Dec. 30, 1969 W. F. HUCK 3,486,444

MULTI-COLOR ROTARY PRINTING PRESS

Filed May 5, 1966 3 Sheets-Sheet 1

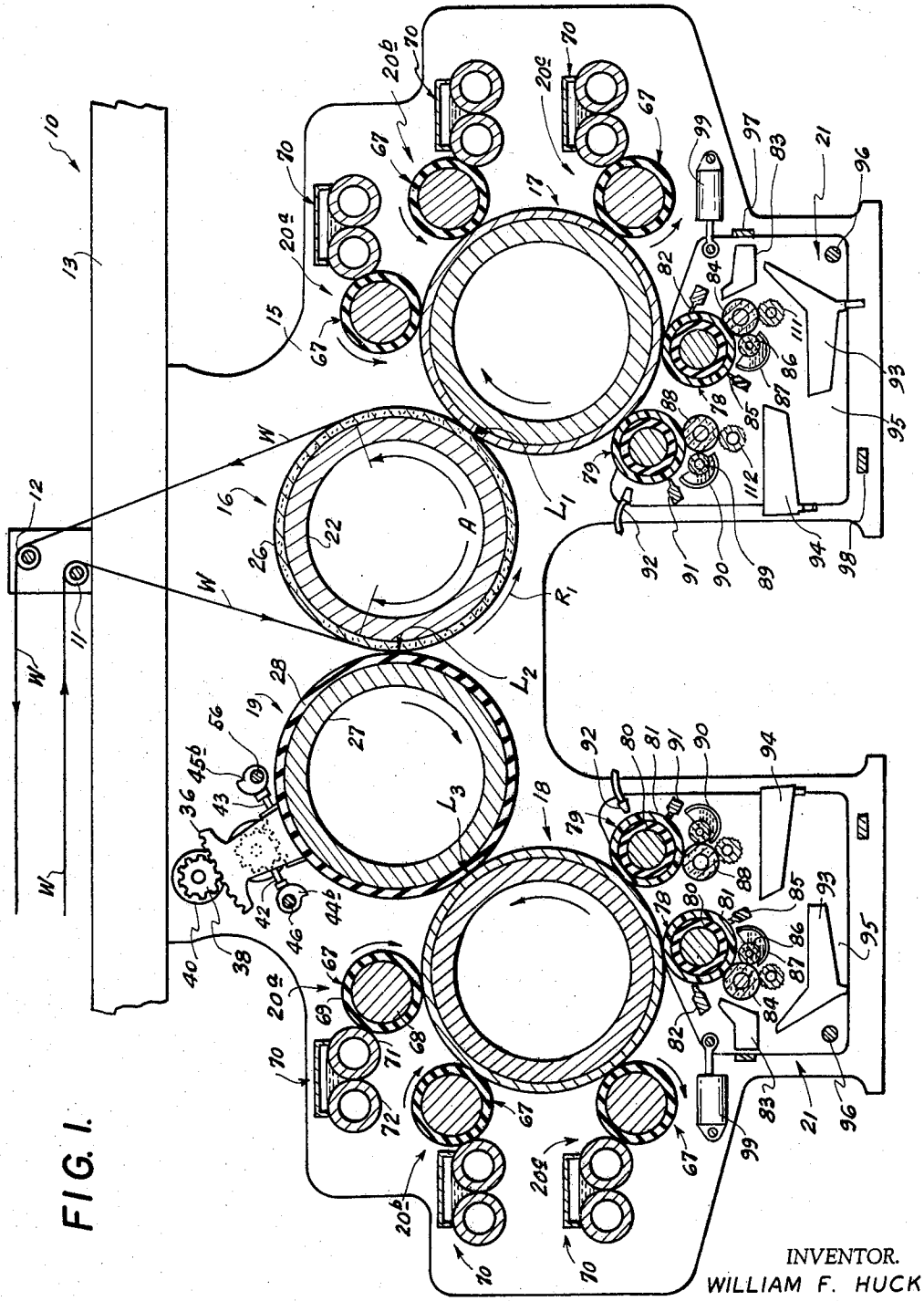

FIG. 1.

INVENTOR.
WILLIAM F. HUCK

BY

Albert C. Johnston

ATTORNEY

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MULTI-COLOR ROTARY PRINTING PRESS

