A method and apparatus for making graphic copies of indicia, lines, or designs on multiple paper parts which are impressed in unison between the members of a printing couple. The printing members may be in cylindrical form for a rotary printing press or in plate form for a flatbed press. Each member of the printing couple has embossed surfaces which represent the indicia, lines, or designs to be printed. The embossing on one of the members is the mirror reverse of the embossing on the other member and the embossing characters are disposed in exact matching relationship. The printing operation is known as "crash" printing.
MATCHED PLATE METHOD FOR PRINTING ON MULTIPLE PAPER PARTS

BACKGROUND OF THE INVENTION

The present invention relates to a method and apparatus for making graphic copies of indicia, lines, or designs on multiple paper parts by what is known in the art as "crash" printing.

The term "crash" printing as used herein refers to the act of printing, wherein the webs are subjected to great pressure while positioned between a hard printing plate and a hard impression plate.

Heretofore, "crash" printing has been accomplished on a rotary press or on a flatbed press by passing the paper parts to be printed between the members which form the printing couple. One member of the printing couple has been designated as the printing cylinder or plate while the other member has been designated as the impression cylinder or plate. The printing cylinder or plate, however, is the only member which has carried the embossing characters or designs and the other member has been formed with a smooth surface. The multiple paper parts may be carbon-interleaved forms or webs or they may comprise carbonless forms or webs which are treated with impressions known in the art as "haze" and reducing the "bunching up" of the forms between the embossing and the printing plate or cylinder. With the present invention, the "floor" clearance is actually doubled, because two plates are used and because each plate in effect is only impressing one-half of the parts involved.

An important advantage of the present invention is the reduction in the diameter of the printing cylinder, because heretofore, the diameter of the cylinder had to be large enough to resist "bouncing" under the pressure required for printing a large number of parts, but such size required two plates on the cylinder. By means of the present invention, the diameter of the cylinder can be reduced sufficiently so that only one plate can be used instead of two. The method also enables the use of lighter and smaller type faces which are most important in fine business form work. This is possible only because each small character impresses against a matching character.

As applied to a rotary press, wherein punched holes are formed in the parts in advance of the passing of the parts through the printing couple, such as is shown in U.S. Pat. No. 3,069,155, issued Dec. 18, 1962, the present invention overcomes the tendency of the printing roller to become a pulling roller because the pull, if any, is the same on the top and bottom of the pack. Thus, the formation of perfect holes is facilitated and the engagement of such holes by punched belts for maintaining the parts in registration while delivering them to the printing couple is assured. By impressing the forms from both the top and the bottom of a number of parts, the definition is increased at least by twofold, because the "spread" of the image is stopped at the halfway point. Moreover, because of the diminished pressure utilized, a satisfactory image is obtained without the occurrence of "showthrough" on the paper.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation of a rotary printing press which utilizes the present invention;

FIG. 2 is a top plan view of the apparatus shown in FIG. 1 but with only one roll of paper being shown;

FIG. 3 is a vertical section taken on a plane indicated by the line 3--3 in FIG. 2 but on a scale larger than that of FIG. 2;

FIG. 4 is a side view of a rotary press partly in section and showing the driving arrangement;

FIG. 5 is a top plan view of a portion of the press but on a scale larger than that of FIG. 2;

FIG. 6 is a side view of a portion of the apparatus for withdrawing the webs from the rolls;

FIG. 7 is a top plan view of a portion of the withdrawing apparatus as indicated by the line 7--7 in FIG. 6;
FIG. 8 is a side view of a portion of the web guiding structure on a scale large than that of FIG. 3.

FIG. 9 is a vertical section taken on a plane indicated by the line 9—9 in FIG. 8.

FIG. 10 is a section taken on a plane indicated by the line 10—10 in FIG. 5 but on a scale larger than that of FIG. 8.

FIG. 11 is a top plan view of the webs removed from the press.

FIG. 12 is a diagrammatic view greatly enlarged to show the progressively increasing size of the image in prior construction of printing couple for "crash" printing.

FIG. 13 is a diagrammatic illustration on a greatly enlarged scale showing the "spread" of the image in accordance with the present invention.

