

Sept. 11, 1956

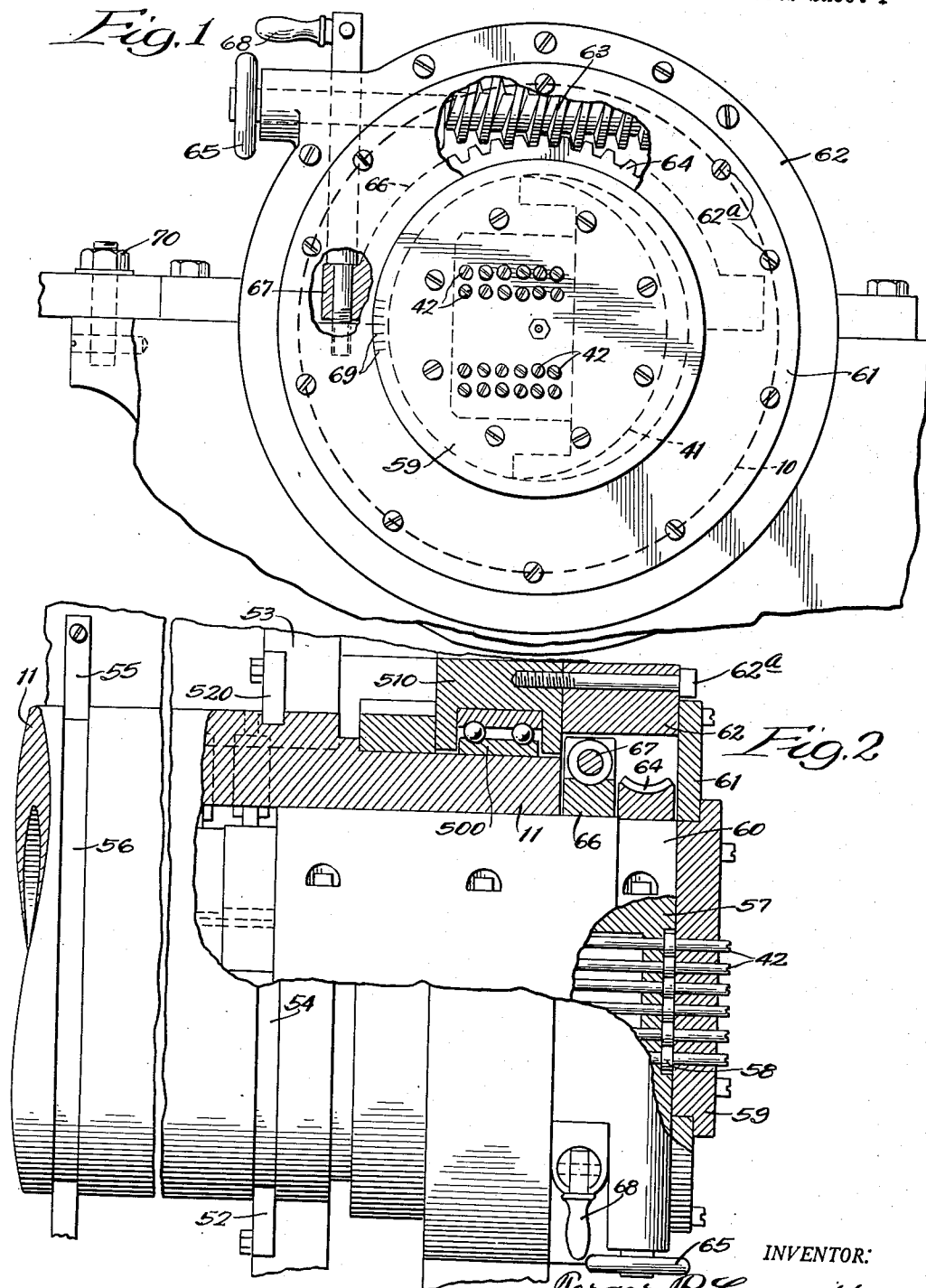
T. R. CORNELL

2,762,301

MECHANISM FOR FEEDING AND DISTRIBUTING INKS AND OTHER FLUIDS

Filed April 13, 1951

5 Sheets-Sheet 1



BY *Dawson, Connors, Brith and Spangenberg,*
ATTORNEYS.

2,762,301

Filed April 13, 1951

5 Sheets-Sheet 2



Sept. 11, 1956

T. R. CORNELL

2,762,301

MECHANISM FOR FEEDING AND DISTRIBUTING INKS AND OTHER FLUIDS

Filed April 13, 1951

5 Sheets-Sheet 3

Fig. 5

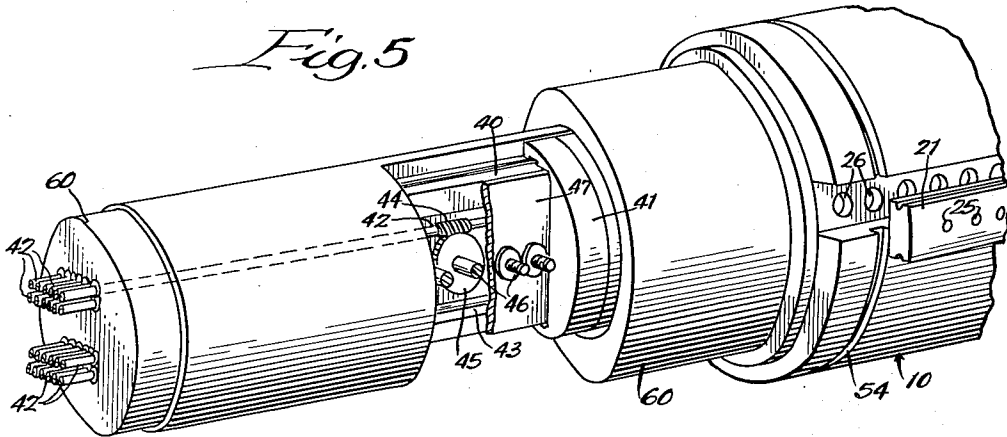


Fig. 6

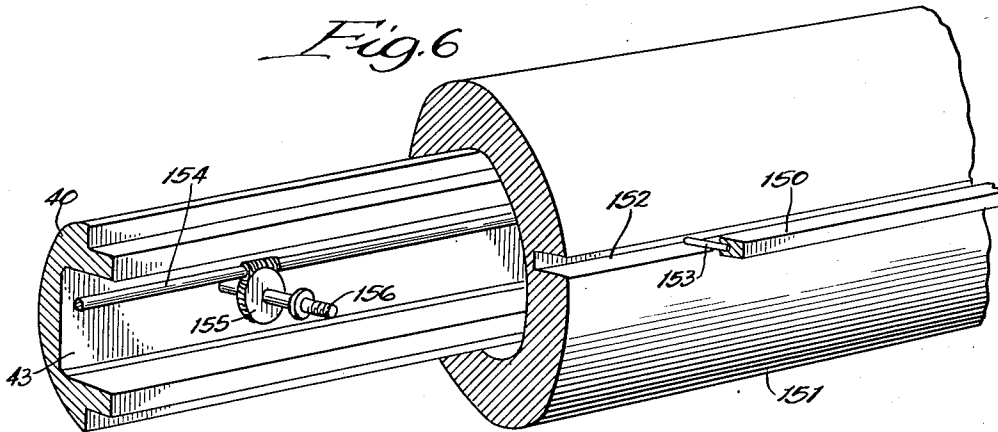
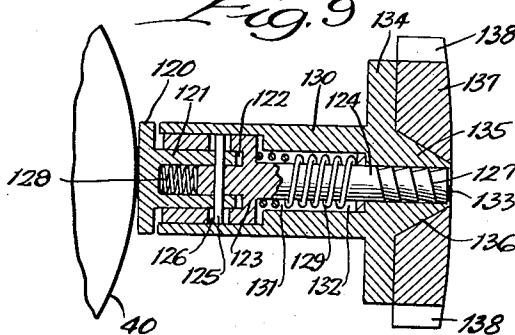


Fig. 9



INVENTOR:

Forger R. Cornell,

BY *Duvern, Orms, Barth and Spangenberg,*
ATTORNEYS.

