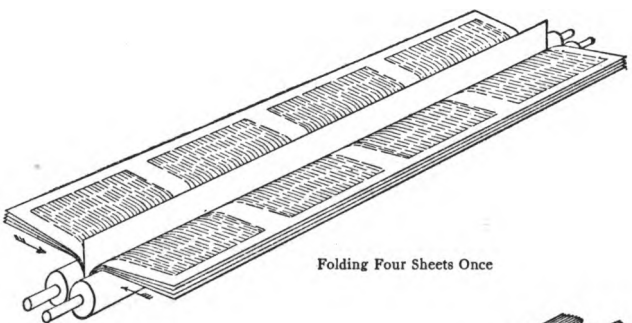
The former delivery is used only on newspaper work, or on printing which is not so particular that the slight rubbing over the edge of the formers is an objection. Small steel rollers are sometimes used on the bearing edge of the formers with the purpose of minimizing this rubbing.

Magazine Folding

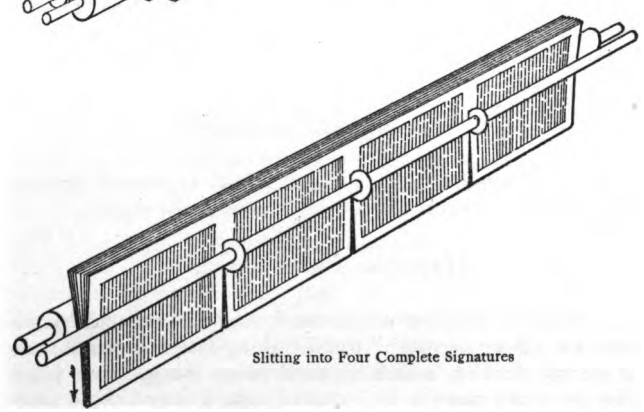
High-grade magazines must be folded without rubbing or smutting the freshly-printed pages. The pages are so small that the paper would "buckle" if folded the usual way. Magazine folding is done in this way: Strips two pages wide are cut from the on-coming web; four of these strips



Collecting Four Sheets



Folding Four Sheets Once



Slitting into Four Complete Signatures

are collected together; the collected strips are given one longitudinal fold through the center; then they pass through slitters and drop into pockets as separate 16 pp. signatures. (See previous page.) This leaves them open on top, bottom and front, making it unnecessary to trim the magazine. Incidentally, to eliminate the trimming saves 5% of the paper, no small annual sum on a big circulation.

Other Methods of Folding

Newspaper folding is usually done by a blade which strikes the center of the paper and forces it between two rollers, which complete the fold; this operation is repeated by other similar mechanisms as many times as there are folds desired.

Sometimes a blade in one cylinder will tuck the center of the collected sheets into a jaw in another cylinder and thus produce a fold. This product may perhaps go to a flat table, be wire stitched, then get its next fold by means of a blade and a pair of rollers.

Methods of Delivery—Creeping Belt Delivery

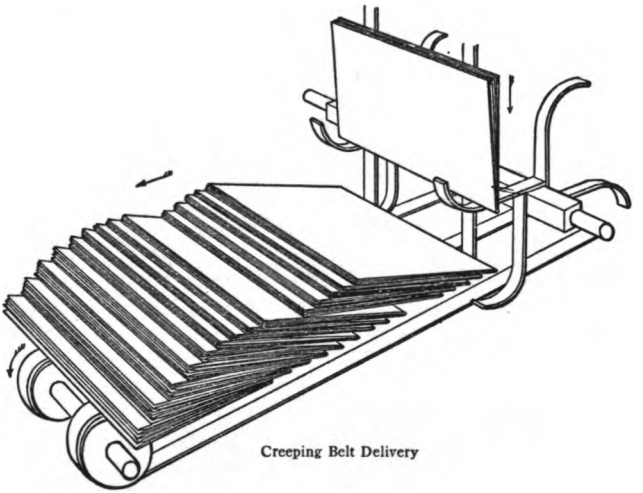
Newspapers are usually handled by this method, an endless belt which moves as fast as the papers pile up, every 25th paper being slightly out of place to make counting unnecessary.