FIG. 14 is a sectional view illustrating diagrammatically the positions of embossed surfaces at the time of impression in accordance with the present invention and also illustrating diagrammatically the clearance between the paper parts and the floor of the respective printing cylinders; and

FIG. 15 is a front view showing coacting cylinders having printing plates with the "mirror image" type thereon.

**DESCRIPTION OF THE PREFERRED EMBODIMENT**

The present invention is intended primarily for use on multiple paper parts and is illustrated in one form as applied to a rotary printing press where in FIG. 1, for example, it is shown in connection with four webs at A, B, C and D as being withdrawn from rolls A1, B1, C1 and D1, respectively, which may be supported on suitable standards A2, B2, C2 and D2, respectively. The webs are passed through a withdrawing apparatus indicated in general at 10 and from thence they fall in festoons as indicated at A3, B3, C3 and D3, respectively, from whence they pass into a guiding apparatus indicated in general at 11 and then into a press which is indicated in general at 12.

The press as shown in the drawings is merely illustrative of one form which is capable of carrying out the present invention. As shown, it has a frame which includes a base 15 and sideplates 16 and 17 which extend parallel to each other and are rigidly fastened to the base. The frame supports a rotary printing mechanism together with apparatus for forming one or more rows of holes in the paper and for propelling the paper and holding it in proper position for web operations such as printing and perforating to be performed thereon.

For the purpose of illustration, in FIGS. 1—5 I have shown shafts 20 and 21 which support a plate cylinder 22 and an impression cylinder 23, respectively, of a printing couple. The impression cylinder, however, in the present invention also comprises a plate cylinder which has embossing thereon exactly matching the embossing on the plate cylinder 22 and in exact registration therewith, but with the embossing characters in mirror image position, as shown in FIG. 15. Additionally, for purposes of illustration I have shown another pair of shafts 25 and 26 which may support a perforating roll 27 and a backup roll 28. If desired, the cylinders 22 and 23 can be mounted on the shafts 25 and 26, respectively, in which case the perforating and backup rolls 27 and 28 would be mounted on the shafts 20 and 21, respectively.

The present invention may be utilized on a rotary press wherein the paper parts are fed through the press by means of traveling pins which engage a row of holes in the paper. Accordingly, I have shown additional shafts 30 and 31 which are journaled in the frame and which carry a roll 32 having uniformly spaced punches 33 therein and a roll 34 having coacting openings 35 respectively. It is understood that the openings 35 are in registration with the punches 33 so as to form a row of holes in the paper as it passes through the press. The roll 32 may be referred to as the punch and the roll 34 may be referred to as the die. In FIG. 2, I have shown the punch 32 for punching one row of holes along one edge of a web of paper and an additional punch 32A also affixed to the shaft 30 for punching a second row of holes along the opposite edge of the paper web. It is to be understood that there is a die roll also affixed to the shaft 31 which is similar to the die roll 34 which coacts with the punch 32A.

To rotate the various shafts for the punching, perforation and printing operations, I have shown an electric motor 40 which is connected in any suitable manner to the apparatus for propelling the webs through the press and for performing work operations thereon.

Thus, in FIG. 4, the motor is shown as being connected by a chain 41 to a sprocket wheel 42 which is fixed to a shaft 43, the latter of which is journaled in the frame. The shaft 43 has fixed thereto a gear 44 which is adapted to mesh with a gear 45 on the shaft 31. A gear 46 which is fixed to each shaft 30 meshes with the gear 45. Such gears have a 1:1 ratio wherefore, the punch and die rotate in unison and remain in registration.

To operate the printing and perforating rolls, I have shown shafts 50 and 51 which are journaled in the frame and which carry gears 52 and 53, respectively. The gear 52 meshes with a gear 54 fixed to the shaft 25 and the gear 54, in turn, meshes with gears 55 and 53 on the shafts 26 and 51, respectively. Additionally, the gear 53 meshes with the gear 56 which is fixed to the shaft 20 and the latter gear meshes with the shaft 57 which is fixed to the shaft 21. In practice, the gear couple 54 and 55, as well as the couple 56, 57, have a 1:1 ratio. As shown, the shafts for the punching, printing and perforating couples are journaled in the press frame.

