Oct. 27, 1942. H. H. GROBECKER 2,299,974

METHOD OF DUPLICATING AND MECHANISM THEREFOR

Filed Feb. 17, 1941 5 Sheets-Sheet 1

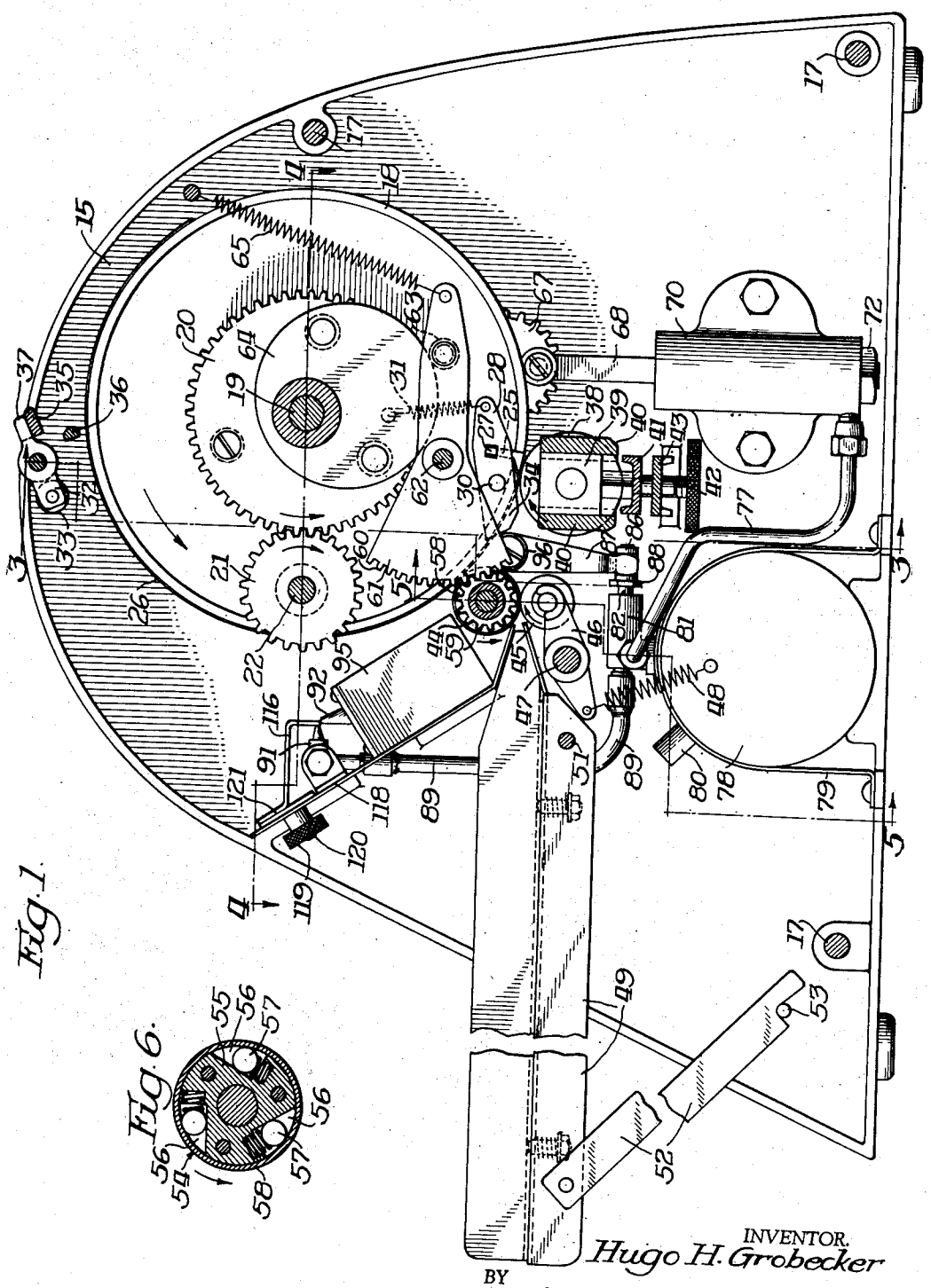


Fig. 1.

Fig. 6.

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METHOD OF DUPLICATING AND MECHANISM THEREFOR

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Fig. 7

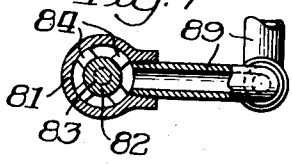


Fig. 2.

