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(54) Starting and stopping the printing of fed sheets.

(57) A printing press has a plurality of successive printing sections (12, 13). Each section includes a frame structure (14) supporting a rotatably driven print cylinder, a rotatable ink roll (16) for inking the print cylinder (18), and an arrangement (30, 32, 34) for relatively moving the ink roll (16) and the print cylinder (18) into and out of inking relationship with each other. A feed section (10) feeds sheets (42) to a first (12) of the successive printing sections and has a feed control (56, 60, 64) for rendering the feed section (10) operative and inoperative, respectively, for feeding sheets. A controller (82) is inter-related with and responsive to actuation of the feed control (56, 60, 64) for sequentially controlling actuation of the successive printing sections (12, 13) one after the other, so as to sequentially bring each ink roll (16) and its associated print cylinder (18) into inking relationship with each other upon the feed section (10) becoming operative to feed sheets. The controller (82) has a plurality of rotary timing switches (108), one for each printing section with the first section switch (108(1)) having a negative timing angle and each subsequent section switch (108(2),(3),-(4)) being timed a predetermined angle after the preceding section switch.

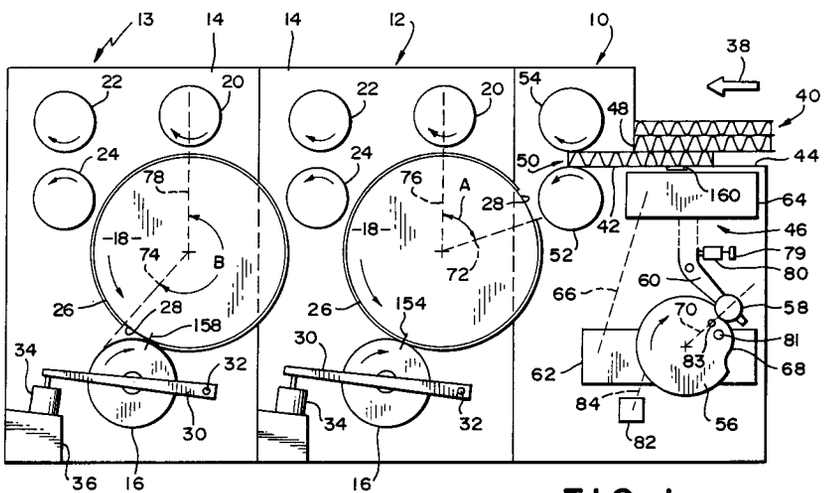

FIG. 1

EP 0 490 475 A1

FIELD OF THE INVENTION

This invention relates to the starting procedure when starting the feeding of sheets to printing apparatus, particularly to a multi-section rotary printing press. This invention also relates to the stopping procedure when stopping or interrupting the printing.

BACKGROUND OF THE INVENTION

When starting printing with a rotary printing press, particularly a flexographic press having one or more rotary flexographic sections, the ink roll or rolls would be positioned for inking when the machine drive was turned on; however, with this procedure, the printing plate or plates would always be inked whether or not the machine was feeding sheets.

In a subsequent development, the ink roll was only positioned if the feed switch was switched on for feeding sheets. But this did not allow the last few sheets of the printing run to be printed.

Thereafter, a timer was installed and set to allow the last sheet to pass through the machine based upon the slowest machine speed. Unfortunately, if the machine was at top speed, the ink roll would still be in position for thirteen or more machine revolutions.

In all these cases, excessive ink build-up tended to occur on the printing plate. Also, sheets at the beginning and end of printing runs were wasted as being either not printed or over inked. When the excessive ink build up occurs at the beginning of a printing run, this can be especially wasteful as it may require a substantial number of sheets to be printed and discarded, before the initial excessive inking is absorbed and reduced sufficiently for normal printing to continue.

SUMMARY OF THE INVENTION

The present invention is concerned with improving the starting and/or stopping of printing runs, particularly runs of sheets through multi-section rotary presses.

One aspect of the present invention is based upon the realization that the ink roll, upon starting up, should be synchronized in being positioned to compensate for the difference between the ink transfer point and the sheet registration. With the first of a series of rotary flexographic sections, the first section ink roll could be positioned in advance of sheet registration, and then each following flexographic section sequenced in dependence upon the center distance between the sections for ink roll positioning.

Another aspect of the present invention is based upon the realization that when the feed is signaled to stop, there should preferably be a wait until the printing die is past the ink transfer point before the ink roll is released from its inking position, so allowing the last sheet to be printed as it passes. Then, each following flexo unit could be delayed in the release of its ink roll in sequence by the relationship of the center distance between consecutive flexo sections and the rotational equivalent thereof.

According to one aspect of the present invention there is provided a printing apparatus comprising a frame structure, a rotatably driven print cylinder supported in this frame structure and rotating once per machine cycle during operation, an ink roll rotatably mounted in the frame structure for inking the print cylinder. Moving means is provided for relatively moving the ink roll and the print cylinder into and out of engagement with each other. A feed section is arranged to feed sheets to the print cylinder to be printed thereby, with a feed switch for switching on the feed section to feed sheets and for switching off the feed section to stop feeding sheets. A timing device is driven in synchronization with the print cylinder and generates an output pulse each machine cycle. A controller is actuated by this output pulse, when the feed switch is switched on, to control the moving means to effect engagement of the ink roll and the print cylinder.

After the switching on of the feed switch with the ink roll and the print cylinder out of engagement with each other, the next pulse preferably causes the controller to effect engagement between the ink roll and the print cylinder. Later when the feed switch is switched off, preferably the next subsequent pulse causes the controller to effect disengagement between the ink roll and the print cylinder.

The feed section may have a continuously driven cam, a cam follower actuated by the cam, and disabling means for disabling the cam follower by preventing the cam follower following the cam, the switching on and off of the feed section by the feed switch actuating the disabling means to render the cam follower operative or inoperative.

Preferably, sensing means sense a predetermined position of the cam, this sensing being interconnected with the disabling means to delay the cam follower becoming operative when the feed switch is switched on until the next predetermined position of the cam is sensed, and the controller not being actuated by the output pulse until this next predetermined position of the cam has been sensed. The sensing means may comprise an actuator on the cam and a proximity switch adjacent the cam.

According to another aspect of the invention,

there is provided a printing press comprising a plurality of successive printing sections, each printing section comprising a frame structure supporting a rotatably driven print cylinder, a rotatably driven ink roll for inking the print cylinder, and moving means for relatively moving the ink roll and the print cylinder into and out of inking relationship with each other. A feed section is provided for feeding sheets to a first of the successive printing sections, with operative means for rendering the feed section operative and inoperative, respectively, for feeding sheets. Control means, interrelated with and responsive to actuation of the operative means, is provided for sequentially controlling actuation of the moving means of the successive printing sections one after the other so as to sequentially bring each ink roll and its associated print cylinder into inking relationship with each other upon the feed section becoming operative to feed sheets.

Preferably, the feed section has a machine zero position each machine cycle in relation to feeding each sheet, a timing switch for the first printing section being angularly timed a first angle relative to the machine zero position in each machine cycle, and a timing switch for the next printing section being angularly timed a predetermined angle after that first angle.

The timing switches may be combined in a single device or be separate units. These switches preferably produce, or cause to be produced, signals for controlling relays, actuating circuits, or the like of the control means for sequentially rendering the ink rolls operative or inoperative.

When the plurality of printing sections contains at least three printing sections, the timing switch of the third section may be angularly timed an angle equal to said predetermined angle after said predetermined angle.