Packing-Box Delivery

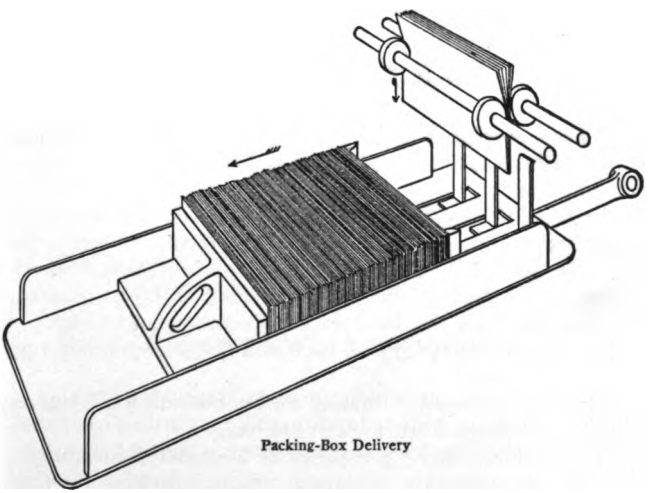
A box supplied with a block which is moved back by the pressure of each on-coming signature or paper.

Magazine Pocket Delivery

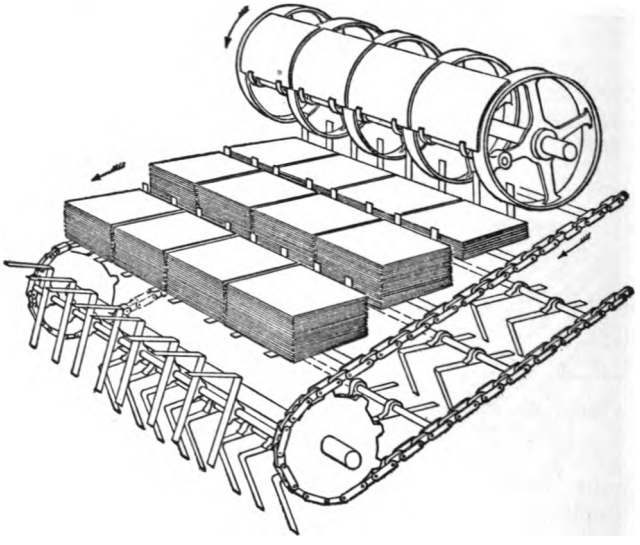
A series of pockets which move one step when 20 signatures have been deposited, thus bringing forward another row of empty pockets which in turn move a step when filled. (See opposite page.)



Creeping Belt Delivery



Packing-Box Delivery



Magazine Pocket Delivery

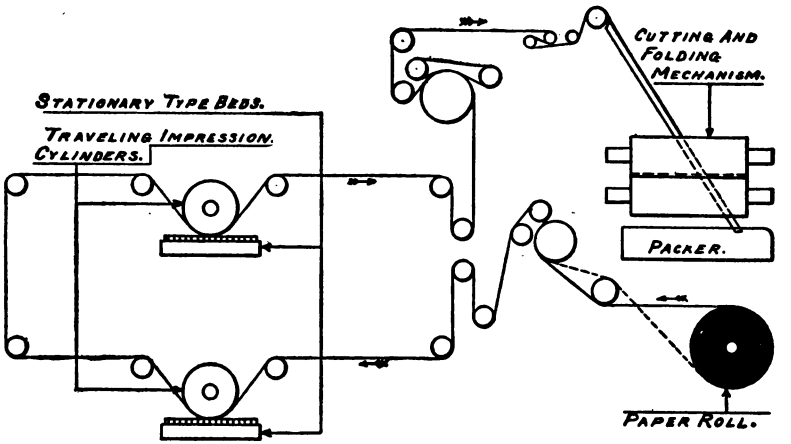
Flat-Bed Newspaper Rotaries

These machines print from the type without stereotyping. There are two beds arranged one above the other or end to end.

