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Farrow et al.

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[54] **APPARATUS FOR PUMPING FLUID THROUGH A DIE PLATE TO A RECESSED DESIGN**

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[52] **U.S. Cl.** **101/150**

[51] **Int. Cl.**..... **B41f 1/40**

[58] **Field of Search** 101/170, 171, 366, 163; 417/496, 505

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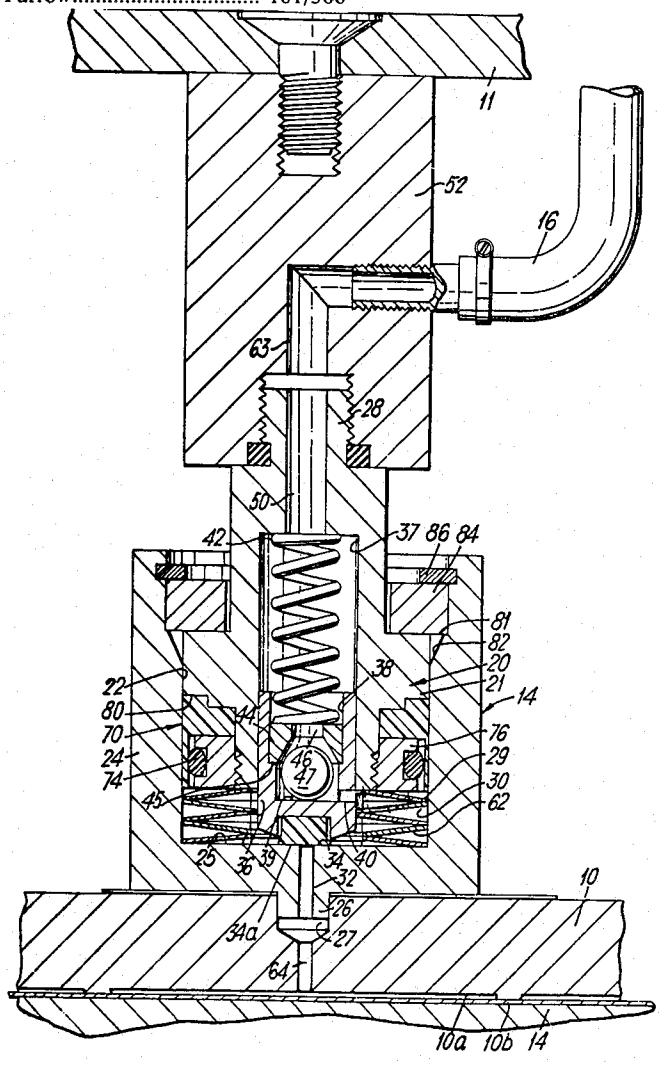
Primary Examiner—J. Reed Fisher

[57] **ABSTRACT**

A liquid feed mechanism feeds liquid to be deposited on a surface in a predetermined design through a die plate into recesses corresponding with the design. The mechanism has at least one pump chamber adapted to be contracted by the application of pressure from a press onto the die plate during depositing the liquid and to expand when the pressure is relaxed. The chamber has an outlet which communicates, in use, with one or more ink passages extending through the die plate, and an inlet which communicates, in use, with supply of the liquid. The inlet is controlled by a valve device which is closed automatically by the application of printing pressure on the die plate, the outlet being also controlled by a normally closed valve device which opens when the chamber is pressurized. The chamber has pressure relief means solely comprising a pressure relief piston biased inwardly against the pressure of printing fluid in the chamber and slidable outwardly, to relieve the pressure in the chamber when it exceeds a magnitude predetermined by the bias.