Filed May 5, 1966 3 Sheets-Sheet 2

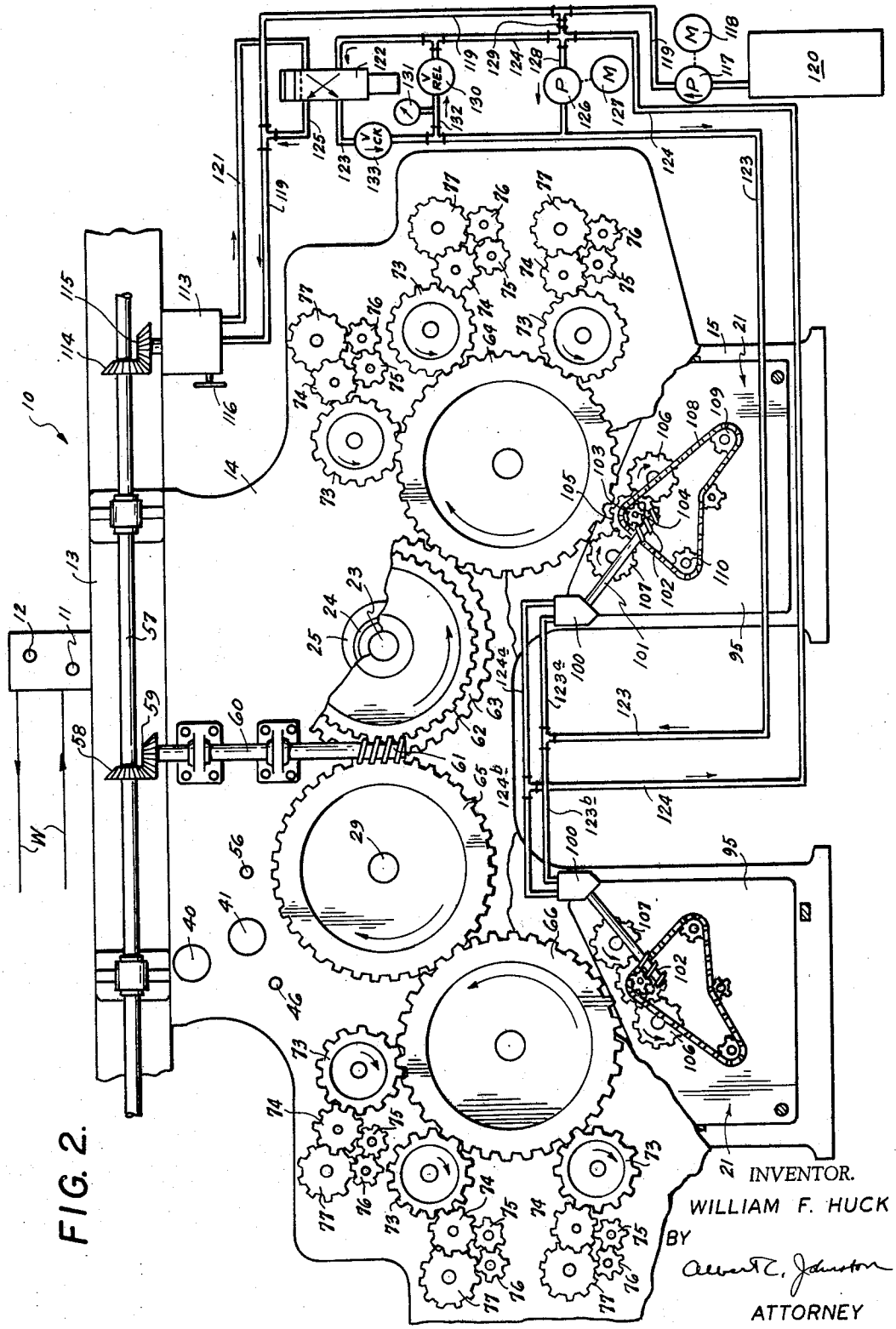

FIG. 2.

INVENTOR.
WILLIAM F. HUCK
BY
Albert C. Johnston
ATTORNEY

Dec. 30, 1969 W. F. HUCK 3,486,444

MULTI-COLOR ROTARY PRINTING PRESS

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FIG. 3.

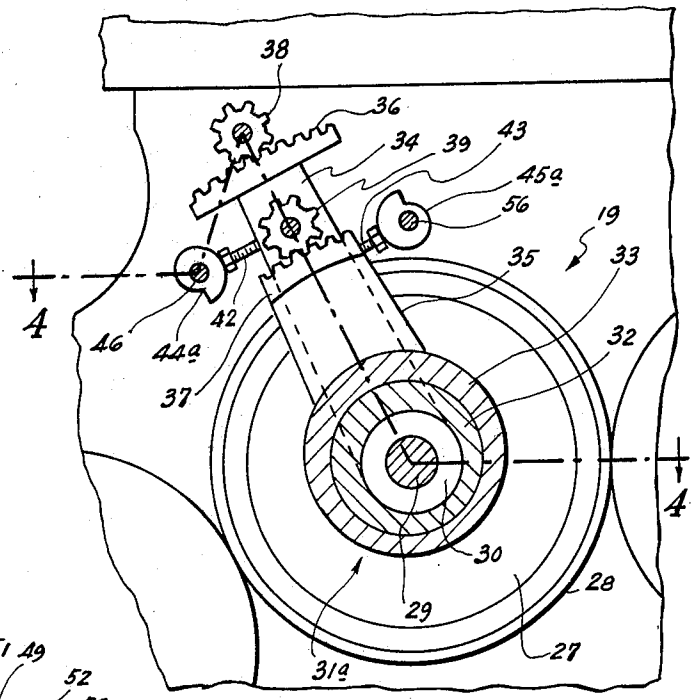
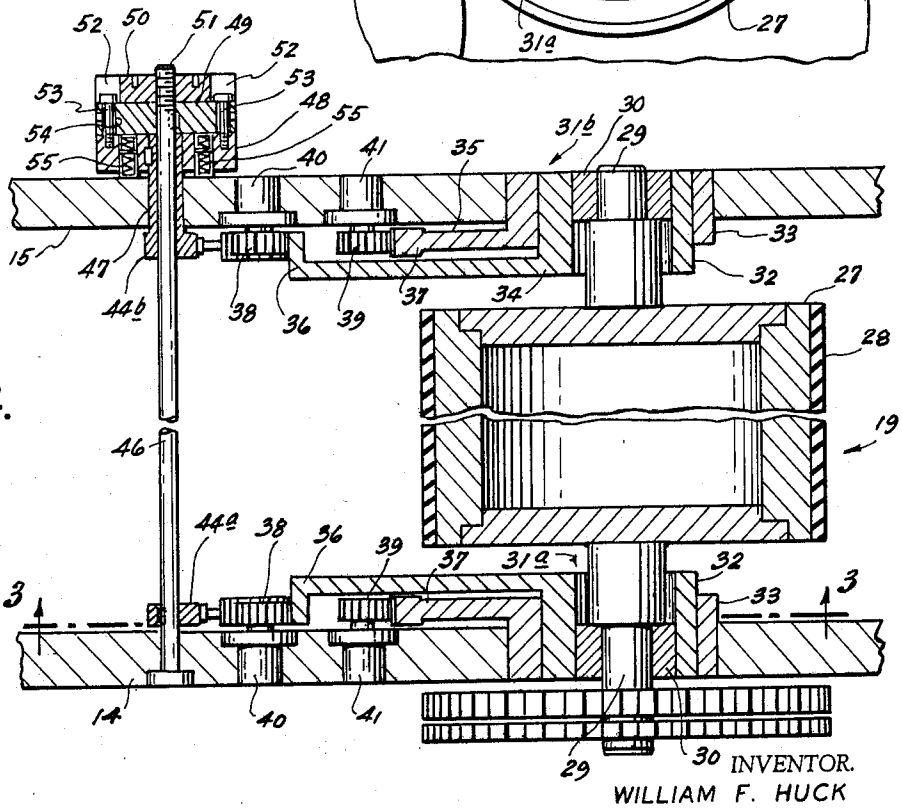


FIG. 4.



INVENTOR.
WILLIAM F. HUCK

BY

Albert C. Johnston

ATTORNEY

United States Patent Office 3,486,444
Patented Dec. 30, 1969

3,486,444

MULTI-COLOR ROTARY PRINTING PRESS

William F. Huck, 81 Greenway Terrace,
Forest Hillls, N.Y.

