Aug. 21, 1962 R. H. DOWNIE 3,049,995

PRINTING EQUIPMENT

Filed Dec. 5, 1957 2 Sheets-Sheet 1

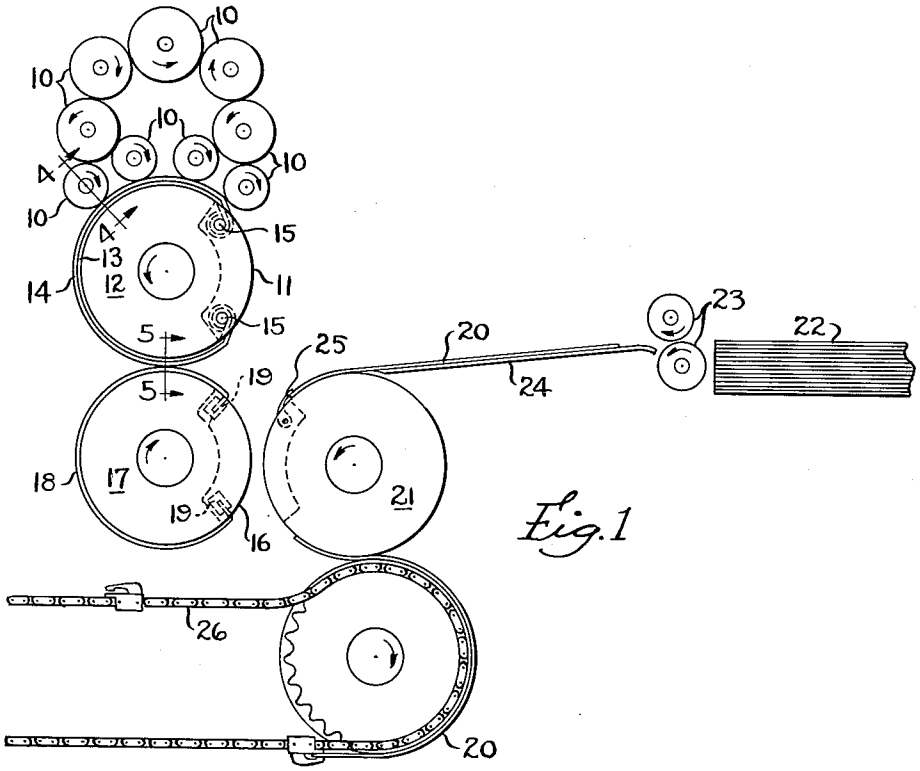


Fig. 1

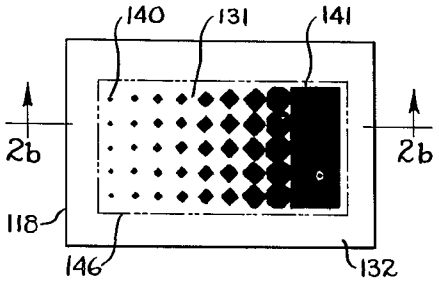


Fig. 2a

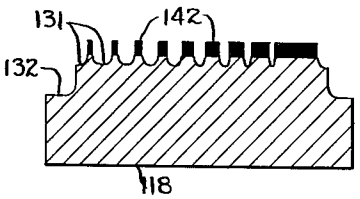


Fig. 2b

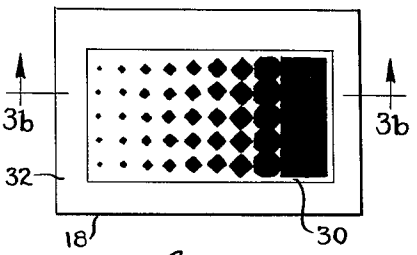


Fig. 3a

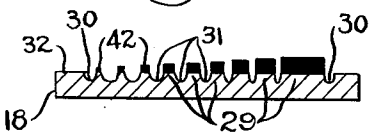


Fig. 3b

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PRINTING EQUIPMENT

Filed Dec. 5, 1957 2 Sheets-Sheet 2

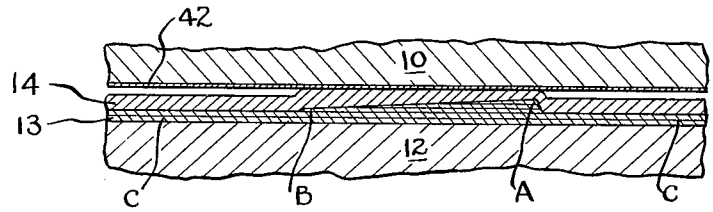


Fig. 4

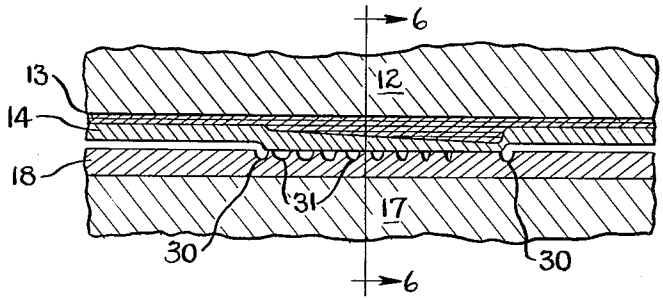


Fig. 5

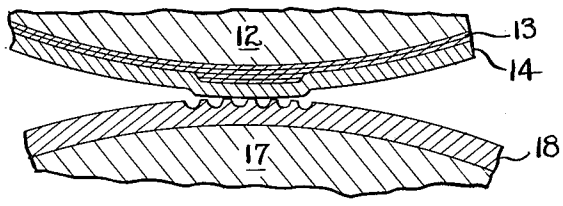


Fig. 6

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PRINTING EQUIPMENT

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Filed Dec. 5, 1957, Ser. No. 700,877
5 Claims. (Cl. 101—216)

This invention relates to relief or typographic printing in which raised surfaces of the plates or other members making up the printing form are inked and thereafter placed in contact with print receiving material to transfer an imprint to the material in the form of an inked image.

When relief printing is practiced in the customary manner, the printing form is made up of what may be called image portions and non-image portions, i.e., printing areas and non-printing areas, respectively. The image portions comprise all those areas which are "type high," that is, which are in the image plane relative to the support member carrying the form, whether the support member be a flat bed as in flat bed presses or a cylinder as in rotary presses. The non-image portions of such a form comprise all those areas which are below type-high, and these may be the areas between letters, the areas between dots of a half-tone plate, or merely areas between plates or other members comprising the over-all form.

When such a form is inked in the customary manner, ink is applied by one or more rollers which pass over the entire form and contact only the areas thereof which are in the image plane, placing a deposit of ink on all such areas, all non-image areas having been cut to a depth very substantially below the image plane. Then when print receiving material is pressed against the inked form, the material receives an imprint from all the image or type-high areas, which are only those areas intended to reproduce an image on the material.

In most present day presses the member carrying the form, or the support carrying the print or image receiving material, or both, are cylindrical in shape so that there is merely a line or narrow zone of contact between the form and the print receiving material. If, under such circumstances, the form is such that at times there are no image areas in the zone of contact, or if there are image areas in one part of the form and large non-image areas in other parts simultaneously in the zone, precise control of the print receiving material may be lost with resulting loss of register, smudging of the edges of the printing, embossing of the material, and other harmful effects.

According to the present invention, a process of relief printing is provided which overcomes many of these difficulties and in addition, provides particular advantages not found in present day relief printing.

