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E. S. L. BEALE ETAL

3,056,384

APPARATUS FOR THE DEPOSITION OF LIQUID MATERIALS

Filed May 5, 1958

5 Sheets-Sheet 1

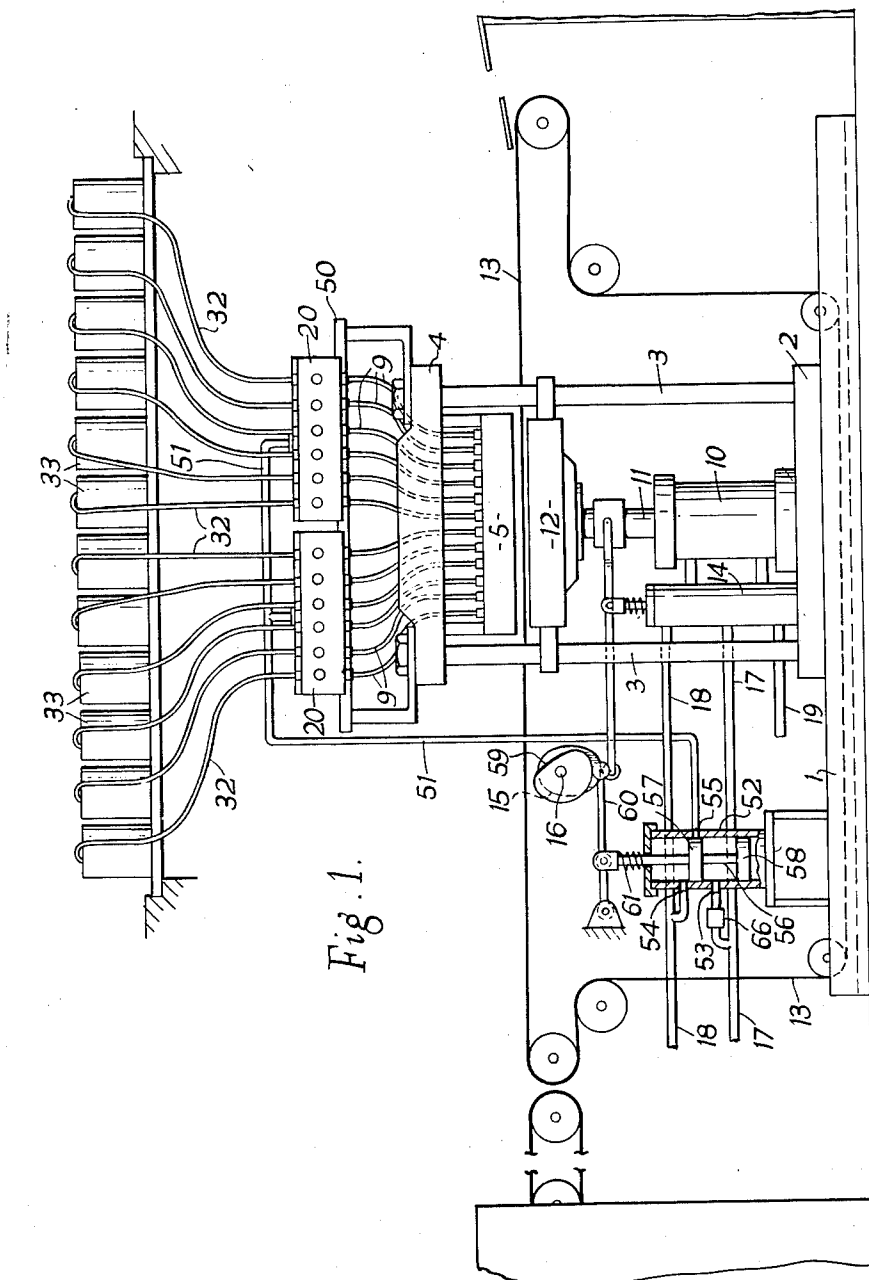


Fig. 1.

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Fig. 2.