According to yet another aspect of the invention, there is provided a method of starting a printing run of sheets with a rotary printing press having a plurality of successive printing sections each having an ink roll and a print cylinder movable into and out of inking engagement, comprising the steps of running the printing press without sheets being fed and with each ink roll out of inking engagement with its associated print cylinder, moving the ink roll and print cylinder of each printing section into inking engagement with each other in timed relation one after the other upon initiation of sheet feeding for feeding a first sheet of the run of sheets, printing the first sheet successively by each printing section, and the first sheet reaching each printing section and printing by that printing section commencing just as the print cylinder of that printing section is inked for the first time for this printing run.

Upon stopping feeding of successively fed sheets, the ink roll and print cylinder of each printing section preferably move out of inking engagement with each other one after the other in the same timed relation as they engaged each other in the moving step.

In a particular preferred embodiment of the present invention, applied to a printing press having a plurality of flexographic printing sections fed by sheets from a feed unit, each printing section is arranged to have a synchronized position setting determined as a function of the rotational position of that section in relation to the linear position of the sheet passing through the printing press. At the start of a printing run, control means position the ink roll in each section just when the sheet registration point meets the ink transfer point, with each printing section being sequenced in position. At the end of the printing run, each ink roll drops out of inking relationship in the same sequence at the same point in the machine cycle. In this way, each printing die or plate is inked only once and the first and last sheets of the run are all of saleable print quality.

Other objects, features and advantages of the present invention will become more fully apparent from the following detailed description of the preferred embodiment, the appended claims and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings, in which like reference characters in the same or different Figures indicate like parts:

- Fig. 1 is a diagrammatic side elevation of a flexographic printing press according to the invention, some parts having been omitted and others simplified for ease of understanding;
- Fig. 2 is a view of a portion of the mechanism indicated in Fig. 1, but including more detail;
- Fig. 3 is a simplified perspective view of a plurality of electronic rotary cam switches employed in the embodiment of Figs. 1 and 2 for controlling movement of ink rolls into and out of inking engagement with the respective print cylinders;
- Fig. 4 is an axial view of one of the switch cams of the arrangement of Fig. 3 when adjusted to provide pulses as indicated in Fig. 6;
- Fig. 5 is an electrical schematic of the control circuitry for controlling sequential engagement and disengagement according to the invention of the ink rolls of Fig. 1 when starting and stopping

the printing of sheets; and

Fig. 6 is a logic diagram of the operation in accordance with the invention of the flexographic printing press of Fig. 1 when provided with four flexographic printing sections, the situation of running a single sheet, stopping the press, and then running a continuous series of sheets being illustrated.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred embodiment of the invention will first be described in relation to the simplified diagrammatic views of Figs. 1 to 5, and then the sequencing of operations when starting and stopping, or interrupting, the printing of individually fed sheets will be further described in relation to the logic diagram of Fig. 6.

Fig. 1 diagrammatically shows a flexographic printing press having a sheet feeder section 10, a first flexographic printing section 12, and a second flexographic printing section 13. Further flexographic printing sections can be added as desired, for example when printing three or more colors, and Fig. 5 shows the electrical control schematic for the press of Fig. 1 when equipped with four flexographic printing sections.

Each printing section 12, 13 *etc.* has its own frame structure 14 which is movable away from adjacent sections for maintenance, making set-up adjustments *etc.* as is well known. In each section are rotatably mounted an anilox or ink roll 16, a print cylinder 18, an impression roll 20, and a pair of feed rolls 22, 24. Each of these rolls is rotatably driven, when printing, in the directions of the arrows associated therewith. A flexible printing die 26 is mounted on and wrapped around each print cylinder 18, a short arcuate gap 28 being left between the leading and trailing edges of the die 26. Each ink roll 16 is rotatably mounted in a cradle 30 which is pivotally mounted at 32 in the associated frame structure 14. An air cylinder 34 supports and adjustably pivots the cradle 30 about its pivot 32 to move the ink roll 16 into inking contact with the respective print cylinder 18, or move accurately the printing die 26 mounted thereon, for printing, and away from the print cylinder when not printing. The air cylinder 34 is mounted on a platform 36 of the frame structure 14, and is connected to an end of the cradle 30 opposite to the cradle's pivot 32. Each cradle 30 is so supported and moved by two air cylinders, one on each side of the associated frame structure 14.

The sheet feeder section 10 can be any suitable feeder for feeding sheets one at a time in a downstream direction 38 from a stack 40 or supply of the sheets. Preferably, the feeder section 10 is a lead edge feeder as disclosed in Ward Sr. et al United States Patent 4,494,745. The lowermost sheet 42, which is shown in Fig. 1 in the process of being fed from the stack 40, is normally supported on a horizontal support surface 44. This sheet is fed in the direction 38 by a lead edge feed mechanism 46 having endless belts which are raised above the support surface 44 and intermittently driven to feed the lowermost sheet 42 through a gate 48 until the leading edge of this sheet 42 is gripped by, and is halfway through, the spaced nip 50 of a pair of feed rolls 52, 54. The upper flights of these endless belts are raised and lowered by a mechanism operated by a rotating cam 56 via a cam follower roller 58 mounted on a lower end of a pivoted arm 60. The continuous rotational drive of the cam 56, and the intermittent drive to the sheet feed belts, are effected via gearing arrangements (conveniently comprising two gear boxes, one for each drive) schematically shown as box 62. The sheet feed belts, the arrangement for raising and lowering their upper flights, and vacuum boxes for drawing the lowermost sheet 42 into stationary frictional contact with these belt upper flights are all represented schematically by the mechanism 64. The intermittent drive between the gearing arrangement 62 and the sheet feed belts of the mechanism 64 is illustrated by a broken line 66. The mechanism 64 and the drive 66 are shown in greater detail in Figs. 1, 2 and 3 of the above Ward Sr. et al patent, and the timing sequence of their operation is shown in Fig. 4 thereof.

Wells et al United States Patent 4,867,433, discloses an advantageous modified form of the feed section 10, particularly the belt lifting mechanism shown in Fig. 3 thereof.

In normal operation, the lowermost sheet 42 is fed by the mechanism 64 to the position shown in Fig. 1; thereupon the feed of this sheet is taken over by the feed rolls 52, 54 and the sheet is fed into and through the nip of the print cylinder 18 and the impression roll 20 of the first printing section 12. With the ink roll 16 thereof being inked and held against the printing die 26 by its air cylinder 34, the printing die 26 of the first printing section prints the sheet 42. This printed sheet is gripped between the feed rolls 22, 24 of this section and fed to the second printing section 13 where it is similarly printed by printing die 26 thereof. To obtain register of each sheet being fed with the printed material printed thereon by successive printing sections 12, 13 *etc.*, the various sections are set-up so that when the center of the cam follower roller 58 is at the end of a dwell 68 of the cam 56 (this being the end of the sheet feed by the feed belts) and on radial position 70, the leading edges of the printing dies 26 of printing sections

12, 13 are respectively at radial positions 72, 74. The various sections of the printing press are geared to each other so that they are operated at the same machine throughput speed. In this way, the cam 56 and the print cylinders 18 all rotate at the same number of revolutions per minute. The registration between the sections is such that when the leading edge of fed sheet 42 reaches and is midway through the nip between the print cylinder 18 and impression roll 20 of the first printing section 12, the radial position 72 will have reached the radial position 76 which passes through the center line of the rolls 18, 20, *i.e.* through the center or bite of the nip therebetween. Similarly, when the leading edge of this sheet 42 reaches the center of the nip between the print cylinder 18 and impression roll 20 of the next printing section 13, the radial position 74 will have reached the radial position 78 passing through the center of this nip.