In this process a relief printing plate is provided having image portions, primary non-image portions corresponding to the dead metal areas of an unrouted electrotype, and secondary non-image portions separating the image and primary non-image areas. The primary non-image portions lie in substantially the same plane as the image portions while the secondary non-image portions lie below the image and primary non-image portions. In carrying out the process, ink is applied only to the image portions of the plate while application of ink to the primary non-image portions of the plate is avoided. The print receiving material is pressed by its supporting member into contact with both the image and uninked primary non-image portions of the plate simultaneously, whereby ink is transferred to the print receiving material only from the image portions of the plate. The print receiving material is at all times during the transfer process under positive control throughout the entire printing zone, due to being supported with image plane travel line as it is carried between

the supporting member and the combined image and the primary non-image plate portions.

In present relief printing operations, the plates are of relatively thick metal and of relatively small area. Except in the image producing portions, the entire surface of the plate is deeply etched away so that the inking roll will not transfer ink to the non-printing portions of the plate. The plates, which after formation of the image portions thereon are curved to conform to the curvature of the supporting cylinder upon which they are to be mounted, must be fairly limited in area in order to avoid excessive distortion of the image portion when the plates are curved. The necessities of using relatively thick plates of small area and of etching deeply result in considerable expense and manufacturing effort. This invention provides marked improvements in these additional respects, since it permits the use of unusually thin plates of large area, and requires but a shallow etch of only a relatively small proportion of the non-printing areas of the plate. The relative thinness of the plates is based upon the absence of need for deep etching, which in turn depends upon the fact that the inking roll or cylinder applies ink only to the image reproducing portions of the plate, and the thinness of the plates reduces the distortion which results from curvature thereof and thus permits plates of remarkably greater area to be used.

These and other advantages and objects of this invention will be more clear from the following description of the accompanying drawings, in which:

FIGURE 1 is a schematic drawing of a printing machine incorporating the invention,

FIGURE 2*a* is a plan view of a conventional printing plate, prior to its curvature,

FIGURE 2*b* is a cross-sectional view taken along the line 2*b*—2*b* of FIGURE 2*a*,

FIGURE 3*a* is a plan view of a printing plate involved in the invention, prior to its curvature,

FIGURE 3*b* is a cross-sectional view taken along the line 3*b*—3*b* of FIGURE 3*a*,

FIGURE 4 is a cross-sectional view, partially cut away, taken along the line 4—4 of FIGURE 1,

FIGURE 5 is a cross-sectional view, partially cut away, taken along the line 5—5 of FIGURE 1, and

FIGURE 6 is a cross-sectional view, partially cut away, taken along the line 6—6 of FIGURE 5.

FIGURE 1 illustrates the preferred form of relief printing machine, suitable for imprinting of a single color upon a print receiving material, adapted to incorporate the present invention. For the imprinting of additional colors, duplicates of pertinent parts of the equipment are conventionally grouped together with the single color equipment illustrated. The machine includes a series of conventional inking rollers **10**, particularly adapted to receive the ink from an ink fountain (not shown), distribute the ink evenly across the length of the rolls and apply it to the inking cylinder **11**. The inking cylinder of this invention comprises a conventional base cylinder **12** with bearers about which there is firmly wrapped a make-ready sheet **13** and inking means in the form of an inking member or blanket **14**. The ends of the make-ready sheet and inking blanket are firmly gripped by conventional elements **15** affixed to the base cylinder **12**. The ink from rolls **10** is transferred to selected areas on the exterior surface of blanket **14**, as will be described in detail later herein.

Blanket **14** transfers the ink to a printing cylinder **16**, which includes a base cylinder **17** and a printing plate **18** which is fastened to cylinder **17** by conventional gripping elements **19**. The printing plate **18** bears on its surface raised images of the work to be reproduced upon a print-receiving material. Inking and printing cylinders **12** and **17** preferably are of the same diameter, so that

they run in a one-to-one relationship and are positioned in precise relationship to each other by bearers.