Filed May 5, 1966, Ser. No. 547,826
Int. Cl. B41f 9/02, 5/18
U.S. Cl. 101—152 7 Claims

ABSTRACT OF THE DISCLOSURE

A rotary press for security printing, comprising an impression cylinder upon which a web receives patterns of several different inks from an intaglio cylinder and from a transfer cylinder engaged by another printing cylinder, is provided with structures for effectively inking, wiping and polishing each intaglio cylinder and structures enabling precise control of the contact pressure and parallelism of the transfer cylinder relative to each of the cylinders running in contact with it.

This invention relates generally to rotary printing, and is particularly directed to improvements in high quality printing, with a rotary printing press, of multi-color designs composed of inks of any color or colors impressed side by side or one upon another on ink receptive material. The invention is especially useful, for example, for "security printing" of the kind employed in the production of postage or commerical stamps, paper money, bonds, stock certificates and the like.

In security printing, at least part of each multi-color design is applied to the ink receptive material by direct intaglio printing so as to obtain a characteristic engraved effect. Where each design involves a large number of different colors, or where only part of the design is to be applied by direct intaglio printing, the entire design cannot be impressed by a single intaglio printing cylinder. In such cases, parts of each design may be applied by direct intaglio printing and other parts may be applied by offset or indirect printing from one or more additional printing cylinders. When the ink receptive material is in the form of a continuous web so as to permit high-speed printing thereof in a rotary press, it has been the usual practice to effect the offset or indirect printing and the direct intaglio printing of the web by separate printing units having individual impression cylinders and acting successively on the web at locations spaced apart by a relatively large distance along the web, and the web is heated between the two printing units to dry the ink impressions applied by the offset or indirect printing unit. This known arrangement is disadvantageous in that the relatively great length of web between the printing units and the application of heat for drying the offset ink impressions tend to cause misregister between the offset ink impressions and the later applied direct intaglio ink impressions. Further, the heating of the web to dry the offset ink impressions also removes moisture from the web so that the web becomes brittle or less resilient and this detracts from the quality of the ink impressions obtained by the direct intaglio printing.

A multi-color rotary press for security printing has also been proposed in which the ink receptive material, particularly in the form of individual sheets, is fed through the nip between a single impression cylinder and an intaglio printing cylinder. As is usual, ink is applied to the surface of the intaglio printing cylinder and such surface is then wiped clean in advance of the nip to leave ink only in the intagliated parts or depressions of the surface. Further, there is provided a transfer roller rotating in contact with the wiped surface of the intaglio printing cylinder and with a number of letter-press printing cylinders having differently colored inks suitably applied thereto. Thus,

it is intended that the transfer roller receive ink impressions in correct register from the letterpress printing cylinders, and that such impressions be transferred from the transfer roller to the wiped surface of the intaglio printing cylinder in correct register with the intagliated parts of the latter, whereby each sheet fed through the nip between the impression and intaglio printing cylinders will simultaneously receive an intaglio ink impression from the intagliated parts or recesses of the surface of the intaglio printing cylinder and offset letterpress impressions from the other parts of such surface. Although the foregoing arrangement can achieve correct register of each direct intaglio impression with the simultaneously printed indirect or offset letter-press impression, the offset letter-press impressions are inherently of poor quality. This results from the fact that a good transfer of the letter-press impressions from the surface of the transfer roller, which is usually of rubber, to the wiped metal surface of the intaglio printing cylinder cannot be obtained by reason of the relatively low affinity of the wiped metal surface for the ink.

Accordingly, it is generally an object of this invention to avoid the above mentioned disadvantages of the previous proposals for the security printing of ink receptive material in a rotary printing press.

More specifically, it is an object of this invention to effect the rotary printing of ink receptive material, preferably in web form, so as to apply thereto multi-inked designs of high quality composed of inks of any desired color or colors and each constituted by a plurality of precisely registered impressions at least one of which is an intaglio impression made directly on the material.

Another object is to provide printing effects that have not been attainable before by the application to ink receptive material of a plurality of precisely registered impressions composed of different colored inks which are printed side by side or one upon another to obtain various combinations of mixed and pure colors.

Another object is to provide a rotary printing press capable of efficiently performing the foregoing printing operations.

A further object is to provide a rotary printing press of relatively simple construction for the multicolored, security printing of ink receptive material, preferably in web form.

In accordance with an aspect of this invention, the ink receptive material, preferably in web form, is wrapped against the surface of a rotatable impression cylinder and carried thereby through an extended arc of its rotation, and, at locations within such arc of rotation, the material receives direct intaglio and offset or indirect impressions respectively from an intaglio printing cylinder and from transfer cylinder which is in surface-to-surface contact with a second printing cylinder. Since the material to be printed is wrapped against the surface of a common impression cylinder during both the indirect or offset printing and the direct intaglio printing, precise register of the respective impressions may be maintained on the material. Further, the contact of the transfer cylinder with the paper or other material which is ink receptive makes it possible to form the surface of the transfer cylinder of an elastomeric blanket having an affinity for the ink transferred from the associated second printing cylinder, without sacrificing the quality of the impressions offset from the transfer cylinder onto the material to be printed.

For the best performance of the invention, the transfer cylinder contacts the impression cylinder at a location in advance of the location at which the intaglio printing cylinder bears against the impression cylinder, considered in the direction of rotation of the latter, so that ink is carried by the transfer cylinder from the associated sec-

ond printing cylinder to the material to be printed before ink is impressed directly on the material by the intaglio printing cylinder. Since the transfer of the offset impression to the material is inherently planographic, it can be effected under relatively low contact pressure between the transfer and impression cylinders and produces a flat ink pattern or impression on the material. Such flat ink impression is compressed into the paper or other ink receptive material by the non-printing or wiped surface areas of the intaglio printing cylinder while the latter is simultaneously applying the direct intaglio impression of relatively heavy ink which, as and when desired, can be either partly or entirely superimposed over the offset impression.

According to another advantageous feature of the invention, the second printing cylinder coacting with the transfer cylinder for indirect or offset printing on the material is also an intaglio printing cylinder, so that the impressions transferred or offset by the transfer cylinder are also of high quality.

A feature of a rotary printing press according to this invention is the provision of the impression cylinder with a compressible surface that becomes embossed by the pressure of the direct intaglio printing cylinder which is of the same diameter as the impression cylinder, whereby the embossments of the compressible surface are maintained in register with the intaglio printing elements or intagliated parts engaging the same. Further, the elastomeric blanket on the transfer cylinder makes it possible for the latter to apply the indirect or offset impressions to the material against the embossed surface of the impression cylinder without disturbing the embossments or being adversely affected thereby.