To draw the webs from the rolls, I have shown a frame which, in the form illustrated, has a base 60 comprising bars which are fixed to the base 15 and to a pedestal 61. The bars are shown as supporting a frame 62 which extends diagonally upwardly from the base 60 and is supported by a brace 63.

The frame 62, as shown, may comprise parallel angle bars which support rolls 65 equal in number to the webs in use. A coacting roll 66 presses against each roll 65 and forms a tight between which a web of the paper extends. Each couple is substantially the same as the others and each is intended to be positively rotated in synchronization with the gearing which operates the punching, printing and perforating rolls. Thus, for example, as shown in FIGS. 6, 7 and 7, each withdrawing couple has a lower roll 65 mounted upon a shaft 67, and the upper roll 66 journaled at 58 in an arm 59. The arm in turn may be fixed to a rod 64 which is supported by and oscillatable within brackets 47 on the frame 62. Another arm 48, also fixed to the rod 64, is attached to one end of a spring 49, the other end of which is attached, as at 36, to the frame 62. Thus, the spring operates to maintain a yieldable pressure against the paper sufficient to withdraw it from the roll.

Each shaft 67 may be journaled in bearing blocks 68 which are fastened to the frame 62, and each shaft 67 may have fixed thereto a sprocket wheel 69 which is driven by a chain 70. The latter is shown (FIGS. 6 and 7) as being driven by a sprocket wheel 71, which is fixed to a shaft 72, the latter of which may be journaled at one end in a bracket 73 on the frame 62, and at the other end in an outboard bearing 74. The bearing is carried on a bracket 75, which is fixed to the frame 62. It is to be understood that the chain 70 passes around a sprocket wheel, similar to 69 on each roll shaft 67 as indicated by the common reference characters in FIG. 6. The lower reach 76 of the chain 70 may be guided by suitable sprocket wheels 77 and 78 at opposite ends of the frame 62.

To drive the withdrawing rolls 65, I have shown a chain 80 which is in mesh with a sprocket wheel 81 fixed to the shaft 72. The chain may be rotated by the motor 40. It follows that the chain 70 is operated in synchronism with the mechanism for punching, printing and perforating the paper.

It is the intention of utilizing the withdrawing apparatus for pulling the webs off the rolls, but to allow a free fall or loop between the withdrawing apparatus and the press, as is shown in FIG. 1. To guide the webs, however, into the press, I have shown a mechanism which places a slight tension upon the paper as it moves into the press. Thus, the apparatus shown includes a frame in the form of spaced bars 85 which are fastened to the base 15 in any suitable way and to the plates 16.
and 17, respectively. The frame supports a series of copious which are in the form of bars as shown particularly in FIGS. 3, 8 and 9. Thus, there is an upper bar 86 and a lower bar 87 in each couple, the first of which is connected to the frame as by wingbolts 88. Each bar 86 carries collars 89 and 90 which, in turn, support the bar 87. The collars 89 and 90 may be adjusted angularly with respect to the bar 86 for varying the position of the bar 87 angularly with respect to the bar 86. Thus, each web of paper passes upwardly around a bar 87, thence, around the coastering bar 86 and into the press. The annular position of the bar 87 with respect to the bar 86 determines the position of 250.4° in one revolution of the paper for achieving the desired degree of resistance sufficient to keep the paper flat as it moves into the press. If desired, a brush 91 may be fixed to a bar 92 the latter of which is adjustably mounted within brackets 93 on the frame. This operates to smooth out any wrinkles in the paper during its movement into the press. Additionally, I may utilize the weight of flat bar 98 which rests freely upon the paper, in advance of the punch, and which operates to smooth out any slight wrinkle in the paper. The bar is moved by the paper into engagement with abutments 99 and 99A and is held thereagainst while supported upon a pan 108, which is fixed to the frame.