The image is reproduced by passing a sheet such as indicated at **20** between the nip of cylinder **16** and impression or back-up cylinder **21**. The sheet material may be conventionally fed in timed relationship from a stack **22** thereof by such as feeding rolls **23**, which carry the sheets individually from the stack onto a conveyor support **24**, from which they are grasped by conventional gripping fingers **25** mounted on impression cylinder **21**. The sheets are then carried through the nip of counter-rotating cylinders **16** and **21**, at which point they receive the ink impression from the image on plate **18**. As the sheets pass through this nip they are conventionally fed to a conveyor such as indicated at **26**, by which they may be carried through a drying zone and/or for stacking or further disposition. As previously suggested, additional banks of printing equipment may be supplied in duplication of that just described, through which the sheets may be consecutively passed to receive further ink impressions.

FIGURE 2*a* shows a conventional printing plate **118** in plan view, intended for printing only a greyscale, with the printing intensity varying from highlight dots **140** to solid color area **141**. Within the area approximately bounded by phantom line **146** and the remote edges of solid portion **141** the plate is etched away as at **131** except in the area of the printing dots and solids. In the area **132** outside line **146**, the plate is deeply routed away so that there will be no transfer of ink to those portions of the plate from which no printed impression will be made upon the print-receiving material. This result is shown also in FIGURE 2*b*, which illustrates the plate with conventional uniform applications **142** of ink to the printing portions of the plate. These conventional plates ordinarily are no more than 15 inches by 18 inches in plane dimensions, and necessarily are about 0.150" thick, with routing in the area **132** being carried out to a depth of about 0.045".

FIGURE 3*a* illustrates a printing plate of this invention, in reduced size, again with a single greyscale to be printed. Referring also to FIGURE 3*b* it will be seen that there is no routing out of material in the area **32** corresponding to **132** of FIGURE 2*a*, but rather this area is at the same elevation as the area of the printing portions **29**. It will be seen that printing portions **29** are separated from the primary non-image portion **32** merely by etched out portions or troughs **30**, similar to and performed in the same operation as the etching away between printed portions as at **31**. Since there is no deep routing away of non-printing portions, the plate of this invention can be made of very thin material, of the order of 0.016", and may be made with large plane dimensions, up to the total length and operating circumference of the printing cylinder. The absence of routing eliminates a costly and time-consuming step, while the use of the thin plate of large plane dimensions permits a considerable saving in plate material and great speed in the plate making and printing make-ready operations. FIGURE 3*b* shows the emplacement of ink **42** on the printing portions **29** in various thicknesses in accordance with this invention as later described herein.

Plate **18** is made in a series of steps many of which are conventional. A plate of magnesium, zinc or copper metal is first given a coating of a light sensitive material. Negative transparencies of the images to be reproduced are then mounted above the coated surface of the plate, and the transparencies surrounded by a narrow border, perhaps ¼" wide, of opaque material. The plate is then exposed to actinic light through the superimposed transparencies and opaque borders, to harden all of the coating except in those areas representing the opaque portions of the transparencies and the opaque boundary strips. The coating is then developed to remove the unhardened portions, and the plate then subjected to an etching acid to etch away the surface of the plate in those areas not covered by the hardened coating. The hardened portions of the coating may then be removed by a suitable solvent. The surface of the plate has then been etched away only in those areas **31** in the transparencies not desired to be reproduced and in the narrow boundary areas **30** immediately adjacent thereto. The plate of FIGURES 3*a* and 3*b* specifically represents the result of the process described above and may be compared to the conventional plate of FIGURES 2*a* and 2*b*. In the surface of the plates are reproduced graduated half-tone greyscales which vignette off to nothing in the highlight end.

In conventional present-day practice, reproduction from one cylinder of a plurality of images would require the use of the corresponding plurality of individual plates, each independently affixed to a common base printing cylinder **16** (FIGURE 1). Between the areas of the individual plates, the periphery of cylinder **16** would lie in a cylindrical plane well below the level of the printing surfaces. It will be clear that in such a situation, as a sheet of paper is fed through the nip of cylinders **16** and **21** there will be intervals where considerable expanses of the sheet in the zone of the nip will not be gripped between the cylinders or maintained in the image plane travel line, since there is support only when the raised printing portions of the plates are in the zone of the nip. Thus there will be frequent intervals when there is substantial loss of contact with the sheet, with consequent loss of control of its movement and serious danger of smudging and loss of registration. However, in the plate of this invention, as shown in FIGURES 3*a* and 3*b*, substantially the entire non-printing surface represented by the areas **32** of the plate outside boundary zones **30**, has not been etched away and consequently these areas lie in the same cylindrical plane as the printing portions **29** of the plate, resulting in continuous control of the sheet as it passes through the nip.