With a printing press having a standard 66 inch (168 cm) cycle, corresponding to the circumference of each print cylinder 18, the distance between centers of the print cylinders 18 is 27 inches (69 cm). The angle A between the radial positions 72 and 76 in the first printing section 12 is 73.6 degrees, and the angle B between the radial positions 74, 78 in the next printing section 13 is 220.9 degrees. Thus, the second printing section 13 is angularly sequenced 147.3 degrees behind the first printing section 12. As additional printing sections are added on, each is sequenced 147.3 degrees behind the preceding printing section.

It is known for an electrically controlled stop 80, *e.g.* a lifting air cylinder controlled by a relay actuated air valve 79, to be extended to prevent the pivoted arm 60 from pivoting clockwise, and so prevent the follower roller 58 from entering the lower dwell 68 of cam 56. This in turn prevents the feed belts of feed mechanism 64 from being raised to feed sheets. The stop 80 is so extended when feed of sheets from the stack 40 is to be interrupted. This extension can be caused to occur when the air valve 79 is turned on with de-energization of the air valve relay; energization of the air valve relay occurring during normal sheet feeding to effect retraction of the cylinder 80.

A stationary proximity switch 81, closely adjacent one side of the cam 56, is actuated by an actuator 83 on the cam each revolution just after the cam passes through the machine zero position 70 in Fig. 1. Preferably, this occurs when the cam 56 has rotated 16 degrees past the position in Fig. 1. When this sheet feeding is to be recommenced, after the feed switch is switched on by the operator, the cam 56 has to rotate till the next actuation of the proximity switch 81 before the valve 79 is actuated to release the stop 80 and allow the cam follower 58 to follow the cam 56. As is known, this prevents incomplete feeding of a sheet when feeding is recommenced.

According to the present invention, the timing for the ink rolls 16 engaging and disengaging the print cylinders 18 of the plurality of printing sections 12, 13 *etc.* is effected sequentially. The preferred way of doing this is by a timing device in the form of a rotary switch box 82 driven by a drive 84 from a convenient element of the printing press, *e.g.* a part of the gearing arrangement 62. The switch box 82 contains a plurality of switches, phased apart rotationally, which actuate relays controlling air valves operating the air cylinders 34.

Fig. 2 shows in more detail how the rotary switch box 82 is driven from the gearing arrangement 62. This gearing arrangement contains a gear box for driving the cam 56 (Fig. 1) and a separate transmission gear box 86 for intermittently driving the feed belts. This gear box 86 is mounted in the frame structure 88 of the feed section 10. An input shaft 90 is continuously rotated via a pulley 92 and timing belt 94 from a pulley 96 driven from the main drive of the printing press. Below the gear box 86, the switch box 82 is mounted on a cross beam 98 of the frame structure 88. A small pulley 100 secured on the outer end of the input shaft 90 drives, via a timing belt 102, an input pulley 104 secured on a drive shaft 106 of switch box 82. The shaft 106 is rotated at the same rpm as the transmission input shaft 90 and also as the print cylinders 18 (Fig. 1).

Fig. 3 is a simplified perspective view of the main elements of the rotary switch box 82. The drive shaft 106 is journalled in and extends the length of the switch box 82, the ends of the shaft 106 protruding through the casing of and from the switch box 82. The input pulley 104 (Fig. 2) is keyed on one of these protruding shaft ends. Two electronic rotary cam switches 108 are illustrated, one for each of the printing sections 12, 13, but more such cam switches 108 can be positioned along the shaft which can extend as indicated in broken lines. For four printing sections there would be four switches 108, for six printing sections six switches 108 would be employed. Each cam switch 108 has a cam disc 110 made up of two semi-circular-like segments 112, 114 locked in position between a pair of hexagonal nuts 116. By loosening and then tightening these nuts 116, the arcuate gap or slot through the composite cam disc 110 can be adjusted as to both arcuate size, and rotational position relative to the shaft 106. The arcuate gap is readily adjustable from 1 to 180 degrees. For the preferred embodiment, this arcuate gap 118 is adjusted to about 7 degrees, as shown in Fig. 4. Each composite cam disc 110, as it rotates, passes through an electronic photocoupler 120. Each photocoupler 120 is U-shaped with two up-

right legs 122, 124. A light source 126 is mounted in the leg 122 and projects a light beam at a photocell 128 mounted in the opposite leg 124. When the composite cam disc allows light to pass, the electronic circuitry of the cam switch 108 produces an output voltage; when this light is blocked, no output is produced. Thus, with the narrow slot 118 as shown in Fig. 4, each revolution of each cam disc 110 produces an output pulse. The angular positions of all the composite cams are adjusted on the shaft 106 so that the series of cam switches 108 produce output pulses in a controlled and timed sequence, one for each printing section as will be explained later. The shaft 106 carries, adjacent one end, a timing wheel 130 marked in increments of degrees from 0 to 360 degrees. A timing pointer 132 is secured via a bracket 134 on the casing of the switch box 82, and extends over the scale on the wheel 130 parallel to the axis of the shaft 106. After the angular position of the wheel 130 has been calibrated on the shaft 106 (using a lock nut) so that zero degrees corresponds to machine zero (which is the relative positions of cam 56 and print cylinders 18 shown in Fig. 1), the angular positions of the composite cam discs 110 can be accordingly set to enable the correctly timed output pulse to be sent to each printing section 12, 13, *etc*. The first disc slot 118, for the first printing section 12, is angularly calibrated, or timed, 125.2 degrees before machine zero for a 66 inch (168 cm) cycle press, *i.e*. 198.8 degrees less 73.6 degrees (angle at inking position 154 less angle A). Each subsequent disc slot 118 for each subsequent printing section 13, *etc*. is then angularly phased 147.3 degrees after the disc slot 118 of the preceding printing section.

A suitable rotary switch box having electronic rotary cam switches 108 is marketed by Electro Cam Corp of 13647 Metric Road, Roscoe, Illinois 61073, U.S.

Fig. 5 is an electrical schematic illustrating the connection of the rotary cam switches 108 (referenced 108(1), 108(2), 108(3), 108(4) for four printing sections) to operate relays 136(1), 136(2), 136(3), 136(4) controlling operation of air valves which actuate the air cylinders 34 in Fig. 1 for moving the ink rolls 16 into and out of inking contact with the print cylinders 18, the two printing sections 12, 13 in Fig. 1 now being extended to four printing sections.