To control the movement of the paper through the press, and to hold it in the desired degree of tautness for performing work thereon, I provide means for engaging the holes in the paper as soon as possible after it has passed through the punching operation. Thus, in the embodiment of FIGS. 1 to 5 where the roll 27 is longer than the width of the web, and where two rolls of holes are punched in the paper, I have shown endless belts 10I and 100A positioned between the punching rolls and the roll 27 and I have shown a similar set of endless belts 10I and 101A, between the roll 27 and the roll 22. In this embodiment the roll 22 is shorter than the roll 27. Additionally, I have shown endless belts 102 and 102A which operate to transfer the paper after it has passed through the printing couple (FIG. 5). Each of said belts carries pins as is shown, for example, at 103 in FIG. 10, which extend upwardly from arms 104, the latter of which are carried by the links 105 of the associated belt and extend inwardly therefrom toward the web.

Due to the fact that the frame roll 22 is shorter than the width of the web, the belt 102 may extend at one end around the roll 23, as is best shown in FIG. 3, and around a roll 94 at the other end, the latter roll being driven by the motor 40 as will be hereinafter described. Tension on the belt 102 may be maintained by a spring-loaded idler roll 79. The belt 102A, however, extends around a sprocket wheel 106 which is fixed to a shaft 107 on the delivery side of the printing couple.

To operate the respective pin belts in unison, and in timed relationship to the punching and other work-performing operations, I have shown in FIG. 4 an arrangement for driving them by motor 40. This may comprise a gear 110 mounted on the shaft 111 and meshing with the gear 44, the shaft 111 being journaled in the frame. The gear 110 meshes with a gear 112 which is fixed to a shaft 113, the latter of which is journaled in the press frame. A sprocket wheel 114 fixed to the shaft 113 drives a chain 115 which, in turn, drives a sprocket wheel 116 fixed to a shaft 117, the latter of which is journaled in the press frame. The shaft 117 has a gear 118 fixed thereto which meshes with a gear 119 mounted on a shaft 120, the latter of which is journaled in the press frame. Another gear 121 fixed to the shaft 119 drives a chain 122 which passes around sprocket wheels 123 and 124 on shafts 98 and 96, respectively. The shaft 125 carries a sprocket wheel 126, which drives a chain 127 and this, in turn, drives the belts 101A and 100A by chain belts 128 and 129, respectively. Thus, all of the pinned belts are synchronized for movement with the rotation of the work-performing operations in the press. Control of the paper during its movement through the press is maintained by engaging the pins of the pinned wheel 97 which is fixed to the shaft 96, as is shown in FIG. 3. Since the shaft 96 is driven by the chain 122, it is rotated in synchronism with the pinned belts and the work-performing members.

By engaging the webs as soon as they have passed through the punching operation, and by holding them until they engage the next set of rolls in the press and thereafter immediately engaging them again after they have passed through the second set of rolls, and by repeating the engagement after each set of rolls has been passed enables the webs to be pulled through the press without any possibility of deviation, and enables the "lengths" of the web to be accurately controlled even though the press is operating at maximum speed.

The matched plate method and apparatus of the present invention consists in making a duplicate plate of the plate which receives the ink and making it with a "mirror" or exact reverse image. Such plate then becomes the platen or "anvil" against which the ink plate is impressed. The mounting of the two plates, for example Dycril plates, is exact so that line for line, character for character, and dot for dot the plates match and use each other for impression. The effect of impressing from both the top and bottom of a number of paper parts such as plies or webs is to increase the definition by at least twofold because the "speed" of the image as heretofore described and shown in FIGS. 12 and 13 is stopped at the halfway point. Thus, for example on a six-part form the top plate in effect impresses the first three parts whereas the bottom plate impresses the last three parts. The maximum spread is on parts 3 and 4. The best images are on parts 1 (the ink copy) and part 6—part 1 being in intimate contact with the inked plate and part 6 being in intimate contact with the uninked plate. The next in definition value are parts 2 and 5 and then parts 3 and 4. Accordingly, the six-part form made with the method and apparatus of the present invention possesses greater definition than a six-part form which is crashed all the way through from the top to the bottom by the use of an embossed plate impressing against a smooth plate. The resulting product in accordance with the present invention can be produced as a faster rate on a more simplified press and with assurance of perfect registration between the paper parts. Moreover, by reducing the printing pressure, an improvement in quality is attained by the elimination of "impression," as is known in the art.