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METHOD OF DUPLICATING AND MECHANISM THEREFOR

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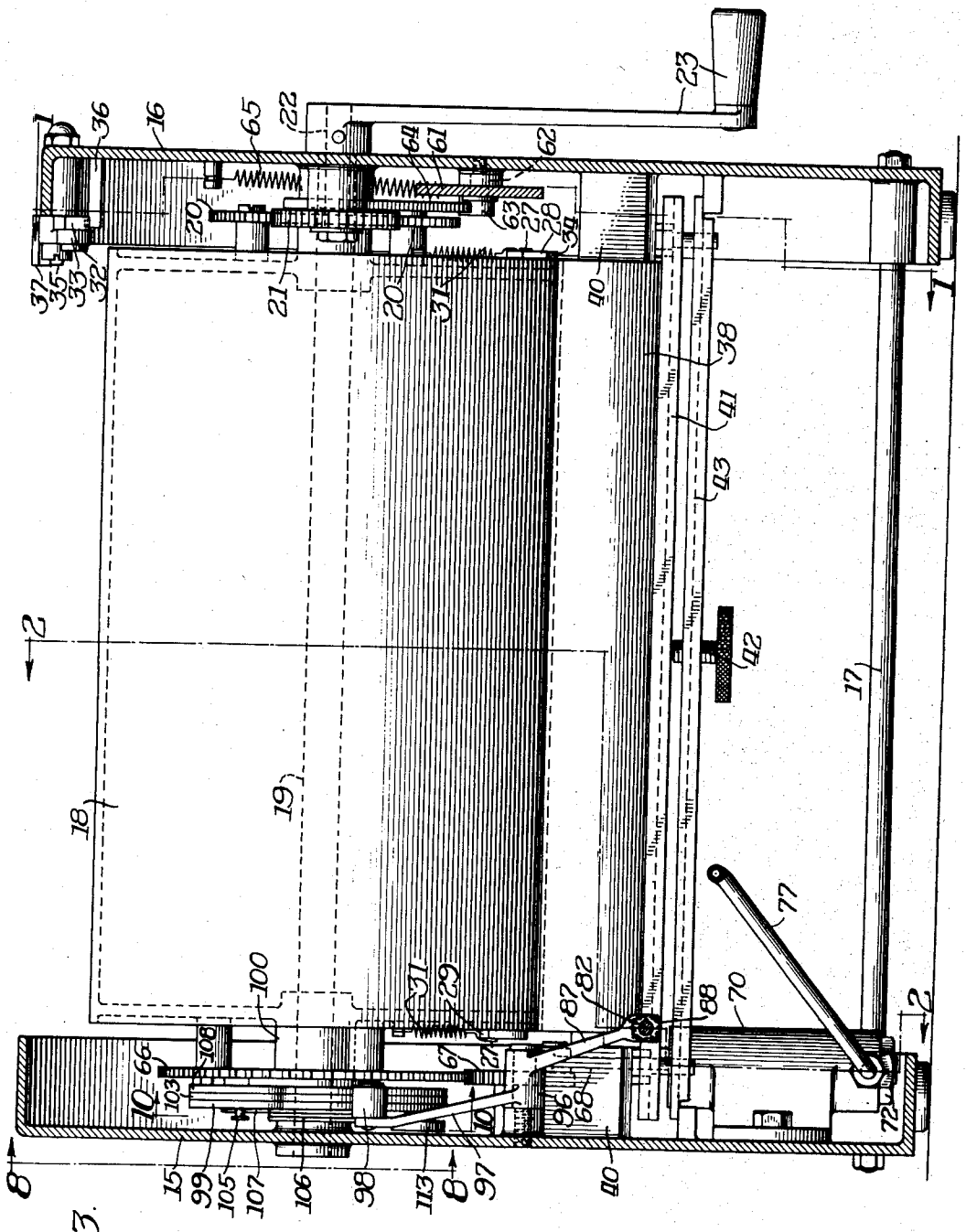


Fig. 3.

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METHOD OF DUPLICATING AND MECHANISM THEREFOR

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Fig. 4.