The cam switches 108(1), 108(2), 108(3) and 108(4) are all mounted on the switch shaft 106 as in Figs. 3 and 4. Each of the four printing sections 12, 13 *etc*. has its respective relay 136(1), 136(2), 135(3), 136(4) for actuating the air valves for extending and contracting the air cylinders 34, relay 136(1) being for the first printing section 12, relay 136(2) being for the second printing section 13, and relays 136(3) and 136(4) being for the third and fourth printing sections in the feed direction 38 in Fig. 1. Each printing section has its own control sub-panel containing a programmable logic controller (PLC) respectively 138(1), 138(2), 138(3), 138(4) for the first to fourth printing sections. The four PLC's are connected by lines 140 to a common supply voltage line 142. Each of the cam switches 108 is connected between the common supply line 142 and the respective PLC. Outputs from the four PLC's 138(1), 138(2), 138(3), 138(4) are fed respectively to the air valve relays 136(1), 136(2), 136(3), 136(4) connected between the respective PLC and a common neutral line 144. The PLC of the first printing section 12 has two additional inputs, one along line 146 from feed switch 148 controlling operation of the sheet feed section 10 (Fig. 1), and the other along line 149 which energizes a feed relay 150 also controlled by the feed switch 148 via time delay circuitry. The feed relay 150 controls and is part of the air valve 79 (Fig. 1). This relay 150 is energized when the feed switch 148 has been turned on; in this way, when feeding of sheets by the feed section 40 is to be stopped, the manual opening of the feed switch 148 subsequently de-energizes the relay 150 to cause the air cylinder stop 80 in Fig. 1 to extend and de-activate the pivoted arm 60 to hold the cam follower roller 58 off the cam 56. Upon closing the feed switch 148 to start feeding sheets, there is a time delay until the cam actuator 83 next actuates the proximity switch 81 (Fig. 1), before the line 149, and so the feed relay 150, are energized to allow the cam follower 58 to follow the cam 56 to feed sheets. This time delay enables the first printing section switch 108(1) to have a "negative" timing, thus causing the ink roll 16 to move into printing contact with the first section print cylinder 18 a portion of one revolution of the cam 56 before the arm 60 starts pivoting to feed the first sheet 42. Also, the second, third and fourth PLC's receive a sequentially timed input from the immediately preceding PLC via line 152(2), 152(3), 152(4), respectively.

In operation, even though the shaft 106 is being driven by the transmission gear box 86 (Fig. 2), if the feed switch 148 is in the Off position, there is no input to PLC 138(1) on the feed relay input line 149 and there are no outputs along the PLC interconnecting lines 152(2, 152(3), 152(4). In this situation, no voltage is applied to the air valve relays 136(1), 136(2), 136(3), 136(4) so that the air cylinders 34 are in their contracted position with the ink rolls 16 spaced from and out of contact with their respective print cylinders 18. Thus, no sheets are fed and the printing dies 26 are not inked.

When the feed switch 148 is closed, there is a delay before a first cycle for feeding the awaiting bottom sheet 42 commences. As previously ex-

plained, the proximity switch 81 is actuated just after the cam 56 passes through the radial position 70 which corresponds to the machine zero position for synchronization of fed sheets. As the lead edge of the sheet 42 only has to travel the distance from the nip 50 of the feed rolls 52, 54 to the nip between the first section print cylinder 18 and impression roll 20 after the cam 56 has passed the zero position 70, the first section print cylinder 18 needs to have inking commence before the machine zero position. The first section air cylinder 34 needs to cause its ink roll 16 to engage the first print cylinder 18 at the gap 28 between the ends of the printing die 26, before the stop 80 allows the arm 60 to become active to feed the sheet 42. The first printing section rotary cam disc 110 is angularly set before machine zero so that the first section air cylinder is actuated via the relay 136(1) to bring the first section ink roll 16 into the inking position for printing when die gap 28 is at the ink transfer point 154; this occurs during the last revolution of the cam before the cam 56 reaches the machine zero position 70, with the first sheet being in the process of being fed by the feed mechanism 64 during the last part of this revolution. The remaining cam switches 108(2), 108(3), 108(4) are each relatively angularly set so that sequentially the next time the die gap 28 of the next printing section reaches the ink transfer position 158 *etc.*, the respective ink roll 16 is moved into its die inking position. In this way, as the leading edge of the first fed sheet 42 is fed along and through the printing press, it is in register with the leading edge of a printing die 26 which has just been inked for the first time since printing previously was stopped or interrupted.

When the first section cam switch 108(1) produces an impulse as its slot 118 passes its light source 126, and the feed switch 148 has been closed, this short impulse cause the first PLC 138-(1) to provide a continuous output to latch On the relay 136(1). This relay stays latched On until the feed switch 148 is opened again. Once the relay 136(1) is latched On, the first PLC 138(1) provides an output on line 152(2) which enables the next impulse from the second section cam switch 108(2) to latch On the second section relay 136(2) via the second PLC 138(2). This in turn, in timed sequence, then causes the relay 136(3) to be latched On and finally the fourth section relay 136(4) to be latched On. Thereafter, as long as the feed switch 148 is closed, the PLC's continue to keep all the relays 136(1), 136(2), 136(3), 136(4) continuously latched On, and inking of all printing sections is effected continuously as in a normal printing run.

However, as soon as the feed switch 148 is opened, the feed relay 150 is energized after completion of feeding the stack bottom sheet 42 to the nip 50, whereupon the feed section 10 stops feeding sheets. That is, the cam actuator 83 has to pass the proximity switch 81, after the feed switch 148 is opened, before sheet feeding stops. This bottom sheet 42 entering the nip 50 is then still fed to and through the first printing section by the feed rolls 52, 54 which continue to run. With the feed relay 150 now de-energized, upon the next pulse from the first section cam switch 108(1), the first PLC 138(1) unlatches the relay 136(1) and the ink roll 16 of the first section moves out of inking contact with the first section print cylinder 18. This occurs as the die gap 28 reaches the ink transfer point 154, so that after the first section die 26 completes printing the last fed sheet 42, no more ink is transferred to this printing die. Once the relay 136(1) is de-energized, the first PLC 138(1) changes the signal via line 152(2) to the second PLC 138(2); this in turn causes the second section relay 136(2) to be de-energized upon the next pulse from the second section cam switch 108(2). This in turn removes the ink roll 16 from the print cylinder 18 of the second section 13 as the die gap 28 reaches the ink transfer point 158. Thus, as the last fed sheet 42 passes the second section print cylinder in contact therewith, this sheet 42 is printed by the inked second printing die 26, but thereafter inking of this second section die 26 ceases. The relays 136(3) and 136(4) are similarly sequentially unlatched as signals change on lines 152(3) and 152(4), so allowing printing of the last sheet 42 to be completed at the third and fourth printing sections,but thereafter sequentially ceasing any further inking of the printing dies of these sections.

It will be appreciated, therefore, that in accordance with the invention, upon starting feeding of sheets, each printing die is only inked immediately before the first fed sheet contacts it. Thus, over inking of the first and subsequent sheets is avoided, while correct multi-stage printing of the first and subsequent sheets is also ensured. Further, in accordance with the preferred arrangement of the invention, upon stopping the feeding of sheets, the last sheet fed is correctly printed at each printing station, but no printing die is further inked after it has printed this last sheet. In this way over-inking of any of the initially fed sheets is avoided, and incomplete printing of the last fed sheets at the end of a run is also avoided.

To avoid inking the printing dies 26 if the stack of sheets 40 runs out unnoticed, a sheet sensor 160 may be placed under the position of the stack 40 as shown in Fig. 1. This sensor 160 can be a photoelectric sensor unit or a pressure (or contact) sensor. When the sensor 160 senses at least one sheet above it, printing will take place as described above. However, as soon as the sensor senses no sheet above it, it provides a signal to the first

section PLC 138(1) the same as if the feed relay 150 had been de-energized; this then sets in motion the above described sequential disengagement of the inking rolls 16 so that the last fed sheet is fully printed, but the printing dies are not further inked.

Fig. 6 illustrates the timed sequential operation of the feed switch 148, the feed lift cam 56, the rotary switches 108, and the air cylinders 34 via the relays 138 to activate or de-activate the ink rolls 16, when a single sheet is fed through the printing press, and also when a new run of sheets is fed through. The vertical axis is marked with eleven items, and the operation in time of each item is extended horizontally.

The top line labelled FEED SWITCH shows the feed switch 148 (Fig. 5) being switched On for a short period time and then switched Off to enable just a single sheet to be fed. Thereafter, the feed switch is shown switched On again and left On for a new run of sheets to be fed through the press and printed.