Another feature of the invention is the provision of each of the printing cylinders with means for applying different inks to selected areas of their printing surfaces, so that both the indirect or offset and the direct intaglio impressions can be, for example, multi-colored impressions, thereby permitting a wide range of colors and distinctive multi-ink effects to be embodied in the designs formed by such impressions.

A further feature is the provision of an improved arrangement to drive the wiping and polishing rollers provided for cleaning each intaglio printing cylinder at a speed which is in a variably controlled ratio to the speed at which the press is operated and, during shut-down of the press, to continue to rotate the wiping and polishing rollers and associated elements at a reduced speed to prevent caking or drying of ink thereon.

Still another feature is the provision of accurately controllable mechanisms for precisely regulating the contact pressures between the various cylinders and rollers of the press.

The above, and other objects, features and advantages of the invention, will be apparent in the following detailed description of an illustrative embodiment which is to be read in connection with the accompanying drawings, wherein:

FIG. 1 is a vertical sectional view of a rotary printing unit for a press in accordance with this invention and which is taken in a plane midway between the side frames of the press;

FIG. 2 is a side elevational view of the printing unit of FIG. 1 which is shown with a side frame partly broken away and with a drive system for wiping and polishing units of the press being schematically represented;

FIG. 3 is an enlarged, fragmentary sectional view taken along the line **3—3** on FIG. 4, and showing details of a mechanism for precisely regulating the contact pressure between cylinders of the printing unit; and

FIG. 4 is a sectional view taken along the line **4—4** on FIG. 3.

Referring to the drawings in detail, and initially to FIGS. 1 and 2 thereof, it will be apparent that there are shown only those parts of a rotary printing unit **10** essential to understanding of the present invention, and that such parts are shown in simplified form so as to avoid structural complexities that would obscure the true nature of the invention.

The rotary printing unit **10** is shown applied to the multi-color printing of paper or other ink receptive material in the form of a web W which may be unwound from a rollstand (not shown) of the type disclosed in U.S. Patent No. 3,061,225, to William F. Huck. The web W, during its movement to rotary printing unit **10** from the rollstand, preferably passes through a number of devices (not shown) which may include a web conditioner for stabilizing the length of the web and thereby reducing register variations, a side register control device of the type disclosed in U.S. Patent No. 3,009,664, to William F. Huck, and a lateral or side tensioning device of the type disclosed in U.S. Patent No. 3,147,898, also to William F. Huck.

The web W enters and leaves printing unit **10** over guide rollers **11** and **12** rotatably supported on an upper frame **13** carried by side frame members **14** and **15**. The printing unit **10** embodying this invention generally includes a single impression cylinder **16** (FIG. 1) rotatably mounted between side frame members **14** and **15** below guide rolls **11** and **12** to receive the web of paper or other ink receptive material to be printed and to carry the web wrapped against its surface through an extended arc A of the rotation of cylinder **16**.

The printing unit **10** further generally includes an intaglio printing cylinder **17** rotatably mounted between side frame members **14** and **15** so as to bear under pressure against the surface of impression cylinder **16** at a location L_1 in the arc A; a second printing cylinder **18** rotatably mounted between side frame members **14** and **15** and being spaced away from impression cylinder **16**; and a transfer cylinder **19** rotatably mounted between the side frame members so as to be in surface-to-surface contact with impression cylinder **16** at another location L_2 in the arc A and also in surface-to-surface contact with the second printing cylinder **18** at a location L_3. The intaglio printing cylinder **17** has associated therewith one or more inking units, for example, three of such units, as indicated at **20***a*, **20***b* and **20***c*, and a wiping and polishing unit **21**. The printing cylinder **18** is preferably also an intaglio printing cylinder, that is, one having the design or impression to be printed thereby in the form of etched recesses constituting intaglio elements or intagliated parts of the surface of cylinder **18**. Intaglio printing cylinder **18** also has associated therewith one or more inking units, as at **20***a*, **20***b* and **20***c*, and a wiping and polishing unit **21**.

Impression cylinder **16** has a cylindrical body **22** (FIG. 2) trunnions **23** (FIG. 2) projecting axially from its opposite ends and being journalled in bearings **24** mounted in eccentric housings **25** carried by side frame members **14** and **15**. Eccentric housings **25** are turnable by suitable mechanisms (not shown) so as to vary the distance between the axes of cylinders **16** and **17** and thereby adjust the pressure with which intaglio printing cylinder **17** bears against the surface of impression cylinder **16**. The surface of impression cylinder **16** is formed by a blanket **26** (FIG. 1) of fiber packing suitably clamped or secured on the periphery of body **22**. Thus, the surface of impression cylinder **16** is compressible and becomes embossed by the pressure of intaglio printing cylinder **17**. Impression cylinder **16** and intaglio printing cylinder **17** have the same diameter, as shown, whereby the embossments of the compressible surface of cylinder **16** are maintained in register with the intagliated parts or intaglio printing elements of cylinder **17** engaging the same when cylinders **16** and **17** are rotated at the same speed.

Transfer cylinder **19** includes a cylindrical body **27** having on its periphery a replaceable one-piece elastomeric blanket **28** of rubber or other material having an

affinity for ink, and trunnions **29** extending axially from the opposite ends of body **27** and being journalled in bearings **30** (FIGS. 3 and 4). In order to permit precise adjustment of the pressure of the surface-to-surface contact of transfer cylinder **19** with impression cylinder **16** and with printing cylinder **18**, bearings **30** are mounted in adjustable bearing housings **31***a* and **31***b* carried by side frame members **14** and **15**, respectively.

Each of bearing housings **31***a* and **31***b* is shown to include an inner eccentric **32** containing bearing **30** and being turnable within an outer eccentric **33** which is, in turn, turnable with respect to the side frame member. Arms **34** and **35** extend radially from the inner ends of eccentrics **32** and **33** and terminate in gear segments **36** and **37** which are respectively in meshing engagement with pinions **38** and **39**. Pinions **38** and **39** are driven by rotary hydraulic actuators **40** and **41** carried by the adjacent side frame member **14** or **15**, and which may be of the type commercially available from Ex-Cell-O Corporation, 945 Sater Street, Greenville, Ohio. The parallelism and pressure of the surface-to-surface contact of cylinder **19** with cylinders **16** and **18** are controlled by suitably limiting the angular displacements of eccentrics **32** and **33** in bearing housings **31***a* and **31***b*.