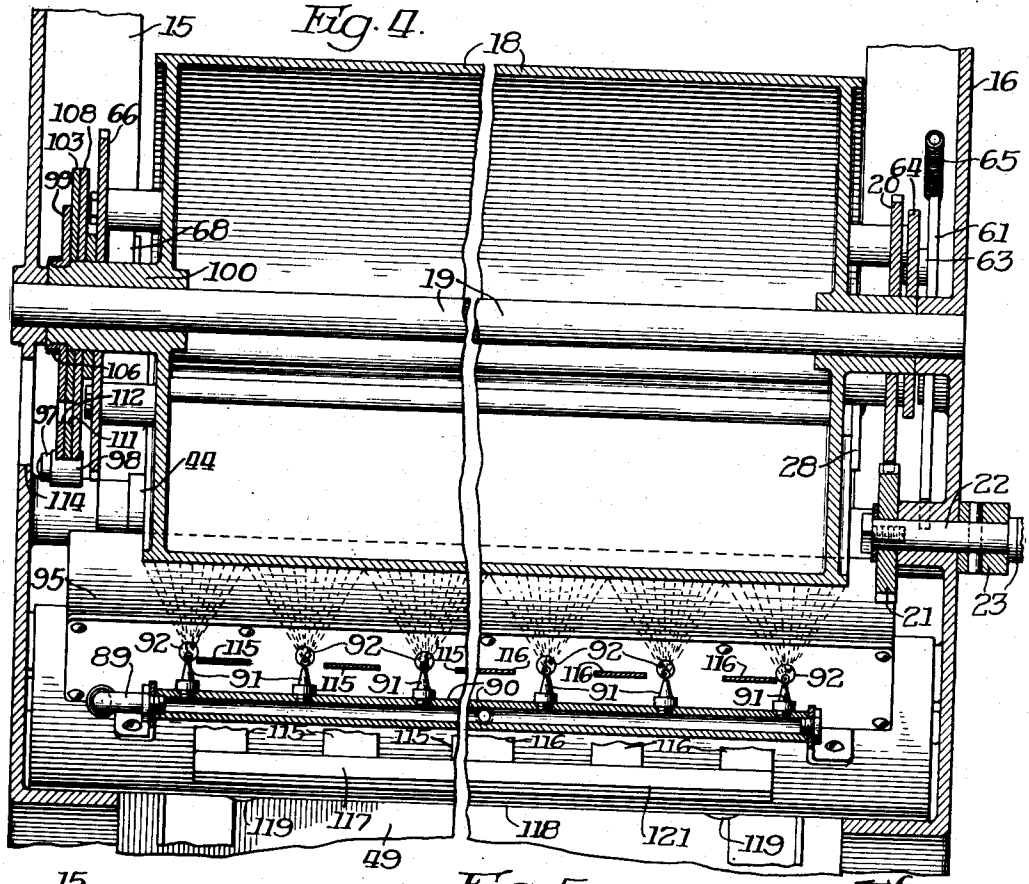
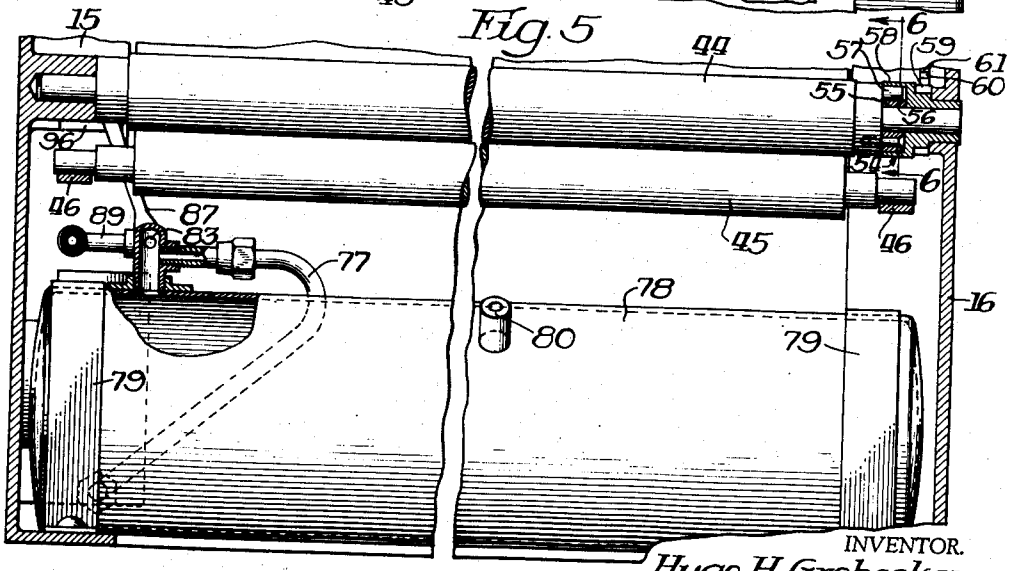


Fig. 5



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METHOD OF DUPLICATING AND MECHANISM THEREFOR

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Fig. 9.

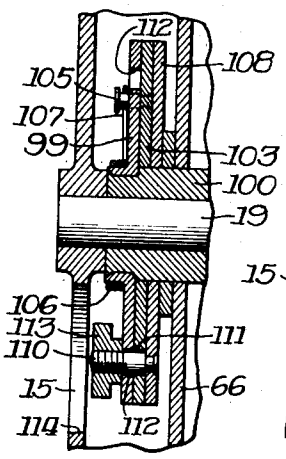


Fig. 8.

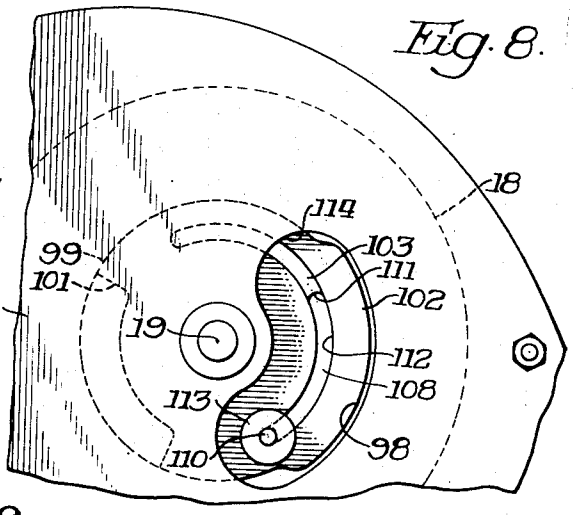


Fig. 10.

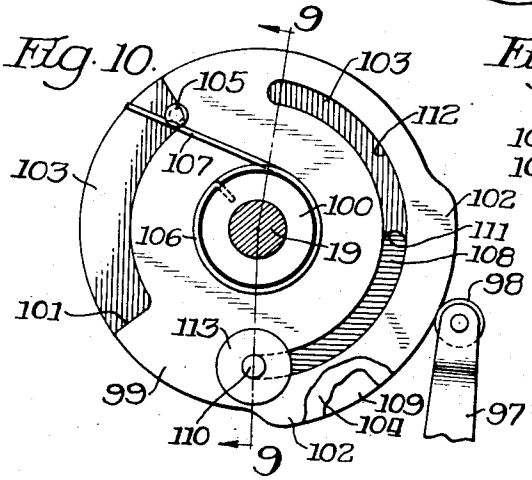


Fig. 12.