Sept. 11, 1956

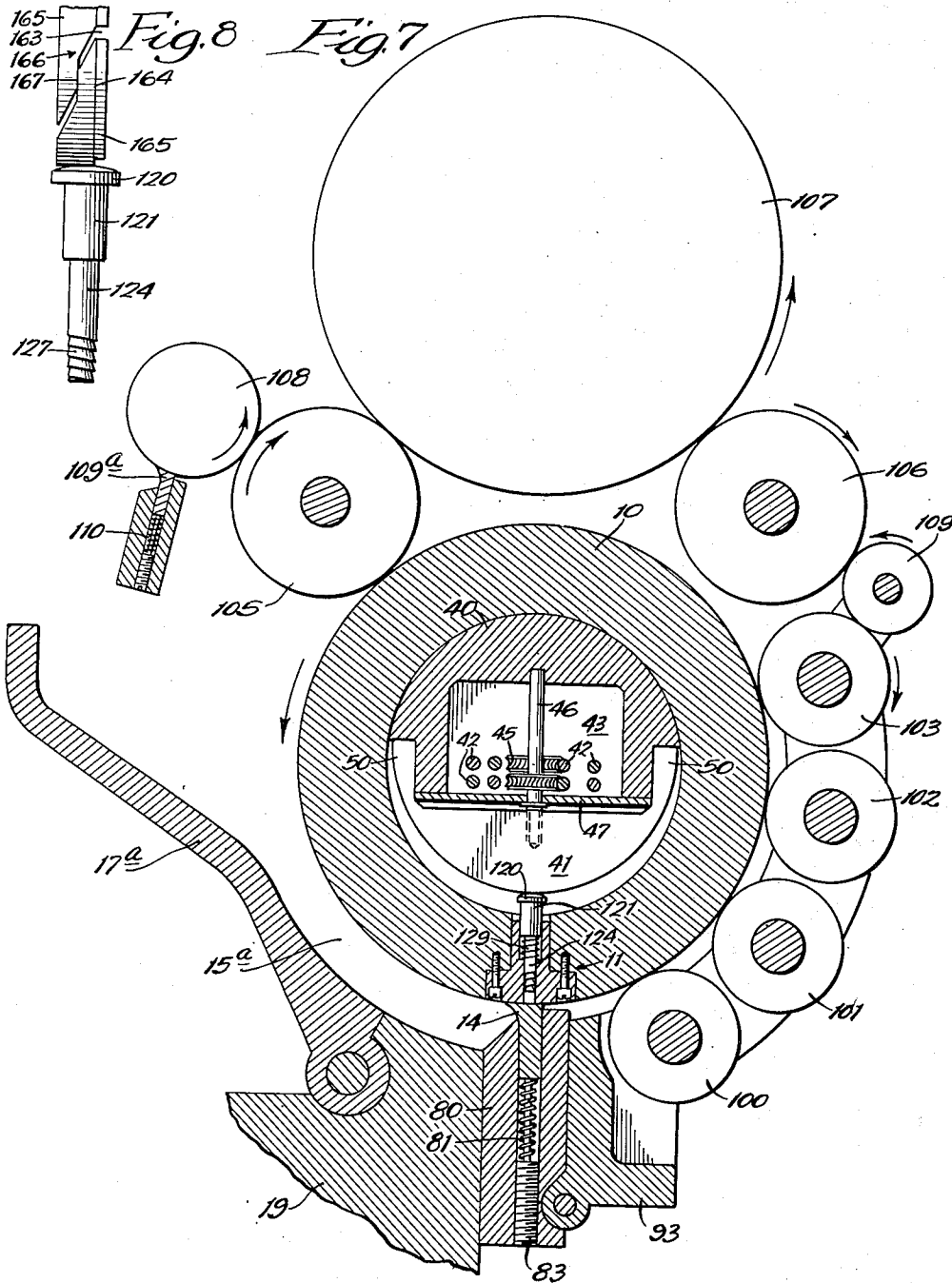
T. R. CORNELL

2,762,301

MECHANISM FOR FEEDING AND DISTRIBUTING INKS AND OTHER FLUIDS

Filed April 13, 1951

5 Sheets-Sheet 4



INVENTOR:

Forger R. Cornell,

BY *Dawson, Criss, Brith and Spangenberg,*
ATTORNEYS.

Sept. 11, 1956

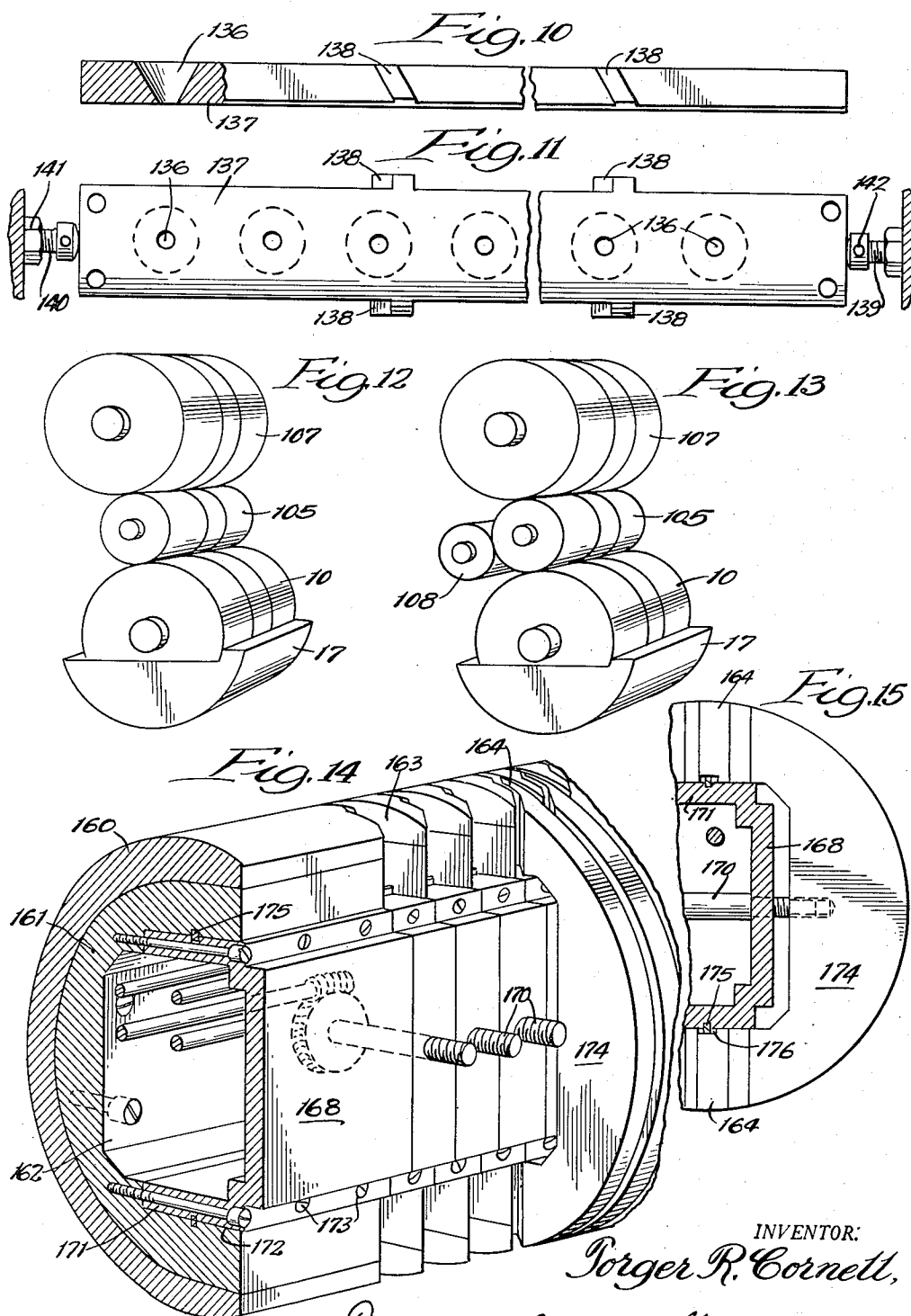
T. R. CORNELL

2,762,301

MECHANISM FOR FEEDING AND DISTRIBUTING INKS AND OTHER FLUIDS

Filed April 13, 1951

5 Sheets-Sheet 5



INVENTOR:

Forger R. Cornell,

BY *Dunsm, Conn, Brith and Spangenberg,*
ATTORNEYS.