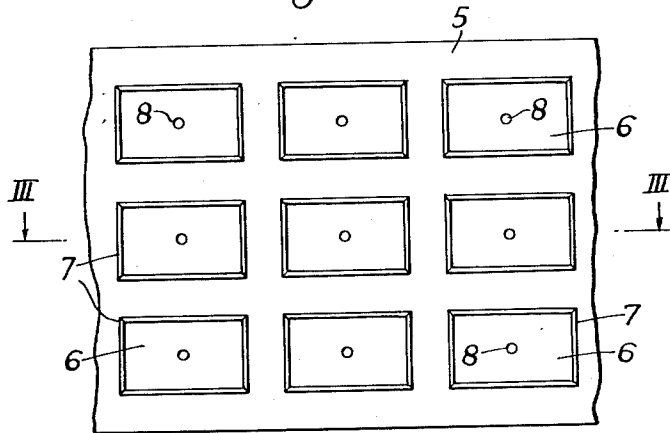
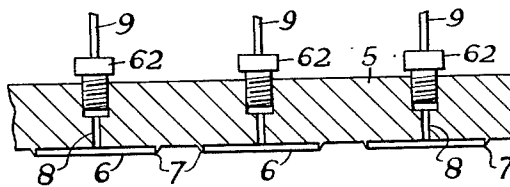


Fig. 3.



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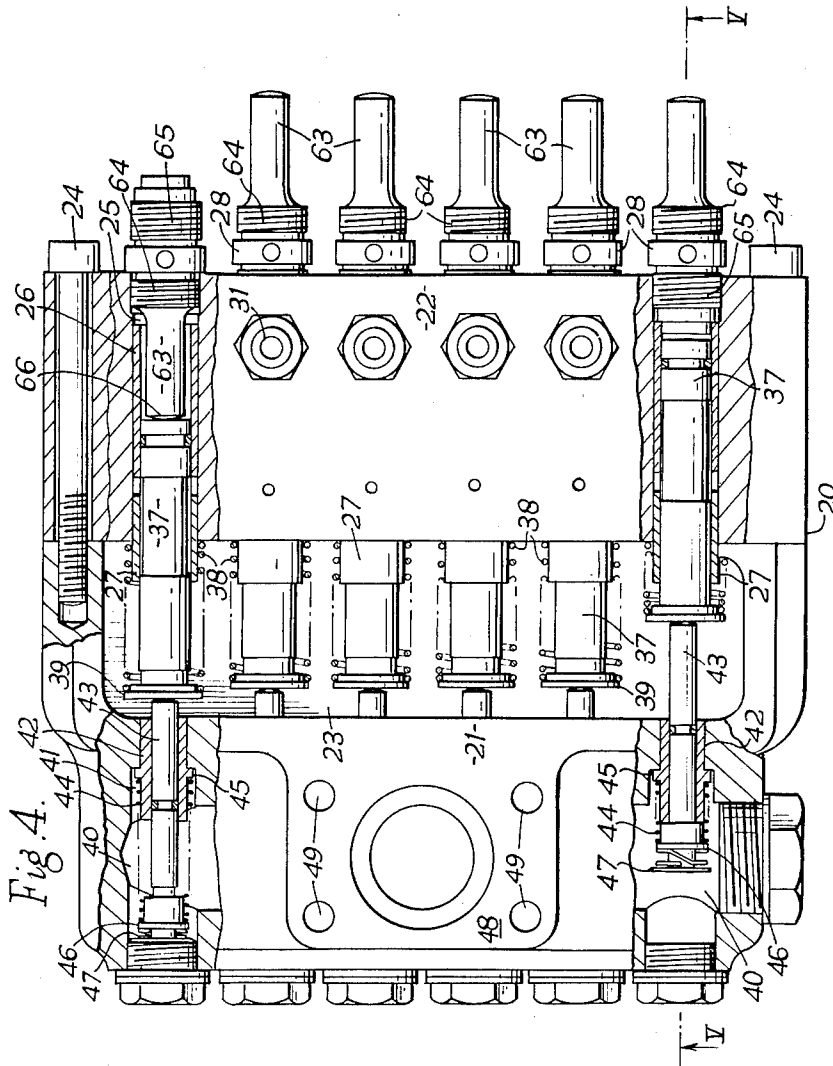
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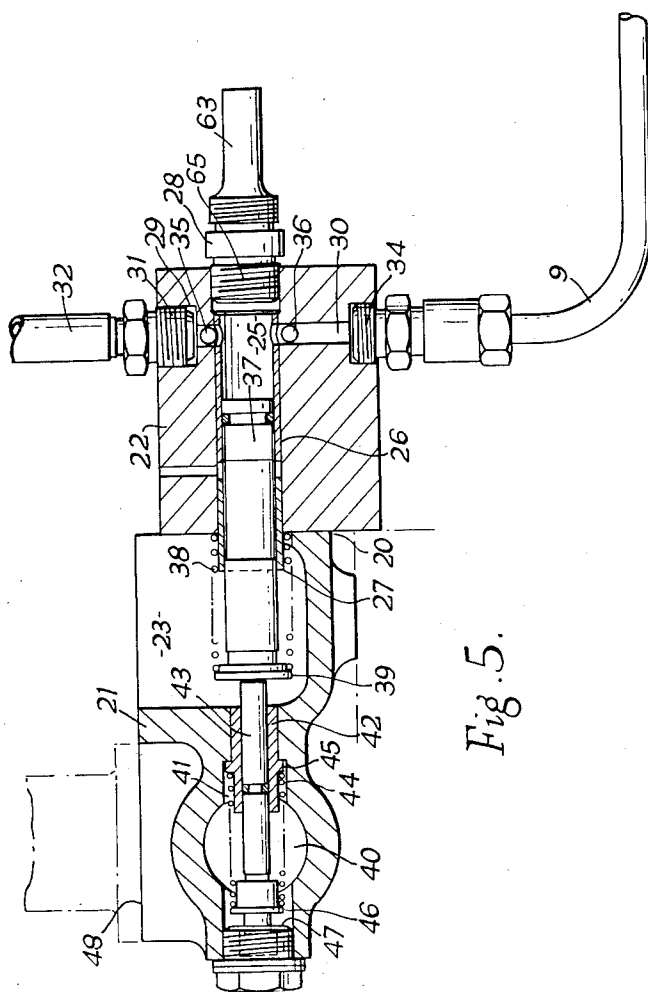