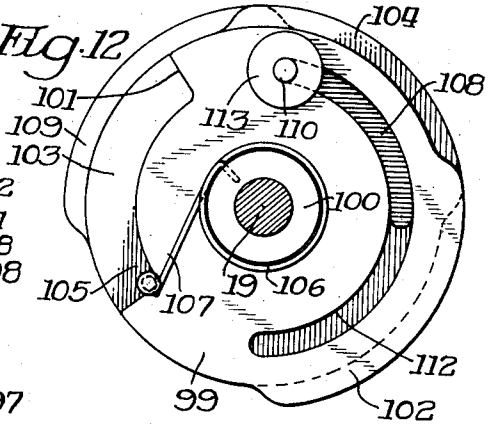


Fig. 11.

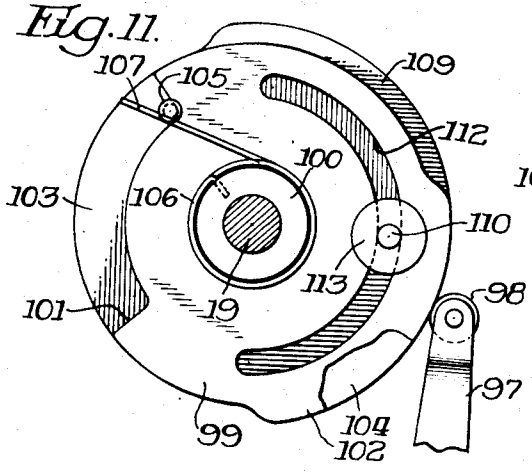
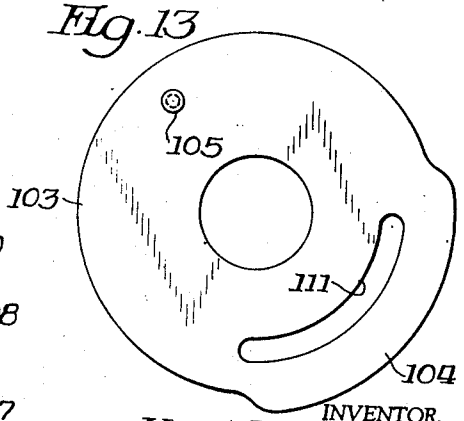


Fig. 13



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Patented Oct. 27, 1942

2,299,974

UNITED STATES PATENT OFFICE

2,299,974

METHOD OF DUPLICATING AND MECHANISM THEREFOR

Hugo H. Grobecker, Milwaukee, Wis., assignor to Ditto, Incorporated, Chicago, Ill., a corporation of West Virginia

Application February 17, 1941, Serial No. 379,259

12 Claims. (Cl. 101—132.5)

This invention relates to a new and improved method of producing copies of a liquid process type and to an improved mechanism by which such method may be carried out. The invention relates particularly to the step by which a film of solvent is applied to a master sheet upon which the subject matter to be copied is carried in reverse in copying ink, whereby a very small fractional portion of the ink may be transferred under pressure from the master sheet to each copy sheet in turn. In operations of this type, it is highly important that the application of solvent to the master sheet be kept even so as to make possible the production of well-inked copies of a substantially uniform shade of inking throughout the copy, and that the film of solvent applied to the master sheet be kept very thin so as to prevent over-inking of the copies and undue consumption of the ink from the master sheet. It is also highly important that the master sheet be protected against contact with any substantial amount of the solvent which would have the effect of "crashing" the master sheet so as to render it useless from a practical standpoint.

For attaining the desired results characterizing the invention, an exceedingly thin film of atomized solvent is applied directly to the master sheet by a series of atomizers in spaced relation to each other along the face of the sheet, the atomizers being preferably arranged in a row along one face of a drum by which the master sheet is carried past the atomizers in position to receive the vapor therefrom. The preferred means for carrying out the improved method of the invention comprises an improved arrangement of controlling and actuating means by which the action of the atomizers is regulated, and particularly by which the timing of the atomizers is controlled with reference to the movement of the master sheet past the point of application of the solvent thereto.

It is another object of this invention to improve in sundry details methods of duplicating and the means for carrying out such methods. The preferred form of the mechanism by which the improved methods are carried out is illustrated in the accompanying drawings, in which—

Fig. 1 is a longitudinal vertical sectional view through the improved mechanism, taken substantially at the line 1—1 of Fig. 3;

Fig. 2 is a longitudinal vertical sectional view taken on an enlarged scale through the mechanism, being taken substantially at the line 2—2 of Fig. 3;

Fig. 3 is a transverse vertical sectional view taken substantially at the line 3—3 of Fig. 1;

Fig. 4 is a horizontal sectional view taken substantially at the line 4—4 of Fig. 1;

Fig. 5 is a transverse vertical sectional view taken substantially at the line 5—5 of Fig. 1;

Fig. 6 is a vertical sectional view taken substantially at the line 6—6 of Fig. 5;

Fig. 7 is a vertical sectional view taken substantially at the line 7—7 of Fig. 2;

Fig. 8 is a fragmentary face view as seen at the line 8—8 of Fig. 3;

Fig. 9 is a vertical sectional view taken substantially at the line 9—9 of Fig. 10;

Fig. 10 is a vertical sectional view taken substantially at the line 10—10 of Fig. 3;

Fig. 11 is a view similar to Fig. 10 but with certain of the parts in changed position;

Fig. 12 is another view similar to Fig. 10 but with the parts in a second changed position; and

Fig. 13 is a face view of the intermediate one of a set of three cooperating cam discs.