7 Claims, 6 Drawing Figures



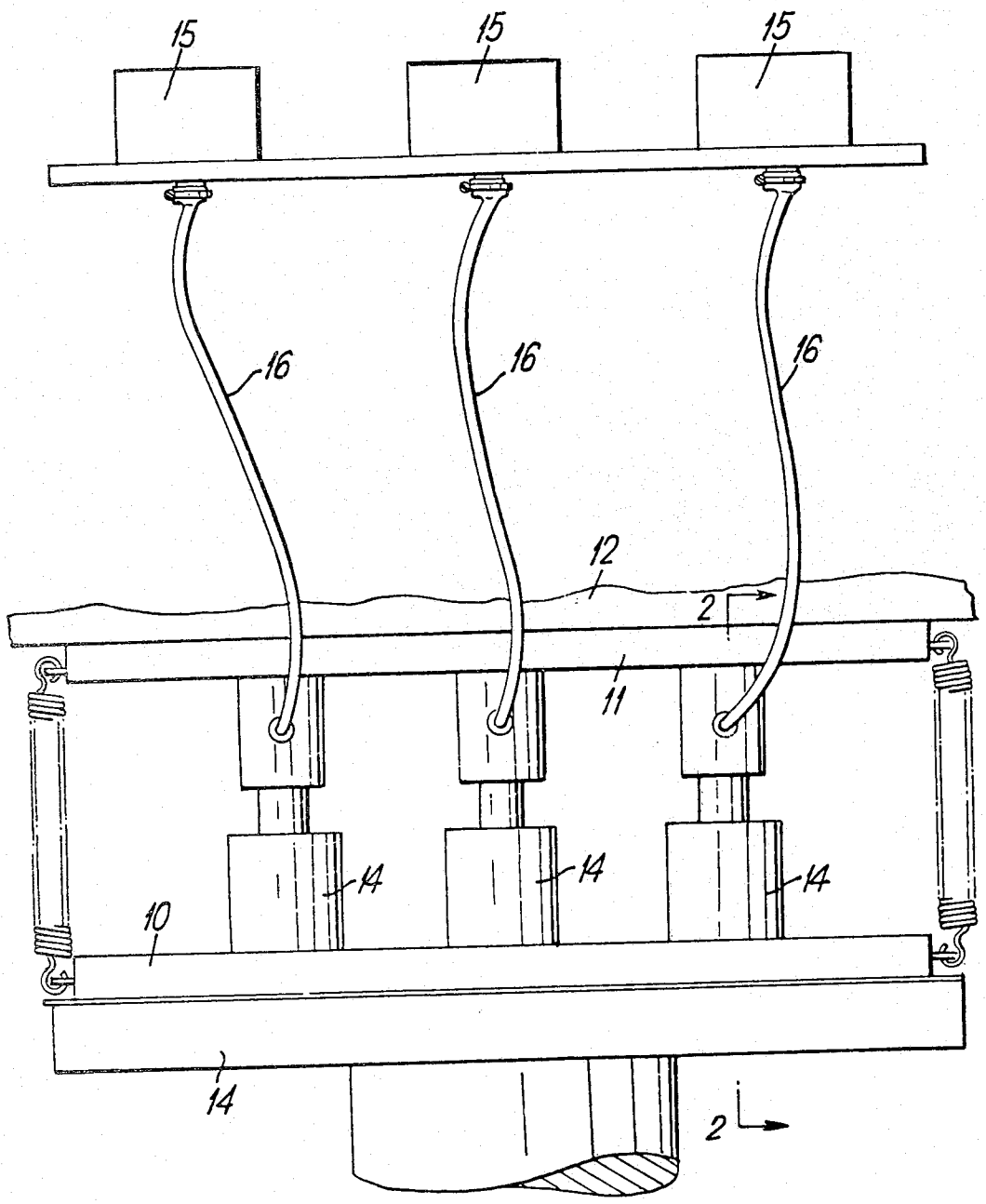


Fig. 1.