The differential inking of the plate, that is, inking the printing areas of the plate without applying ink to the primary non-image areas co-planar therewith, is achieved through a novel process, involving "make-ready" of the inking cylinder **11** and by the fact that the inking cylinder is precisely positioned in relation to the printing cylinder by bearers, as previously noted. It has been found convenient to use for this purpose the methods and materials substantially as conventionally utilized in make-ready of printing and impression cylinders.

For example, make-ready sheet **13** (FIGURE 1) may consist of a standard multiply paperboard sheet suitably affixed to base cylinder **12**. An impression upon this sheet is made by the printing plate. There is then stripped away from the surface of sheet **13** plies porportional to the lightness of printing tone desired. That is, where the heaviest of printing tone is desired, the make-ready sheet is left intact, at areas of lighter printing one or more plies are stripped away, and at areas of no printing perhaps four or five plies are stripped away. The number of plies to be stripped away of course depends upon the number of plies initially in the make-ready sheet, the stripping to be roughly proportional to the lightness of printing tone desired. The printing blanket **14** is then wrapped about the make-ready sheet and affixed to base cylinder **12**, and the inking cylinder is registered with the printing cylinder **16**.

By this procedure, the radius of the inking cylinder at particular points becomes roughly proportional to the depth of tone to be imprinted by the printing cylinder with which it is in register, greater radius corresponding to deeper tone. Sufficient plies are stripped from the make-ready sheet in the area where no printing is to take place so that the printing blanket **14** will not contact the primary non-image portions **32** of plate **18**. The etched away areas of plate **18** (FIGURE 3) as at **30** provide an

area of separation so that the make-ready sheet 13 may be stripped sufficiently to avoid printing upon the raised primary non-image areas 32 of plate 18.

FIGURES 4, 5 and 6 illustrate the resulting construction. Referring particularly to FIGURE 4 it will be seen that the make-ready sheet 13 varies in thickness from point A to point B. At A, the make-ready sheet is in its original thickness, for example, five plies, representing an area where the corresponding printing plate 18 is to print the heaviest tone. At point B, sheet 13 has had one or more plies stripped away, corresponding to a printing area of lesser intensity. At point C the maximum number of plies of the make-ready sheet have been stripped away, for example, three of the five plies, corresponding to the primary non-image portions of the printing plate. The transition areas from A or B to C correspond to the etched secondary non-image portions 30 of the plate (FIGURES 4 and 5).

It will be clear that the rollers 10 will be positioned so that they do not contact the blanket 14 in the areas corresponding to the primary non-image portions 32 of plate 18, that is, in the areas above area C of make-ready sheet 13. Similarly, printing cylinder 16 and inking cylinder 11 are positioned so that there is no contact between printing plate 18 and inking blanket 14 in the same primary non-image areas. Such precise positioning is made possible by the presence of the bearers, previously mentioned. The spacing in each instance is such that even in the lightest printing area there is contact, and the degree or firmness of that contact increases proportionally with the depth of printing tone to be achieved.

FIGURE 5 depicts raised printing portions of plate 18 corresponding to the graduated half-tone greyscale of FIGURE 3, bounded by etched secondary non-image portions and raised or type-high primary non-image portions.