As shown, angular displacements of the eccentrics may be limited by engagement of stops **42** and **43** threadably secured in arms **34** and **35**, respectively, with adjustable cams **44***a* and **45***a*, in the case of bearing housing **31***a*, and with adjustable cams **44***b* and **45***b*, in the case of bearing housing **31***b*. As particularly shown on FIG. 4, cam **44***a* is keyed or otherwise secured on a shaft **46** adjacent the end of the latter journalled in side frame member **14**, and cam **44***b* is integral with a hollow stub shaft **47** which is rotatable in side frame member **15** and through which shaft **46** extends so as to be rotatable with respect thereto. An inner flange **48** is keyed or otherwise secured on the end portion of hollow stub shaft **47** projecting beyond side frame member **15**, and an outer flange **49** is keyed or otherwise secured on an end portion of shaft **46** projecting beyond hollow shaft **47**. A locking cap **50** is threadably engaged with a threaded end **51** of shaft **46** and has cutouts or holes **52** providing access to the heads of bolts **53** extending through arcuate slots **54** in flange **49** and by which the latter is normally secured with respect to flange **48**. Flange **48** has axial bores containing spring biased buttons **55** urged into contact with the adjacent surfaces of side frame member **15** and flange **49**, thereby to provide a frictional drag resisting the rotation of flange **48** relative to side frame member **15** and of flange **49** relative to flange **48**.

When it is desired to simultaneously adjust both cams **44***a* and **44***b*, thereby to limit the angular displacement of eccentrics **32** in housings **31***a* and **31***b* to the same extent, locking cap **50** is loosened, and flanges **48** and **49** held securely to each other by bolts **53** are turned to the extent desired. However, if the cylinders in question are not parallel, bolts **53** are loosened following loosening of cap **50** and flanges **48** and **49** are turned relative to each other to effect corresponding angular displacement of cams **44***a* and **44***b*. After such adjustment has been effected, bolts **53** are again tightened to secure flanges **48** and **49** relative to each other, and then locking cap **50** is tightened to secure both flanges against turning relative to side frame member **15**. If desired, the amount of displacement of the axis of cylinder **19** resulting from turning of cams **44***a* and **44***b* may be indicated by providing flange **48** with a calibrated scale on its periphery cooperating with a suitable index on the adjacent side frame member **15**.

The cams **45***a* and **54***b* are mounted with respect to a shaft **56** in the same way as has been described above with respect to cams **44***a* and **44***b* so as to be adjustable either simultaneously or with respect to each other for adjustably limiting the displacements of eccentrics **33** of housings **31***a* and **31***b* by the associated actuators **41**.

Impression cylinder **16** is set or adjusted by means of its eccentric bearing housings **25** so as to provide a relatively heavy pressure at the location L_1 of its bearing contact with the surface of the intaglio printing cylinder **17** which is rotatable about a fixed axis. On the other hand, transfer cylinder **19** is set by adjustment of its bearing housings **31***a* and **31***b*, as described above, to provide relatively light contact pressure at the location L_2 of its surface-to-surface contact with impression cylinder **16**, and a relatively heaver pressure at the location L_3 of its surface-to-surface contact with intaglio printing cylinder **18** which is also rotatable about a fixed axis.

Inking units **20***a*, **20***b* and **20***c* associated with intaglio printing cylinder **17** are operative to successively apply inks of different colors to selected areas of the intagliated parts or intaglio printing elements at the surface of cylinder **17**, and the wiping and polishing unit **21** associated with the latter cylinder is operative to wipe clean the surface of cylinder **17** in advance of the location L_1 and to leave the variously colored inks only in the intaglio printing elements of the cylinder. Thus, the ink remaining in the intaglio printing elements at the surface of cylinder **17** is impressed directly onto web W at location L_1. The inking units **20***a*, **20***b* and **20***c* and the wiping and polishing unit **21** associated with intaglio printing cylinder **18** similary operate to provide variously colored inks in selected areas of the intaglio printing elements in the surface of cylinder **18** in advance of location L_3, and such ink applied to the intaglio printing elements of cylinder **18** is impressed onto the surface of transfer cylinder **19** at location L_3 and is carried by transfer cylinder **19** to web W at location L_2. Since web W is wrapped against the surface of impression cylinder **16** within arc A that includes both locations L_1 and L_2, precise register of the plurality of distinct inked impressions made at such locations L_1 and L_2 can be maintained.

Preferably, as shown on FIG. 1, the location L_2 at which transfer cylinder **19** contacts impression cylinder **16** is in advance of the location L_1 of bearing of printing cylinder **17** against the impression cylinder, considered in the direction of the rotation of cylinder **16**, as indicated by the arrow R_1. Thus, ink is carried from the intaglio printing elements of cylinder **18** to the web by transfer cylinder **19** before ink is impressed directly on the web by intaglio printing cylinder **17**. Since the transfer of the offset impression to the web at location L_2 is inherently planographic, it can be effected under relatively low contact pressure between transfer cylinder **19** and impression cylinder **16** and produces a flat ink pattern or impression on the web. Such flat ink impression is compressed into the paper or other ink receptive material of web W by the non-printing or wiped surface areas of intaglio printing cylinder **17** at location L_1 while cylinder **17** is simultaneoulsy appliying the direct intaglio impression of relatively heavy ink which may be, at least in part, superimposed over the registered offset impression

The provision of transfer cylinder **19** with the blanket **28** of rubber or other elastomeric material having an affinity for the ink in the intaglio printing elements of cylinder **18** ensures the high quality transfer of ink from such printing elements to the surface of transfer cylinder **19**, and further ensures that the indirect or offset impressions will be applied to web W against the embossed surface of impression cylinder **16** without disturbing the embossments of such surface or being adversely affected thereby. The fact that the blanket **28** of transfer cylinder **19** has an affinity for the ink picked up from the intaglio printing elements of cylinder **18** does not disadvantageously affect the transfer of the impressions from cylinder **19** to the web W against cylinder **16** as the paper or other ink receptive material of the web has an even greater affinity for the ink.

As shown on FIG. 1, cylinders **18** and **19** preferably also have the same diameter as cylinders **16** and **17** so that embossments of the surface of transfer cylinder **19**

resulting from the pressure of its contact with intaglio printing cylinder **18** will be maintained in register with the intaglio printing elements of cylinder **18** producing such embossments, and in register with the intaglio impressions applied directly to the web at location L_1.