The second line labelled ZERO TIMING shows each time the actuator 83 on the cam 56 passes through the machine zero position 70, these zero timing positions being also referenced 70. Shortly after each zero timing position 70, a pulse 162 is shown which comes from the stationary proximity switch 81 each time this is passed by the moving actuator 83. The feed circuit connected to the proximity switch 81 also senses whether the feed switch 148 is on or off as each pulse 162 occurs - this sensing is schematically indicated by a broken line 164.

The third line labelled FEED OUTPUT shows when the follower roller 58 is free to follow into the cam dwell 68 so rendering the feed mechanism operative to feed sheets (by raising the feed belts each time the follower 58 is in the dwell 68). When a pulse 162 occurs and the feed switch 148 is closed (*i.e.* On), then the relay 150 of air valve 79 is latched On to allow sheet feeding; but, when a pulse 162 occurs and the feed switch is open (*i.e.* Off), then the latching output ceases and the relay 150 causes the air cylinder 80 to discontinue the sheet feeding by preventing lifting of the feed belts. As can be seen, as soon as a timing pulse 162 (see second line) senses the feed switch is On (see first line), the latching output occurs for sheet feeding; but as soon as a subsequent timing pulse 162 senses the feed switch is Off, the latching output ceases and sheet feeding is discontinued.

The fourth line shows the pulsing output from the rotary switch 108(1) of the first printing section 12. The first section PCL 138(1) senses whether or not the feed output (see third line) is latched On each time a pulse 166 issues from first section switch 108(1), this sensing being indicated by broken lines 168.

The fifth line shows when the ink roll 16 of the first section 12 is operational, *i.e.* in inking engagement with the first section print cylinder 18. As can be seen, as soon as a switch pulse 166 finds the feed output latched On (via sensing 168), the first ink roll 16 engages and starts inking the first section print cylinder 18. Conversely, instantly the sensing 168 detects the feed output has ceased, *i.e.* is Off, the first ink roll 16 is disengaged from and stops inking its associated print cylinder 18.

The sixth line shows the pulses 170 from the second rotary switch 108(2) and the sensing 172 via the second section PLC 138(2) whether the first printing section ink roll 16 is inking or disengaged from inking.

The seventh line shows when the second print section ink roll is inking or disengaged from inking, such inking commencing instantly the sensing 172 senses the first section ink roll is inking; and such disengagement from inking occurring instantly the sensing 172 detects that the first section ink roll has been disengaged.

The next two lines show the pulses 174 from the third section switch 108(3), and the operative or inoperative position of the ink roll 16 of the third printing section. The broken lines 176 indicate the sensing of the position of the second section ink roll at each third section timing pulse 174.

Similarly, the last two lines show the pulses 178 from the fourth section switch 108(4), and the position of the fourth section ink roll, with the broken lines 180 showing the sensing of the third section ink roll at each pulse 178 to control the position of the fourth section ink roll.

The left portion of Fig. 6 starts with the feed switch, and the feed output, being off. The feed switch is then turned On and Off to allow a single sheet to be fed. It can clearly be seen how the ink rolls of the successive printing sections are sequenced in timed controlled relation into inking position for the printing of this sheet, and then successively returned to their non-inking position as the sheet is being printed in the respective section. The passage of the single sheet 181 through the four printing sections, as it is printed in each respective section, is illustrated by the broken line 182. In this respect, note that the inking roll is disengaged while the printing plate just inked thereby is still in the process of printing the sheet.

The right portion of Fig. 6 shows the feed switch again switched On and then left On for continuous printing of a new run of sheets through the printing press. The passage of the first sheet 183 of this new run through the four printing sections is illustrated by the broken line 184.

It will be appreciated, therefore, that whether a single sheet or a continuous run of sheets is fed

through the printing press, the printing die of each printing section is inked just before the first sheet passes through that section for printing, so avoiding over-inking of any die, and also avoiding any incomplete printing of the sheet by the first (or only) printing section.

It will also be appreciated, that when printing or sheet feeding is to be interrupted, each printing plate continues to be inked until it has printed the last sheet, but after printing the last sheet is not inked further. Thus, no unprinted sheets occur at the end of the run; and with multistage printing, the end sheets of the run, including the last sheet, are all properly and completely printed by every printing section.

Thus, waste of sheets at the beginning and end of each printing run is avoided, even when the printing run is temporarily or inadvertently stopped. Further, and most importantly, over inking of any printing die at the beginning of printing is avoided.

With reference to Fig. 5, it should be noted that if one or more printing sections are removed - even center sections - then the inter-section signal line 152 (2, 3 or 4) from the preceding section's PLC connects to the next section's PLC is always connected as the top input thereto. In this way, correct sequencing of the starting and stopping of inking through whatever printing sections are present is obtained; each printing die gets inked once before printing and is not inked after it has printed its last sheet. Also, once the rotary switches 108 have been angularly timed relative to each other, regardless of how many there are, then the correct sequential timing through a plurality of printing sections is obtained simply by plugging the correct numbered rotary switch to the printing section occupying that numbered position. If there are less printing sections than rotary switches, then the excess rotary switches are left unconnected.

The above described embodiments, of course, are not to be construed as limiting the breadth of the present invention. Modifications, and other alternative constructions, will be apparent which are within the scope of the invention as defined in the appended claims.

For example, the timing switches or devices may conveniently comprise a resolver or an encoder having a rotatably driven input member and producing a series of counts, pulses or signals each 360 degrees of rotation. Selected signals during each 360 degree cycle can be arranged, preferably via a computer, to produce the appropriate outputs to control all the relays 136. In this way, one resolver or encoder could contain all the timing switches 108 for all the printing sections 12, 13 *etc.*

Claims

1. A printing apparatus, characterized by:

a frame structure;

a rotatably driven print cylinder supported in said frame structure and rotating once per machine cycle during operation;

an ink roll rotatably mounted in said frame structure for inking said print cylinder;

moving means for relatively moving said ink roll and said print cylinder into and out of engagement with each other;

a feed section for feeding sheets to said print cylinder to be printed thereby;

a feed switch for switching on said feed section to feed sheets and for switching off said feed section to stop feeding sheets;

a timing device operated in synchronization with said print cylinder and generating an output pulse each machine cycle;

a controller actuated by said output pulse when said feed switch is switched on to control said moving means to effect engagement of said ink roll and said print cylinder.

2. The printing apparatus of Claim 1, wherein after the switching on of said feed switch with said ink roll and said print cylinder out of engagement with each other, the next said pulse causes said controller to effect engagement between said ink roll and said print cylinder, and then later when said feed switch is switched off the next subsequent pulse causes said controller to effect disengagement between said ink roll and said print cylinder.

3. The printing apparatus of Claim 1 or 2, wherein said timing device is a timing switch comprising a rotated disc having a slot, a light source, and a photocell.

4. The printing apparatus of Claim 3, having a plurality of print cylinders and associated ink rolls, and wherein said timing switch has a plurality of slotted discs all mounted on a common rotated shaft with the slotted discs angularly orientated with respect to each other about said shaft.

5. The printing apparatus of Claim 1, comprising:

a plurality of print cylinders and associated ink rolls;

a plurality of moving means for relatively moving the print cylinders separately into and out of engagement with their associated ink rolls;

a plurality of timing devices generating output pulses;

the print cylinders and their associated ink

rolls being disposed one after the other in series to print successively each sheet fed by said feed section; and

said timing devices being angularly timed with respect to each other to effect sequential engagement of said print cylinders and their associated ink rolls after said feed switch is switched on.

