

March 11, 1941.

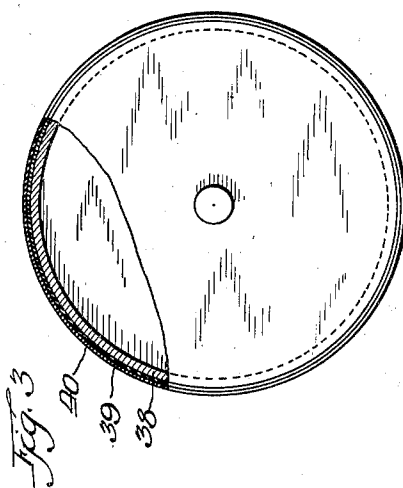
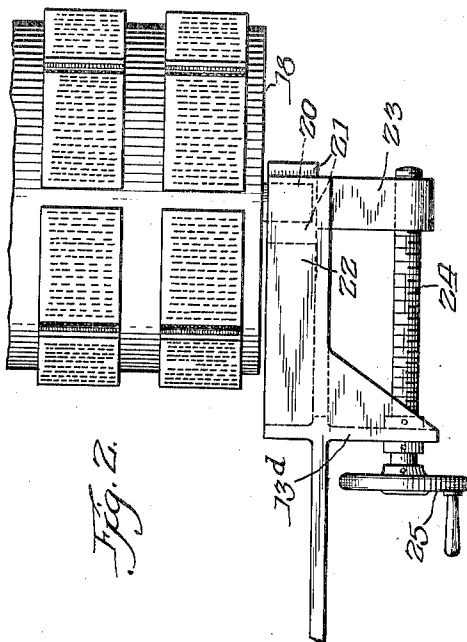
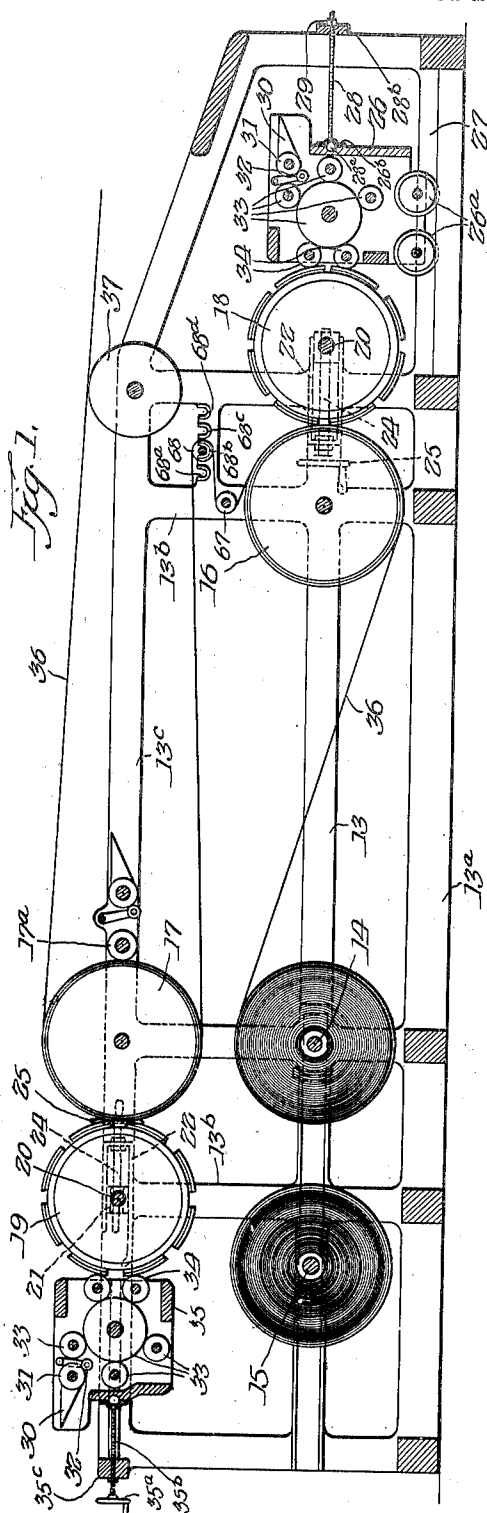
P. A. FRAZIER

2,234,726

ROTARY PRESS

Filed May 24, 1937

3 Sheets-Sheet 1



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2,234,726

ROTARY PRESS

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3 Sheets-Sheet 2

Fig. 4.