In the following illustration the form is stationary, the impression cylinders traveling back and forth. As the cylinder goes forward it prints the width of two pages; while the cylinder is reversing the paper is pulled along to present a fresh surface for the backward movement, and so on. It prints two or four pages on each bed delivering either 4 pp. or 8 pp. papers.

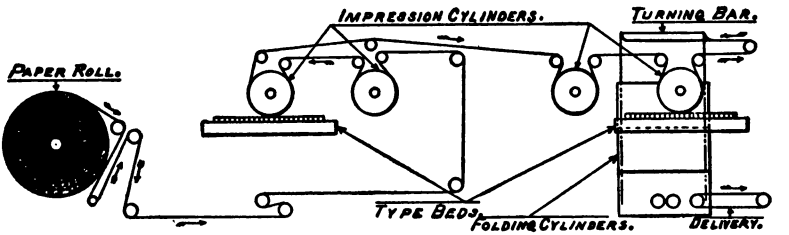
Flat-bed newspaper rotaries are built which will print any number of pages from four to twelve.

The movement of the paper is necessarily intermittent since it must remain stationary while printing, yet there



Flat-Bed Newspaper Rotary, One Bed Above the Other

must be a steady pull upon the paper roll and a constant supply to the folder. To accomplish this, compensating arms or other devices are used to take up the slack in the web and release it as required.



Flat-Bed Newspaper Rotary, Two Beds in Same Plane

Web-Perfecting Newspaper Rotaries

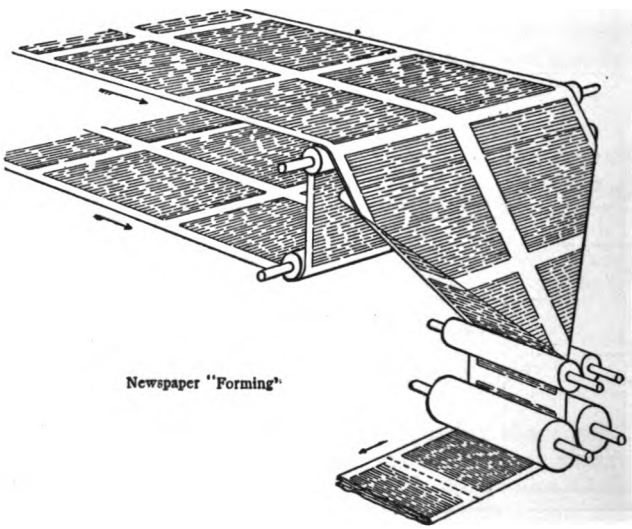
Are made either two plates wide or four plates wide, printing from stereotype plates, curved with the column rules running around the cylinder, each plate covering half the circumference.

A single press prints eight pages and will deliver its product as two 4 pp. papers or one 8 pp. paper.

A two-tier (double-deck) press is two printing mechanisms, one upon the other. The full capacity (if two plates wide) is 16 pages; it can deliver one 16 pp., two 8 pp., etc. By running an upper web of half width it will deliver one 12 pp. or two 6 pp. papers.

These presses are built three-deck, four-deck, five-deck, their product being 24 pages, 32 pages and 40 pages respectively. The purpose of building presses in tiers or decks is to get more variety in number of pages. Sometimes two or more folders are provided so that the product may all go into one folder for a many-paged paper, or part to each folder for papers of fewer pages.

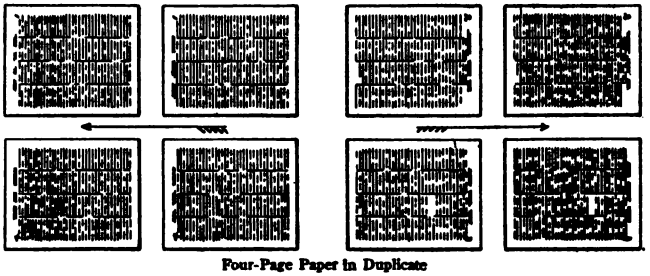
Presses four pages wide are built in all these varying combinations as to tiers, folders, etc. A single press four pages wide prints 16 pages at each revolution, double-deck 32 pages, and so on.