Referring now to the several figures of the drawings, in which corresponding parts are indicated by the same reference characters, 15 and 16 indicate side frame members in spaced relation to each other and rigidly connected together by means of crossbars 17, as is best shown in Fig. 1. Between the frame members 15 and 16, a drum 18 of any appropriate type is rotatably mounted by means of a heavy shaft 19. As is clearly shown in Figs. 1 and 4, the drum 18 is provided at one end with a gear 20 fixedly mounted thereon meshing with a pinion 21 rotatably mounted by means of a shaft 22 supported by the frame member 16 and having a crank handle 23 on its outer end for rotating the drum 18.

The drum 18 is provided at one side portion with an outwardly open groove 24 in which a gripper bar 25 is slidably mounted so as to hold a master sheet 26 releasably in position on the drum, as is best shown in Fig. 2. At its end portions, the gripper bar 25 is provided with outwardly extending lugs 27 which are in engagement with openings in arms 28 and 29 pivotally mounted on the ends of the drum, such arms being fixedly mounted upon a rock shaft 30 extending longitudinally of the drum, as is best shown in Fig. 2. Coiled springs 31 are connected with the arms 28 and 29 for holding the gripper bar 25 normally in gripping position on the drum.

Means is provided for automatically moving the gripper bar 25 outwardly out of its operative gripping position at a predetermined point in

the revolution of the drum 18 when desired. This means comprises an arm 32 pivotally mounted on the standard 16 at the near side of the machine, as shown in Fig. 1, such arm being provided with a roller 33 on its inner end in such position as to engage a cam portion 34 of the arm 28 when the arm 32 is moved to the limit of its motion in counter clockise direction in said Fig. 1. Stops 35 and 36 are provided for limiting the swinging movement of the arm 32 for holding the arm either in its retracted position as shown in Fig. 1 or in its operative position. The arrangement is such that upon rotation of the drum in counter clockwise direction in Fig. 1, with the arm 32 swung to the limit of its movement in counter clockwise direction in said Fig. 1, the arm 28 is given a slight stroke in clockwise direction for moving the gripper bar 25 outwardly out of gripping position. The arm 32 is provided with a handle portion 37 by which the arm may be conveniently moved.

Below the drum 18, I have provided a platen roller 38 rotatably mounted in slide blocks 39 which are mounted so as to move vertically under the control of clips 40 carried by the frame members 15 and 16. Underneath the roller 38, a spring bar 41 is provided operatively engaging the slide blocks 39 and being supported by a set screw 42 mounted by means of screw-threads in a transversely extending bar 43, as is clearly shown in Figs. 1 and 2. The arrangement is such that upon upward adjustment of the set screw 42 spring pressure is applied upon the platen roller 38 for forcing it yieldingly into pressure relationship with the drum 18.

Immediately in rear of the platen roller 38, I have provided forwarding rollers 44 and 45 in cooperative relation to each other for carrying copy sheets one at a time toward the right in Fig. 2 into the bite of the drum 18 and the platen roller 38. The roller 44 is mounted upon a fixed axis in the frame members 15 and 16, as is clearly shown in Fig. 5. The lower roller 45 is rotatably mounted in arms 46 pivotally mounted upon the frame members 15 and 16 by means of lugs 47, as is best shown in Fig. 1, each of said arms being held normally moved to the limit of its motion in counter clockwise direction in said Fig. 1 by means of a coiled spring 48. The rollers 44 and 45 are of any suitable material so as to be adapted to be effective for forwarding a copy sheet fed into the bite of the rollers from the left in Fig. 2. In the arrangement illustrated, a tray or table 49 is provided for supporting a pile of copy sheets, the top sheet 50 of which is shown in Fig. 2 as being moved forwardly in impression relationship with the master sheet 26. The table 49 is shown as being pivotally mounted at 51, the rear end portion of the table being releasably supported by brace bars 52 engaging lugs 53 carried by the standards 15 and 16.

Means is provided for intermittently driving the rollers 44 and 45 in timed relation to the rotation of the drum 18. This means comprises a clutch 54, as shown in Fig. 6, by which the roller 44 is driven in counter clockwise direction in Fig. 1 and is free to rotate in the same direction independently of the clutch. The clutch as illustrated comprises a head member 55 connected with said roller 44 and having recesses 56 in its outer face within which driving rollers 57 are mounted, such driving rollers being held in position by means of a housing member 58 in the form of a sleeve. As is clearly shown in Fig. 5, the housing member 58 is provided with a pinion 59 which meshes with teeth 60 in concentric position upon an arm 61 pivotally mounted on a lug 62 carried by the frame member 16 (see Fig. 1). The arm 61 is provided with a roller 63 in position to engage an eccentric 64 fixedly mounted on the drum. The arm 61 is normally held moved to the limit of its motion in counter clockwise direction in Fig. 1 by means of a spring 65, as is best shown in Figs. 1 and 4. The arrangement is such that upon rotation of the drum 18 in counter clockwise direction in Fig. 1 the arm 61 is moved in clockwise direction by the influence of the eccentric 64 and against the action of the spring 65, such swinging movement of the arm in clockwise direction serving to drive the pinion 59 and the roller 44 in counter clockwise direction in said Fig. 1. Upon the return movement of the arm 61 by the spring 65, the housing 58 is adapted to move in clockwise direction independently of the head 55 and the driving rollers 57.