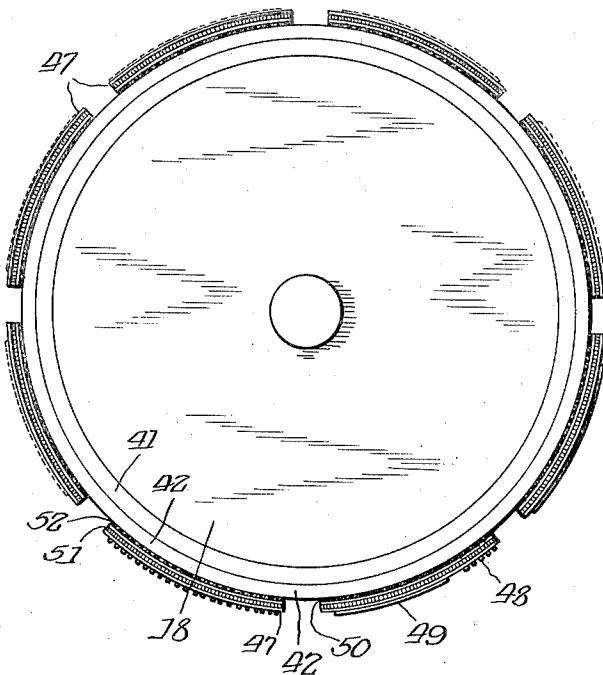


Fig. 5.

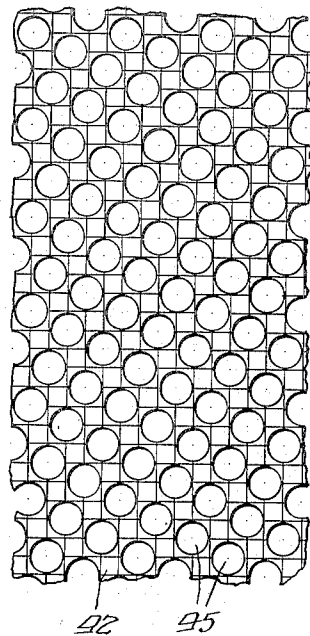


Fig. 6.

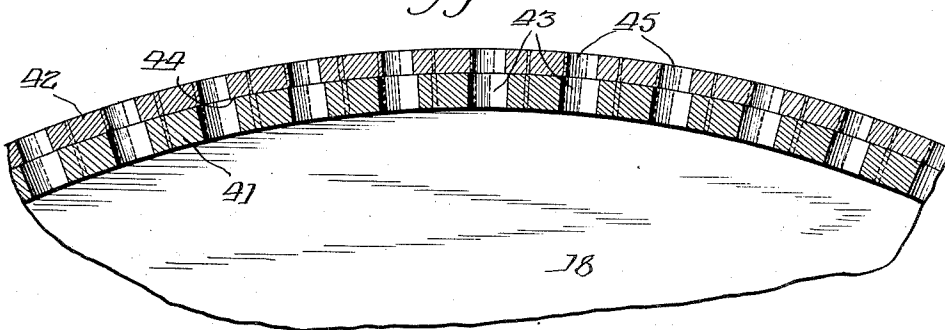


Fig. 11.

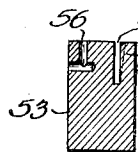
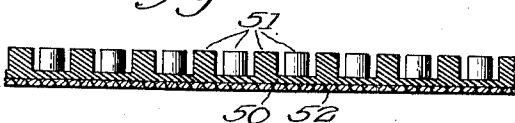


Fig. 12.