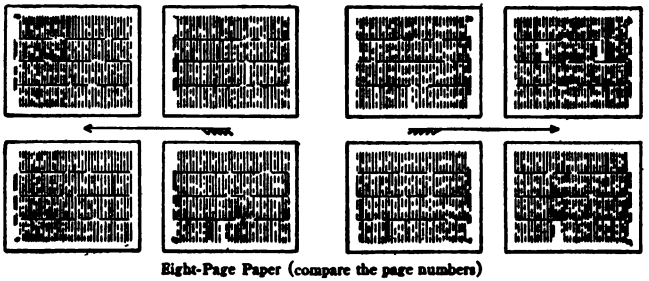
Newspaper "Forming"

Newspaper webs are slit into ribbons two pages wide. These ribbons are folded once longitudinally over a "former." A cut is made each page length no matter how many ribbons are running over the "former." If only one ribbon, each cut will produce a 4 pp. paper; two ribbons an 8 pp. paper, and so on. But the product may be "collected"—that is, the first cut may be held on a "collecting cylinder" until the next cut is collected on top of it, then both go together into the folder. Thus the collected product of a single ribbon would be 8 pages, of two ribbons 16 pages, etc. In case of collected product the folder runs only half as fast as in case of single product. As there are two pages around each printing cylinder the product must be collected or else the folder must run twice as fast as the press in order to take care of the product.

In a single product there must be two sets of plates in duplicate.



Four-Page Paper in Duplicate



Eight-Page Paper (compare the page numbers)

In a collected product the full capacity of the printing cylinder is gathered into one paper, and duplicate plates are not necessary unless more than one printing couple is being used on the same matter.

A quadruple (or "quad") press is one that prints up to 16 pages single at full capacity, or collects up to 32 pages (four eights).

A sextuple prints up to 24 pages single at full capacity, or collects up to 48 pages (six eights).

An octuple prints up to 32 pages single at full capacity, or collects up to 64 pages (eight eights).

Double-quad, double-sextuple, triple-quad, double-octuple, quad-sextuple, sextuple-octuple, etc. are self-explanatory terms.

These terms represent the printing capacity only, no matter whether built in tiers or decks, side by side, or tandem; and regardless of the folder combinations.

A "straight line" press is one which carries its webs in parallel planes from the feeding-in end of the press to the folder.

A "multi-unit" press is one which has several complete machines so disposed on the floor that each can be used as a separate press or the product of any two or more may be assembled in one folder when occasion requires.

A "tubular-plate" press is one with small printing cylinders one plate around. Each plate forms almost a tube or complete circle instead of semi-circle as on other types of machines. These presses admit of the plates being slipped over the cylinders endwise. Duplicate plates are not required for a "single" product. One printing couple four plates wide produces 8 pages. There are no collected products; press and folder always run at same speed.