6. The printing apparatus of any one of Claims 1 to 5, wherein said feed section has a continuously driven cam, a cam follower actuated by said cam, and disabling means for disabling said cam follower by preventing said cam follower following said cam, the switching on and off of said feed section by said feed switch actuating said disabling means to render said cam follower operative or inoperative.

7. The printing apparatus of Claim 6, comprising sensing means for sensing a predetermined position of said cam, said sensing being interconnected with said disabling means to delay said cam follower becoming operative when said feed switch is switched on until the next predetermined position of said cam is sensed, and said controller not being actuated by said output pulse until said next predetermined position of said cam has been sensed.

8. The printing apparatus of Claim 7, wherein said sensing means comprises an actuator on said cam and a proximity switch adjacent said cam.

9. The printing apparatus of any one of Claims 1 to 8, wherein said ink roll is rotatably mounted in a cradle pivotally supported in said frame structure, and the moving means comprises an air cylinder operative upon said cradle.

10. A method of starting a printing run of sheets with a rotary printing press having a plurality of successive printing sections each having an ink roll and a print cylinder movable into and out of inking engagement, characterized by the steps of:

running the printing press without sheets being fed and with each ink roll out of inking engagement with its associated print cylinder;

moving the ink roll and print cylinder of each printing section into inking engagement with each other in timed relation one after the other upon initiation of sheet feeding for feeding a first sheet of the run of sheets;

printing the first sheet successively by each printing section; and

said first sheet reaching each printing section and printing by that printing section commencing just as the print cylinder of that printing section is inked for the first time for this printing run.

11. The method of Claim 10, wherein after said first sheet, sheets are successively fed through the printing press.

12. The method of Claim 11, wherein upon stopping feeding of said successively fed sheets, the ink roll and print cylinder of each printing section move out of inking engagement with each other one after the other in the same timed relation as they engaged each other in said moving step.

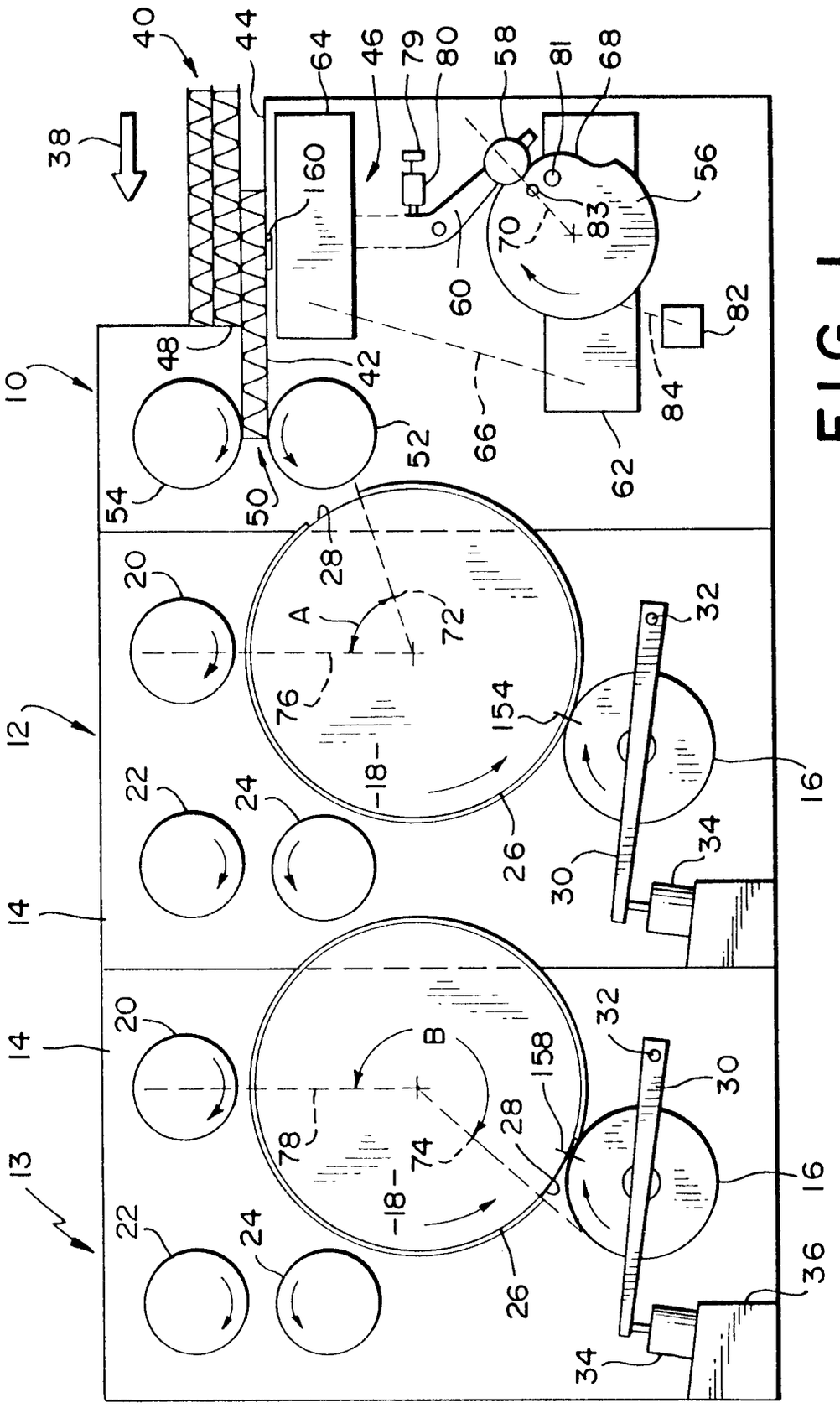
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FIG. 1