A further advantage of the present invention is that when two embossed cylinders are operating against each other, they produce a "feeding" effect, which is somewhat similar to the action of gears, as distinct from the separate effect of a single cylinder plate operating against a smooth anvil cylinder. The latter uses more power and tends to reduce the speed of operation and to limit greatly the number of parts which can be printed.

While I have illustrated and described the invention in connection with a rotary "crash" printing press, it is to be understood that the method and apparatus is applicable to other forms of apparatus, such as a flatbed press and still be within the spirit of the invention as set forth in the appended claims.

In FIG. 12 I have shown on a greatly enlarged scale a graphic representation of what I have termed an "image" increase where a large number of paper parts are "crash" printed by using a plate cylinder and a smooth impression cylinder of the prior art. Thus, if the line 151 represents the length of a character as impressed on the form nearest to the plate cylinder, which is indicated by the arrow 152 as a direction of force or pressure against the forms, then the line 153 will represent the length of the image on the bottom form. The lines 154 and 155 respectively, show the progressive increase to a shaft through the stack. In FIG. 13 I have shown diagrammatically on a greatly enlarged scale a representation of the image increase for comparison with that of FIG. 12. Thus, in FIG. 13 the line 161 represents the length of the image on the top form and the line 162 represents the length of the image on the bottom form. Such lines are sub-divided in length. The line 164 represents the length of the image and the midpoint of the stack while the lines 165 and 166 represent progressive in-
increases from the line 161 to the line 164. Additionally, the lines 167 and 168 show progressive increases from the line 162 to the line 164. It is to be noted that with line 161 equal in length to line 151 and to the line 162 then the line 164 which represents the largest image in Fig. 13 is shorter than the line 153 of Fig. 12. Thus, the result is that the quality of the product as represented by “definition” is greatly improved.

Fig. 14 is a diagrammatic sectional view on an enlarged scale to show registration of an embossed surface or character 170 on plate cylinder 22 in exact registration with the embossing surface or character 171 on plate cylinder 23. In this illustration, the webs are indicated at 15 as being impressed by the embossments 170 and 171 simultaneously with the result that the webs near the impression points are only slightly cramped as at 176, 177, 178 and 179, respectively. It is to be noted that such cramped portions are spaced from the floor 180 on the cylinder 22 and from the floor 181 on the cylinder 23. Thus, the webs are free from a condition known in the art as “haze.” Additionally, “bunching up” of the webs between the characters and lines is no longer a problem, wherefore, the invention permits the use of lighter and smaller type faces which are most important in fine business form work. By means of the present invention, the available “floor” clearance is actually doubled.

A further advantage of the present invention is the saving which can be made in reducing the diameter of the plate cylinder because of the reduction in pressure exerted by each cylinder. Such reduction in pressure eliminates the “bounce” which develops after the pressure reaches a point which is necessary to effectively print a large number of parts. Thus, for example, a “crash” printing of an eight-part form would require only the pressure heretofore required for “crash” printing a four-part form by the prior art method which employed a plate cylinder and a smooth impression cylinder. This has an additional advantage of reduction in plate costs because it is now possible to use single plate cylinders instead of multiple plate cylinders.

I claim:

1. A method of making graphic copies of indicia on multiple paper webs comprising:
   providing multiple paper webs with a substrate of pressure-responsive marking material between adjacent webs,
   forming raised indicia on a pair of coacting cylinders wherein the indicia on one cylinder is the mirror image of the indicia on the other cylinder,
   positioning the cylinders in opposing relationship with the indicia on one cylinder in registration with the mirror image of the indicia on the other cylinder,
   inking the indicia on one of said cylinders,
   rotating the cylinders at synchronous speed,
   pulling the multiple paper webs between the rotating cylinders,
   imprinting the outermost web with ink by the inked indicia on one of the cylinders, and
   creating a pressure by the raised indicia upon the webs during the printing operation sufficient to duplicate on the other webs, by means of the substrate, the printed indicia on the outermost web.

2. A method according to claim 1, wherein, the substrate comprises a carbon interleaved web.

3. A method according to claim 1, wherein, the substrate comprises a part of the paper webs.

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