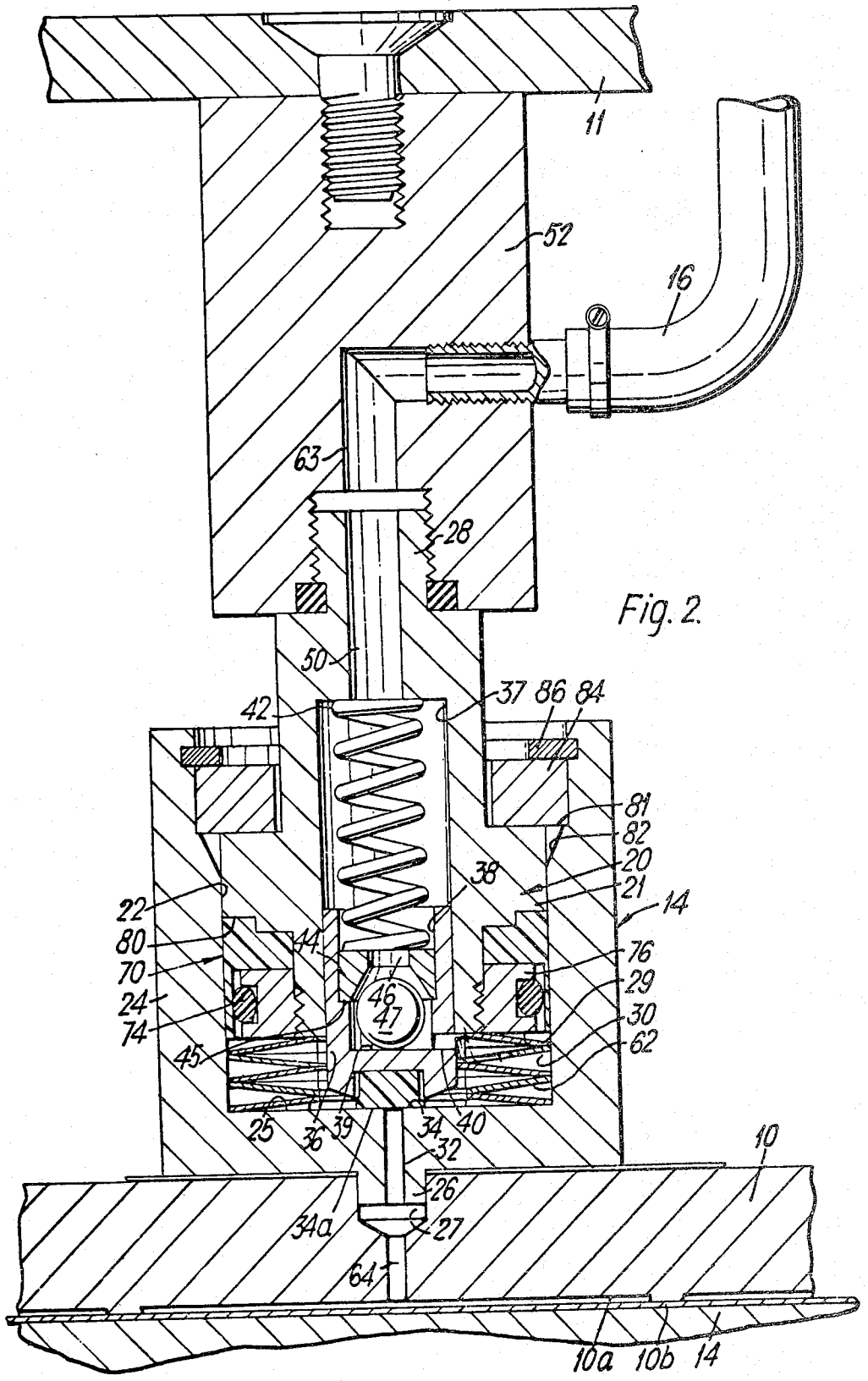

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Fig. 2.

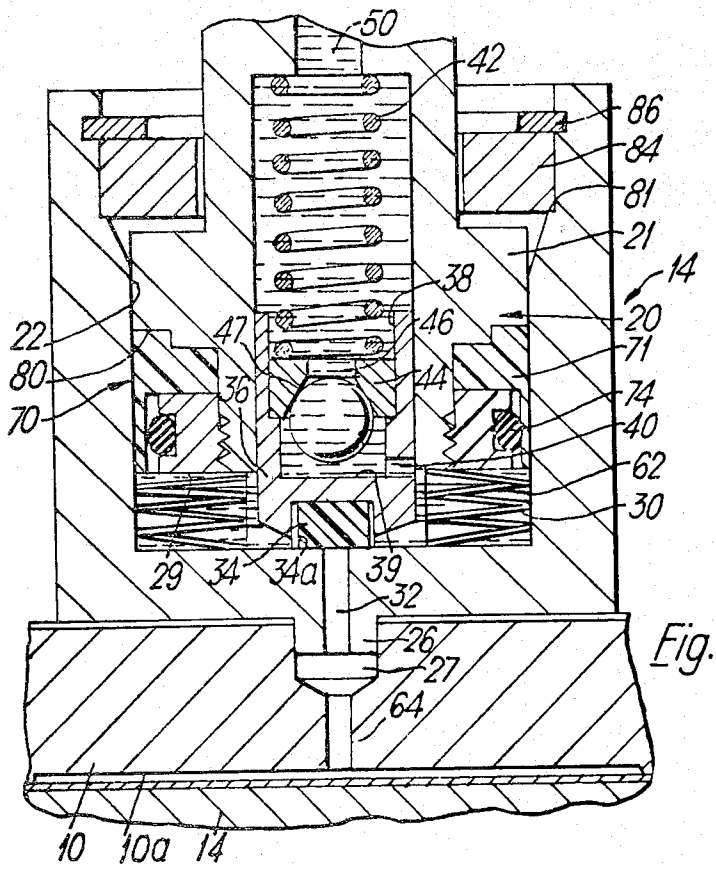
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Fig.3.