1

2,762,301

MECHANISM FOR FEEDING AND DISTRIBUTING INKS AND OTHER FLUIDS

Torger Ronald Cornell, Berwyn, Ill.

Application April 13, 1951, Serial No. 220,949

19 Claims. (Cl. 101—365)

This application is a continuation-in-part of application Serial No. 153,227 entitled Inking Mechanism, filed March 31, 1950, and now abandoned.

This invention relates to a new and improved mechanism for applying substances capable of fluid flow such as water, inks, coatings, adhesives and the like onto a supporting sheet which may be in the form of a continuous web of paper. It relates particularly to inking mechanism for high speed rotary ink metering fountain and distribution mechanism for use in feeding and distributing high viscosity, fast drying or fast setting ink to a printing plate cylinder of a high speed rotary printing press.

It is an object of this invention to produce a mechanism which meters a predetermined but adjustable quantity of ink or other substance capable of fluid flow to the surface of a rotating drum and uniformly distributes the ink or other substance upon the surface of the drum for transmitting a portion thereof to a plate cylinder in an efficient manner for subsequent application onto a supporting sheet or the like.

Other objects are to provide mechanism, which overcomes inefficiencies characteristic of present inking mechanism such as, color variations which result from changing press speeds, temperature changes during operation and the presence of dirt particles or other foreign matter at point of fountain blade, because the ink becomes too tacky and dries up on rollers when insufficient ink is consumed to insure keeping the carriage moist.

Which affords a constant and even film of ink to be brought up to the form rollers and printing plate cylinder by the ink fountain drum or ink drum, the ink film being in contact with the form roller for only a single passage, the unused portion being returned to the fountain to be metered and redistributed anew onto the ink drum, thereby to minimize errors created by the usage of only portions of the form roller ink film taken up by the printing plate.

Which constantly provides an even and entirely new film of ink to the form rollers, unaffected by errors in the ink film of any preceding film contact with the form rollers.

Which returns the unused portion of the ink film on the inking drum to the ink fountain and thereby prevents flooding or the buildup of an ink film heavier than that calculated to give most efficient coverage.

Which continuously yields a fresh film of ink on the ink drum at points of margin, roller ends and spot color of printing line points, thus preventing drying of ink at these points of the printing line which are some of the undesirable features in present inking mechanism.

Which eliminates the necessity for moistening the carriages of the inking mechanism at the outset of production in order to reduce overtackiness of drying ink, which not infrequently causes breakage of the web or spoilage of work run off until the wetting material is run off.

Which prevents ink buildup or dryup on the ends of

2

the rollers because of the return of unused portions of the ink from the surface of the inking drum back into the ink fountain;

Which prevents buildup of ink film on distributors and form rollers greater in thickness than the metered film on the ink fountain drum since the inking mechanism automatically carries back into the fountain a portion of the contacted film of like consistency in the event that it is greater than the metered film;

Which may be adjusted for working with light or heavy bodied inks in feeding metered amounts in a positive manner to high speed printing presses, and which feeds the desired amount of ink irrespective of speed or variation in speed of the printing press;

Which permits reduction in the number of working parts ordinarily used in the transmission of ink from the inking fountain to the cylinder or printing plate, and permits the use of ink distribution mechanism having a minimum number of working parts and calls for a minimum amount of ink travel and working space;

Which permits more accurate and stable color control and adjustments as a result of a positive metering mechanism in contact with distribution mechanism, characteristics which are not present in conventional ductor roller or ink rail inking systems;

Which because of the absence of one or more conventional fountain blades, eliminates the presence of color streaks caused by buckling of fountain blade or foreign matter settling at blade edge adjustment;

Which because of the absence of conventional ductor rollers eliminates possible variation in color because of variation in ductor roller applications resulting from changes in ink consistencies and variations in ductor roller speeds and press speeds.

Which permits the use of a number of different colors to be used in one fountain through the use of fountain dividers which are impractical with the present ink rail mechanisms;

Which system of inking provides an almost perfect film of ink to the form roller, and theoretically would not require any individual adjustments but which are provided with means for adjustment to take care of inadvertent error or necessary color variations required to meet matching of color progressives.

Which makes it possible for ink feed and ink distributor rollers both to have travel or surface speeds corresponding to that of the printed web or printing plate;

Which, because of the return of unused portions of the ink to the fountain and the provision of a newly metered quantity of ink onto the surface of the inking drum, provides for the substantial elimination of errors, ghosting or undesirable variability of ink film across or around the press;

Which permits adjustment of ink film on the inking drum for individual columns to be printed and which permits simultaneous adjustment of all the ink film across the entire inking drum;

Which permits positioning the ink fountain in practically any position in the feed system;

Which, in operation provides for sufficient mixing and mastication of the ink in the ink fountain to prevent hardening, gelling, lumping, settling or unequal distribution, and places the ink in better condition for trapping and operation in the metering pump mechanism;

Which, in operation, builds up forces within the ink fountain that assists in the efficient and uniform operation of the feed mechanism;

Which reduces the need for a plurality of distributing roller branches and permits a film of ink to be transmitted almost directly from the inking drum to the printing plate through a single form roller without loss of

uniformity while decreasing the possibility of error and ghosting:

Which permits repair or replacement of parts to be effected in a simple and efficient manner, and which permits cleansing of feed mechanism and operating parts to be effected quickly and without the need for disassembly of parts:

Which may be installed as a conversion unit in standard equipment and ink distributing system to give more exacting color control at high speeds, especially with heavy bodied inks, such as heat set or fast drying inks:

Which can be used on new equipment as a complete inking mechanism to give more exacting color control at higher press speeds with heat set, heavy bodied or fast drying inks: and

Which can be employed in new equipment as a complete carriage within itself to give more exacting color control particularly in a system wherein the peripheral travel of the inking drum and the amount of ink metered to the inking drum will correspond to the speed of the press and wherein ink distribution is effected on the surface of the inking drum by means operative therewith such that the unit may be made more compact and require less parts and space in accordance with the desires in high speed equipment.

These and other objects and advantages of this invention will hereinafter appear, and for purposes of illustration, but not of limitation, embodiments of this invention are shown in the accompanying drawings, in which—

Figure 1 is an end view of the ink feed mechanism embodying features of this invention with parts broken away for a more detailed showing of the arrangement of parts;

Figure 2 is a top view partially in section of the end mounting of the ink feed mechanism shown in Figure 1;

Figure 3 is a sectional elevational view through an intermediate portion of the ink feed mechanism showing the arrangement of parts for metering a predetermined portion of ink and distributing it on the surface of the inking drum;

Figure 4 is a fragmentary sectional view taken along the line 4—4 of Figure 3;

Figure 5 is a perspective view of the ink feed mechanism with parts partially withdrawn from within the inking drum and with parts broken away to illustrate various features of this invention;

Figure 6 is a perspective view similar to that of Figure 5 but showing a modified form of inking mechanism embodying features of this invention;

Figure 7 is a sectional elevational view showing an ink feed mechanism embodying features of this invention in combination with a new and improved arrangement of parts for effecting distribution and transfer of ink from the inking drum to the printing plate;

Figure 8 is a perspective fragmentary view showing an improved arrangement between adjacent adjustment cams and the fixed axle for establishing a better guiding relation:

Figure 9 is a sectional view of a modified form of metering pump for withdrawing ink from the fountain and feeding it to the surface of the printing plate cylinder:

Figure 10 is a fragmentary view partially in section showing means for mounting a metering pump of the type shown in Figure 9 in the fountain drum:

Figure 11 is a front elevational view of the elements shown in Figure 10;

Figure 12 is a perspective view of one arrangement employing a two point system which may be employed for printing in accordance with this invention:

Figure 13 is a perspective view showing an improved three point system embodying features of this invention:

Figure 14 is a perspective sectional view showing an

improved arrangement cam assembly and associated parts embodying features of this invention: and

Figure 15 is a sectional side elevational view of a part of the assembly shown in Figure 14.