Fig. 5.

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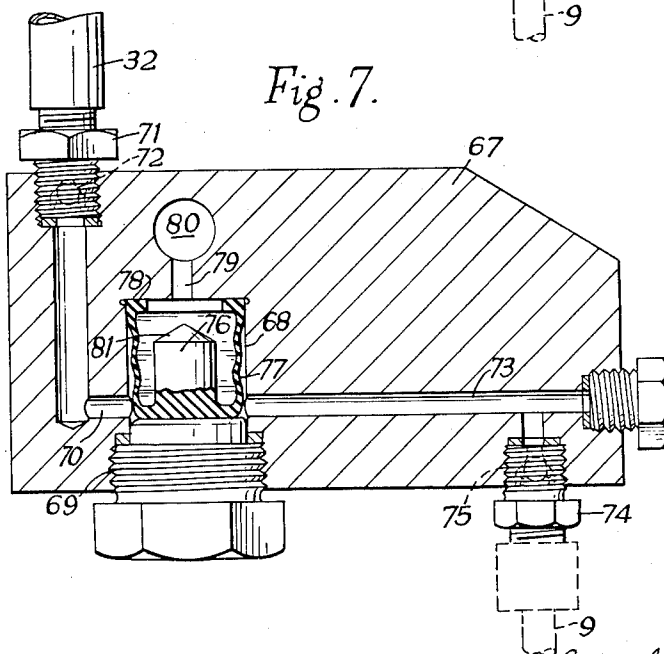
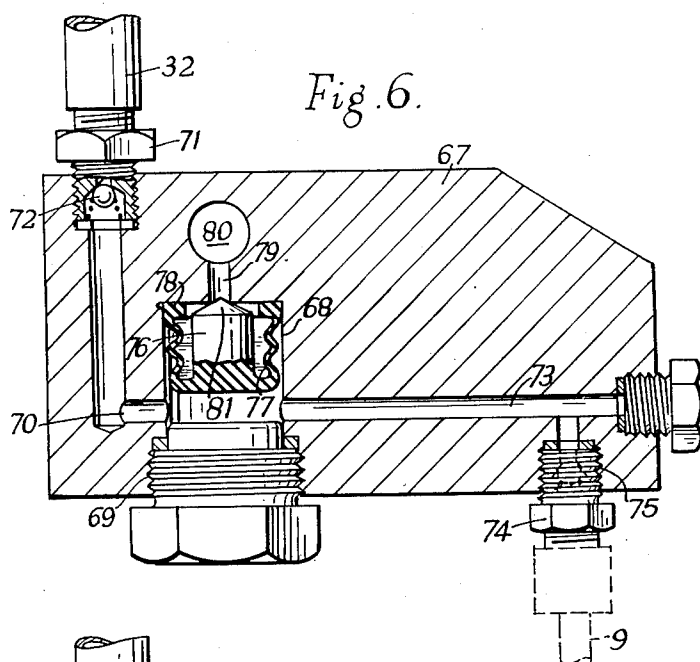
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5 Sheets-Sheet 5