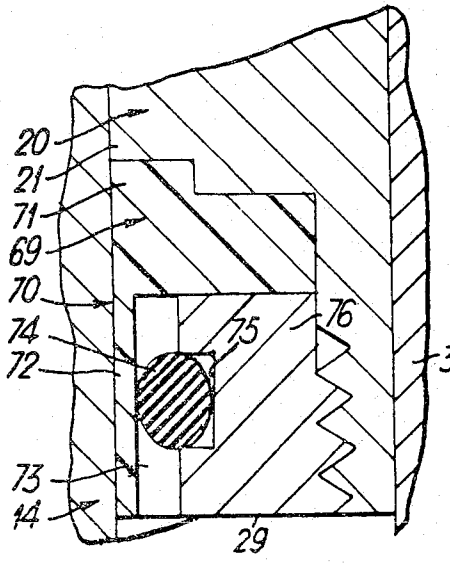
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Fig.5.

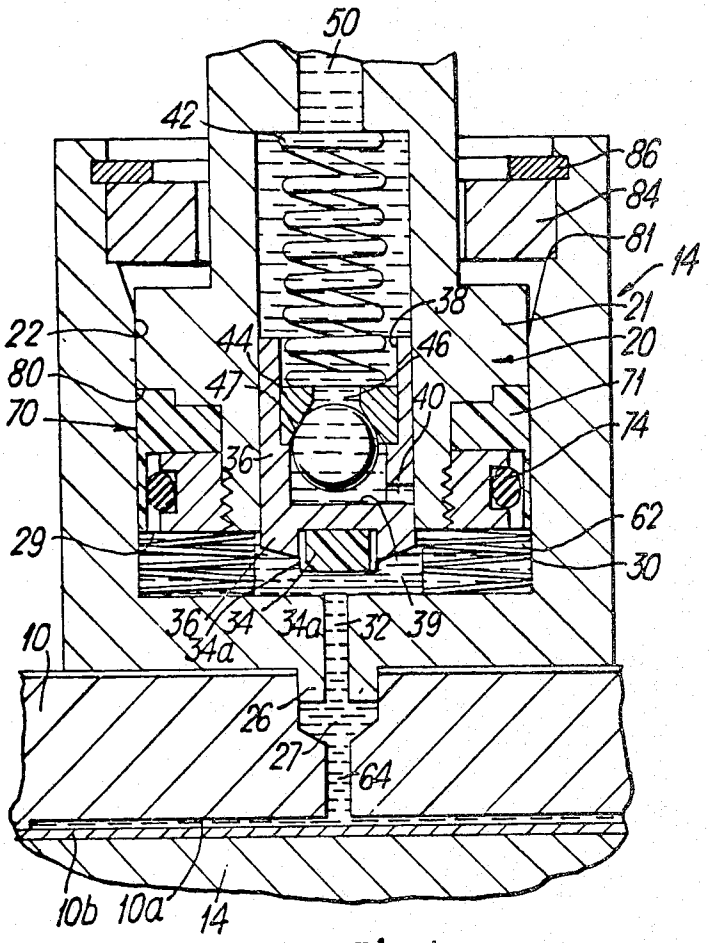
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Fig. 4.

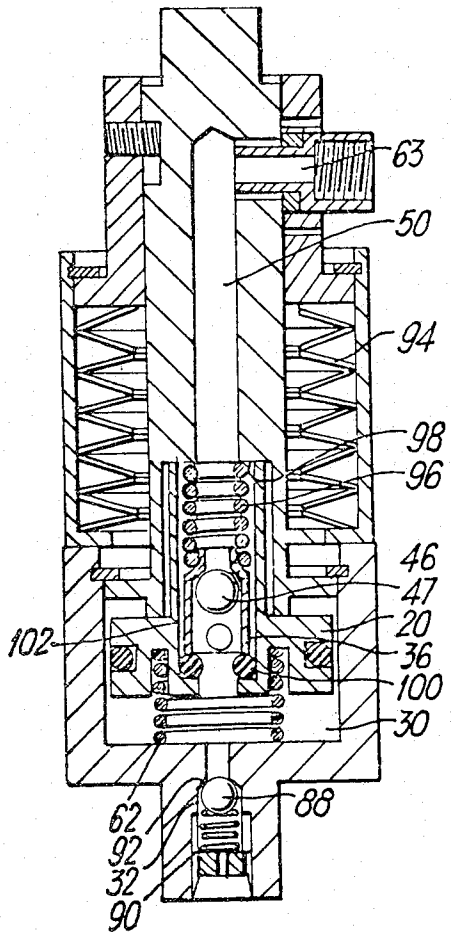

Fig.6.

APPARATUS FOR PUMPING FLUID THROUGH A DIE PLATE TO A RECESSED DESIGN

This invention relates to apparatus for depositing fluid, such as printing ink or paint or adhesive, on material in a predetermined pattern or design, and particularly relates to apparatus using an injector or injectors for pumping the fluid through the thickness of a die plate to a recessed design.