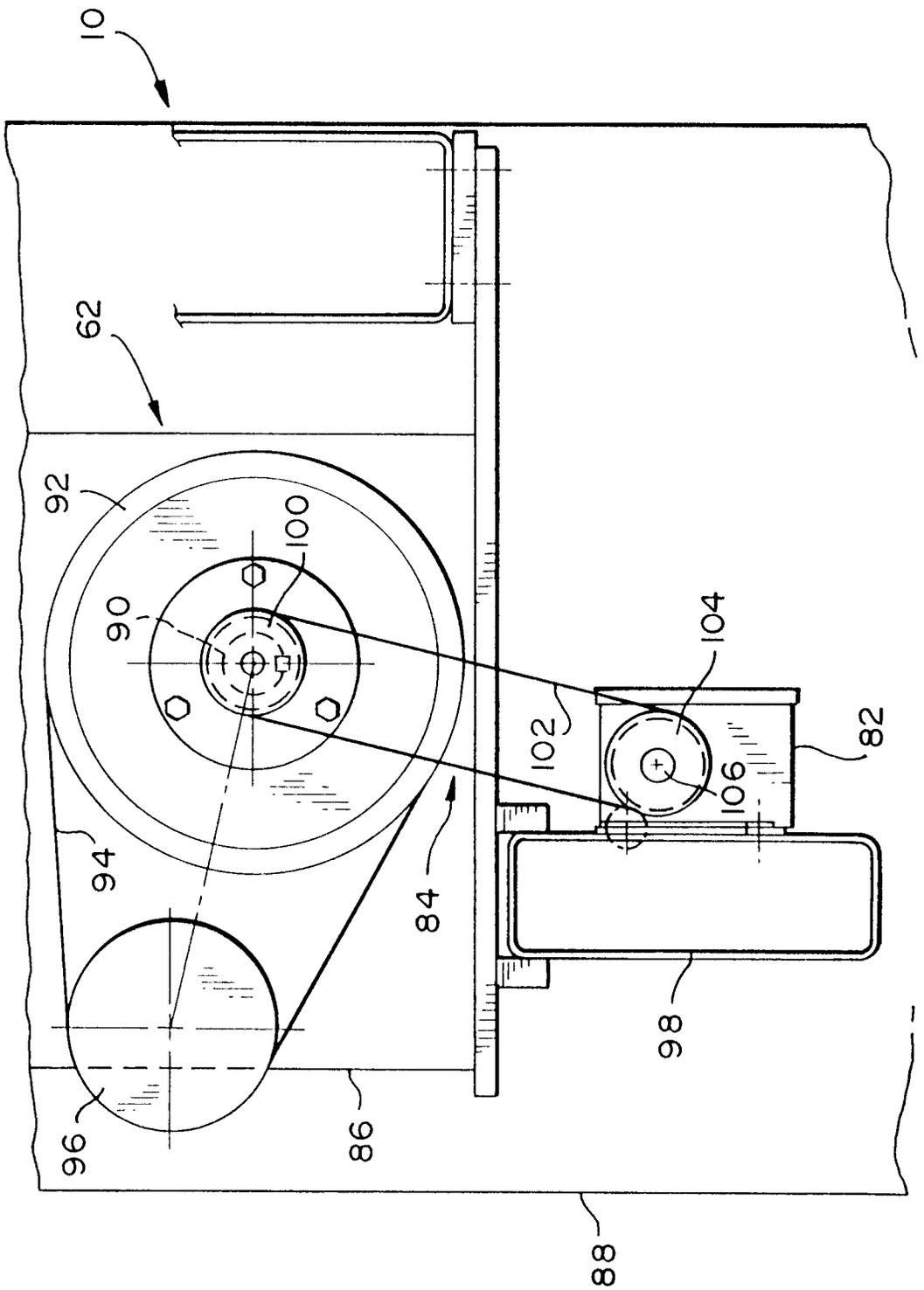
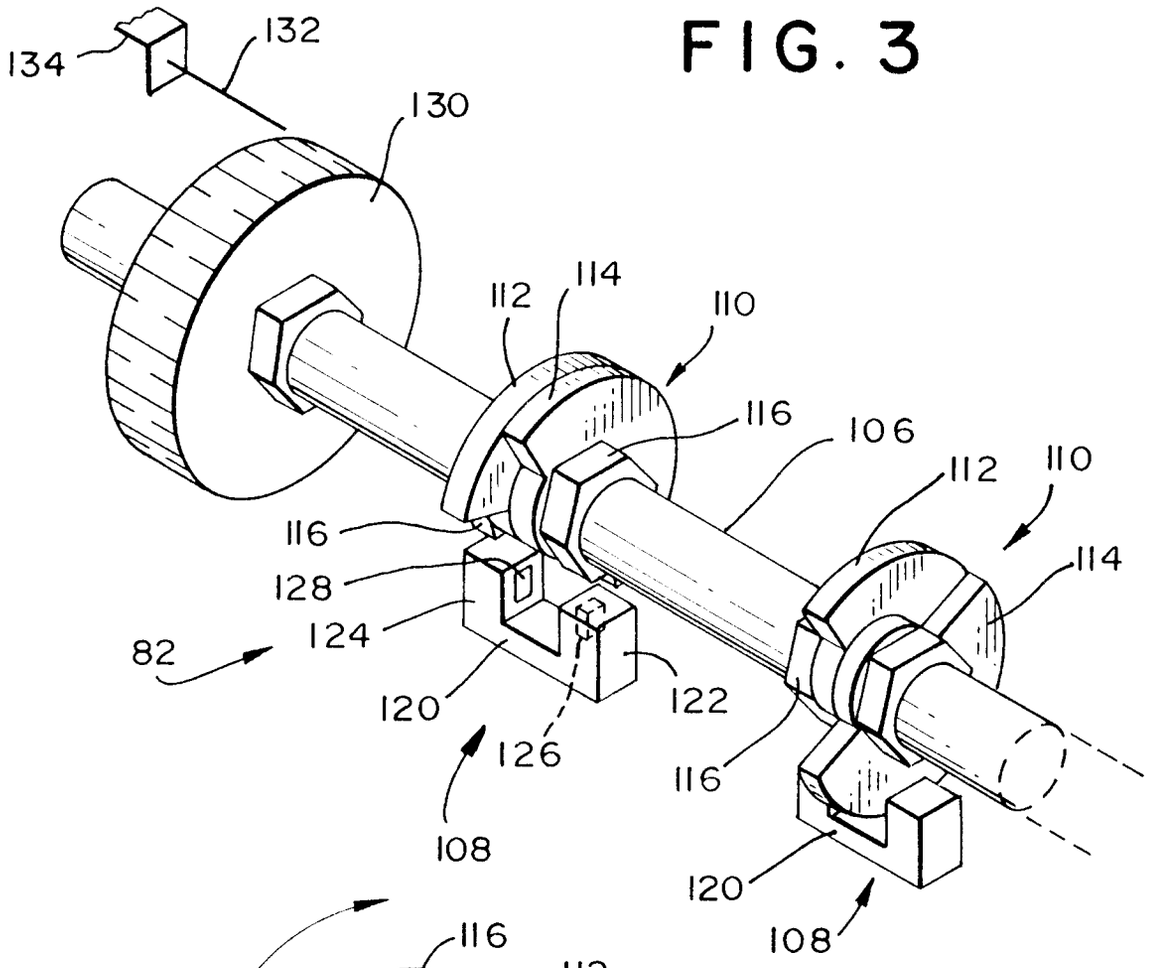