The means for delivering solvent in the form of a vapor upon the face of the master sheet 26 comprises a plurality of atomizers to which liquid solvent and air under pressure are delivered in the desired timed relation. This means comprises a gear 66 constrained to rotate with the drum 18, as shown at the left in Fig. 4, such gear meshing with a pinion 67 to which the connecting rod 68 of an air pump is pivotally connected, as shown in Fig. 2. The lower end of the connecting rod 68 is pivotally connected with a piston 69 slidably mounted in a pump cylinder 70, the piston 69 being provided with a suction member 71 of leather or other suitable material. The lower end of the cylinder 70 is effectively closed by a head 72 which is provided with an inlet opening 73 provided with a check valve 74 so as to permit air to enter the cylinder upon the upward stroke of the piston but to prevent the escape of air upon the downward stroke. The head 72 is also provided with an outlet opening 75 provided with a check valve 76 arranged for permitting the escape of air through the opening upon the downward stroke of the piston but to prevent movement of the air in the opposite direction upon the upward stroke of the piston.

The outlet opening 75 of the pump in the arrangement shown is connected by means of a pipe 77 with a pressure tank 78 which is mounted in position by means of bands 79, as best shown in Figs. 2 and 5. The arrangement is such that upon rotation of the drum air is forced into the tank 78 so as to establish a pressure condition therein. The degree of pressure in the tank 78 is controlled by means of a pressure relief valve 80 of any suitable type.

For controlling the escape of air under pressure from the tank 78, a needle control valve 81 is provided comprising a tapered needle member 82 normally closing a correspondingly shaped opening 83 leading from the tank. In the arrangement shown (see Fig. 7), the member 82 is provided with outwardly extending lugs 84 against which one end of a compression spring 85 bears for holding the member 82 normally in position for closing the opening 83. At its outer end, the member 82 is adjustably connected by means of screw threads with a head member 86 which has articulated connection with the lower end of a lever 87, as is best shown in Fig. 2. The head 86 is normally held in adjusted position with respect to the member 82 by means of a lock nut 88.

As is clearly shown in Fig. 7, the needle valve 81 is connected at one side with a pipe 89 which is connected at its upper end with a transversely positioned header 90, as is best shown in Fig. 4. The header 90 is located directly opposite one side face of the drum 18 and is provided at its inner face with a plurality of nozzles 91 which open toward the drum. The nozzles 91 are preferably adjustable for controlling the effective size of the openings. Between the nozzles 91 and the drum there are a plurality of nozzle members 92 which communicate by means of tubes 93 with a supply of solvent 94 in a tank 95. The arrangement of the parts is such that when air is forced outwardly through the nozzles 91 under suitable pressure solvent is drawn upwardly through the tubular members 93 and atomized so as to be delivered in the form of spray upon the face of the drum 18 or the master sheet 26 carried around thereby. By an adjustment of the position of the needle valve 82 with respect to its head portion 86, and by an adjustment of the size of the openings through the nozzle members 91, the amount of solvent drawn upwardly through the tubes 93 for projection toward the drum by the force of the air blasts through the nozzles 91 can be controlled.

In the arrangement shown, adjustable means is provided for controlling the timing of the action of the atomizers, this control being effected through the medium of the needle valve 81. In the arrangement shown, the lever 87 by which the needle 82 of the valve 81 is actuated is pivotally mounted by means of a sleeve 96 rotatably mounted upon the frame member 15, such sleeve being provided with an upwardly extending arm 97 provided at its upper end with a roller 98, as is clearly shown in Figs. 2 and 3.

Upon the drum 18 in position for engagement with the roller 98, an adjustable cam device is mounted so as normally to rotate with the drum. This means comprises a cam disc 99 fixedly mounted upon a hub portion 100 of the drum, such member being cut out at 101 at one side portion and being provided with a high portion 102 at its opposite side forming the effective portion of the cam. Immediately adjacent to the disc 99, a second disc 103 is mounted so as to rotate freely upon the hub portion 100 of the drum. As is best shown in Fig. 13, the cam member 103 is circular in shape except for a high cam portion 104 corresponding in size and shape to the high portion 102 of the cam disc 99. As is clearly shown in Figs. 9 and 13, the cam disc 103 is provided with a pin 105 extending from one face so as to engage the end portions of the notch 101 in the disc 99, as shown in Figs. 10 and 12. A coiled spring 106 is mounted upon the disc 99 with an extending end portion 107 engaging the pin 105 so as to resist movement of the cam disc 103 with respect to the cam disc 99. Immediately adjacent to the disc 103, there is a third cam disc 108 also rotatably mounted upon the hub 100, the disc 108 being circular in form except for a high cam portion 109 at one side thereof corresponding in size and shape with that of the high portion 102 of the cam disc 99. The cam disc 108 is provided with a pin 110 extending from one face through an arc-shaped slot 111 in the disc 103 and an arc-shaped slot 112 in the cam disc 99. Upon the outer end of the pin 110, a thumb nut 113 is mounted by means of screw-threads, the arrangement being such that the nut 113 may be tightened in position for holding the several cam discs in fixed position with respect to each other.