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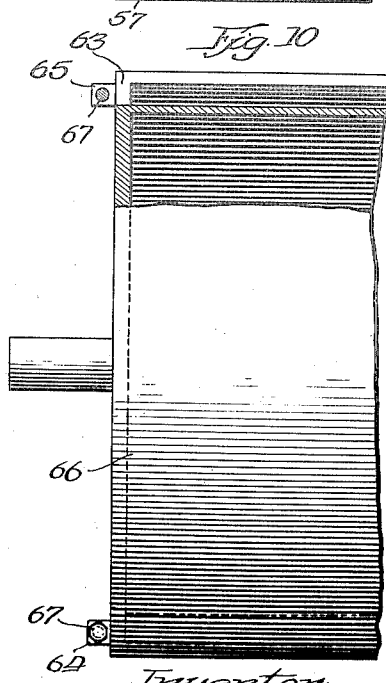
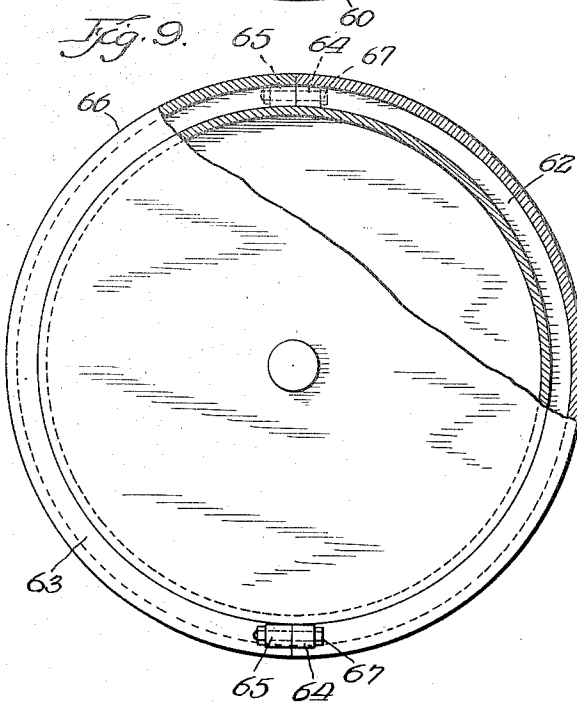
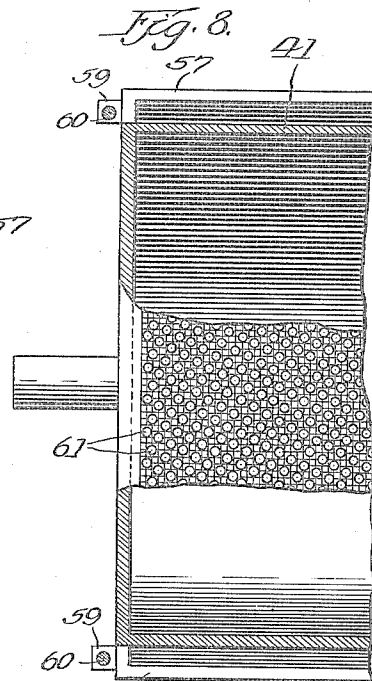
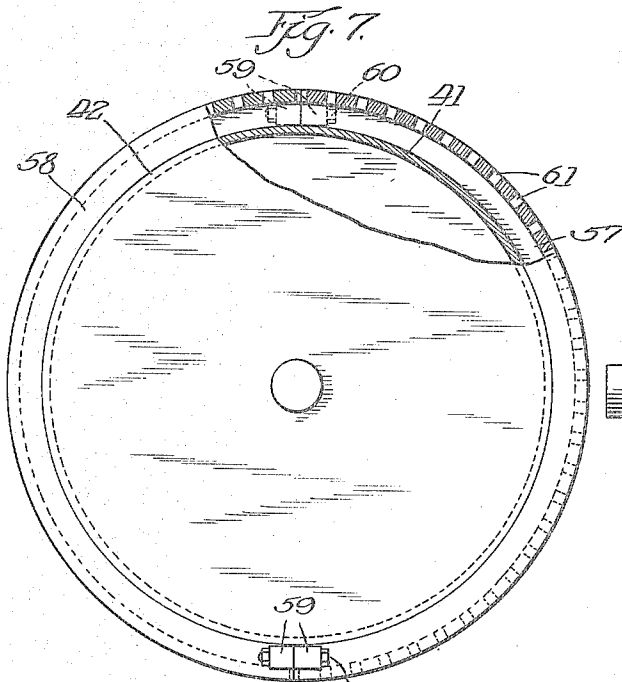
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ROTARY PRESS

Filed May 24, 1937

3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,234,726

ROTARY PRESS

Philip A. Frazier, Oak Park, Ill.

Application May 24, 1937, Serial No. 144,345

18 Claims. (Cl. 101—220)

The invention relates to rotary presses and more particularly to web and sheet rotary presses wherein products of various kinds and sizes may be printed. The invention may also be employed in color presses.

This application is a continuation in part of my application Serial No. 129,211, filed March 5, 1937, for a Method of securing a squeeze impression in printing and apparatus therefor.

In rotary presses the cylinder supporting the material to be printed upon, which is of a relatively soft or embossable nature, is maintained during printing at a fixed distance from the cylinder carrying the curved plates on which the printing is done. The curved plates are of the type known as letterpress in which the printing surfaces are raised above the general level of the plate. In letterpress printing, the printing pressures are developed by compression of the material to be printed upon, held between rigid surfaces which are maintained apart at predetermined distances.

The invention is particularly directed to the field of small rotary presses and is especially adapted for printing books, catalogues and the like. There has long been a demand in this field for a rotary press having certain flexible features, that is, a web or sheet press adapted to produce signatures of various sizes.