FIG. 2

FIG. 3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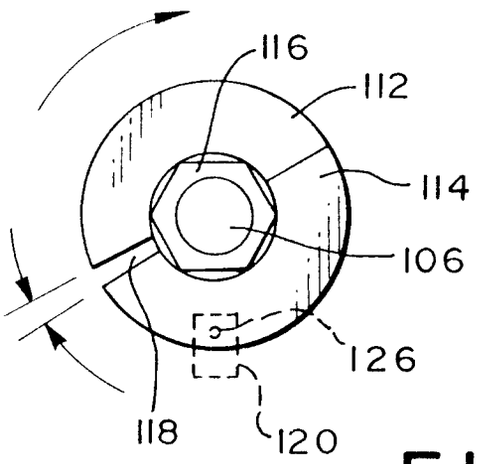
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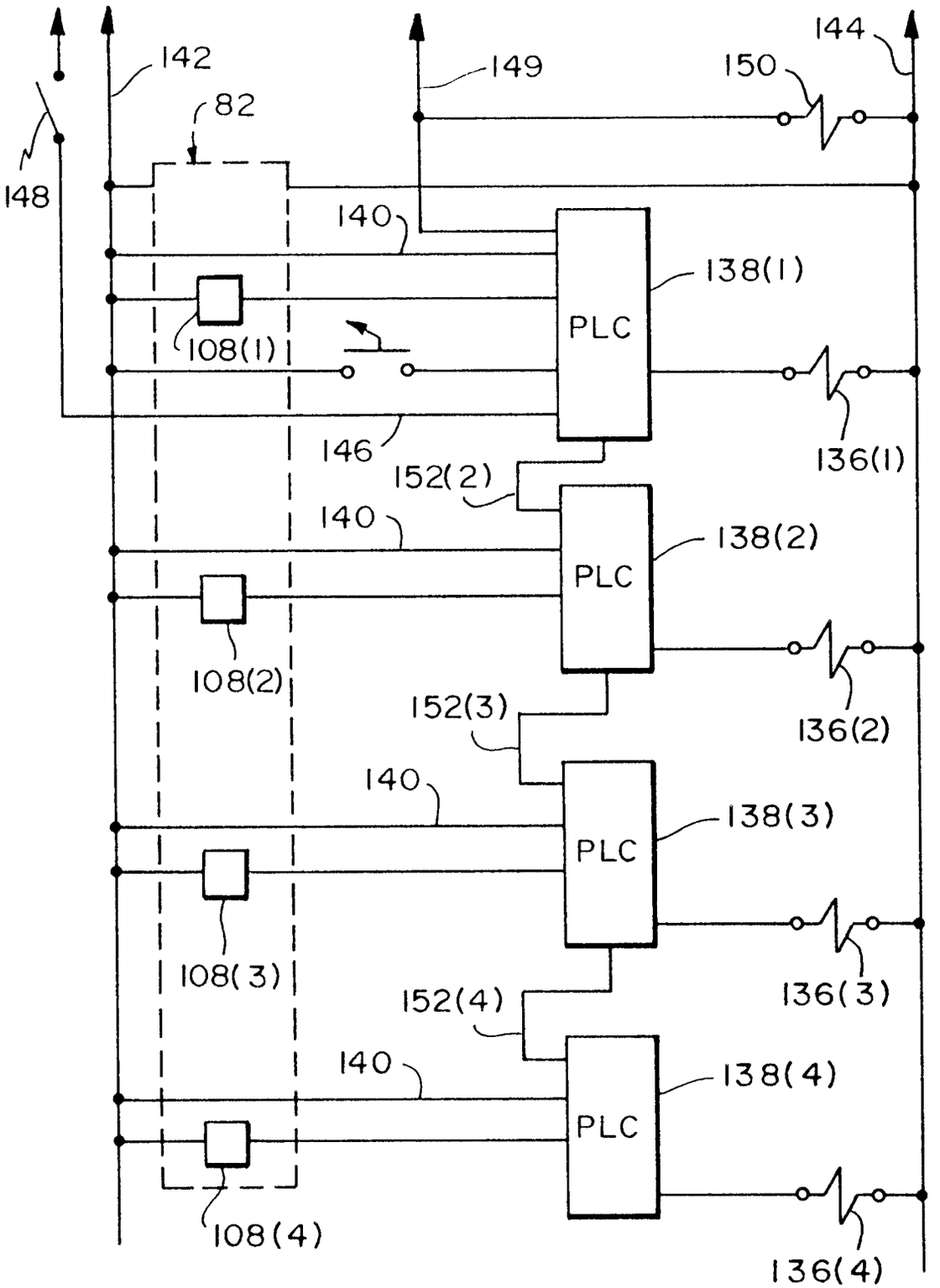
FIG. 4

FIG. 5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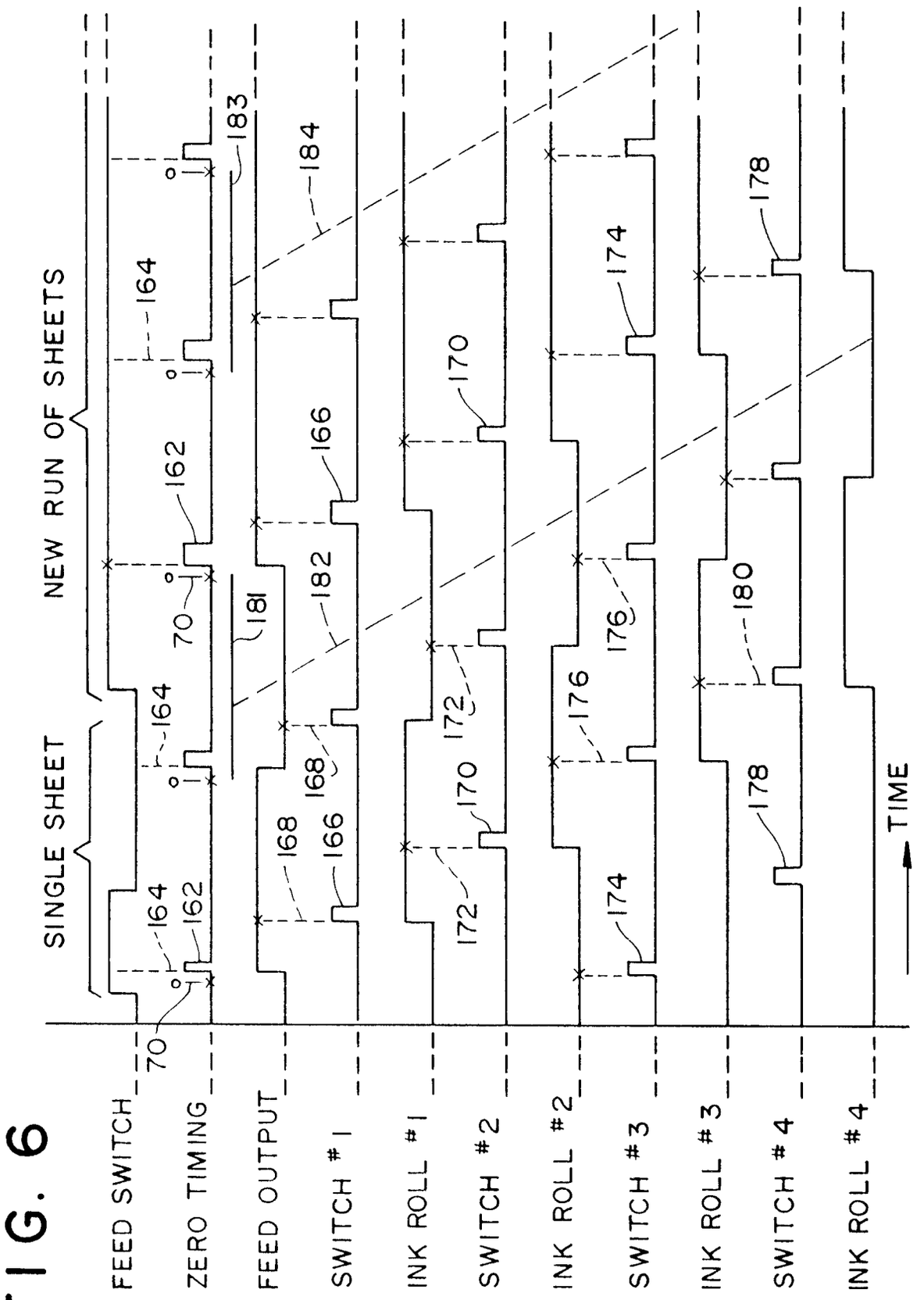
140
138(4)
PLC
108(4)
136(4)

FIG. 6


SINGLE SHEET
NEW RUN OF SHEETS
FEED SWITCH
ZERO TIMING
FEED OUTPUT
SWITCH #1
INK ROLL #1
SWITCH #2
INK ROLL #2
SWITCH #3
INK ROLL #3
SWITCH #4
INK ROLL #4
TIME
70
162
164
166
168
170
172
174
176
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180
181
182
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184

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 30 9477

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	EP-A-0 382 347 (THE WARD MACHINERY COMPANY) * figure 1 * ---	1,10	B41F33/10 B41F31/36
D,A	US-A-4 867 433 (WELLS; VAN NOY; BACHMANN, JR.) * the whole document * -----	1,10	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B41F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	27 MARCH 1992	MADSEN P.

CATEGORY OF CITED DOCUMENTS

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