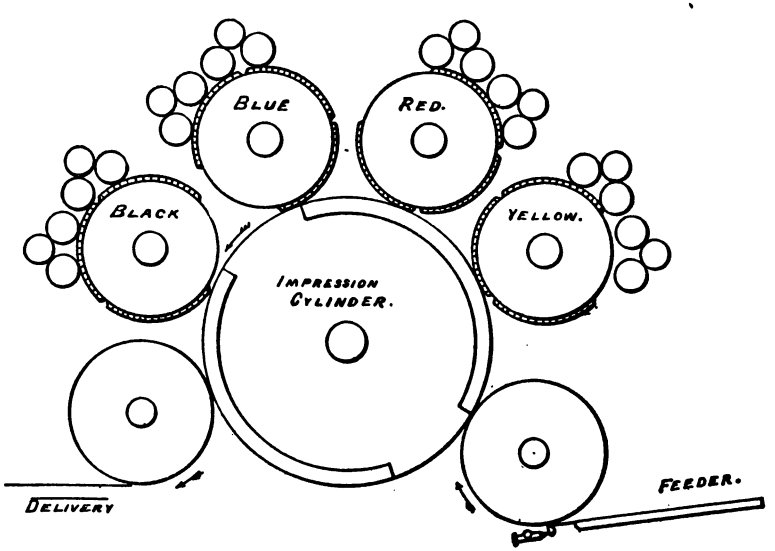
Rotary Color Press

Newspaper web-perfecting color work is usually done on machines which have as many printing units as there are colors. The web is first printed in black, then passes on to the yellow, red, and blue printing mechanisms, and finally

to the folder. The slack and stretch of the web between printings is not sufficient to matter on newspaper work and other printing done in this manner. The character of the paper and ink used makes for quick absorption and drying and the offset is not enough to be objectionable. There is register only at full speed when everything is drawn taut and the play of the gearing taken up. Little make-ready is necessary and the printing is usually from stereotype plates.

Fine Process Color Printing

Rotary presses for fine multicolor printing (from half-tone process plates) must necessarily register each and every color at any speed; and the most careful make-ready is necessary in order to bring out the intended value of each color.



Multicolor Press

A single large impression cylinder is provided, its grippers taking the sheet of white paper and never releasing it until all the colors are printed, thereby insuring a perfect registering of all colors. The usual succession of colors is yellow, red, blue, and black, but this is not necessary and the colors are sometimes otherwise arranged. The plate cylinders are half the circumference of the impression cylinder and two sheets may be printed (on one side only) at each revolution of the impression cylinder. After allowing time to dry thoroughly the sheets of paper are printed on the second side. Manila slip sheets are automatically fed to a mechanism which carries them under the large cylinder and delivers one with every printed sheet.

Each plate requires a different make-ready because each has a different printing character. One will be heavy and require a strong impression while another will be light and need less impression. All the colors take their impression on the same place on the impression cylinder and on top of each other. It is manifestly impossible to prepare four different make-readys for four different plates and put them on the same place on the impression cylinder. Therefore, the make-ready is put into the plates themselves by a patented process, with no make-ready on the impression cylinder. That is, after being treated, the plate is thicker at the darker printing parts where the most impression is required, thinner at the medium tones where less impression is necessary, and thinnest at the high-lights which need the least squeeze. Such treated plates, printing against a flat tympan, give each color the needed variations of impression to bring out its features as the artist and engraver intended. Printing one color upon another while wet has the effect of mixing the colors to some extent thereby making it easier to perfectly reproduce the work of the artist, who mixes his colors wet in making the original picture. Special inks are necessary.

CONCLUSION

NO one can foresee the future, but if relief printing be not superseded by some other process the probabilities are that it will continue to be done on presses basically similar to those now in use. Over half a century of intense application to the problem of improving the printing press has raked the possibilities pretty thoroughly and it is hardly probable that any valuable principle of mechanical combination has been overlooked. Changes in details are constantly going on, however, and every year sees improvements in method and refinements in construction. No attempt has been made in these pages to go into the peculiarities of construction for the reason that changes are so frequent and for the further reason that the finer details of machinery can be learned only by actual study of the mechanism itself. All a book can hope to do is to supply such basic information as will enable the novice to study printing machines with more intelligence and understanding.

SUPPLEMENTARY READING

It is unfortunately impossible to direct the apprentice to any satisfactory supplementary reading on the subject of this book. The subject is nowhere treated as a whole so far as the author is aware. References to it are to be found here and there, and there is a good deal of information about the older types of press in the "American Dictionary of Printing." This book has long been out of print, but copies may be found in some printing offices and in some libraries. The trade journals contain articles bearing on the different types of presses and their peculiarities. Where files of these journals are accessible the instructor will do well to make a selection of articles for the apprentices to read and study.