Accordingly, an object of the present invention is the provision of a press whereby the size of the plate cylinder may be readily and easily changed without rebuilding the press; the provision of a press in which plate cylinders of various circumferences may be readily substituted, one for the other; the provision of a press in which the plate cylinders and impression cylinders may be of the same circumferences, or a multiple thereof, or in which the plate cylinders and impression cylinders may be of incommensurate circumferences; the provision of a press in which the circumference of the plate cylinder and impression cylinder may be altered incommensurably without removing either cylinder; the provision of a press which may be readily changed to produce different products; and the provision of a rotary press having the foregoing characteristics, which may be built at a reasonable cost and is simple in construction.

A further object of the invention is the provision of a rotary press requiring substantially no "make-ready"; make-ready is exceedingly costly, and a feature of the improved press, accordingly, is that it is exceedingly economical in operation. The present invention contemplates the provision of means automatically compensating for inaccuracies in the printing surface, the curved printing plates, and plate support.

A further object of the invention is to provide

a rotary press construction adapted to produce a finer grade printing than has been formerly possible in ordinary commercial printing on web sheet rotary presses. To accomplish this, a printing couple is provided adapted to impart a squeeze impression upon the material being printed. It has been found that a squeeze impression may be obtained in a rotary press by providing a resilient support for the printing plates, and employing an impression cylinder having a surface relatively less yielding than the plate cylinder surface.

A feature of the invention is the provision, in a rotary press, of means of absorbing pressure variations arising from irregularities in the plates and impression surfaces without resort to make-ready. An additional feature of the invention is the provision, in rotary presses, of means of supplying the varying amounts of pressure required to print different portions of a printing plate, or plates, without resort to make-ready. It has been found that the foregoing desirable results may be obtained by employing material having a pattern temporarily displaceable under printing pressure between the curved printing plate and printing cylinder in rotary presses, by means of which the printed impression is of uniform texture.

An additional feature resides in the provision of a rotary printing structure adapted to print evenly upon material of different thicknesses, within certain limits, without adjusting the printing couple. For example, paper, cloth and thin cardboard may be printed upon by the improved structure without adjusting the printing couple.

The invention will be readily understood from the following description in conjunction with the accompanying drawings, in which certain preferred embodiments of the invention are shown.

In the drawings:

Fig. 1 is a longitudinal, diagrammatic view of an embodiment of the invention;

Fig. 2, an enlarged plan view of a portion of the press shown in Fig. 1;

Fig. 3, an end elevation, partly broken away, of an impression cylinder employed in the press;

Fig. 4, an end elevation of a plate cylinder;

Fig. 5, a laid out plan view of a portion of the surface of the plate cylinder with the plates removed;

Fig. 6, an enlarged vertical section of a portion of the plate cylinder of Fig. 4;

Fig. 7, an end elevation, partly cut away, of another type of plate cylinder;

Fig. 8, a fragmentary side elevation, partly in section, of the plate cylinder shown in Fig. 7;

Fig. 9, an end view, partly broken, of another type of impression cylinder;

Fig. 10, a fragmentary side elevation, partly in section, of the impression cylinder shown in Fig. 9;

Fig. 11, a sectional view of a plug adapted to be inserted in the plate supporting shell; and

Fig. 12, a sectional view of the resilient strip material used to support plates on the plate cylinders.

Referring to the embodiment of the invention illustrated in Fig. 1, it will be seen that the press there shown comprises two printing couples, each printing couple comprising an impression cylinder and a plate cylinder, the couples being horizontally and vertically spaced apart, the cylinders of the couples being in tracking relation to each other so that the web may travel from one couple to the other without sidewise deflection. It is to be understood that other series of couples may be added to the press, as desired, within the scope of the invention. Any suitable frame construction may be provided for supporting the printing couples and the parts associated therewith.

The reference character 13 indicates a frame including a base 13a, vertical members 13b and cross members 13c suitably carrying the printing couples, a web supply roll 14, and an additional web supply roll 15. The impression cylinders 16 and 17 are preferably fixedly but rotatably mounted upon the frame 13, and the plate cylinders 18 and 19 are detachably carried thereon in printing relation to the impression cylinders 16 and 17, respectively. It will appear hereinafter that the circumference of the plate cylinder need not be the same, nor multiples of the circumference of the impression cylinders, and that plate cylinders of incommensurate circumference may be employed with the impression cylinders, and, accordingly, means are provided for positioning, regulating and maintaining the plate cylinder in printing relation with the impression cylinder when plate cylinders of various circumferences are employed. In the embodiment shown, the plate cylinders 18 and 19 are mounted upon shafts 20 rotatably journaled as in Fig. 2, in bearing blocks 21 reciprocable in guides or gibs 22 formed in the frame structure. Arms 23 extend sidewardly from the gibs 22 and fixedly carry one end of a threaded shaft 24, the other end of which is journaled in an extension 13d of the frame structure and carries a control wheel 25. The ends of gibs 22 away from the impression cylinders are open and the plate cylinders are easily removed from the frame by turning wheel 25 to slide shafts 20 toward the open end where the cylinders may be removed by a crane. Obviously, other suitable means for positioning the plate cylinders in printing relationship to the impression cylinders may be employed.