By the use of the improved cam means as above described, the action of the atomizers can be controlled so as to make them operative during only the time when the master sheet is moving past the position of the atomizers. When a comparatively short master sheet is in use, the cam disc 99 and a portion of the disc 108 will be employed for securing the desired short-time operation of the atomizers. For adjusting the cam members for the desired effect, the nut 113 is first loosened, access to the nut being had through an opening 114 in the frame member 15, as is shown in Fig. 8. The cam disc 108 is moved circumferentially with respect to the disc 99 by pressure applied directly upon the nut 113 so as to cause the disc 108 to rotate with respect to the discs 99 and 103, the disc 103 being held by the spring 106 from rotary movement. When the desired adjustment of the disc 108 has been effected, the nut 113 is tightened so as to hold the cam discs in their desired adjusted position. When a long master sheet is being employed, the adjustment of the cam members is effected in the same manner. It will be understood that when the pin 110 in its movement with respect to the disc 103 comes into contact with the leading end of the slot 111, the further movement of the nut 113 causes the discs 103 and 108 to move together in spread relation to each other for a further extension of the effective cam size. This movement of the disc 103 is of course effected against the action of the spring 106.

By the use of the improved arrangement as above described, the effective size of the cam arrangement circumferentially can be controlled readily and easily so as to correspond closely to the length of the master sheet in use so as to cause the delivery of vapor upon the master sheet to begin at the start of the movement of the sheet past the atomizers and to stop substantially at the end of the movement of the master sheet past the point where the solvent is delivered thereon.

Means is also provided for shutting off one or more of the nozzles 91 at each side of the machine so as to put a corresponding number of the nozzles 92 out of operation for restricting the zone of delivery of the solvent to a width corresponding substantially to the width of the master sheet 26 in use. This means comprises a series of arms 115 at one side of the machine and a series of arms 116 at the opposite side of the machine adjustably mounted in position so as to be movable successively into position for closing the nozzles 91 (see Fig. 4). The arms 115 are carried by a plate 117 slidably mounted on a stationary plate 118 extending across the machine, being adapted to be secured in the desired adjusted position on said plate 118 by means of the desired number of thumb nuts 119 mounted by means of screw-threads on a corresponding number of pins 120 connected with the plate 117 and extending backwardly through a slot or slots in the plate 118, as is clearly shown in Fig. 2. The arms 115 are movable from their inoperative positions as shown in Fig. 4 into position for closing the openings through the nozzles 91 by engagement with the discharge outlets of said nozzles, the arrangement of the arms with respect to the plate 117 being such that upon the initial movement of the plate 117 toward the left in said Fig. 4 the arm farthest toward the left becomes effective, that upon further movement the next adjacent arm becomes effective for closing the

adjacent nozzle, and that upon still further movement of said plate 117 toward the left the third arm becomes effective for closing the third nozzle. In this way any desired number of the nozzles 91 at the left are closed successively according to the extent of the movement of the plate 117. The arms 116 at the opposite side of the machine are carried by a plate 121 slidably mounted on said stationary plate 118, such plate 121 being held adjustably in position likewise by one or more nuts 119 and pins 120. The arms 116 are arranged on the plate 121 just oppositely as compared with the arrangement of the arms 115, so that upon progressive movement of the plate 121 toward the right in Fig. 4, one, two, three or more of the nozzles 91 at that side of the machine are closed successively.

By the use of my invention, I am enabled to project an exceedingly small amount of solvent in the form of a vapor evenly over the face of a master sheet so as to have highly satisfactory results both with respect to the evenness and clearness of the inking of the copies and with respect to the prolongation of the life of the master sheet.

In the specification and claims, the solvent is variously referred to as being "atomized" so as to provide a "fine spray" in the form of a "vapor." By these terms I mean that the liquid solvent is broken up into finely divided form in order that it may be applied directly and uniformly to the master sheet in such minute quantities as to soften the ink of the master sheet only to a very slight extent such as is required for making a readily legible copy.

While I prefer to employ the form and arrangement of parts as illustrated and as above described, the invention is not to be limited to such arrangement, except as the claims may be so limited, it being understood that changes in the form and arrangement of the parts might well be effected without departing from the spirit of the invention.

I claim:

1. The method of duplicating which comprises the step of applying solvent to a master sheet by blowing an exceedingly small amount of the solvent in the form of a vapor directly onto the inked face of the master sheet.

2. The method of duplicating which comprises forwarding an inked master sheet and a copy sheet into registering relationship to each other, applying solvent directly to the inked face of the master sheet during its forward movement and independently of said copy sheet, and promptly thereafter pressing the copy sheet against the master sheet.

3. The method of duplicating which comprises moving an inked master sheet and a copy sheet forwardly edgewise separately into registering relationship to each other, applying a small amount of solvent directly to the inked face of the master sheet at a point in spaced relation to the point of contact of said sheets with each other for softening slightly the ink on the master sheet, and pressing said two sheets together for transferring a small fractional portion of the ink from the master sheet to the copy sheet.

4. The method of duplicating which comprises moving a master sheet and a copy sheet forwardly edgewise separately into impression relationship to each other, and applying directly to the inked face of the master sheet an exceedingly small amount of solvent in the form of a vapor for softening the ink of the master sheet slightly at a point ahead of the contact of the master sheet with the copy sheet.