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APPARATUS FOR THE DEPOSITION OF LIQUID MATERIALS

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Claims priority, application Great Britain May 7, 1957
9 Claims. (Cl. 118—411)

The present invention relates to improvements in and relating to apparatus for the deposition of thin layers of paints, inks and other liquid materials in accurately defined areas on surfaces, the apparatus being of the kind in which the surface to receive the deposit is brought and held in pressure contact with the operative face of a matrix having a number of shallow cavities in that face for the reception of materials to be deposited introduced through conduits leading through the matrix to the cavities so that deposition takes place on the applied surface in patches or areas defined by the boundaries of the cavities in the matrix.

The liquids to be deposited are such as will remain in the accurately defined areas in which they have been deposited when the surface and matrix are separated.

Such apparatus is employed for example in the production of sample colour cards as used for the selection of paints and other coloured materials or articles.

In practice it is necessary to use pressure feed for the introduction of the liquid into the cavities in order for example to remove the air entrapped in the cavities by the sheet applied to the matrix face, and to ensure filling or near filling of the cavities with the liquid.

For this purpose it has been usual to employ a number of open reservoirs for the liquids to be deposited connected through separate pipe lines with the passages through the matrix, the several reservoirs being enclosed within one or more chambers capable of being sealed so that a super-atmospheric pressure may be created therein to effect the liquid feed from the reservoirs and the pipe lines terminating in control valves mounted on the matrix for initiating and terminating the flow of the liquid from the reservoirs to the cavities.

Such an arrangement however, has certain disadvantages in that replenishment of liquid of any one of the reservoirs involves opening of the pressure chamber and exposure of the usually very volatile contents of all reservoirs during such replenishment. Furthermore uniformity in the pressure and quantity of liquid delivered to all the cavities under the control of a multiplicity of valves though often desirable is difficult to achieve and the need to mount the valves on the matrix itself imposes limitations on the size and number of patches of deposited liquid which can be produced with a matrix of given size.

In accordance with the present invention an apparatus of the kind indicated is provided having a number of reservoirs for liquid to be deposited and means for feeding liquid from said reservoirs to a number of cavities in the matrix, said feeding means comprising a plurality of similar pumps assembled as a unit and mounted on the machine separate from the matrix, individual pumps being connected by suction tubes with the reservoirs and by delivery tubes to the passages through the matrix to the cavities, the delivery stroke of said assembly of pumps being effected simultaneously by fluid pressure in a manifold common to all the pumps of said unit.

In the at present preferred form the delivery stroke of the unitary assembly of pumps is effected by hydraulic pressure derived from a manifold common to all the pumps of the unit.

Means are provided to enable the pump operating

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pressure e.g. the fluid pressure in the manifold to be varied, so that the delivery pressure of all the pumps of the assembly embodying that manifold is correspondingly varied.

Thus the delivery pressure can be readily set to a minimum necessary to effect deposition of the liquid in a manner ensuring effective removal of all or substantially all the air from the cavities and filling or substantial filling of the cavities with deposit liquid and at the same time keeping the pressure on the surface receiving the deposit due to the operation of the pumps, as low as possible so that risk of breakage of the seal between the face of the matrix and the sheet receiving the deposit is reduced.

When liquid from a large number of reservoirs is to be delivered to a large number of cavities the pumps may be assembled in units of for example six, each unit with its own manifold, a common fluid supply line being provided for all the manifolds.

The invention is illustrated by way of example in the accompanying drawings in which:

FIG. 1 is a view in side elevation of a complete machine embodying the invention and utilising hydraulic control.

FIGS. 2 and 3 are views in underside plan and sectional side elevation of a part of a matrix as used in a machine of the kind to which the invention relates, FIG. 3 being taken on the line III—III of FIG. 2.

FIG. 4 is a view in part sectional plan and on a larger scale of a pump unit for hydraulic operation and

FIG. 5 is a view in end sectional elevation taken on the line V—V of FIG. 4.

FIGS. 6 and 7 are diagrammatic sectional views showing an alternative form of pump unit.

Referring to FIG. 1 the body of the machine shown is in general of the kind fully described in the specification of co-pending patent Application No. 690,825 and comprises a hollow base 1 on which is mounted a rectangular base-frame 2 supporting four rigid vertical corner posts 3 of circular section and an open top frame 4 fixedly connected with the upper ends of the posts 3.