Cylinders **16**, **17**, **18** and **19** are all rotated at the same speed, for example, from the main drive shaft **57** (FIG. 2) of the printing press. As shown, the drive for the enumerated cylinders may include a bevel gear **58** on shaft **57** meshing with a bevel gear **59** on a take-off shaft **60** carrying a worm **61** meshing with a worm gear **62** secured to an extension of the trunnion **23** at one end of impression cylinder **16**. The resulting rotation of impression cylinder **16** is transmitted to cylinders **17** and **19** by way of a gear **63** secured to cylinder **16** and meshing with gears **64** and **65** secured to cylinders **17** and **19**, respectively. Printing cylinder **18** is rotated by way of a gear **66** secured relative thereto and meshing with gear **65**. Preferably, gears **63**, **64**, **65** and **66** are all heavy-duty blacklash take-up gears, for example, as disclosed in U.S. Patent No. 2,911,847, to William F. Huck, thereby to ensure precise circumferential registration of all of cylinders **16**, **17**, **18** and **19** with respect to each other.

As shown on FIG. 1, each of the inking units **20***a*, **20***b* and **20***c* includes an inking-in cylinder **67** having a cylindrical body **68** to the periphery of which one or more metal-backed rubber printing plates **69** is suitably secured. Each rubber printing plate **69** has raised areas or lines corresponding to the pattern of the respective colored ink to be applied to the surface of the associated intaglio printing cylinder **17** or **18**. Each inking unit further includes an ink fountain **70** which maintains a supply of the respective ink above the nip between an ink applicator roller **71** and a mill roller **72**. Each inking-in cylinder **67** is preferably mounted in eccentric bearing housings (not shown) similar to the housings **31***a* and **31***b* described above in connection with transfer cylinder **19** so as to permit independent adjustment of the contact pressure of cylinder **67** with cylinder **18** and with the associated ink applicator roller **71** which is mounted to rotate about a fixed axis. The mill roller **72** is preferably mounted in eccentric bearing housings (not shown) to permit adjustment of the pressure of contact at the nip between rollers **71** and **72**, thereby to control the thickness of the layer of ink carried by roller **71** for application to the rubber printing plate **69**.

Each inking-in cylinder **67** is driven at the same peripheral speed as the associated intaglio printing cylinder **17** or **18**, for example, through a gear **73** secured to cylinder **67** and meshing with the gear **64** or **66** secured to the respective intaglio printing cylinder. The ink applicator roller **71** of each printing unit is rotated at the same peripheral speed as the associated cylinder **67**, for example, by a gear **74** (FIG. 2) secured to roller **71** and meshing with gear **73**. Each mill roller **72** is preferably driven at a peripheral speed less than that of the associated applicator roller **71**, for example, through meshing pinions **75** and **76** respectively engaging gear **74** and a gear **77** secured to roller **72** and having a larger pitch diameter than gear **74**. The relatively slower peripheral speed of each mill roller **72** causes the latter to grind the ink onto the surface of the associated applicator roller **71**.

Each of the wiping and polishing units **21** includes a wiping roller **78** and a polishing roller **79** that engage the surface of the associated intaglio printing cylinder **17** or **18** in succession, considered in the direction of rotation of the printing cylinder, following the application of ink to selected areas of the surface of the printing cylinder by the associated inking units **20***a*, **20***b* and **20***c*. The rollers **78** and **79** were operative to clean excess ink from the surface of printing cylinder **17** or **18** and to leave ink only in the recesses or intaglio printing elements thereof.

Each of rollers **78** and **79** preferably has a soft inner layer **80** of resilient material, for example, of sponge rubber, and a hard, smooth outer shell, for example, of polytetrafluoroethylene, which firmly contacts the peripheral surface of the respective printing cylinder. In order to permit quick replacement of the outer shell **81** when the latter becomes worn, each of rollers **78** and **79** may have its outer shell arranged thereon in the manner disclosed in U.S. Patent No. 3,205,814, to William F. Huck.

The rollers **78** and **79** are preferably oscillated axially by suitable known mechanisms (not shown) to ensure even wiping and polishing of the associated printing cylinder. Further, during operation of printing unit **10**, rollers **78** and **79** of each unit **21** are rotationally driven, as hereinafter described in detail, at a peripheral speed greater than the peripheral speed of the associated printing cylinder **17** or **18** and in the same rotational direction as the latter so that the peripheral movement of each of rollers **78** and **79**, at the location of the contact thereof with the printing cylinder **17** or **18**, is opposed to the direction of the peripheral movement of the printing cylinder.

The heavy ink deposits removed by wiping roller **78** from the surface of the associated intaglio printing cylinder are scraped from roller **78** by a scraping knife **82** and drained from the knife into a waste box **83**. After moving past scraping blade **82**, the surface of wiping roller **78** is contacted by a solvent saturated, felt-covered roller **84** that dilutes the remaining ink film on the surface of roller **78** so that such film can be removed from the roller by a plastic squeeze blade **85**. Solvent is applied to felt-covered roller **84** by a cloth-covered roller **86** which is rotatable in a solvent containing fountain **87** and in rolling contact with the surface of roller **84**.

Polishing roller **79** wipes off the scum left on the surface of the intaglio printing cylinder **17** or **18** by wiping roller **78** and leaves just the correct amount of ink for printing in the intagliated parts or intaglio printing elements of the printing cylinder. The scum removed from the printing cylinder by roller **79** is diluted on the surface of the latter by a solvent saturated felt-covered roller **88** which receives solvent from a cloth-covered roller **89** running in a solvent fountain **90**. The diluted scum is removed from the surface of roller **79** by a plastic squeeze blade **91**, and the surface of roller **79** is dried prior to contacting the surface of the printing cylinder by an air blast from a nozzle **92**. Dirty solvent that has been used for cleaning rollers **78** and **79** is drained into collecting pans **93** and **94** disposed therebelow, and such solvent may be cleaned by a commercially available solvent recovery system and recirculated to the fountains **87** and **90**.

The rollers **78** and **79** and the other elements associated therewith in each unit **21**, as described above, may be mounted in a sub-frame **95** which is pivotally supported, as at **96**, between side frame members **14** and **15**. Each sub-frame **95** is rockable about its pivot **96** between an operative position, as shown on FIG. 1, where the sub-frame engages a stop **97** and rollers **78** and **79** are disposed in contact with the associated printing cylinder **17** or **18**, and an inoperative position, where the sub-frame engages a stop **98** and rollers **78** and **79** are spaced away from the surface of the printing cylinder. An actuator **99**, which may be electrically controlled, is suitably connected to sub-frame **95** to hold the latter in its operative position, as shown, only during operation of printing unit **10**.