Although description herein will be made specifically to the use of the mechanism embodying features of this invention as an ink fountain and ink carriage in printing operations, it should be understood that the mechanism may be used equally well for the application of other substances capable of fluid flow to overcome objectionable features to their application in the manner recited by the objects and described and claimed herein. For example instead of ink, water may be disposed in well described as being occupied by the ink fountain for transmission in metered amounts across the roller to a printing plate or paper web, as in off set lithography or the like. Similarly, resinous coatings may be disposed within the well for uniform distribution and application in metered amounts into a web or fabric in the manner of roller coating or the like. Adhesives color coatings or the like may be similarly applied with little, if any, modification in the parts. It will be understood that in such use with other substances, the objects, description and claims may be changed to substitute such other substance for the word "ink," wherever used.

In accordance with this invention, withdrawal of a variable but predetermined portion of ink from the ink fountain, gradual displacement of the withdrawn increment of ink onto the surface of the ink drum, distribution of the metered ink on the peripheral surface of the drum, transfer of a portion thereof to the printing plate, coupled with the return of unused portions back into the ink fountain, constitute successive steps which are simultaneously performed during and as a consequence of the rotational movement of the drum.

As shown in Figure 3, the ink drum 10 is in the form of a hollow rotating cylinder of steel or the like material having one or more metering pumps 11 located in and forming a part of the cylinder wall 12. Although the drawings show only one metering pump extending through a portion of the cylinder wall, it will be understood that two, three, four, or even more such pump members in equidistantly spaced relation may be provided in circumferential alignment about the cylinder wall and that a plurality of such metering pumps may be provided in side by side relation or in any other arrangement across the cylinder for metering predetermined quantities of ink to the corresponding surface of the ink drum, as shown in Figures 4 and 5.

A portion of the inking drum 10 such as a quarter portion or more (about 120°) in advance of a shear block 14 is adapted to be submerged within a pool or reservoir of ink 15 contained within an ink well 16. Although operation of the inking mechanism may be carried out independently of the shape of the ink well, a number of advantages flow from an arrangement wherein the ink well in this region is of limited space. For this reason, the inner wall of a lower fountain arm 17, which spans the entire width of the ink drum 12 and is pivoted at its inner end upon pivot pins 18 fixed to a support 19, extends flush with the curvilinear upper wall 20 of the support 19 and for a short distance the surfaces are in narrowly spaced substantially parallel relation with the surface of the ink drum. Thereafter the lower fountain arm flares outwardly away from the drum to provide a greater spaced relation with the ink drum and then terminates at a level above the shear block 14. When the lower fountain arm is rocked about the pivot pins to its inoperative position of adjustment, it will be apparent that the ink will drain from the well and that all surfaces of the ink reservoir become accessible for cleaning.

The metering pumps 11 are fixed in predetermined positions within suitable openings provided in the ink drum. These openings are fitted with correspondingly shaped metal plugs 21 locked into position by rotatable

5

keys 22 having a flat wall 22a which corresponds to the distance the key seats into the plug to enable the removal thereof when the flattened portion faces the plug. The plug 21 is provided with consecutive radial openings 23, 24, and 25 of decreasing diameters respectively with diametrically opposed slotted portions 26 in the walls defining the opening 23. A pin 28 operative within the opening 23 mounts an actuating roller 27 running in the slots 26 for guiding movement thereof between extended and retracted positions of adjustment. A plunger 29, shiftable as a piston in the opening 25 of smaller diameter, has a head portion 30 that is slidable in the intermediate opening 23 of larger diameter. The length of the opening 25 is a dimension to limit the outward movement of the plunger so that, when the head 30 seats on the shoulder, the end of the plunger is flush with and forms a part of the outer surface of the cylinder. The movable parts that is, the plunger and roller are constantly urged toward their inner or retracted positions of adjustment by a coil spring 31 disposed between the head portion 30 and a packing ring 32 adapted to prevent infiltration of ink into the pump mechanism. In the event that the actuating means hereinafter described operates positively to retract the plunger a predetermined distance responsive to rotational movement of the cylinder it will be understood that corresponding resilient means may be employed constantly to urge the plunger toward its outer position of adjustment.

Responsive to turning movement of the ink drum 10, radial shifting movement of the plunger is effected as the roller 27 is engaged by the peripheral surface of a fixed substantially semi-circular shaft 40 and the surface of a cam 41 adjustably mounted in cooperative relation on the shaft, all of which is arranged within the hollow portion of the ink drum. The shaft 40 extends as a unitary member through the ink drum while a separate cam is provided for each pump assembly across the ink drum to permit individual adjustment, as illustrated by cams 41, 41a, 41b, and 41c, arranged in side by side relation on the shaft 40 in Figure 4. While the roller 27 operatively engages the peripheral surface of the fixed shaft 40, the end of the plunger is adapted to be substantially flush with the peripheral surface of the drum. While the roller operatively engages the surface of the cam, the plunger retracts a certain amount and then gradually returns to flush position unless the cam member 41 is originally adjusted outwardly to bring the surface thereof concentric with the shaft 40.

Selective adjustment of each cam 41 is effected by means of a horizontally disposed keyed rod 42 which extends transversely through an opening 43 within the fixed shaft. A worm portion 44 of the rod operatively engages a worm gear 45 which threadably engages a horizontally disposed rotatable cam adjusting shaft 46 extending centrally there-through. The shaft 46 is held in alignment by a collar 46a located adjacent a guide plate 47 secured at its edge portion by bolts 48 to the face of the fixed shaft to form a sealed chamber 49 in which all of the keyed rods 42 and all of the worm gears are located. Thus, the shaft is turned by the associated worm gear, and the cam 41 threadably engaged to the end thereof is shifted in or out responsive to such turning movement. The cam 41 is guided in radial movement by the adjacent cams and by guide flanges 50 which slidably engage corresponding cut out portions 51 in the outer wall of the fixed shaft 40. Keys 52 operative in keyways in the cooperating flanged and cut out portions limit the extent of outward movement and also by their removal, easy separation of the cam can be effected when the assembly is withdrawn endwise from within the hollow ink drum.

The end mounting for the ink drum and its associated parts is shown in Figures 1 and 2. The end portion of the ink drum 10 is mounted for free rotational movement in a roller bearing 500 positioned in a stationary carriage frame 510. Just in advance of that portion of the drum which is to be used as an inking surface, a circular end plate 520, formed of bronze or the like and fixed to the

6

fountain side frame 53 seats within a groove 54 formed all around the drum to provide a barrier to the migration of ink into the mounting. A similar plate in the form of a divider 55 may be provided for seating within a groove 56 in the ink drum for the separation of one color or the like from another within the same fountain. Located within the hollow of the drum and within the area between the fountain control plate 59 and sealing end plates 61 is the fixed shaft 40, the adjustable cams 41 and the filler block 60.

The horizontally disposed keyed rods 42 extend through the fountain key control plate 59 and filler block 60 which is provided with cutouts in which the fountain key control collars 58 are located. The rods then extend through the cover and control plate 59 bolted to a filler block 60, which functions to keep the worms 44 and cams in alignment. The portions of the rods 42 which project from the face of the cover plate 59 are of some polygonal shape to permit actuation for adjustment with an appropriate tool.

The cover plate bears against an end plate 61 which is bolted to a worm gear retainer ring 62 that is secured, as by bolts 62a, to a bearing cap which forms a part of the carriage 51. Located within the opening 63 defined by the retainer ring 62 is a worm gear 64 fixed to the filler block 60 and shaft 40 assembly to effect rotational adjustment thereof relative to the ink drum responsive to turning movement of a worm 64 manually actuated by hand wheel 65. By this means, it is possible simultaneously to adjust the cams across the form to shift the high point of each cam and increase or decrease the amount of ink metered across the drum. Thus, it is possible by means of the key rods to adjust for color or ink concentration in specific columns, and it is also possible to adjust for color or ink concentration supplied to the drum across the form.

In order to lock the cam assembly in position of adjustment, a cam locking cap 66 embraces the cam unit assembly and it is actuated to locked or open position by a cam locking unit 67 operated by a locking handle 68 which is pivotally mounted to assist in carrying out turning movement. Calibrations 69 are provided on the face of the cam cover plate to indicate the relative position of the cam unit assembly.

In Figure 1, 70 indicates the lockup bolt and nut assembly by which the fountain pan or bottom is held in the mounted relation on the support.