To the underside of the top frame 4 is fixedly connected a matrix 5 of known kind as shown in FIGS. 2 and 3 consisting of a metal block having hollow shallow cavities 6 formed in its operative under face, the cavities 6 being bounded by ridges 7 of small height of the order of a few thousandths of an inch, extending from the surface of the matrix.

Holes 8 are provided in the matrix block leading from the upper side thereof to the interior of the cavities 6.

On the rectangular base frame 2 and in the space within the four posts 3 of the frame structure and below the matrix 5 is located a vertically disposed hydraulic press the cylinder 10 of which is supported on the base frame 2.

The vertical ram 11 of the hydraulic press carries a platen 12 the upper surface of which is disposed parallel with the operative face of the matrix 5, both usually being horizontal as shown, the platen 12 being raised and lowered by the ram 11.

Sheets of paper, card or the like upon which deposits are to be made are fed singly in succession, for example by automatic conveyor means indicated diagrammatically at 13 and forming no part of the present invention, onto the surface of the platen 12 in the lowered position of the latter and the platen raised by the ram 11 to urge the sheet into pressure engagement with the underside of the matrix 5 in such a manner as to seal off the cavities 6, and thereafter the liquid to be deposited is fed under pressure from a number of reservoirs through the passages 8 in the matrix to the cavities 6 in order to deposit it on the sheet in areas defined by the ridges 7.

The platen 12 after interruption of the feed of the

liquid to the cavities in the matrix is lowered to enable the sheet with the deposit thereon to be removed e.g. by the conveyor means 13 and a next succeeding sheet substituted on the platen.

The rising and falling movements of the platen 12 may be arranged to take place in a pre-determined time cycle in accordance with the operation of a double-acting hydraulic-control valve 14 the movements of which are determined by a continuously driven cam 15 on a cam shaft 16 all as fully described in the specification of application No. 690,825. The hydraulic fluid pressure supply line to the press is indicated at 17 and the return flow lines therefor at 18 and 19 in FIG. 1.

The means for effecting pressure feed of the liquid to be deposited to the cavities in the matrix comprises a plurality of similar suction and discharge pumps, usually one pump for each cavity 6, said pumps being built as elements of one or a number of unitary structures each embodying a number of pumps and such that the delivery strokes of all the pumps of a unit are effected simultaneously by common control with a similar pressure in all the cavities fed by the or a given unit.

One such pump suitable for hydraulic operation and embodying six pumps is illustrated in FIGS. 4 and 5 of the drawings.

The unit comprises a metal body 20 formed of two main parts 21 and 22, the part 21 being provided with a large rebate 23, and the two parts being bolted together in face-to-face relationship by bolts 24 so that the rebate 23 becomes a deep channel open from above as shown.

The part 22 is bored with six parallel and similar holes to provide six pump chambers 25, the chambers being provided with liners 26 of a length to extend for a short distance into the channel 23 as shown at 27. The outer ends of the chambers 25 in the part 22 are closed by screwed plugs 28.

Diametrically opposed counterbored side ports 29 and 30 are formed through the wall of the part 22, two for communication with the interiors of each of the chambers 25, the ports 29 being screw-threaded for the reception of pipe unions 31 for connecting liquid supply pipes 32 leading from individual liquid reservoirs of which a series are shown at 33 in FIG. 1, and the ports 30 being screw threaded for the reception of pipe unions 34 for connecting liquid delivery pipes 9 leading to the matrix 5. Non-return valves 35 and 36 are provided in each of the ports 29 and 30.

Cylindrical pump plungers 37 are mounted to slide in the chambers 25, the plungers being of a length to extend into the recess 23 and the ends extending into the recess are surrounded by compression springs 38 abutting between on the one hand the wall of the part 22 of the body and on the other hand flanges 39 formed on the ends of the plungers 37 and centralised by the ends 27 of the liners 26.

The part 21 of the body 20 is formed with a transverse chamber 40 extending across the width of the unit the chamber 40 being closed at both ends.

The wall of the part 21 adjacent the recess 23 is bored with six counterbored holes 41 co-axial with the chambers 25 in part 22, the small-diameter parts of these holes being fitted with liners 42 in which are mounted slidable rods 43 extending at one end into the recess 23 and at the other end into the chamber 40. Sealing means such as O-rings, bellows or the like provide a hydraulic seal between the slidable actuators 43 and the liners 42. The rods 43 constitute actuators for the pump plungers 37 and they are surrounded by compression springs 44 between shoulders 45 on the exterior of the liners 42 and washers 46 mounted on the ends of the actuators 43 and backed by spring washers 47.