Preferably, rollers **78** and **79** of each wiping and polishing unit **21** are mounted in eccentric housings similar to the housings **31***a* and **31***b* described above with reference to transfer roller **19** so as to permit adjustment of the contact pressure of rollers **78** and **79** with the printing cylinder **17** or **18** and also with the solvent-saturated rollers **84** and **88**, respectively.

In accordance with the present invention, rollers **78** and **79** are driven at speeds that vary proportionally with the speed of the press during operation of the latter and, when the press is stopped and actuator **99** causes disengagement of rollers **78** and **79** from the associated printing cylinder **17** or **18**, rollers **78** and **79** are continuously rotated, but at a relatively slower speed, to ensure continued cleaning of rollers **78** and **79** and thereby prevent caking of the waste ink in each wiping and polishing unit **21**.

As shown on FIG. 2, the drive for each unit **21** includes a hydraulically operated motor **100** having a rotated shaft **101** carrying a worm **102** that meshes with a worm gear **103** secured on a stub shaft **104** which is journalled in sub-frame **95**. A gear **105** is also secured on shaft **104** and meshes with gears **106** and **107** respectively secured to the shafts of rollers **78** and **79** of the associated unit **21**. Shaft **104** further carries a sprocket (not shown) that engages a chain **108** running around sprockets **109** and **110** (FIG. 2) secured on the shafts of rollers **111** and **112** (FIG. 1). Rollers **111** and **112** have axially grooved or serrated surfaces and are mounted in sub-frame **95** in rolling contact with rollers **84** and **88**, respectively. Thus, when motor **100** is operated by the pumping of hydraulic fluid therethrough, stub shaft **104** is rotated to effect rotation of rollers **78** and **79** through gears **105**, **106** and **107** and, simultaneously, rollers **111** and **112** are rotated through chain **108** and sprockets **109** and **110** to effect rotation of rollers **84** and **88** of rollers **86** and **89** through contact of the latter with rollers **84** and **88**.

The system for pumping hydraulic fluid through motors **100** of wiping and polishing units **21** is shown to include a variable displacement hydraulic pump **113** (FIG. 2) driven from main drive shaft **57**, as by meshing bevel gears **114** and **115**. The pump **113** is of a type which is adjustable, as by a hand wheel indicated schematically at **116**, to vary the output of the pump in relation to the speed at which the pump is driven from drive shaft **57**. A pump **117** driven continuously by an electric motor **118** is interposed in a conduit **119** extending from a hydraulic fluid reservoir **120** to the inlet of variable capacity pump **113** and maintains a pressure head on variable pump **113**. A conduit **121** extends from the outlet of pump **113** to a solenoid operated valve **122** which is energized during operation of the press to establish communication between conduit **121** and a feed conduit **123** extending from valve **122** to branches **123***a* and **123***b* leading to the inlets of motors **100**. The outlets of motors **100** are connected through branched lines **124***a* and **124***b* to a return conduit **124** connected to valve **122** and communicating through the latter, during operation of the press, with a conduit **125** connected to conduit **119** intermediate pump **117** and the inlet of pump **113**. Another pump **126** driven continuously by an electric motor **127** is interposed in a conduit **128** connected across conduits **123** and **124** and further connected by a line **129** to conduit **119** so that pump **126** also operates under a pressure head provided by pump **117**. In order to prevent the overloading of motors **100** by excessive hydraulic pressure, a pressure relief valve **130** and gauge **131** are interposed in a conduit **132** connected across conduits **123** and **124** at a location between conduit **128** and solenoid valve **122**. Further, a check valve **133** is interposed in conduit **123** between valve **122** and conduit **132** to permit flow through the related section of conduit **123** only in the direction away from solenoid valve **122**.

When the press is operating and actuators **99** maintain sub-frames **95** in their operative positions to contact rollers **78** and **79** with printing cylinders **17** and **18**, solenoid valve **122** is energized and hydraulic fluid is carried from variable displacement pump **113** through conduit **121**, energized valve **122**, conduit **123** and branches **123***a* and **123***b* to motors **100** and returns from the motors by way of branches **124***a*, conduit **124**, energized valve **122** and conduits **125** and **119** back to pump **113** so as to effect rotation of rollers **78** and **79** at a peripheral speed that is greater than that of the printing cylinders **17** and **18** by an adjustable ratio that is predetermined by the setting of variable displacement pump **113**. The pressure head established by pump **117** compensates for any leakage in motors **100** and in pumps **113** and **126**, which leakage may be drained back to the reservoir **120** through suitable lines (not shown). It will be apparent that any change in the press speed will result in a corresponding change in the rate at which hydraulic fluid is delivered by pump **113** and therefore will result in a corresponding change in the rotational speed at which rollers **78** and **79** are driven.

When the press is stopped, actuators **99** cause movement of sub-frames **95** to their inoperative positions so that rollers **78** and **79** are spaced away from printing cylinders **17** and **18**. Stopping of the press is further accompanied by deenergizing of solenoid valve **122**. The deenergized valve **122** communicates conduit **121** with conduit **125** and thereby isolates variable displacement pump **113** from the remainder of the system for driving motors **100**. Upon such isolation of pump **113**, the motor-driven pump **126** supplies hydraulic fluid under pressure to motors **100** to effect rotation of rollers **78** and **79**, and also of rollers **84**, **86**, **88** and **89**, at relatively slower constant speeds thereby to prevent caking of the waste ink on the rollers of the wiping and polishing units **21** during shut-down of the press. During driving of motors **100** by pump **126**, check valve **133** ensures that any excess pressure will be relieved through valve **130**.

Inking units **20***a*, **20***b* and **20***c* coacting with printing cylinder **17** and with printing cylinder **18**, respectively, can apply different colored inks side by side or one upon another on the surface of the respective printing cylinder, so that each direct intaglio impression and each indirect or offset impression can be formed of three different pure colors and of various mixed colors produced by the overlapping or close proximity of the pure colors. Further, the direct intaglio impression and the indirect or offset impression can be applied to the ink receptive material in side by side or overlapped relation to obtain additional mixing of colors. Thus, each design or pattern applied to web W by printing unit **10** can be formed of six pure colors and various mixed colors resulting from the overlapping of the pure colors on the printing cylinders **17** and **18** and/or on the ink receptive material of the web.