The effect noted above, variation in degree of contact between inking and printing cylinders proportional to depth of tone desired, permits an additional and very desirable result. Conventional printing methods do not provide the desired variation in printing tone from, for example, highlights to shadows. In fact, this is due to lack of the precise position control provided by the bearers in the present invention. The reason for this is that it has not been possible to transfer to the printing cylinder or surface an amount of ink sufficiently variable but proportional with the desired depth of tone to give the optimum results. That is, the amount of ink transferred from a printing surface for reproduction of the darkest image did not vary sufficiently from that transferred from the lighter surface to give the desired distinction in tone and detail. Rather, this distinction was solely dependent upon the areas of half-tone dots and the slight auxiliary help to be gained by make-ready of the printing and impression cylinders.

However, depth of tone may be increased by transferring to the printing plate a layer of ink of greater thickness, in addition to transferring it to "dots" of greater area as in half-tone printing. The problem thus far has been to provide a means or method by which such a greater thickness of ink could be transferred to darker tone printing areas, for subsequent transfer to the material to be printed. This process provides such means and method.

The amount and thickness of ink transferred is proportional to the pressure between the surface bearing the supply of ink and the surface to which the particular supply is being transferred. Thus, referring to FIGURES 1 and 4, form rolls 10 transfer an ink layer of greater thickness to blanket 14 above areas A than they do to blanket 14 areas above areas B, since the pressure at A is greater than it is at B due to the greater number of make-ready sheet plies at the former point. Of course, as previously noted, no ink is transferred at areas C.

Upon this transfer, then, the inking cylinder 11 bears upon its surface layers of ink in thickness varying widely with the depth of tone ultimately to be produced upon the surface of the printing material, and referring to FIGURE 5, this effect is multiplied in transferring ink to the printing cylinder. By virtue of this same make-ready of the inking cylinder and the positional control afforded by the bearers, the inking blanket 14 transfers to the printing plate 18 an ink layer of thickness corresponding to the thickness of the make-ready sheet. The multiplying effect results from the fact that not only does the differential pressure between inking cylinder and printing plate tend to produce this result, but the tendency is increased by virtue of the fact that the blanket has initially received ink in quantities proportional to the depth of tone desired.

Thus it is seen that this invention not only permits the use of thin printing plates of large area, which may be produced in a particularly inexpensive and rapid fashion, but largely as a consequence of the same factors the invention permits the imprinting of images with a new and startling contrast between light and dark surfaces.

It will be obvious that certain modifications of the invention as specifically described above might readily be made without departing from the spirit of the invention. For example, a conventional and well known thermoreactive plastic make-ready sheet manufactured and sold by Minnesota Mining & Manufacturing Company of St. Paul, Minnesota, might conveniently be used as the make-ready sheet 13. As is well known, a sheet of this type swells upon exposure to heat in an amount directly proportional to the amount of heat applied. The sheet can be used in this invention by interposing a sheet of carbon between the make-ready sheet and the printing plate 18, so that the carbon is printed upon the make-ready sheet in duplication of the image ultimately to be printed. The carboned make-ready sheet is then exposed to heat for a controlled time. A greater amount of heat is absorbed at the areas where the carbon is heaviest, with proportionally less heat absorbed where the carbon is lighter or no carbon was imprinted upon the surface of the make-ready sheet. In consequence, the make-ready sheet swells in proportion to the density of the surface coverage by carbon, which is proportional to the ultimate depth of tone desired to be printed. This make-ready sheet can then be fastened to the base inking cylinder 12 in conventional fashion and the inking blanket 14 fastened thereover. The result is an ink blanket surface the variation in depth of which is unusually sensitive with respect to the varying depth of tone desired, and this variation is thus produced in a very rapid and relatively inexpensive manner.

It should be noted that the differential in application of ink by rollers 10 to make-ready blanket 14 can be increased by spacing rollers 10 at varying distances from the center of rotation of cylinder 11, so that, for example, all of rollers 10 apply ink to the most elevated portions of the blanket 14, which correspond to and will contact the solid or most elevated portions of the printing plate 18, while progressively fewer of rollers 10 will contact the progressively less elevated portions of blanket 14 corresponding to the progressively less elevated portions of printing plate 18, such as the highlight areas.