REVIEW QUESTIONS

1. What is a printing press?
2. Why is pressure necessary in printing?
3. What is "packing"? Its purpose?
4. What are the elements of a printing press?
5. What are the three general forms, and how do they differ?
6. When, where and by whom was the first cylinder press built?
7. What advantage over the platen press?
8. What forms of the cylinder press are now in use in this country?
9. Describe their basic differences.
10. Describe the operation of a single revolution press.
11. What forms of inking mechanism, and the uses of each?
12. Describe the "Napier" bed motion.
13. What are air springs, and what is their purpose?
14. What are slider racks, and their purpose?
15. Describe a board printing press.
16. What led to the development of the two-revolution press?
17. Describe its operation.
18. What points of superiority over the single revolution?
19. What are the comparative capacities of the three forms of flat-bed presses?
20. Describe the principles of the "direct drive" bed motion.
21. What are "bearers," and what is their purpose?
22. What is the "printing line"?
23. Describe the method of delivering the printed product.
24. Describe the operation of the two-revolution perfecting press.
25. How is the offset taken care of?

26. Describe the operation of two-revolution two-color presses.
27. What is the distinguishing feature of a rotary press?
28. In what shape are its "forms," and how put on?
29. What is a sheet-feed rotary?
30. What does "perfecting" mean as applied to a press?
31. How many kinds of offset mechanisms?
32. Describe each.
33. How are extra colors printed on a rotary?
34. Name the methods of cutting off the sheets and describe each.
35. Describe a flat-delivery mechanism.
36. What is the turning-bar method of delivery?
37. What is a collecting cylinder, and its purpose?
38. Describe three methods of delivery.
39. What is a flat-bed newspaper rotary, and how does it operate?
40. How many plates on each plate cylinder of a web-perfecting newspaper rotary?
41. What is the meaning of "deck" or "tier," and what is their purpose?
42. What is the purpose of a "former," and how does it operate?
43. What is a collected product?
44. What is a quad press, a sextuple, an octuple?
45. What distinguishes a straight line press, a multi-unit, a tubular-plate?
46. How is newspaper four-color printing done?
47. Describe the method of doing multicolor printing from half-tone process plates.

GLOSSARY

AIR SPRINGS—Air chambers used to ease the reverse of the bed and form on flat-bed presses.

ANGLE ROLLERS—Distributors set at an angle across the ink table so that they naturally vibrate back and forth.

BED—Where the form is placed while printing.

BED BEARERS—The high metal strips on each side of the bed, to insure even impression in conjunction with similar bearers around each end of the cylinder.

BED MOTION—Means of driving bed back and forth.

CLAMPS—Used to fasten plates on bed or on plate cylinder.

COLLECT—To gather two or more sheets together before passing them on to the folder.

CUTTER BLADE—The knife which severs a printed sheet from the web.

CYLINDER BEARERS—Raised rims around each end of impression cylinders, in rolling contact with bed bearers.

DECK—As double-deck, triple-deck, etc. Each printing mechanism is called a deck when two or more are built on top of each other.

DELIVERY MECHANISM—Apparatus which disposes of the paper after printing.

DELIVERY REEL—The mechanism which takes the printed sheet from the cylinder and passes it to the fly.

DELIVERY TABLE—Where printed sheets are finally deposited.

DISTRIBUTING ROLLERS—The rollers which receive the ink and supply it in an even film to the form rollers.

DISTRIBUTION DRIVING RACK—Toothed rack on side of the bed which drives the vibrators and distributing rollers.

DUCT ROLLER—Carries ink from fountain to distributors.

FEED BOARD—Carries the supply of unprinted paper, from which one sheet at a time is "fed" to the press.

FEEDER—Mechanical means for supplying presses with paper, one sheet at a time.

FEED GUIDES—Metal stops against which sheets are placed ready for the press to take them.

FLAT-BED—A general term referring to all forms of presses with form on a flat surface or bed.

FLAT-BED ROTARY—Press which prints from a continuous roll, but having its form on a flat bed, instead of curved stereotype.