A suitable inking mechanism is provided for each plate cylinder, and as shown in Fig. 1, inking mechanism for plate cylinder 18 is housed in carriage 26 having wheels 26a traveling on rails 27 on the base 13a of the frame 13. Carriage 26 is provided with an outwardly extending threaded rod 28, having a bulb-like end 28a rotatable in the housing 26b of the carriage, extending through a bore in the rear portion of the frame 13, and a plate 28b having a threaded bore. The screw 28 is provided with a wheel, not shown, and a locking nut 29 adapted to move and to lock the inking mechanism carriage in operative position. The inking devices, as shown, are duplicates of each other and include a

fountain 30, a fountain roll 31, a ductor roll 32, distributing rolls 33, and form rollers 34.

The inking device of the plate cylinder 19 is housed in a carriage 35 adjustably mounted upon the cross member 13c. The carriage 35 may be brought into and out of operative position when plate cylinder 19 is being changed, or the plates changed, by turning wheel 35a upon the threaded rod 35b secured to the inking carriage 35 and passing through plate 35c equipped with a threaded bore.

When the press is running, the web 36 travels from the supply roll 14, around the impression cylinder 16, where one side of the web is printed upon, around the impression cylinder 17, where the other side of the web is printed upon, and over a guide roll 37 to a cutter and folder, not shown. The members of the printing couples are driven in timed relation by any suitable series of shafts and gears well known to the art. The impression cylinder 17 may be provided with an oil wiper roller 17a, as shown in Fig. 1. To change the length of page or signature produced, the form cylinders 18 and 19 may be removed and form cylinders of a different circumference substituted therefor, in the manner previously described.

The invention contemplates the provision of an impression cylinder having a smooth, unbroken circumference without packing or overlay. Inasmuch as a packing sheet is not required, the provision of a longitudinal recess housing clamping devices and a reel for the packing sheet, as in the presses known to the art, is not necessary. Accordingly, it will be understood that the entire circumference of the impression cylinder may be employed as a printing support, and that it is not necessary that the plate cylinder be of the same size or a multiple of the size of the impression cylinder. Accordingly, the invention includes the substitution of various size plate cylinders or the building up of a plate cylinder to the various desired sizes. The impression cylinder preferably has a slightly yielding circumferential surface portion which may be provided in any suitable manner, for example, a solid, hard, rubber cylinder mounted on a metal core has been found suitable, or, as shown and described in my co-pending application, Serial No. 129,211, the impression cylinder may be equipped with a cylindrical cork shell and a smooth surface shell of "Formica," or, as shown in Fig. 3, the impression cylinder may comprise a hollow metal portion 38 having a circumferential shell 39 of soft rubber and an outer surface shell 40 of hard rubber sprayed or molded thereon. Thus a slightly yielding surface is provided for the impression cylinder that is adapted to absorb any inaccuracies in the surface of the curved printing plates.

The plate cylinders 18 and 19 preferably comprise a hollow metal shell 41 provided with helicoidal undercut grooves to anchor the plate clamps, or, as shown in Figs. 5 and 6, with a plurality of cylindrical radial bores 43 disposed in honeycomb arrangement. The bores preferably have inner shoulder portions 44 which may be cast in the cylinder shell 41 or may be formed by providing an outer surface shell 42 provided with radial bores 45 of less diameter than the inner bores 43 and secured in alignment therewith.

The curved metallic printing plates 47 are secured to the support 42 in any suitable fashion,

for example, by clamps (not shown) adapted to be inserted in the bores 43 and 45 to grip the shoulder portions 44. The plates are shown for convenience as having a printing surface comprising type 48 and a half tone portion 49.

The curved plates 47 are yieldingly mounted upon the cylinders 16 and 17 to obtain a "squeeze" printing impression and to absorb any inaccuracies in the plate structure in order that such inaccuracies will not appear upon the printed surface. Accordingly, a strip of resilient material having a pattern temporarily displaceable under printing pressure is provided between the plate 47 and the plate-supporting structure 42. A satisfactory yielding support has been obtained by employing a strip 50 of rubber matting or of any resilient composition having compressible portions 51. For example, a strip such as shown in Fig. 12 may be used, the strip 50 having a fabric backing 52 and projecting discs 51 of compressible rubber. A resilient strip of .046" thickness under Hacker gauge reading has been found to be suitable, but it is to be understood that the thickness and outline of the resilient matting and projecting portions may be varied. The resilient portions 51 are spaced apart from one another to afford a displacement pattern, and it is to be understood that the shape, height and spacing of the resilient portions may be varied considerably to afford displacement areas or patterns when pressure is applied to the printing plate mounted thereon, for example, the resilient projections may be conical, square or irregular in shape. The resilient projections shown are approximately .028" thick under Hacker gauge reading.