The part 21 of the body 20 is formed with a face plate 48 and bolt holes 49 enabling the unit to be bolted to a support plate 50 (FIG. 1) carried in fixed position above the open top frame 4 of the machine, the face plate 48 being bored and screw threaded for connection of a

hydraulic pressure supply line 51 leading hydraulic liquid to the transverse chamber 40.

In the case illustrated in FIG. 1, two such pump units 20 are shown mounted for use and connected with the same liquid pressure supply line 51.

The hydraulic supply to the pump unit is controlled by a hydraulic control valve of conventional form shown diagrammatically in FIG. 1 and comprising a fixed cylinder 52 having pressure and return ports 53 and 54 respectively connected with the existing hydraulic pressure and return pipes 17 and 18 of the hydraulic press cylinder 10, and an outlet port 55 intermediate the ports 53 and 54 and connected with the line 51 leading to the manifold 40 of the pump units 20. An adjustable pressure reducing valve 66 is provided in the connection between the port 53 and the hydraulic supply line 17 (FIG. 1). A control valve stem, or spool 56 provided with lands 57 and 58 is movable in the cylinder 52 in such a manner as to place the port 55 into communication alternately with the pressure port 53 and the return port 54 according to the position taken by the land 57 with reference to the port 55.

The movements of the spool 56 are controlled by a cam 59 rotated by the shaft 16 in conjunction with a cam follower on a pivoted lever 60 and a return spring 61, so that the valve is operated in timed relation with the movements of the platen 12.

In operation, the pressure reducing valve 66 having been adjusted, and with a sheet on the platen 12 held in pressure engagement with the matrix 5, the valve spool 56 is moved by the cam 59 to place the pressure supply line 17 and the port 53 into communication with port 55 and the line 51 so that hydraulic liquid is introduced to the manifold chamber 40 of the pump unit.

The actuators 43 are thereby thrust simultaneously and with similar pressure outwards from the chamber 40 i.e. to the right in FIGS. 4 and 5 and the ends of the actuators engage the ends of the pump plungers 37 to move them in the pump chambers 25 to transfer liquid from the pump chambers by way of the pipes 9 to the cavities 6 in the matrix. The non-return valves 35 at the ports 29 leading from the reservoir lines 32 are closed by the pressure of the liquid being transferred and the non-return valves 36 at the delivery ports 30 opened and the movement of all the plungers 37 ceases when the pressure in the cavities 6 balances the pressure in the manifold chamber 40.

Movement of the cam 59 thereafter moves the spool 56 of the hydraulic valve to place the line 51 and port 55 into communication with the port 54 and the return flow line 18 so that pressure is relieved in the manifold space 40 and the actuators 43 and the plungers 37 make return movements under the urge of their return springs 44 and 38.

The return movement of the plungers 37 closes the non-return valves 36 to prevent suction taking effect in the pipes 9 and at the cavities 6 and non-return valves 35 are opened and liquid drawn in by way of the pipes 32 from the reservoirs 33 to recharge the pump chambers 25 with liquid to be deposited.

The platen 12 is now lowered to permit removal of the sheet with the deposits thereon and substitution of a fresh sheet and the platen again raised and the above described sequence of pumping operations repeated.

The tubes 32 between the reservoirs 33 and the pump units 20 may be of flexible material such as polythene connected at their upper ends with syphon sections extending into the reservoirs 33. The pipes 9 between the pump units 20 and the matrix 5 are of flexible but relatively inextensible material and are usually of metal e.g. copper or aluminium, though other materials such as nylon may be used.

In some cases when a similar liquid is required to be delivered to more than one cavity in the matrix, the delivery port 30 from one pump chamber 25 may be

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branched for connection with two or more delivery pipes 9.

With the improved arrangement described the delivery pipes 9 can be directly coupled with the matrix with the aid of simple screw couplings as illustrated diagrammatically at 62 in FIG. 3 which may be of very small size so that it is possible to accommodate a very large number within the area of the rear face of the matrix and a correspondingly large number of cavities 6 may be provided in a matrix of relatively small area. In some cases as when pipes 9 of nylon are used simple push-on connections may be used.

The screwed plugs 28 closing the ends of the pump chambers 27 are formed with axial extensions 63 normally extending outwards from the pump unit, the inner ends 64 of the extensions being of a similar size and screw threaded in a manner similar to the plug portions 65 normally screwed into the end of the chamber.