In the type of apparatus such as intaglio printing apparatus to which the invention relates, and which forms the subject of our U.S. Pat. No. 3543682, the injector units are located between the engraved die plate and one of two cooperating press platens so that when the press platens are moved toward each other to effect the deposition of the liquid, the injector units are contracted to pump fluid into the recesses in the plate. The platens are moved toward each other to engage the printing plate with a sheet onto which the fluid is to be deposited to establish a pressure and to effect a contraction of the fluid injector units to pump fluid through the die plate into the recessed design on the front of the plate. Preferably, the arrangement is such that a sealing pressure is established before the injector units are contracted sufficiently to inject ink into the intaglio recesses. The establishment of a sealing pressure causes a seal to be effected between the sheet onto which the design is to be printed and the edges of the recesses forming the design. This seal is for preventing liquid from flowing out of the recess. Since the contraction of the injection units will cause the liquid to be supplied under pressure, it is important that the injection unit supply the proper quantity of ink under a pressure which is controlled so that the seal between the material and the die is not broken so that the ink will not be splattered to other areas of the material.

The printing pressure is controlled by a liquid feed mechanism of the invention which has at least one pump chamber adapted to be contracted by the application of pressure from the apparatus on the die plate during depositing the liquid and to expand when the pressure is relaxed, the or each, chamber having an outlet which communicates, in use, with one or more ink passages extending through the die plate, and an inlet which communicates, in use, with a liquid supply, the inlet being controlled by a valve device which is closed automatically by the application of pressure on the printing plate, the outlet being also controlled by a normally closed valve device which opens when the chamber is pressurized, the chamber having pressure relief means solely comprising a pressure relief piston biased inwardly against the pressure of printing fluid in the chamber and slidable outwardly, to relieve the pressure in the chamber when it exceeds a magnitude predetermined by the bias. The outward movement of the relief piston preferably compensates for further contraction of the chamber. In one embodiment however, the piston constitutes a valve member and its movement opens the valve.

The fluid inlet passage to the chamber of the mechanism is preferably controlled by a non-return valve. The valve closes automatically on rise of pressure in the pump chamber. Better control of the fluid to be supplied for each printing operation can be achieved particularly when the fluid is not very viscous as is the case when the apparatus is used to deposit patches of paint e.g., on a colour selection card. The pump chamber is

generally provided between a main piston and cylinder and non-return valve which may be in the form of a ball valve may be used in addition to or instead of a valve arrangement provided by inlet holes in the pressure relief piston head which are closed by downward movement of the main piston over the pressure relief piston.

The main pump piston is preferably sealed to its cylinder wall by a sliding seal comprising a cup sealing member which is carried by the piston and the skirt of which extends around and is spaced somewhat from the body of the piston and an O ring which is carried by the piston and which bridges the space between the piston and the skirt of the cup member and acts to hold the skirt against the cylinder wall. In use the pressure of the fluid in the chamber also acts on the inner face of the skirt to reinforce the bias provided by the O ring.

If the O ring is made of a rubber composition or the like which is suitably affected for example by a solvent in the fluid to be printed, the O ring can be caused to swell somewhat increasing the pressure on the cup seal.

A spring (for example a stack of Bellevile spring washers) is preferably located in the pump chamber of each injector to bias the piston away from the chamber. The strength of the spring is preferably such that the printing plate is pressed properly against the sheet to be printed prior to the injection of fluid. It also causes the chamber to expand to provide a suction on the outlet from the chamber on the conclusion of a printing operation which helps to prevent smuding of fluid on the sheet.

The fluid food mechanism of the invention may be used to feed ink through an intaglio printing plate, to feed paint through a die plate to print a colour chart, to feed liquid seal material through a die plate onto asbestos or the like to form a gasket, to feed liquid material through a die plate onto a release-backing from which the material when congealed may be stripped, to feed liquid material through a die plate onto an engineering part such as an engine piston head to act as a gasket and so on.

An embodiment of apparatus in accordance with the invention will now be described by way of example with reference to the accompanying drawings in which:

FIG. **1** is a view somewhat schematic, of intaglio printing apparatus in accordance with the invention;

FIG. **2** is a cross-sectional view of the printing fluid feed mechanism used in the apparatus of FIG. **1**;

FIGS. **3** and **4** are illustrations showing the apparatus of FIG. **2** in different operating positions;

FIG. **5** is an enlarged fragmentary view of a portion of FIG. **2** showing a seal in accordance with the invention used in the unit; and

FIG. **6** is a cross-section of an alternative embodiment of the fluid feed mechanism.