The resilient strips 50 are preferably adhesively secured to the bottom of the curved plates 47 before they are clamped upon the printing support 41. The resilient strips may be secured with the projecting portions adjacent the bottom of the plate, as shown in Fig. 4, or the matting may be reversed, with the projections 51 bearing against the cylindrical base 42.

In order that an even printing impression may be obtained when plates having half tones are used, the printing pressure under the half tone area is built up by inserting metal plugs 53 in the bores 45 of the honeycomb support underlying the half tone area. The plugs 53 are preferably provided with slots 54 and an adjacent yielding portion 55 to obtain a frictional engagement in the bores 45. The plugs may also be provided with small bores 56 adapted to be engaged by a gripping member (not shown) to facilitate removal of the plugs. The top surface of the plugs may be flush with the surface of the cylindrical support 42, or the top of the plugs may protrude slightly above the support, thereby increasing the pressure upon the printing surface above the plugs. The curved plates 47 are preferably cast or cut down until they are .04" thinner than the standard plates of .187" or .250" thickness usually employed in rotary presses.

Other methods and apparatus may be employed for increasing the pressure beneath the printing surfaces requiring increased pressure without employing plugs 53. For example, a thicker strip of resilient material may be employed under these areas, or the pressure may be built up by pasting a paper strip of approximately .004" thickness to the fabric backing 52 of the matting, or by employing a less resilient

strip beneath the areas requiring greater pressure; or a smooth sheet of rubber matting approximately .04" thick, not having a displaceable pattern, may be employed under the half tone area, and the matting 50 having a displaceable pattern employed under the type portions. Thus the portions underlying the half tone areas, where increased pressure is desired, are preferably more firmly backed than are the remaining portions of the plate. When a printing impression is made, the more firmly backed portions of the plate provide increased printing pressure on the corresponding areas of the printing surface requiring such pressure to produce a clear printing impression.

The size of the signatures or pages produced may be varied within relatively wide limits by substituting a larger or smaller plate cylinder, as desired, in the manner previously described. Likewise, the circumference of the printing surface, and the resulting signatures or pages, may be increased within narrow limits by utilizing thicker plates.

The invention also contemplates varying the size of either the plate or impression cylinder, or both, by adding cylindrical shell members of varying diameters removably secured to the cylinder cores; for example, as shown in Figs. 7 and 8, two semicircular shell or "turtle" sections 57 and 58, adapted to fit tightly over the cylindrical core 41 and provided on their ends with shoulders 59 having aligned bores adapted to receive a bolt 60 to firmly secure them to each other and to cylindrical shell 41, may be employed. As shown in Figs. 7 and 8, the surface of the shell is preferably provided with bores 61 disposed in a honeycomb arrangement. Curved plates provided with a resilient backing having a displaceable pattern may be yieldingly mounted upon the shell portion, thereby supplying a plate cylinder having a predetermined increased printing circumference. Plugs 53 may be inserted in bores 61 in areas underlying surfaces where increased printing pressure is desired, as previously described. Shells having helicoidal undercut grooves, well known to the art, for retaining hooks clamping the plates in position, may also be employed. In shells employing helicoidal grooves, the pressure under the areas, such as half tones, requiring increased printing pressure may be built up by employing thicker matting, paper strips, under the predetermined areas, or by employing a resilient strip without a displaceable pattern under the areas requiring the increased pressure.

Where the circumference of the plate cylinder and the impression cylinder are not commensurate, the gearing must be adjusted or changed in order that the circumferential speed of the plate and impression cylinders is the same. Likewise, the horizontal disposition of the plate cylinder must be adjusted by turning hand wheels 25 to move plate cylinders 18 and 19 toward or away from the impression cylinders in order that the cylinders are positioned in printing relationship.

In some instances it is desirable to increase the circumference of the impression cylinders. This may likewise be accomplished by placing semicircular shell members 62 and 63 over the impression cylinders, as shown in Figs. 9 and 10. The shells 62 and 63 are likewise provided with means to secure them together and to the impression cylinders such as shoulders 64 and

65 having aligned bores to receive a bolt 67. The shells 62 and 63 are preferably provided with a yielding surface portion 66, relatively less yielding than the plate-supporting structure. The surface portion 66 may be formed of rubber, cork or composition material.