Thus when less than the full complement of pumps of a pump unit are required for use, the plugs of unwanted pumps may be removed, reversed and re-inserted with the extensions 63 of the plugs inside the selected pump chambers 25 as shown at 66 in FIG. 4, in which position the ends of the plug extensions make abutting engagement with the pump plungers 37 to hold the latter and also the actuators 43 in the retracted position against the pressure in the manifold 40.

FIGS. 6 and 7 illustrate an alternative form of pump unit adapted for pneumatic operation.

The body 67 of the unit is formed with a number of bores 68 closed at their lower ends by screw plugs 69 and constituting pump chambers and each in communication at one side with passage 70 communicating in turn with a supply pipe 32 leading from one of the reservoirs, the pipe 32 being coupled with the unit through a screwed union 71 provided with a non-return valve 72. At the other side each pump chamber 68 communicates with a passage 73 communicating in turn with a delivery pipe 9, the pipe 9 being coupled with the unit through a screwed union 74 embodying a non-return valve 75.

In each pump chamber 68 of the unit is mounted a piston 76 carried by the closed lower end of a bellows 77 with the piston 76 inside the bellows.

The bellows 77 at its upper end is sealed to the bottom wall of the chamber 68 as shown at 78 and it is of a size to substantially fill the chamber 68 when the bellows is extended.

The interiors of all the bellows 77 of a pump unit are in communication through passages 79 with a manifold 80 provided in the body of the unit, the manifold being connected with means (not shown) for supplying the manifold with compressed air and for creating a degree of vacuum therein alternately.

The upper end of the piston 76 is tapered as shown at 81 so as to provide an air seal with the lower end of the passage 79 leading to the manifold.

In the condition shown in FIG. 6 vacuum exists in the manifold 80 and all the bellows 77 of the unit are collapsed with the piston 76 held raised and the passages 70 and 73 and the spaces in the chambers 68 outside the bellows filled with the liquid to be deposited.

Creation of pressure in the manifold 80 causes all the bellows 77 of the unit to be expanded with equal pressure to take the position shown in FIG. 7 so that liquid is displaced from below the bellows. The non-return valve 72 closes under the pressure to prevent liquid passing back through the pipes 32 to the reservoirs 33 and the non-return valves 75 are opened by the pressure of the liquid so that liquid is fed by way of the pipes 9 with equal pressure to all the cavities 6 in the matrix 5.

Re-creation of vacuum in the manifold 80 causes collapse of all the bellows 77 of the unit to positions as shown in FIG. 6. The non-return valves 75 in the unions 74 of the outlet pipes 9 close so that no suction occurs at the cavities of the matrix whilst the non-return

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valves 72 in the unions 71 of the supply pipes 32 open and liquid is drawn from the reservoirs 33 to recharge the space in the chambers 63 outside the bellows 77.

The pressure of the liquid delivered to the cavities in the matrix is determined by the air pressure admitted to the manifold and is the same at all the cavities supplied by the pumps of the unit.

We claim:

1. An apparatus for use in depositing thin layers of liquids in accurately defined areas on surfaces, comprising a frame structure, a matrix mounted in said frame structure and having a plurality of shallow cavities in one face thereof, conduits leading through the matrix to the said cavities, a platen, means for imparting relative movement between said matrix and said platen and applying a surface intended to receive the deposit into cavity-sealing engagement with the face of the matrix, a plurality of separate containers for liquids to be deposited, a pump unit mounted in said frame structure and remote both from said containers for liquids and from the matrix and embodying a plurality of similar suction and delivery pumps and a fluid-pressure manifold common to all the said pumps of the unit, means connected to the manifold for introducing pressure fluid thereto for controlling the operation of the suction and delivery pumps of the pump units, tubes each connecting one of said containers to the suction side of one of said pumps of the said pump unit, further tubes each connecting the delivery side of one of the said pumps of the said pump unit to one of the said conduits leading through the matrix to the cavities and means alternately creating and relieving of fluid pressure in said fluid pressure manifold.

2. An apparatus as claimed in claim 1 wherein the said further tubes are of flexible, inextensible and inexpandable material.