5. The method of duplicating which comprises moving a master sheet and a copy sheet forwardly edgewise separately into impression relationship to each other, projecting directly toward the inked face of the master sheet a small amount of solvent in the form of a vapor at a point ahead of the point at which the master sheet contacts the copy sheet, and controlling the delivery of the solvent so as to be limited substantially to the time when the master sheet is moving directly past the point of delivery of the solvent.

6. A duplicating mechanism comprising in combination a drum provided with gripping means for holding a master sheet in position thereon, means for carrying a copy sheet into impression relationship with a master sheet carried around by the drum, means for projecting solvent in the form of a vapor onto the inked face of the master sheet ahead of the point at which the master sheet contacts the copy sheet, and means actuated in timed relation to the rotation of the drum for starting and stopping the delivery of solvent so as to be limited substantially to the time when the master sheet is passing the point of delivery of the solvent.

7. A duplicating mechanism comprising in combination a drum provided with gripping means for holding master sheets of varying lengths in position thereon, means for carrying a copy sheet into impression relationship with a master sheet carried around by the drum, means for projecting solvent in the form of a vapor onto the inked face of the master sheet ahead of the point at which the master sheet contacts the copy sheet, and means actuated in timed relation to the rotation of the drum for starting and stopping the delivery of solvent and adjustable for varying the period during which solvent is delivered and arranged so as to limit the delivery of the solvent substantially to the time when the master sheet in use is passing the point of delivery of the solvent.

8. A duplicating mechanism comprising in combination a drum provided with gripping means for holding a master sheet in position thereon, means for carrying a copy sheet into impression relationship with a master sheet carried around by the drum, means for projecting solvent in the form of a vapor onto the inked face of the master sheet ahead of the point at which the master sheet contacts the copy sheet, and means comprising a cam carried around by the drum for controlling the action of said solvent-projecting means adapted to start and stop the delivery of solvent so as to be limited substantially to the time when the master sheet is passing the point of delivery of the solvent.

9. A duplicating mechanism comprising in combination a drum provided with gripping means for holding master sheets of varying lengths in position thereon, means for carrying a copy sheet into impression relationship with a master sheet carried around by the drum, means for projecting solvent in the form of a vapor onto the inked face of the master sheet ahead of the point at which the master sheet contacts the copy sheet, means for controlling the action of said solvent-projecting means for regulating the period during which solvent is delivered, and cam means carried around by the drum and adjustable for varying the effective size of the cam circumferentially of the drum adapted by engagement with said control means

to limit the delivery of the solvent substantially to the time when the master sheet in use is passing the point of delivery of the solvent.

10. A duplicating mechanism comprising in combination a drum provided with gripping means for holding master sheets of varying lengths in position thereon, means for carrying a copy sheet into impression relationship with a master sheet carried around by the drum, means for projecting solvent in the form of a vapor onto the inked face of the master sheet ahead of the point at which the master sheet contacts the copy sheet, means for controlling the action of said solvent-projecting means for regulating the period during which solvent is delivered, and cam means adapted by engagement with said control means to limit the delivery of the solvent substantially to the time when the master sheet in use is passing the point of delivery of the solvent, said cam means comprising a cam disc constrained to rotate with the drum and having a high portion at one side thereof, a second cam disc rotatably mounted adjacent to said first-named cam disc and having a high portion at one side adapted to be positioned opposite to the high portion of said first-named cam or alternatively in adjusted extended relation thereto, and means for releasably locking said two cam discs together in adjusted position with respect to each other.

11. A duplicating mechanism comprising in combination a drum provided with gripping means for holding master sheets of varying lengths in position thereon, means for carrying a copy sheet into impression relationship with a master sheet carried around by the drum, means for projecting solvent in the form of a vapor onto the inked face of the master sheet ahead of the point at which the master sheet contacts the copy sheet, means for controlling the action of said solvent-projecting means for regulating the period during which solvent is delivered, and cam means adapted by engagement with said control means to limit the delivery of the solvent substantially to the time when the master sheet in use is passing the point of delivery of the solvent, said cam means comprising a cam disc constrained to rotate with the drum and having a high portion at one side thereof, second and third cam discs rotatably mounted adjacent to said first-named cam disc and each having a high portion at one side adapted to be positioned opposite to the high portion of said first-named cam or alternatively in adjusted extended relation thereto, and means for releasably locking said three cam discs together in adjusted position with respect to each other.

12. A duplicating mechanism comprising in combination a drum provided with gripping means for holding master sheets of varying lengths in position thereon, means for carrying a copy sheet into impression relationship with a master sheet carried around by the drum, means for projecting solvent in the form of a vapor onto the master sheet ahead of the point at which the master sheet contacts the copy sheet, means for controlling the action of said solvent-projecting means for regulating the period during which solvent is delivered, and cam means adapted by engagement with said control means to limit the delivery of the solvent substantially to the time when the master sheet in use is passing the point of delivery of the solvent, said cam means comprising a cam disc constrained to rotate with the drum and having a high portion at one side thereof, second and third cam discs rotatably mounted adjacent to said first-named cam disc and each having a high portion at one side adapted to be positioned opposite to the high portion of said first-named cam or alternatively in adjusted extended relation thereto, spring means normally holding the intermediate one of said cam discs against movement into extended relation to said first-named cam disc, means adapted when the third disc is moved to the limit of its motion with respect to said first-named disc to move said intermediate cam disc into adjusted position against the action of said spring means, and means for releasably locking said three cam discs together in adjusted position with respect to each other.

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