Referring to FIG. **1**, an intaglio plate or die **10** for printing a pattern is supported from an upper support plate **11** mounted on an upper press platen **12**. The press platen **12** cooperates with a lower press platen **14** onto which the sheet to be printed is placed. In the specification, the material to be printed will be described as a sheet of paper with the understanding that the invention is applicable to any material to be printed with a design whether or not in sheet form or of paper.

In the apparatus of FIG. **1**, paint, or other printing fluid being printed, is injected through the printing plate **10** by a plurality of injector units **14**, three such units being illustrated in the drawings for printing three

different colours. The injector unit illustrated is particularly suitable for printing paint patches on a colour-card used to indicate the respective colours of specific paints. Each injector unit supplies printing fluid to one intaglio recess 10a in the face of the plate having edges 10b which seal against the material to be printed.

The injector units 14 are each supplied from a corresponding printing fluid reservoir 15. Each injector unit 14 is connected to a corresponding one of the reservoirs 15 by a flexible conduit 16 which conducts printing fluid from the reservoir to the inlet of the injector. While the reservoirs 15 may be under pressure, preferably the feed from the reservoirs 15 is a gravity feed.

The cross section of one of the injector units and the printing plate as illustrated in FIG. 2. As illustrated therein, an injector unit 14 comprises a piston 20 having a piston head 21 receivable in a bore 22 in a cylindrical housing member 24. The bore 22 opens inwardly from the upper end of the housing member 24 and is closed at the lower end of the housing by a wall 25. The bottom end of the housing member 24 abuts the printing plate 10 and has a cylindrical central pilot portion 26 which is received in an opening 27 in the rear of the printing plate 10. Piston head 21 has a piston face 29 which forms the movable wall of a pump chamber 30, the pump chamber 30 contracting as the piston member moves inwardly of the housing 24 to pump the printing fluid from the pump chamber through an outlet passageway 32 in the bottom of the housing 24. The passageway 32 is coaxial with the pilot portion 26 and opens into the opening 27 in the back of the printing plate 10.

The pumping of printing fluid from the pump chamber 30 is controlled by an outlet valve 34 comprising a pip of resilient rubber-like material which is supported on the end of an auxiliary piston 36 which slides in a bore 37 in the piston 20. The valve 34 has a flat face 34a which seals against the bottom wall 25 of the pump chamber 30. The auxiliary piston 36 which supports the valve 34 has a bore 38 and extending downwardly from the top to a bottom wall 39 adjacent the lower end of the auxiliary piston 36. The printing fluid is supplied to the pump chamber 30 through the bore 38 and through a port 40 which extends radially of the auxiliary piston 36 adjacent the bottom wall 39 of the bore 38 to communicate with the pump chamber.

The auxiliary piston member 36 is urged inwardly of the pump chamber 30 by a spring 42 which at one end abuts the bottom of the bore 37 in the piston 20 and its other end received in the bore 38 of the auxiliary piston 36 to abut against a valve seat 44. The lower end of the bore 38 in the auxiliary piston 36 is of reduced cross section to provide a shoulder 45 against which the valve seat 44 abuts and against which it is urged by the spring 42. The valve seat 44 has a central passageway 46 therethrough, the lower end of the passageway having a conical shape which opens downwardly and outwardly and which is adapted to receive a non-return ball check valve 47 disposed in the lower end of the bore 38 between the valve seat 44 and the bottom wall 39 of the bore 38 in the auxiliary piston 36.

Printing fluid is supplied to the bore 38 in the auxiliary piston 36 through an inlet passage comprising a passageway 50 extending upwardly from the bottom of bore 32 in the piston member 20 to the upper end of the piston member 20. The upper end of the piston member 20 is of reduced cross section and threads into a connector block 52 which has a right angle passageway 63 therein connected to the flexible conduit 16 for supplying printing fluid to the injector unit 14. The block 52 is connected to the upper plate 11 which is, as described above, in turn, connected to the upper platen 12.

When an injector unit 14 is contracted by relative movement of the platens 12 and 14 toward each other, the piston head 21 will move downwardly to establish a pressure to close the non-return ball valve 47 as shown in FIG. 3. When the valve 47 is closed, the ink in the chamber is trapped and pressure starts to build up. As the contraction of the injector unit continues, the buildup of pressure will be applied to the lower end of the auxiliary piston 36 to cause the valve 34 to be lifted from its seat against the bottom wall of the chamber 30 to unblock the outlet passageway 32, as is shown in FIG. 4. The lower end of the piston 36 is maintained in spaced relationship from the bottom wall of the chamber 30 by the valve member 34 and by a taper on its lower end so that the pressure in the chamber will act in an upward manner to move the auxiliary piston outwardly of the pump chamber 30 and open the outlet valve 34.