3. An apparatus for use in depositing thin layers of liquids in accurately defined areas on surfaces comprising a frame structure, a matrix mounted in the frame structure and having a plurality of shallow cavities in one face thereof, conduits leading through the matrix to the said cavities, a platen, means imparting relative movement between said matrix and said platen and applying a surface intended to receive the deposit into cavity-sealing engagement with the face of the matrix, a plurality of separate containers for liquids to be deposited, a pump unit mounted in said frame structure and remote both from said separate containers for liquid and from the matrix and embodying a plurality of pump cylinders, a suction and delivery piston movable in each of said cylinders respectively, a fluid-pressure manifold common to all the cylinders of the unit and isolated therefrom, means connected to the manifold for introducing pressure fluid thereto, a plurality of plunger-actuators extending from the interior of the manifold into engagement with the said pistons and urging said pistons in the delivery direction upon introduction of the fluid-pressure into the said manifold and springs urging the said pistons and the said plunger-actuators in the other direction, tubes each connecting one of said containers to one of said pump cylinders of the said pump unit, further tubes each connecting one of the said pump cylinders of the said pump unit to one of the said conduits leading through the matrix to the cavities and means alternately creating and relieving fluid pressure in said fluid pressure manifold.

4. Apparatus as claimed in claim 3 wherein the ends of the pump cylinders remote from the plunger-actuators are closed by screw plugs, extension pieces on the outer ends of said plugs capable of being introduced into and fixed in the pump cylinders by removal, reversal and re-introduction of the screw plugs and forming abutments for engagement with the related one of said pump pistons to prevent pumping operation of said piston.

5. In an apparatus for use in depositing thin layers of liquids in accurately defined areas on surfaces, which apparatus comprises a matrix having a plurality of shallow

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cavities in one face thereof, conduits leading through the matrix to the said cavities, a platen, means imparting relative movement between said matrix and said platen and applying a surface intended to receive the deposit into cavity-sealing engagement with the face of the matrix and a plurality of separate containers for liquid to be deposited; the improvement comprising a pump unit mounted in said frame structure and remote both from said separate containers and from the matrix and embodying a plurality of pump chambers, a liquid displacing bellows mounted in each of said pump chambers and a fluid pressure manifold communicating with the interior of all the said bellows of the pump unit, tubes each connecting one of the said containers with the space in one of the pump chambers outside the bellows therein, further tubes each connecting the space in one of the pump chambers outside the bellows to one of the conduits leading through the matrix to the cavities and means alternately creating fluid pressure and vacuum in said fluid pressure manifold.

6. Apparatus as claimed in claim 5 in which the pump unit includes a part carried by the closed end of the interior of each of the bellows and engageable with a wall of a respective pump chamber for limiting the extent of collapse of the bellows when a vacuum is created in the manifold common to all the bellows of said pump unit.

7. Apparatus as claimed in claim 5 wherein a valve seat is provided in the manifold inlet adjacent the open end of each of the said bellows, the said part carried by the interior of the closed end of each of the said bellows making sealing engagement with said valve-seatings in the collapsed condition of the bellows to seal off communication between the interiors of the said bellows and the manifold.

8. Apparatus as claimed in claim 5 and including non-return valves between the said containers and the suction-delivery pumps of the pump unit preventing transmission of pressure to the containers during delivery by the pumps and further non-return valves between the suction-delivery pumps of the pump unit and the conduits leading through the matrix preventing suction at the cavities in the matrix during suction of the pumps.

9. An apparatus for use in depositing thin layers of liquids in accurately defined areas on surfaces, compris-

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ing a frame structure, a matrix mounted in said frame structure and having a plurality of shallow cavities in one face thereof, conduits leading through the matrix to the said cavities, a platen, means for imparting relative movement between said matrix and said platen and applying a surface intended to receive the deposit into cavity-sealing engagement with the face of the matrix, a plurality of separate containers for liquids to be deposited, a pump unit mounted in said frame structure and remote both from said separate containers for liquids and from said matrix, said pump unit comprising a body structure including a first main part and a second main part and means rigidly connecting said first and said second main parts, a plurality of similar and parallel pump cylinders in said first main part and a manifold in the said second main part, a wall constituting a part of the boundary of said manifold and spaced from said first main part, a corresponding plurality of pump plungers one in each of said cylinders and extending into the space between said wall and said first main part and a corresponding plurality of actuator rods sliding in the said wall and each axially aligned and engaged at one of its ends with one of said pump plungers and with its other end in the said manifold for movement in one direction to actuate the pump plungers in response to fluid pressure in the manifold, spring means cooperating with the pump plungers and the actuator rods for moving them in the reverse direction and means alternately creating and relieving fluid pressure in said fluid pressure manifold.

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