In web presses having two or more printing couples, it is necessary either to make the length of web between couples an exact multiple of the cylinder circumference, or to rotate the couple, in order to bring a later printing into proper relation or register with preceding printing. In a press which is built with only one size of plate cylinder, this requirement is easily met in the design of the press. Where a number of exchangeable plate cylinders of different sizes are to be used in the same or in different presses, it is desirable, in order to facilitate setting up the press, to mark each plate cylinder with a zero point which may be set to coincide with a zero point on the cylinder mounting. This precludes rotating the cylinder to obtain register in each case, and it is then necessary to vary the web length between couples so that such web length may be an exact or nearly exact multiple of the plate cylinder circumference in each case; exact register being obtained in well-known manner, either by register rolls or slight adjustment of the cylinder gear. To secure this condition, a roller 72 is provided, journaled in the frame 13 in fixed position, and a second roller 68 which may be placed in any one of several journals 68a, 68b, 68c and 68d, in the frame 13. The position of each of these journals is so chosen that the correct web length between printing couples is insured for one of the plate cylinder sizes which are to be used.

In inserting the web in the press, it is first carried over impression cylinder 16, then over roller 72, then in reverse direction over roller 68 and thence to impression cylinder 17, the position of roller 68 governing the total length of the web along this path.

It will be understood that the roller 68 may also be mounted in any other manner which will permit of the required change in position, such as the screw adjustment mounting shown for the plate cylinder and inking mechanisms.

There is thus provided in a single press the capacity to print at high speed, on a web press, books, catalogues and the like of a very wide variety of sizes, both as to page size and number of pages, with any desired arrangement of half tone or type matter in letterpress printing.

It is believed that the invention will be fully understood from the foregoing description, and it is obvious that numerous changes may be made in the form, construction and arrangement of the various components, without departing from the spirit or scope of the invention, the forms herein described being simply selected embodiments for the purpose of illustrating the invention.

Having thus described my invention and illustrated its use, what I claim as new and desire to secure by Letters Patent is:

1. In a printing couple in a rotary printing press, the combination of an impression cylinder carrying and yieldingly supporting material to be printed upon, and printing plates carried on a second cylinder and having a relatively greater yielding support than said material carried on said impression cylinder.

2. In a rotary web press, the combination of a web-carrying cylinder having a smooth, un-

broken circumference without requirement of overlay, a second cylinder in printing relation to said first mentioned cylinder, thin flexible curved plates carried on said second mentioned cylinder, and resilient material interposed between said plates and said second mentioned cylinder, said resilient material having a displaceable pattern adapted to yield locally under printing pressure and to compensate for inaccuracies in the plates and said second mentioned cylinder.

3. In a rotary web press, a web-carrying cylinder having a slightly yielding, unbroken impression circumference without requirement of overlay, a plate-carrying cylinder in printing relationship to said web-carrying cylinder, plates on said plate-carrying cylinder, the printing surfaces of said plates having areas requiring different printing pressures to print evenly, and resilient material interposed between said plates and said cylinder, the resiliency of said material being variable to meet the printing pressure requirements of the plate surfaces.

4. In a rotary web press, a web-carrying cylinder having a smooth, unbroken impression circumference, a second cylinder in printing relationship to said web-carrying cylinder, plates mounted upon said second mentioned cylinder having surface portions requiring different printing pressures to form an even impression, resilient material interposed between said plates and said second mentioned cylinder said resilient material having a pattern temporarily displaceable under printing pressure, and means for varying said pattern to conform to the pressure requirements of said plate surfaces.

5. In a rotary web press, a web-carrying cylinder having a smooth, unbroken impression circumference without requirement of overlay, a second cylinder disposed in printing relationship to said web-carrying cylinder, the surface portion of said second mentioned cylinder having a plurality of radial bores, metallic plates yieldingly mounted on said second mentioned cylinder, said plates having printing surfaces requiring different printing pressures to form an even printing impression, and members inserted in the bores beneath the plate portions requiring increased pressure.

6. In a rotary web press, a web-carrying cylinder, a second cylinder disposed in printing relationship to said web-carrying cylinder, said second mentioned cylinder having a surface portion provided with a plurality of radial bores, printing plates resiliently secured to said second mentioned cylinder, said plates having portions requiring increased printing pressure to form an even printing impression, and members disposed in said radial bores of said surface portion beneath the plate portions requiring increased printing pressure.

7. In a printing press, a frame, a plurality of printing couples mounted in tracking relationship on said frame, said couples comprising impression cylinders and plate cylinders, said impression cylinders having a slightly yielding, smooth, unbroken circumference, curved printing plates removably mounted on said plate cylinders, the plate cylinders of said couples being adjustable toward and away from said impression cylinders, and inking means carried on said frame and adjustable toward and away from said plate cylinders, whereby plates of varying thicknesses may be carried on said plate cylinders to alter the circumference thereof.