To assure that there is a part of the piston on which the pressure in the chamber can act upwardly when the valve 34 is in its valve closed position, the lower end of the auxiliary piston 36 is tapered downwardly and inwardly from its outer edge as illustrated in the drawings to provide an inclined surface which will assure that the lower end of the auxiliary piston cannot fully seat against the bottom wall of the pump chamber 30.

As the contraction of the pump chamber 30 continues, the buildup of pressure in the pump chamber is limited by the auxiliary piston 36, thus constituting a pressure relief piston and the biasing spring 42. As the pressure builds up, the spring 42 will yield to allow the auxiliary piston 36 further to move outwardly so as to compensate for further contraction of the pump chamber and relieve the pressure. Accordingly, the auxiliary piston 36 and spring 42 operates as a pressure limiting element as well as a control valve for the outlet passage 32.

In operation, the pump chamber preferably does not start to pump fluid until printing pressure between the die plate and the sheet is established. Accordingly, Belleville spring washers 62 are placed in the pump chamber to yieldably resist contraction of the chamber. The resistance of the washers is preferably such that the proper printing pressure is established before the pressure in the pump chamber 30 builds up sufficiently to close ball valve 47 and open outlet valve 34.

When the fluid pressure against the lower end of the auxiliary piston 36 lifts the auxiliary piston 36 to move the valve 34 out of its position closing the outlet passage 32 and the ink discharges through the passage 32 into the opening 27 in the rear of the plate 10 and from the opening 27 through a passage 64 which communicates with one of the intaglio recesses 10a in the printing plate 10 to supply printing fluid thereto. When the recess fills, excess pressure will be prevented from building up by reason of the floating action of the auxiliary piston 36.

The injector unit is provided with a novel and improved seal 70 between the piston member 20 and the wall of bore 22 as is best shown in FIG. 5. The seal 70 comprises a self-lubricating cup shaped seal member

69, preferably of polytetrafluoro-ethylene resin, having an annular ring portion 71 set into a groove in the piston head 21 and an annular skirt 72 depending from the ring portion to surround the lower end of piston head 21 and bear against the side wall of bore 22. The lower end of the piston head is of reduced cross-section to provide a space 73 between the skirt and the piston head which opens to the pump chamber 30. A resilient O ring 74 is disposed in the space 73 and is, preferably of rubber-like material, received in a groove 75 in the reduced portion of the piston head. The diameter of the ring 74 is larger than the width of space 73 and the ring biases the skirt 72 outwardly against the side wall of the bore 22. When the injector unit is pumping, the fluid pressure in the space 73 provides additional pressure for forcing the skirts 72 against the wall of the bore 22 to prevent leakage and loss of pressure.

To facilitate emplacement of the seal member 69, the lower portion of the piston head comprises a ring 76 which threads onto a lower central portion 77 formed integrally with the upper portion of the piston 20. The top of the ring 76 forms a wall of the groove receiving the ring portion 71 of the seal member 69 and the ring 76 abuts the underside of the ring portion 71 to clamp it against a shoulder 80 at the upper end of the central portion 77. The shoulder 80 is, in the illustrated embodiment, stepped and the ring portion 71 is stepped in a corresponding manner to mate with the shoulder. By tightly clamping the ring portion 71 against the shoulder 80, there is a tendency for the ring portion to flow outwardly to bear against the wall 22.

To facilitate assembly of the piston member including seal 70 into the bore 22, the upper end of the bore is enlarged to provide a shoulder 81 and a taper 82 joining the smaller portion in which the piston operates. A collar 84 seats on the shoulder 81 and is held in place by a snap ring 86 to maintain the piston 20 and housing 24 in an assembled condition.

Another embodiment of the injector unit is illustrated in FIG. 6. In this case the auxiliary piston 36 working in a bore in the main piston 20 incorporates the inlet valve but not the outlet valve. The inlet to the chamber 30 is through the supply inlet 33 down through the passage 50 in the main piston 20 and down through a passage 46 leading to the interior of the auxiliary piston, the passage 46 being controlled by a ball valve 47, constituting the inlet valve, which seats against a shoulder when the inlet is to be closed. When, however, the pressure of the ink supply exceeds the pressure in the pump chamber 30 the ball valve 47 is forced from its seat allowing ink to be fed through the auxiliary piston and through an inlet passage in the bottom face of the main piston into the pump chamber 52.

The outlet valve for the pump chamber comprises a ball valve 88 located in the outlet passage 32 and urged by a spring 90 to a position as shown abutting a valve seat 92 formed by a shoulder in the outlet passage. The ball is forced from its seat when the pressure in the pump chamber 30 exceeds the bias of the spring 90.