The shear block, which operates in the manner of a scraper blade to remove ink from across the face of the drum 10 as it emerges from the ink well 16, is an elongated plate which is slidably mounted in a holder 80 and is constantly urged in the direction of the drum by a coil spring 81, disposed about a pin 82 carried by a screw thread plug 83 which is operative within the opening in which the shear block is shiftable. The shear block is usually fabricated of metal, such as brass, or other material which is softer than the material of which the drum is fabricated in order to minimize wear of the drum while concentrating wear in the block, which is replaceable.

An ink spreader 84 is pivotally mounted at one end about a pin 85 fixed to the upper wall of the shear block holder 80. When secured in its operative position by the fastening bolt 86, a curvilinear rail portion 87 embraces a portion of the ink drum beyond the shear block with decreasing spaced relation to effect a uniform spread of the ink which is forced from the metering pumps as the drum passes through this portion of its turning cycle.

The spaced relation between the ink spreader rail 87 and the face of the ink drum may be adjusted by means of screw 88 rotatably mounted in a post 89 fixed to the support 19 and threadably engaged at its inner end portion 90 with a threaded socket in the holder 80. Means 92 are provided in the head of the screw to receive a tool for effecting turning movement whereby the holder 80 and its associated parts are shifted in the direction to-

ward or away from the periphery of the inking drum. A shoulder 93 is provided in the end of the spreader base portion pivoted on pin 85 to limit the extent to which the rail assembly may be rocked to its inoperative position to expose the surfaces thereof and the surface of the drum for cleaning.

Instead of relying on the confining space between the drum and the ink rail to bring out uniform spread of the ink forced upon the surface of the drum, a plurality of vibrating rollers 100, 101, 102, and 103, may be mounted progressively to operate on the face of the drum to effect the desired spread. In either event, it is sufficient if a single rubber distributing roller 104 is used thereafter as a transfer roller when used on conventional carriages.

When four or more spreaders 100, 101, 102, and 103 are used on the ink drum, the roller 104 may be dispensed with prior to transfer of a portion of the ink film from the face of the drum to a form roller 105 from which a portion may be transferred directly to the printing plate 107.

When four or more rollers are used on and in conjunction with the ink drum and reservoir, the use of a pair of form rollers, such as rollers 105 and 106 (Figure 7) in contact with drum 10 and plate cylinder 107, in combination with vibrator rollers 108 and 109 respectively, constitute a complete carriage unit in itself.

By the use of this system wherein a definite and predetermined quantity of ink is provided at all times on the face of the inking drum, it is possible to eliminate some of the banks of steel and rubber reciprocating or vibrating rollers normally used to minimize error in ink distribution. In this system it is possible to achieve transfer of a desired quantity of ink to the work to be printed with a minimum of error in the ink film being applied to the printing plate or error as a result of ghosting of the type characteristic when printing heavy forms with conventional inking mechanism. This may be accomplished by the use of a combination of possible settings of form rollers 105 and 106 and vibrators 108 and 109 to provide a two point system or three point system not possible with presently known inking mechanisms.

Further to minimize error and ghosting roller 108 is adapted to be engaged by a scraper blade 109a constantly urged by springs 110 into contact with the periphery of the roller 108 to remove ink from the face thereof and return it to the ink well. When roller 108 is used without a scraper blade, its principal purpose is to produce distribution of ink and to iron out errors which might have occurred in its form roller ink replenishing cycle but which might not have been corrected at its point of contact with the ink drum. When used with a scraper blade 109a, half of the ink film on form roller 105 is transmitted to roller 108 and returned to the ink well.

Description will now be made to the operation of the inking mechanism wherein a single metering pump is operative within a circumferentially designated increment of the inking drum. It will be understood that as more such metering pumps are located within the circumferential confines of the inking drum, each will operate independently in equivalent manner.

Starting with the inking drum turned so that the roller is riding on the surface of the fixed shaft 40, the roller and plunger will be in their outermost position of adjustment and the end of the plunger will be substantially flush with and form a part of the periphery of the drum. As the inking drum 10 continues to rotate in the counterclockwise direction, the roller leaves the surface of the fixed shaft and begins to ride on the surface of the adjusted cam. At this stage the portion of the inking drum is also submerged in the ink composition disposed within the ink well.

As the roller 27 shifts inwardly as permitted by the cam 41, the plunger is also shifted inwardly and an amount of ink composition sufficient to fill the space

vacated by the plunger is drawn into the opening. Filling of the opening vacated by the retracting plunger is also assisted by the compression forces generated by the movement of the drum through the ink well, and it is chiefly for this purpose that it is expedient to limit the spaced relation of the well in this area.

Maximum intake occurs as the roller passes over the low point of the cam, thereafter continued rotational movement causes the roller and plunger to shift outwardly and force the ink drawn into the cavity to flow out upon the surface of the drum. Before this change of motion takes place, the face of the drum is engaged by the shear block which removes ink from the surface of the drum throughout its length and functions as a cutoff for the amount of ink taken in the cavity vacated by the plunger.

Thus, the amount of ink deposited on the surface of the inking drum after it has passed beyond the shear block is accurately metered by the amount taken up by the pump in advance of the shear block. This amount may be varied as previously described by adjustment of the corresponding cam to increase or decrease the stroke of the plunger. This same type of action occurs all the way across the inking drum except that the amount of ink taken up and then deposited on the surface of the drum may be individually varied by proper cam adjustment.

As the inking drum rotates in its cycle to carry the metering pump just beyond the shear block, the ink is gradually forced from the cavity such that the spreaders may operate on proportional amounts of the ink to be delivered and thereby achieve more efficient and more accurate spreading. Before the respective metering pump passes beyond the spreader rail with or without its associated vibrating spreaders, the plunger is again returned to the outer end of its stroke so that its end may then form a part of the inking drum.

Roller 104, when used, provides a means of transferring an ink film from the fountain drum to a conventional carriage if conventional mechanism is converted for use with the metering fountain. The fountain drum 10 is engaged by the form roller 105 for transfer to the printing plate 107. Less than one-half of the ink on the surface of the inking drum is taken off by the form roller, the remainder is returned by the inking drum to the ink well. As a result of this return of ink remaining on the surface of the ink drum to the ink well, the inking mechanism embodying features of this invention is not encumbered with the error resulting from the buildup of ink film on the inking rollers to accent errors and flood the ink carriage roller and drums in the manner inherent with present processes. The return of all ink remaining on the face of the drum and the scraping off of all ink except that contained within the metered cavity insures the presence of a new ink film in measured amount and concentration on the surface of the drum as it passes through the spreading cycle and engages the form roller.

The presence of a new measured ink film on the face of the drum immediately after startup, eliminates the difficulties invariably encountered in present processes at the start of the printing cycle wherein the tackiness of the drying film left on the drum from prior operation often leads to breakage of the web or else a spray is required to liquify the film and then a certain amount of waste is produced until the liquifying material is dissipated.

The return of the ink remaining on the drum after it has passed the form roller coupled with the frictional forces created by the rotating drum causes a turbulent mixing action to take place within the ink well which prevents setting and assists in mastication, fluidity and redistribution of non-uniform parts.

The film of ink left on the ink drum 10 on its return to the fountain affords an adhesive surface onto which

the ink in the reservoir may cling, thus assisting in the draw or pull of ink into the narrowed fountain channel and into the plunger cavities.

In Figure 7, concepts of this invention are embodied in an inking mechanism in which the elements are substantially arranged in a vertical direction with the fountain arm 17a flaring outwardly and upwardly after an initial portion thereof conforms generally to the contour of an inking drum 10 but in closely spaced relation thereto for providing a restricted opening to define that portion of the ink well 15a.

In this modification, a preferred form of metering pump is employed, which is further illustrated in greater detail in Figure 9. In this modification, the roller 27 is replaced by a tappet head 120 fixed to the end of a sleeve 121. The sleeve 121 is slidable within an annular groove 122 formed in a circular head member 123 from which the plunger 124 depends. A pin 125 inserted through registered openings in the sleeve 121 and elongate slots 126 through the head member prevent relative turning movement while permitting relative axial movement by an amount limited by the slots. The point of contact between the surfaces of the cam 41 and the fixed shaft 40 is off the center of the tappet head so that rotational movement is imparted to the tappet during operative engagement. The end portion 127 of the plunger 124 is grooved to provide a screw feed reversing the direction of flow of ink compositions which find their way between the walls.