8. In a rotary printing press, an impression cylinder having a smooth, unbroken surface, a plate cylinder in printing relationship to said impression cylinder, members secured to said plate cylinder to increase the circumference of said plate cylinder, and printing plates yieldingly mounted upon said members.

9. In a rotary printing press, the combination of an impression cylinder carrying and yieldingly supporting material to be printed upon, a plate cylinder, members detachably secured to said plate cylinder to increase the circumference thereof, and printing plates carried on said members and having relatively greater yielding support than said material to be printed upon yieldingly supported on said impression cylinder.

10. In a rotary web press, the combination of a web-carrying cylinder having a smooth, unbroken impression circumference without requirement of overlay, a second cylinder in printing relationship to said web-carrying cylinder, shell members secured to said second mentioned cylinder to increase the circumference thereof, printing plates mounted on said shell members, and resilient material interposed between said plates and said second mentioned cylinder, said resilient material being adapted to yield locally under printing pressure.

11. In a rotary web press, the combination of a web-carrying cylinder having a smooth, unbroken circumference without requirement of overlay, a second cylinder in printing relationship to said web-carrying cylinder, shell members secured to said second mentioned cylinder to increase the circumference thereof, printing plates carried on said shell members, and resilient material interposed between said plates and said shell members, said resilient material having a displaceable pattern adapted to yield locally under printing pressure and to compensate for inaccuracies in the printing structure.

12. In a rotary web press, a web-carrying cylinder having a smooth, unbroken impression circumference without requirement of overlay, a second cylinder in printing relationship to said web-carrying cylinder, means carried on said second mentioned cylinder to increase the circumference thereof, printing plates mounted upon said means, said plates having surface portions requiring different printing pressures to form an even printing impression, resilient material interposed between said plates and said means, said resilient material having a pattern temporarily displaceable under printing pressure, and means for varying said pattern to conform to the pressure requirements of said plate surfaces.

13. In a rotary web press, a web-carrying cylinder having a smooth, unbroken impression circumference without requirement of overlay, a second cylinder disposed in printing relationship to said web-carrying cylinder, members mounted on said second mentioned cylinder to increase the circumference thereof, the surface portions of said members having a plurality of radial bores, printing plates yieldingly carried on said members, said plates having portions requiring increased printing pressure to form an even impression, and members inserted in said bores beneath the plate portions requiring increased pressure.

14. A printing press as specified in claim 10, in

which the web-carrying cylinder is provided with members detachably secured thereto to increase the circumference thereof, said members having a slightly yielding surface.

15. In a rotary web printing press, a frame in which a plurality of plate cylinders may be removably mounted in varying positions, the plate cylinders so mounted at any one time being all of the same circumference but exchangeable with other plate cylinders of a different circumference, a web caused to traverse a path contacting in succession each of said plate cylinders, and means of varying the path of said web so that the length of web extending along said path between contacting points of any successive pair of said plate cylinders shall be a substantially exact multiple of the circumference of said plate cylinders.

16. In a rotary web printing press, a frame, a pair of impression cylinders mounted in permanent positions in said frame, a plate cylinder removably mounted in printing contact with each of said impression cylinders, said plate cylinders being both of the same circumference but exchangeable for other plate cylinders of a different circumference, a web passing first between one of said impression cylinders and the plate cylinder in printing contact therewith, and thereafter between the other impression cylinder and the plate cylinder in printing contact therewith, and means for varying the path of the web between said passages to cause the length of web extending along said path to be a substantially exact multiple of the circumference of said plate cylinders.

17. In a rotary web printing press, a frame, a pair of impression cylinders mounted in permanent positions in said frame, a plate cylinder mounted in printing contact with each of said impression cylinders, said plate cylinders being both of the same circumference but having plate-supporting members exchangeable with other plate-supporting members of different size for altering said circumference, a web passing first between one of said impression cylinders and the plate cylinder in printing contact therewith, and thereafter between the other impression cylinder and the plate cylinder in printing contact therewith, and means for varying the path of the web between said passages to cause the length of web extending along said path to be a substantially exact multiple of the circumference of said plate cylinders.

18. In a rotary web printing press, a frame in which a plurality of plate cylinders may be removably mounted in varying positions, the plate cylinders so mounted at any one time being all of the same circumference but exchangeable with other plate cylinders of a different circumference, a web caused to traverse a path contacting in succession each of said plate cylinders, and means including a movable mounted roller, over which the web passes, of varying the length of the path of said web between the plate cylinders so that the length of web extending along said path between contacting points of any successive pair of said plate cylinders will be a substantially exact multiple of the circumference of said plate cylinders.

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