If it is desired to apply designs or impressions to the web in more than the six pure colors and various mixtures thereof possible with the illustrated printing unit **10**, the printed web emerging from unit **10** can be dried and then passed through another similar multi-color rotary printing unit which will apply impressions in other colors registered with respect to the impressions applied in unit **10**. Further, it will be apparent that the application of precisely registered indirect or offset impressions and direct intaglio impressions successively to the ink receptive material wrapped against the surface of a single impression cylinder, may be employed in the printing of individual sheets of paper or other ink receptive material as well as in the printing of a continuous web thereof, as in the illustrated embodiment.

What is claimed is:

1. A rotary printing press comprising a rotatable intaglio printing cylinder and inking means for depositing ink on selected areas of the intagliated surface of said cylinder, wiping and polishing roller means engageable with said intagliated surface after said inking means and drive means operated in synchronism with said cylinder to rotate said wiping and polishing roller means at a peripheral speed which is in an adjustably predetermined ratio to the peripheral speed of said cylinder and in the direction opposed to the movement of said intagliated surface at the location of its engagement by said wiping

and polishing roller means, whereby said roller means remove the applied ink from the parts of said intagliated surface other than the intaglio printing elements in said selected areas thereof, said wiping and polishing roller means including at least one roller having a relatively hard outer shell of a material having a low coefficient of friction with respect to said surface of the intaglio printing cylinder, and a soft resilient inner layer underlying said outer shell to allow the latter to deflect for conforming to said surface of the intaglio printing cylinder.

2. A rotary printing press according to claim 1, said outer shell of the roller being of polytetrafluoroethylene.

3. A rotary printing press comprising a rotatable intaglio printing cylinder and inking means for depositing ink on selected areas of the intagliated surface of said cylinder, wiping and polishing roller means engageable with said intagliated surface after said inking means and drive means operated in synchronism with said cylinder to rotate said wiping and polishing roller means at a peripheral speed which is in an adjustably predetermined ratio to the peripheral speed of said cylinder and in the direction opposed to the movement of said intagliated surface at the location of its engagement by said wiping and polishing roller means, whereby said roller means remove the applied ink from the parts of said intagliated surface other than the intaglio printing elements in said selected areas thereof, said drive means including a fluid pressure operated motor, means connecting said motor with said roller means to rotate the latter at a speed corresponding to the volumetric rate at which fluid under pressure is supplied to said motor, a variable displacement pump for supplying fluid under pressure to said motor at a volumetric speed adjustably corresponding to said speed at which the pump is driven, and means for driving said pump at a speed synchronized to the speed of rotation of said intaglio printing cylinder.

4. A rotary printing press according to claim 3, further having cleaning means operated by said motor of the drive means to clean said wiping and polishing roller means, and auxiliary pump means supplying fluid under pressure to said motor at a constant volumetric rate for continuing the rotation of said wiping and polishing roller means and the operation of said cleaning means at reduced speeds when the press is stopped, thereby to prevent caking of ink on said roller means.

5. A rotary printing press comprising a rotatable impression cylinder to receive ink receptive material wrapped against its surface in an extended arc, a rotatable intaglio printing cylinder bearing under pressure against the surface of said impression cylinder at one location in said arc means for applying to the intaglio elements of said printing cylinder ink to be impressed directly onto said material at said one location, a second rotatable printing cylinder spaced away from said impression cylinder, a transfer cylinder rotating in surface to surface contact with said impression cylinder at another location in said arc and also in surface to surface contact with said second printing cylinder, and means for applying to the printing elements of said second printing cylinder ink to be impressed onto the surface of said transfer cylinder and carried by the transfer cylinder to said material at said other location, whereby a plurality of distinct ink impressions may be made in precise register on said material, said press further comprising eccentric bearing housing means supporting said impression cylinder and being adjustable to vary the pressure under which said intaglio printing cylinder bears against the impression cylinder, and respective eccentric bearing housing means supporting trunnions on opposite ends of said transfer cylinder and being adjustable to independently vary the pressures of the contact of said transfer cylinder with said second printing cylinder and with said impression cylinder, respectively, each said eccentric bearing housing means including independently turnable inner and outer eccentrics and motor operated means for turning each of said eccentrics, a first pair of cams adjustably limiting turning of said inner eccentrics for the opposite ends of the transfer cylinder, a second pair of cams adjustably limiting turning of said outer eccentrics for the opposite ends of the transfer cylinder, and means to adjust the cams of each of said pairs simultaneously and with respect to each other, thereby to respectively vary the contact pressures of said transfer cylinder with said impression and second printing cylinders and the parallelism of said transfer cylinder with said impression and second printing cylinders.

6. In a rotary printing press comprising a first rotary cylinder arranged to rotate in surface to surface contact with a plurality of other rotary cylinders simultaneously, said first cylinder having on its opposite ends axially disposed trunnions journalled in respective bearings supported in opposite frame members of the press, means for positioning said first cylinder in contact and parallelism with each of said other cylinders at a selected pressure thereagainst, including for each of said bearings an eccentric housing holding the related bearing in the related frame member and comprising a plurality of eccentric sleeves fitted and turnable one within another and in said frame member, said bearing being in the innermost of said sleeves, means connected with each of said eccentric sleeves for turning such sleeve relative to each other of said sleeves and relative to said frame member so as to displace the axis of the trunnion in said bearing toward or away from the axis of one of said other cylinders, adjustably positioned stop means for limiting the turning movement of each of said sleeves so that by appropriate settings of the several stop means said first cylinder will be positioned to have a desired extent of surface contact with each of said other cylinders, means interconnecting the respective stop means for the innermost sleeves of the two eccentric housings for simultaneously and equally adjusting their positions, and separate means interconnecting the respective stop means for corresponding outer sleeves of said housings for simultaneously and equally adjusting their positions.

7. A rotary press according to claim 6, said means for turning each sleeve comprising an arm extending radially from the sleeve and a motor operated gear for turning said arm, said stop means for each sleeve comprising a turnable cam abutted by a stop member on said arm of such sleeve, and each of said interconnecting means comprising adjustably interconnected shafts respectively carrying and for turning the said cams related to correspondingly located sleeves of the two housings.

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ROBERT E. PULFREY, Primary Examiner

J. F. FISHER, Assistant Examiner

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