For purposes of compensating for the spaced relation which may exist between the tappet head and the surface of the fixed shaft during normal operation of the metering pump, a separate spring 128 is located between the plunger and the tappet to urge these separate parts in opposite direction, the force of this latter spring being more than that available from spring 129 which constantly urges all of the movable parts towards their rearmost position of adjustment. In the event that the cam members function as the means for positively retracting the plunger rearwardly, spring 129 or other means may be employed for urging the plunger toward its outer position of adjustment.

Longitudinal slots 126 permit limited relative movement between the tappet member and the plunger, calculated to compensate for the necessary tolerance, as described when the metering pump is in that portion of the cycle which requires the end of the plunger to be flush with and form a part of the inking surface of the drum, while the tappet remains in contacting relation with the surface of the fixed shaft.

A metering pump of this type may be made accessible for removal or insertion from the periphery of the inking drum by forming the plug of a cylindrical member 130 having cavities 131, 132, and 133, a rectangular flange 134 of larger dimension and an inwardly tapering end 135. A conical opening 136 having the same taper as the end 135 is provided for each pump in an elongate plate 137 which is secured as by screws in fixed relation with the inking cylinder—the outer wall of the plate forming a part of the inking surface of the ink drum. Lugs 138, insertable between similarly tapered sidewalls urge adjacent portions of the cylinder about the rectangular flange 134 to effect a rigid assembled relation. The transverse position of the plate 137 may be adjusted by screws 139 and 140 operated within a fixed veil or bushing 141 as by a key which may be inserted into opening 142.

Another modification of this invention is embodied in a metering pump, wherein a uniform and required amount of ink is supplied throughout the width of the inking drum. In this modification, shown in Figure 6, the plunger is in the form of a rectangular rod-like member 150 which extends all the way across the inking surface of the drum 151 and is operative within an elongate cavity 152 in the same manner as is each individual plunger 29 or 124 in the embodiments previously de-

scribed. Pins 153 may be employed to limit transverse movement of the bar feed plunger relative to the cylinder. In this modification, it is only necessary to have a single keyed rod 154 for actuation of one more worm gears 155 for rotating a corresponding number of cam adjusting shafts 156 by which the position of the cams are simultaneously adjusted to increase or decrease the stroke of the elongate bar feed plunger 150.

In a preferred arrangement for mounting the adjustable cams operatively on the fixed shaft (Figures 14, 15, and 8), the fixed shaft is formed with an outer shell 160 about a shaft 161 having a rectangular opening 162 extending transversely therethrough. Grooves 163 are formed in side by side spaced relation in the ends of the combined shell 160 and shaft 161 for receiving similarly shaped extensions 164 of the cams in sliding relation. Each groove 163 and end 164 is formed with one straight wall 165 while the other wall 166 extends from the straight wall in angular relation until it intersects the straight wall of the next adjacent groove with an intermediate portion 167 thereof extending parallel to the straight wall for a distance greater than the extent of adjustment so that there will be a continuous surface over which the roller or tappet may ride during operation.

The end plate 168 which carries the cam adjusting shafts 170, has end flanges 171 which seat within grooves 172 formed in the walls of the fixed shaft 161 in which position it is secured by bolts 173. Thus, the outer walls of the flanges 171 form the floors of the grooves 163 on which the cams 174 ride. A key 175 extends through registered slots in the flanges and fixed shaft and is operative within elongate slots 176 in each extension 164 to control the extent of adjustment.

In addition to the features previously described as resulting from the mechanism embodying features of this invention, it will be apparent that modification of the amount of ink deposited by each individual metering device may be simultaneously increased or decreased by means of rotating the fixed shaft and cam assembly. This can be accomplished by operation of handle 65 after the cam assembly has been unlocked by loosening the locking unit previously described in connection with the end mounting assembly.

When this is accomplished, for example, when the fixed shaft and cam assembly is turned as a unit in the clockwise direction, the low point of each cam will be reached in advance of the strike-off member 14. As a result, a portion of the return stroke of each metering plunger will occur before the metering pumps pass by the shear block or strikeoff member. By this means, the amount of ink taken up into the cavity will be reduced across the form, thereby simultaneously to minimize the amount of ink metered by each pump member. This means for reducing the amount of ink all the way across is particularly useful when it is found that color of excessive concentration is being supplied throughout and that the desired reduction is not necessary in particular columns.

By way of further modification, shear block 14 can also be locked in its holder and drawn back from the ink drum 10 by adjustment screw 33 to allow a calculated amount of ink to be retained on the surface of the drum as it passes the shear block. This will be in addition to the plunger meter amounts and will keep a constant film of ink on drum 10 where it may serve to some advantage in ink distribution and minimize wear of the shear block.

It will be apparent from the description that ink distribution upon feeding will occur on the surface of the inking drum while it is traveling at a speed equivalent to the speed of the printing plate cylinder; that the ink which remains on the drum after it has passed beyond the form roller is all returned to the ink well and that a new and fresh supply of predetermined quantity is provided for each cycle of the drum. In this manner, buildup of the ink layer on the inking roller,

drying up of ink on the drum and flooding are substantially eliminated.

By the use of dividers, as illustrated by the cooperating elements 55 and 56 in spaced apart portions of the drum it will be possible to make application of unlike colors to various columns of the material to be printed.

Compared to inking mechanism of the type heretofore employed, the many advantages of this invention will immediately become evident. For example, in the past, ink has been supplied to increments of the surface of an inking drum by metering devices adjacent the ink drum and operated separately therefrom. As a result, the amount of ink deposited is always in addition to that which remains on the drum and rollers after it has been contacted by a form or plate cylinder. Under such circumstances the ink on the surface of the drum and rollers is cumulative and where it is unused in proportion to the amount calculated, the thickness of the ink film builds up to a point where error often occurs and flooding of the drum may usually be expected in certain parts. Where ink remains on the surface of the drum and is merely replenished during normal operation, it will be apparent that that which remains after a length of time and that which is on the surface after inadvertent interruption of the printing process will become tacky or adhesive and will cause picking of the fibers of the printed medium or breakage of the web unless properly diluted.

With mechanism of the type described, these ordinary objectionable features characteristic of presses now in use are substantially completely absent. As the ink film on the ink drum leaves the form roller, the amount of ink which remains on the drum is returned completely and blended with the ink supply in the reservoir or ink well. As the metering plunger retracts in accordance with the amount permitted by the contacted cam, a definite and predetermined quantity of ink is taken into the cavity and only that portion remains with the drum after it passes the strikeoff member or shear block. Thus, only that newly measured quantity of ink is supplied to the surface of the drum for spreading over the surface in advance of contacting the form roller. In each cycle, that which remains on the drum is removed and a fresh and measured amount of ink of the desired viscosity is supplied each time.

Because of the control of amount and concentration of ink across the drum, and by division and redistribution of the ink on the form roller by a vibrating roller from which the ink taken off is constantly removed, error and ghosting are minimized. By such novel and new means for supplying fresh ink in desired concentration to the surface of the inking drum and form rollers in evened distribution, it is possible to eliminate the banks of form and distributing rollers heretofore employed in high speed printing presses.

Because of the ready access to the interior of the drum through plugs in the end plates, it is possible to cleanse the parts disposed therein of ink composition or other foreign matter by filling the cavity with solvent and operating the unit for a short time. Repeated flushings of this type make color ink changes and cleansing of parts a simple and easy process compared to the difficulties encountered with present mechanism. It is also possible to pack the channel opening 43 with lubricant to keep the various parts operating smoothly.

Heater elements 180 installed in the body of stationary shaft 40 and other heater elements 181 may be placed in the support 19 for the purpose of conditioning the inks so that characteristics of the ink may be maintained even though the press is stopped. It is desirable to maintain the ink viscosity as controlled by temperature substantially constant whether the press is temporarily stopped or running for a period of time so as to have perfect color control and ink trapping at all times. Temperature of the ink and mechanism should be thermo-

statically controlled to that normally existing when the inking mechanism has been in continual operation for a period of time.

Inks with higher trapping qualities, highly desirable in color work can be used as a result of controlled ink supply and ink mechanism temperatures. Temperatures and mastication control also afford a stabilized ink trapping quality in color inks. This is a very important factor on presses during various seasons of the year and where presses are of necessity shut down for week-ends, nights, and make-ready periods after which many trapping and ink trapping problems occur causing much loss of time and consequently spoilage.