FLAT DELIVERY—Sheets delivered without folding.

FLY—A frame with wooden fingers, used to receive the sheet from the press and deposit it on a table.

FOLDER—Mechanism for folding paper, either part of a press or separate.

FORM—The assembled types, cuts, plates, etc., ready for printing.

FORMER, OR TURNER—A V-shaped surface which folds longitudinally as the web passes over it.

FORM ROLLERS—The rollers which deposit ink on the form.

FOUNTAIN—Storage place for ink supply.

GRIPPERS—Metal fingers which grasp and hold a sheet while it is being moved. They are operated by the gripper mechanism.

HARD PACKING—A special cardboard, very even and hard, placed around the impression cylinder for fine printing.

IMPRESSION CYLINDER—The cylinder which carries the packing and make-ready.

JOGGER—Apparatus for straightening printed sheets into an even pile.

MAKE-READY—Preparation of impression surface for printing.

MULTICOLOR PRESS—One that completes a sheet in all its colors at one operation.

NAPIER MOVEMENT—Bed motion on principle of universal joint.

OCTUPLE PRESS—A newspaper rotary that prints 64 pages at each revolution.

OFFSET—Ink which comes off a freshly-printed sheet when it comes into contact with another surface.

OIL WIPE—Mechanism used to keep tympan continuously oiled to lessen offset.

ON THE PRINTING LINE—When the cylinder is so packed that its surface and the surface of the form move at exactly the same speed.

PACKING—The material between the form and the metal surface of the impression cylinder.

PERFECTING—Printing both sides of the sheet.

PLATE CYLINDER—The cylinder which carries the form in the shape of curved plates, on a rotary press.

QUADRUPLE PRESS—A rotary that prints 32 newspaper pages at one revolution.

RACK-AND-CAM DISTRIBUTION—Where the ink is spread evenly by means of a pyramid of vibrators and rollers working together.

RACK HANGER—The frame which carries the driving mechanism, bolted to the under side of the bed.

REGISTER—To make successive impressions print in exactly the same place on the sheet.

REGISTER RACK—Rack on the bed which engages a similar segment on the cylinder, to bring both into synchronous action.

ROLL-FEED—Taking paper from a roll instead of single sheets.

ROTARY PRESS—One which prints between two cylinders.

SEXTUPLE PRESS—A rotary that prints 48 newspaper pages at each revolution.

SERRATED CUTTING—Separating roll into sheets by means which leave serrated edges.

SHEET-FEED—Feeding single sheets instead of from a roll.

SHEET GUARDS—Metal straps to prevent paper coming in contact with ink rollers on flat-bed presses.

SHIFTING TYMPAN—An impression surface which shifts itself.

SIGNATURE—A folded sheet ready for binding, usually 16 pages.

SINGLE REVOLUTION—A press whose cylinder revolves once for each impression.

SLIDER RACKS—A form of roller bearing, used in the track-ways of flat-bed presses.

SLITTING—Cutting paper longitudinally while passing through the press.

STRAIGHT CUTTING—Cutting roll into sheets having smooth edges.

TABLE DISTRIBUTION—Where a table is the principal means of evenly spreading ink.

TIER—As two-tier, three-tier, etc. Each printing mechanism is called a tier when two or more units are built on top of one another.

TOP SHEET—The final covering of the impression surface, put on over the packing and make-ready.

TRANSFER CYLINDER—Passes sheet from one operation to the next.

TRAVELING TYMPAN—An impression surface which travels with the white paper, unwinding from one roll and winding up on another.

TURNER—See "Former."

TURNING BARS—Bars set at an angle to give the sheet a quarter turn—from flat to edgewise.

TWO-REVOLUTION—A press whose cylinder revolves twice for each impression.

TYMPAN—The surface against which impression is given.

VIBRATORS—Rollers which have a lateral motion and thus assist ink distribution.

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The Committee also desires to acknowledge its indebtedness to the many subscribers to this Series who have patiently awaited its publication.

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