In use when the pressure of the spring 62 (in this case a coiled spring) and of an additional biasing spring 94 of stacked Belleville washers is overcome the main piston 20 is forced downwardly to contract the pump chamber 30 and when the pressure in the chamber 30 reaches a certain value the inlet valve 47 closes and the outlet valve 88 opens allowing ink to be fed to the printing plate.

When sufficient ink has been fed, excess pressure in the pump chamber can be relieved by the auxiliary or relief piston 36 moving upwardly in its bore in the main piston against the bias of spring 96 acting between the top of the auxiliary piston and a shoulder 98 in the main piston 20. As this movement occurs the bottom of the auxiliary piston is lifted from a circular seal 100 opening an annular passage 102 for liquid between the side of the auxiliary piston and the internal wall of the bore in the main piston thus allowing fluid to flow from the pump chamber 30 to the space above the auxiliary piston and hence back to the ink supply via the passage 50 in the main piston.

When the printing pressure is relaxed the pressure on the relief or auxiliary piston 36 is also relaxed allowing the spring 96 to move the auxiliary piston back to the position shown closing the relief passage 102. At the same time the spring 90 causes the outlet valve 58 to close the outlet passage 32. In this position ink is no longer fed to the printing plate thus avoiding the possibility of excess ink being supplied as the plate is lifted from the surface which has just been printed.

As the pressure is further relaxed the springs 62 and 94 move the main piston 20 upwardly to the position shown and as the chamber 30 is now expanded. The inlet valve 47 then opens to allow ink to be drawn from the supply ready for the next printing operation.

The mechanism can be used for example to feed colour paint adhesive or like liquid to be printed rather than coloured ink into different parts of an intaglio printing surface, each injector unit being supplied with paint of one particular colour so that coloured patterns can be printed. Alternatively two or more injector units such as those described can be connected to a common outlet of an intaglio printing plate so that by using different colours of ink or paint one for each injector unit marbled effects can be obtained.

If a plate is supplied with more than one injector unit then the outlets from the chambers of each unit can be made of different cross-section so that the quantity of each colour ink or paint can be regulated.

What is claimed is:

1. A mechanism for use in applying a fluid design onto material comprising, a plate having a recessed design therein in accordance with the fluid design to be applied to the material and at least one passage through the thickness of the plate communicating with said recessed design, a fluid injector unit for delivering a charge of fluid under pressure through said passage to said recessed design, said fluid injector unit including means defining a chamber for the fluid, an inlet valve for controlling fluid flow into said chamber, a normally closed outlet valve which opens upon pressurization of said chamber, a piston member movable to pressurize said chamber to open said outlet valve and force fluid through said passage and into said recessed design, means for relieving the pressure of the fluid in said recessed design, said means for relieving the pressure solely comprising, a pressure relief piston, means biasing said pressure relief piston inwardly against the pressure of fluid in said chamber, and means enabling movement of said pressure relief piston outwardly to relieve the pressure in the chamber when it exceeds a magnitude predetermined by the bias, and said outlet valve comprising one end of said pressure relief piston.

2. A mechanism as defined in claim 1 wherein said piston member has a chamber therein in which said pressure relief piston is movably located.

3. A mechanism as defined in claim 1 wherein a pad of resilient material is attached to the outer end of said pressure relief piston and comprises said outlet valve.

4. A mechanism as defined in claim 1 further comprising an inlet valve for controlling fluid flow into said chamber, said inlet valve comprising a one-way ball-type check valve.

5. A mechanism as defined in claim 1 wherein said means defining said chamber inclues a housing having a wall defining a bore, said piston member operating in said bore and further including a sliding seal between said piston member and said wall, said sliding seal comprising a resilient cup sealing member carried by said piston member and having a skirt which extends around and is closely spaced from the body of said piston member, and an O-ring which is carried by said piston member and bridges the space between said piston member and said skirt and acts to hold said skirt against said wall.

6. A mechanism as defined in claim 1 further including a stack of Belleville washers located in said chamber and biasing said piston member outwardly relative to said chamber.

7. A mechanism as defined in claim 1 wherein said pressure relief piston has a fluid passage therethrough and an opening communicating said fluid passage with said chamber, said outlet valve comprising a resilient pad located on one end of said pressure relief piston blocking fluid flow from said chamber, and said end of said pressure relief piston having a surface area exposed to the pressure in said chamber when said outlet valve is closed and against which said pressure in said chamber acts to move said pressure relief piston to thereby open said outlet valve.

* * * * *