It will be understood that the above merely sets forth a few of the outstanding features and advantages of this invention and it will be further understood that numerous changes may be made in the details of construction, arrangement, and operation, without departing from the spirit of the invention, especially as defined in the following claims.

I claim:

1. The combination of a cylindrical member having a peripheral surface over which a fluid is distributed for transfer in part and mechanism for receiving the remainder and returning a new increment onto the surface, comprising a hollow drum mounted for rotational movement, means maintaining a supply of fluid in surface contact with a portion of the peripheral surface of the drum during rotational movement, openings extending radially through the drum, a piston mounted for shifting movement in each of said openings between extended and retracted positions of adjustment, the ends of the pistons having a curvilinear contour corresponding to that of the peripheral surface of the drum and being flush with the outer peripheral surface of the drum to form a continuous part thereof when the piston is in its normal extended position, and means operative in response to rotational movement of the drum and in timed relation therewith to control the movement of the piston to retracted position while in the peripheral portion in contact with the fluid to draw an amount of fluid into the cavity formed in the drum surface and to actuate the piston to extended position after passing beyond the surface portion in contact with the fluid to position the curvilinear end portion of the piston substantially flush with the remainder of the peripheral surface of the drum to form a part of the continuous peripheral surface thereof and concurrently to displace the increment of fluid from the cavity onto the peripheral surface of the drum and a spreader mounted to engage the surface of the drum beyond the fluid supply source for distributing the fluid uniformly over the surface of the drum during extrusion of the fluid from the cavity upon movement of the piston to extended position.

2. The combination of a cylindrical member having a peripheral surface over which a fluid is distributed for transfer in part and mechanism for receiving the remainder and returning a new increment onto the surface, comprising a hollow drum mounted for rotational movement, means maintaining a supply of fluid in surface contact with a portion of the peripheral surface of the drum during rotational movement, openings extending radially through the drum, a piston mounted for shifting movement in each of said openings between extended and retracted positions of adjustment, the ends of the pistons having a curvilinear contour corresponding to that of the peripheral surface of the drum and being flush with the outer peripheral surface of the drum to form a continuous part thereof when the piston is in its normal extended position, means operative in response to rotational movement of the drum and in timed relation therewith to control the movement of the piston to retracted position while in the peripheral portion in which the opening is located is in contact with the fluid to draw an amount of fluid into the cavity formed in the drum surface and to activate the

piston to extended position after passing beyond the surface portion in contact with the fluid to position the curvilinear end portion of the piston substantially flush with the remainder of the peripheral surface of the drum to form a part of the continuous peripheral surface thereof and concurrently to displace the increment of fluid from the cavity onto the peripheral surface of the drum, and means for adjusting the stroke of the piston thereby to vary the increment of fluid drawn into the cavity and subsequently extruded onto the surface of the drum and a spreader mounted to engage the surface of the drum beyond the fluid supply source for distributing the fluid uniformly over the surface of the drum during extrusion of the fluid from the cavity upon movement of the piston to extended position.

3. In the combination of an inking drum and means forming a part of the drum for supplying a measured amount of fluid ink composition onto the peripheral surface thereof for spreading and transfer, an inking drum mounted to revolve about an axis, an ink reservoir containing ink in fluid condition in surface contact with a portion of the drum during rotational movement thereof, openings extending radially through the drum, a piston mounted for shifting movement in each of said openings between extended and retracted positions of adjustment, the ends of the pistons having a curvilinear contour corresponding to that of the peripheral surface of the drum and being flush with the outer peripheral surface of the drum to form a continuous part thereof when the piston is in its normal extended position, means operative in timed relation with the rotational movement of the drum for controlling movement of the piston to retracted position while in the portion of the drum in surface contact with the ink to draw an amount of ink into the cavity corresponding to the volumetric displacement of the piston and for actuating the piston to extended position when the surface portion passes beyond the ink reservoir to position the curvilinear end portion of the piston substantially flush with the remainder of the peripheral surface of the drum to form a part of the continuous peripheral surface thereof and concurrently to displace the increment of ink in the cavity onto the surface of the drum for distribution and transfer and a spreader engaging the surface of the drum beyond the ink reservoir for distributing the ink uniformly over the surface of the drum upon extrusion of the ink composition from the cavity upon movement of the piston to extended position.

4. In the combination of an inking drum and means forming a part of the drum for supplying a measured amount of fluid ink composition onto the peripheral surface thereof for spreading and transfer, an inking drum mounted to revolve about an axis, an ink reservoir containing ink in fluid condition in surface contact with a portion of the drum during rotational movement thereof, openings extending radially through the drum, a piston mounted for shifting movement in each of said openings between extended and retracted positions of adjustment, the ends of the pistons having a curvilinear contour corresponding to that of the peripheral surface of the drum and being flush with the outer peripheral surface of the drum to form a continuous part thereof when the piston is in its normal extended position, means operative in timed relation with the rotational movement of the drum for controlling movement of the piston to retracted position while in the portion of the drum in surface contact with the ink to draw an amount of ink into the cavity corresponding to the volumetric displacement of the piston and for actuating the piston to extended position when the surface portion passes beyond the ink reservoir to position the curvilinear end portion of the piston substantially flush with the remainder of the peripheral surface of the drum to form a part of the continuous peripheral surface thereof and concurrently to displace the increment of ink in the cavity onto the surface of the drum for distribution and transfer, and adjustable means

for regulating the stroke of the piston member to adjust the increment of ink withdrawn into the cavity and forced onto the surface of the drum and a spreader engaging the surface of the drum beyond the ink reservoir for distributing the ink uniformly over the surface of the drum upon extrusion of the ink composition from the cavity upon movement of the piston to extended position.

5. An inking system as claimed in claim 4 which includes means for adjusting the stroke of the piston during rotation movement of the drum.

6. In the combination of an inking drum and means forming a part of the drum for supplying a measured amount of ink onto the peripheral surface thereof for spreading and transfer, a hollow drum mounted to revolve about an axis, an ink reservoir containing ink in fluid condition in surface contact with a portion of the drum during rotational movement, openings extending radially through the drum, a piston mounted for shifting movement in each of said openings between extended and retracted positions of adjustment, the ends of the pistons having a curvilinear contour corresponding to that of the peripheral surface of the drum and being flush with the outer peripheral surface of the drum to form a continuous part thereof when the piston is in its normal extended position, and means responsive to rotational movement of the drum for controlling the movement of the piston whereby retraction occurs while the portion of the drum is in surface contact with the ink composition to withdraw a portion thereof into the drum and movement to the extended position occurs principally while the portion of the drum in which it is contained is beyond the ink reservoir to position the curvilinear end portion of the piston substantially flush with the remainder of the peripheral surface of the drum to form a part of the continuous peripheral surface thereof and concurrently to force the increment of ink onto the surface of the drum and spreaders engaging the surface of the drum beyond the ink reservoir for distributing the ink uniformly over the surface of the drum upon movement of the piston to extended position.

7. In the combination of an inking drum and means forming a part of the drum for supplying a measured amount of fluid ink composition onto the peripheral surface thereof for spreading and transfer, an inking drum mounted to revolve about an axis, an ink reservoir containing ink in fluid condition in surface contact with a portion of the drum during rotational movement thereof, openings extending radially through the drum, a piston mounted for shifting movement in each of said openings between extended and retracted positions of adjustment, the ends of the pistons having a curvilinear contour corresponding to that of the peripheral surface of the drum and being flush with the outer peripheral surface of the drum to form a continuous part thereof when the piston is in its normal extended position, means operative in timed relation with the rotational movement of the drum for controlling movement of the piston to retracted position while in the portion of the drum in surface contact with the ink to draw an amount of ink into the cavity corresponding to the volumetric displacement of the piston and for actuating the piston to extended position when the surface portion passes beyond the ink reservoir to position the curvilinear end portion of the piston substantially flush with the remainder of the peripheral surface thereof and concurrently to displace the increment of ink in the cavity onto the surface of the drum for distribution and transfer, adjustable means for regulating the stroke of the piston member to adjust the increment of ink withdrawn into the cavity and forced onto the surface of the drum, and a scraper in surface contact across the drum immediately beyond the ink reservoir to remove ink from the surface of the drum as it emerges from the ink composition and spreaders engaging the surface of the drum beyond the ink reservoir for dis-

tributing the ink uniformly over the surface of the drum upon movement of the piston to extended position.