In view of the many other variations possible without departing from the spirit of my invention, it is to be understood that no limitations thereon are intended except as specifically set forth in the following claims.

I claim:

1. In a rotary printing press the combination of an inking cylinder and a plate cylinder of the same diameter mounted in predetermined closely spaced and parallel relation and driven in counter-rotating relation at equal peripheral speeds, a relief printing plate fixed to the surface of said plate cylinder and including printing portions slightly raised with respect to non-printing portions thereof, resilient inking means on said inking cylinder providing inking surfaces raised with respect to the remaining surface thereof and arranged in corresponding relation to said raised printing portions of said plate, means for applying ink to said resilient raised inking surfaces for transfer to said printing portions only of said plate, and

packing means of varying thickness in accordance with the desired thickness of ink deposit desired on said plate printing portions, said packing means being positioned beneath the raised inking surfaces of said inking means to control the pressure of contact between said printing portions of said plate and said raised inking surfaces.

2. In a rotary printing press the combination of an inking cylinder and a plate cylinder of essentially the same diameter and mounted in predetermined closely spaced and parallel relation for concurrent rotation at equal peripheral speeds, a relief printing plate fixed to the surface of said plate cylinder and including printing portions slightly raised with respect to non-printing portions thereof, resilient inking means on said inking cylinder providing inking surfaces raised with respect to the remaining surface thereof and arranged in corresponding relation to said raised printing portions of said plate, means for applying ink to the resilient raised inking surfaces of said inking means for transfer to said printing portions only of said plate, and packing means of varying thickness in accordance with the desired thickness of ink transfer to said printing portions, said packing means being positioned beneath said raised inking surfaces of said resilient inking means to control the pressure resultant from contact between said inking surfaces and said raised printing portions of said plate.

3. In a printing press the combination of a relief printing member having printing portions and non-printing portions depressed slightly with respect to said printing portions, a resilient inking member corresponding in extent to said printing member, means mounting said inking means and said printing member for contact between corresponding areas thereof once during each operating cycle of said press, packing means between said inking means and said support means raising the areas thereof corresponding to printing portions of said printing member with respect to the remainder of said inking means, and means applying ink only to said raised areas of said inking means for transfer only to said raised printing portions of said printing member during each operating cycle, said packing means being of varying thickness in accordance with the desired thickness of ink deposit on said raised printing portions.

4. In a printing press, a form carrying member, printing means on said member including raised printing portions, an inking surface support and an inking means removably attached to said support and arranged to ink said printing portions, means driving said form carrying member and said inking surface support such that the same areas of said inking means are always brought into contact with corresponding areas of said printing means, means between said inking means and support in said area corresponding to said printing portions to raise the surface of said inking means in said areas relative to the support to a level higher than the level surface of said inking means corresponding to other areas of said printing means, an inking roller arranged to apply ink to the raised surface areas of said inking means, means supporting said form carrying member and said inking surface support for controlled contact therebetween such that only the printing portions of printing means are inked by said inking surface, and impression means to press print-material against the inked printing portions for transfer of the ink to said printing material, the means to raise the surface of said inking means being of varying thickness substantially proportional to the desired thickness of ink deposit on said printing portions, being thicker with thicker deposit of ink desired.

5. In a rotory printing press the combination of an inking cylinder and a plate cylinder of essentially the same diameter and mounted in predetermined closely spaced and parallel relation for concurrent rotation at equal peripheral speeds, a relief printing plate fixed to the surface of said plate cylinder and including printing portions slightly raised with respect to non-printing portions thereof, resilient inking means on said inking cylinder presenting inking surfaces raised with respect to the remaining surface thereof and arranged in corresponding relation to said raised printing portions of said plate, said raised surface portions of said resilient inking means being raised in varying amounts corresponding to the desired thickness of ink deposit on different areas of the printing portions of said plate, and means for applying ink to said resilient raised inking surfaces for transfer to said printing portions only of said plate.

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