8. An inking mechanism as claimed in claim 7 which includes means constantly urging the scraper into surface contact with the drum.

9. In the combination of an inking drum and means forming a part of the drum for supplying a measured amount of ink onto the peripheral surface thereof for spreading and transfer, an inking drum mounted to revolve about an axis, an ink reservoir containing ink in fluid condition in surface contact with the drum during rotational movement thereof, openings extending radially through the drum, a piston mounted for shifting movement in each of said openings between extended and retracted positions of adjustment, the ends of the pistons having a curvilinear contour corresponding to that of the peripheral surface of the drum and being flush with the outer peripheral surface of the drum to form a continuous part thereof when the piston is in its normal extended position, guide means in the form of a stationary cam adjustably positioned within the drum, and an operative connection between the piston and the cam guide means for controlling movement of the piston as the drum revolves whereby the piston shifts to retracted position while in communication with the ink composition to withdraw an increment of the ink into the cavity formed in the drum and is actuated to extended position upon passage beyond the ink reservoir to position the curvilinear end portion of the piston substantially flush with the remainder of the peripheral surface of the drum to form a part of the continuous peripheral surface thereof and concurrently to force a measured portion of the ink composition onto the surface of the drum and spreaders engaging the surface of the drum beyond the ink reservoir for distributing the ink uniformly over the surface of the drum upon movement of the piston to extended position.

10. Inking mechanism as claimed in claim 9 which includes means constantly urging the piston toward retracted position into operative engagement with the cams.

11. In the combination of an inking drum and means forming a part of the drum for supplying a measured amount of fluid ink composition onto the peripheral surface thereof for spreading and transfer, a hollow inking drum mounted to revolve about an axis, an ink reservoir containing ink in fluid condition in surface contact with a portion of the drum during rotational movement thereof, openings extending radially through the drum, a piston mounted for shifting movement in each of said openings between extended and retracted positions of adjustment, the ends of the pistons having a curvilinear contour corresponding to that of the peripheral surface of the drum and being flush with the outer peripheral surface of the drum to form a continuous part thereof when the piston is in its normal extended position, means operative in timed relation with the rotational movement of the drum for controlling movement of the piston to retracted position while in the portion of the drum in surface contact with the ink to draw an amount of ink into the cavity corresponding to the volumetric displacement of the piston and for actuating the piston to extended position when the surface portion passes beyond the ink reservoir to position the curvilinear end portion of the piston substantially flush with the remainder of the peripheral surface of the drum to form a part of the continuous peripheral surface thereof and concurrently to displace the increment of ink in the cavity onto the surface of the drum for distribution and transfer, and thermostatically controlled heater elements in the ink reservoir for maintaining the ink composition at a predetermined temperature level and spreaders engaging the surface of the drum beyond the ink reservoir for distributing the ink uniformly over the surface of the drum upon movement of the piston to extended position.

12. In the combination of an inking drum and means forming a part of the drum for supplying a measured

amount of fluid ink composition onto the peripheral surface thereof for spreading and transfer, an inking drum mounted to revolve about an axis, an ink reservoir containing ink in fluid condition in surface contact with a portion of the drum during rotational movement thereof, a piston member shiftable radially through the drum between extended position wherein the end of the piston is flush and forms a part of the continuous peripheral surface of the drum and a retracted position which provides a cavity extending inwardly from the surface of the drum, means operative in timed relation with the rotational movement of the drum for controlling movement of the piston to retracted position while in the portion of the drum in surface contact with the ink to draw an amount of ink into the cavity corresponding to the volumetric displacement of the piston and for actuating the piston to extended position when the surface portion passes beyond the ink reservoir to displace the increment of ink in the cavity onto the surface of the drum for distribution and transfer, and spreaders engaging the surface of the drum beyond the ink reservoir for spreading the ink uniformly over the surface of the drum during extrusion of the ink composition from the cavity upon movement of the piston to extended position.

13. In the combination of an inking drum and means forming a part of the drum for supplying a measured amount of fluid ink composition onto the peripheral surface thereof for spreading and transfer, an inking drum mounted to revolve about an axis, an ink reservoir containing ink in fluid condition in surface contact with a portion of the drum during rotational movement thereof, openings extending radially through the drum, a piston mounted for shifting movement in each of said openings between extended and retracted positions of adjustment, the ends of the pistons having a curvilinear contour corresponding to that of the peripheral surface of the drum and being flush with the outer peripheral surface of the drum to form a continuous part thereof when the piston is in its normal extended position, means operative in timed relation with the rotational movement of the drum for controlling movement of the piston to retracted position while in the portion of the drum in surface contact with the ink to draw an amount of ink into the cavity corresponding to the volumetric displacement of the piston and for actuating the piston to extended position when the surface portion passes beyond the ink reservoir to displace the increment of ink in the cavity onto the surface of the drum for distribution and transfer, thermostatically controlled heater elements in the ink reservoir for maintaining the ink composition at a predetermined temperature level, spreaders mounted to engage the surface of the drum beyond the ink reservoir for distributing the ink over the surface of the drum upon movement of the piston to extended position and means operatively engaging the drum beyond the spreaders for transferring a portion of the ink film from the surface of the drum to a printing plate.

14. An inking mechanism as claimed in claim 9 wherein means are provided for adjusting the camming member relative to the drum.

15. An ink metering pump as claimed in claim 9 in which the piston is formed with a tappet in operative engagement with the cam to effect turning movement of the piston during rotational movement of the drum about the guide, the end portion of the piston being formed with screw threads leading in the direction to feed toward the surface of the drum.

16. Inking mechanism as claimed in claim 3 in which the ink reservoir is divided transversely for color and the surface of the drum is similarly separated by dividers for confining the color across the surface of the drum.

17. Inking mechanism as claimed in claim 13 in which the means for transferring a portion of the ink film from the surface of the drum to the printing plate comprises a single form roller.

18. Inking mechanism as claimed in claim 17 in which another roller contacts the surface of the form roller at a point in advance of the printing plate to minimize film error and scraper means removes ink from the surface of the other roller after contact with the form roller.

19. In the combination of an inking drum and means forming a part of the drum for supplying a measured amount of fluid ink composition onto the peripheral surface thereof for spreading and transfer, an inking drum mounted to revolve about an axis, an ink reservoir containing ink in fluid condition in surface contact with a portion of the drum during rotational movement thereof, a piston mounted for shifting movement through the wall of the drum between extended and retracted positions of adjustment with the ends of the piston being formed curvilinearly corresponding to that of the peripheral surface of the drum and being substantially flush with the outer peripheral surface of the drum to form a part thereof when the piston is in its extended position, means operative in timed relation with the rotational movement of the drum for controlling movement of the piston to retracted position while in the portion of the drum in surface contact with the ink to draw an amount of ink into the cavity that is formed corresponding in amounts to the volumetric displacement of the piston and for actuating the piston to extended position when the surface portion passes beyond the ink reservoir to position the end portion

of the piston substantially flush with the peripheral surface of the drum and concurrently to displace ink from the cavity onto the surface of the drum for distribution and transfer, adjustable means for regulating the stroke of the piston to adjust the increment of ink withdrawn into the cavity and forced onto the surface of the drum, and a scraper in surface contact across the drum beyond the ink reservoir to remove ink from the surface of the drum as it emerges from the ink composition, said ink reservoir in advance of the scraper having a narrow spaced relation with the surface of the drum to build up pressure responsive to the operation of the drum for forcing ink composition into the drum during reciprocation of the piston in one direction.

References Cited in the file of this patent

UNITED STATES PATENTS

1,175,284	Miller	Mar. 14, 1916
1,214,787	Hoe	Feb. 6, 1917
1,275,256	Hoe	Aug. 13, 1918
1,778,476	Wood	Oct. 14, 1930
1,874,010	Hess	Aug. 30, 1932
1,961,829	Rutkoskie	June 5, 1934
2,039,992	Harold	May 5, 1936
2,341,020	Curtis	Feb. 8, 1944