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[54] **LIQUID LEVEL SENSING DEVICE**
 1 Claim, 2 Drawing Figs.

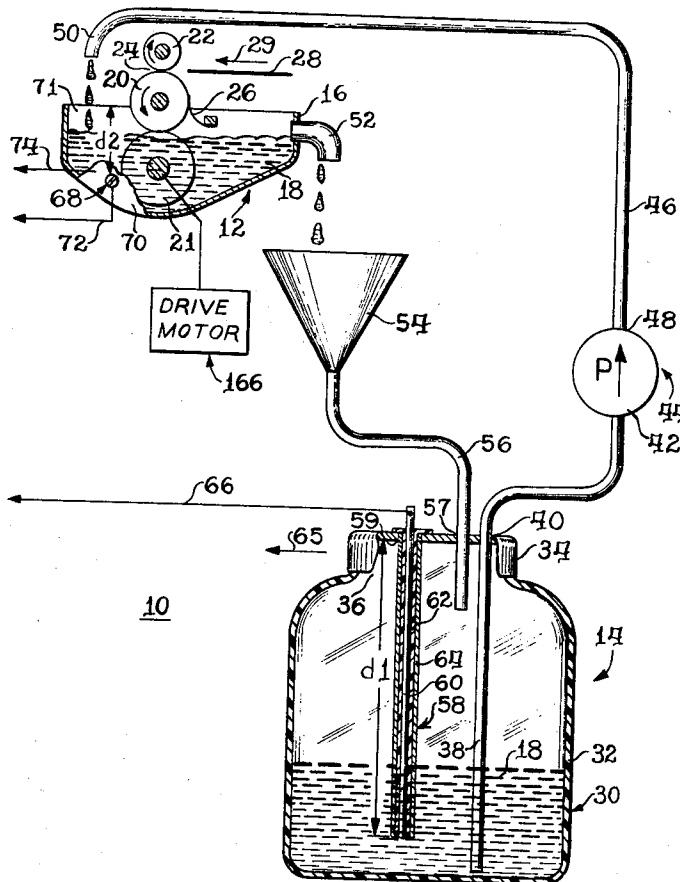
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 G03d 7/00, G03d 3/06

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ABSTRACT: Liquid level sensing apparatus is disclosed for use with liquid developing apparatus including a reservoir of conductive developer fluid. A current flow is maintained between the conductive fluid and an electrode included in the sensing apparatus, immersed in the reservoir of fluid. The depletion of developer fluid below a predetermined level causes the cessation of the current flow, which in turn causes the operation of additional circuitry of the sensing apparatus for, indicating the need for replenishment of the fluid, or for preventing the further operation of the developing apparatus.



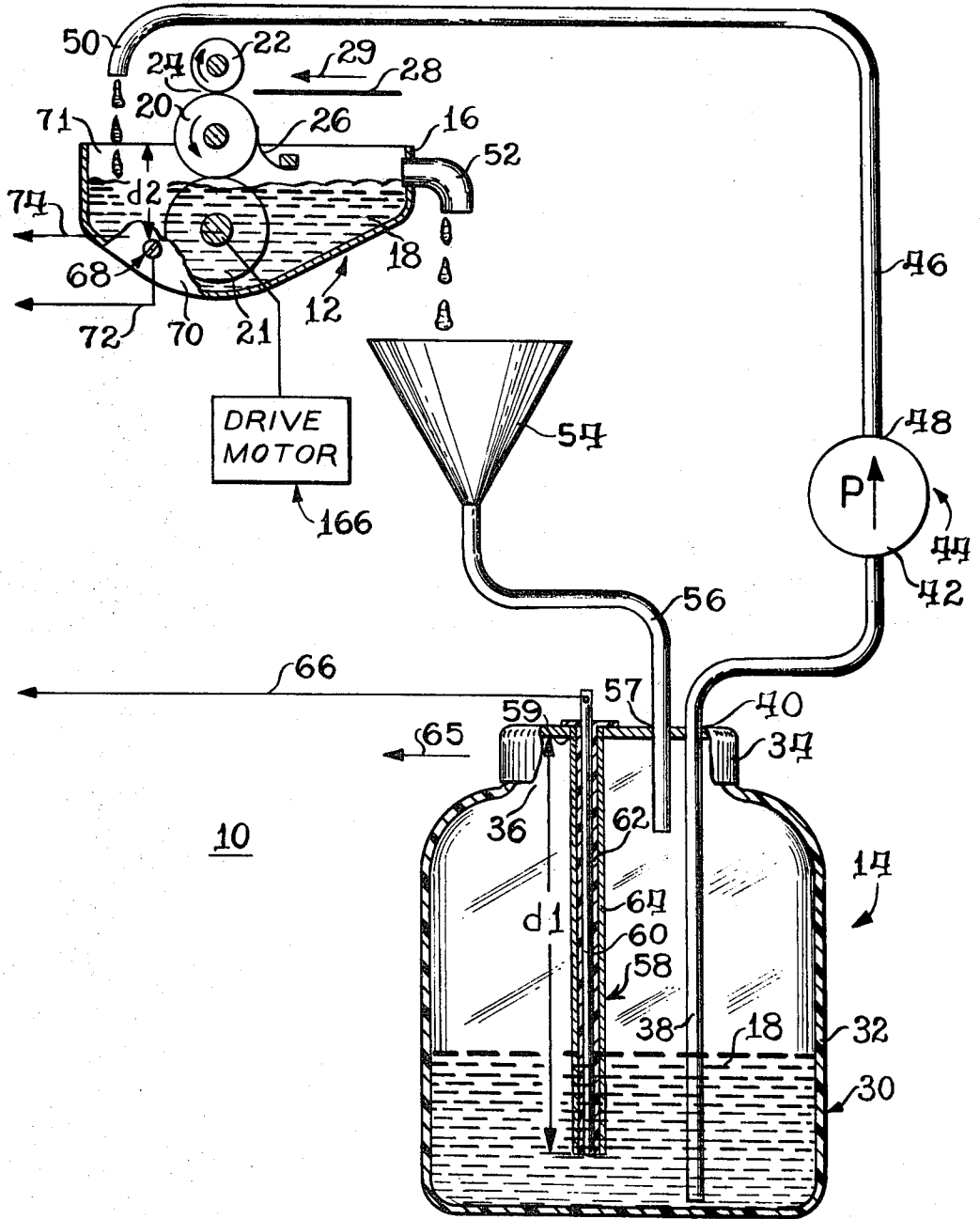
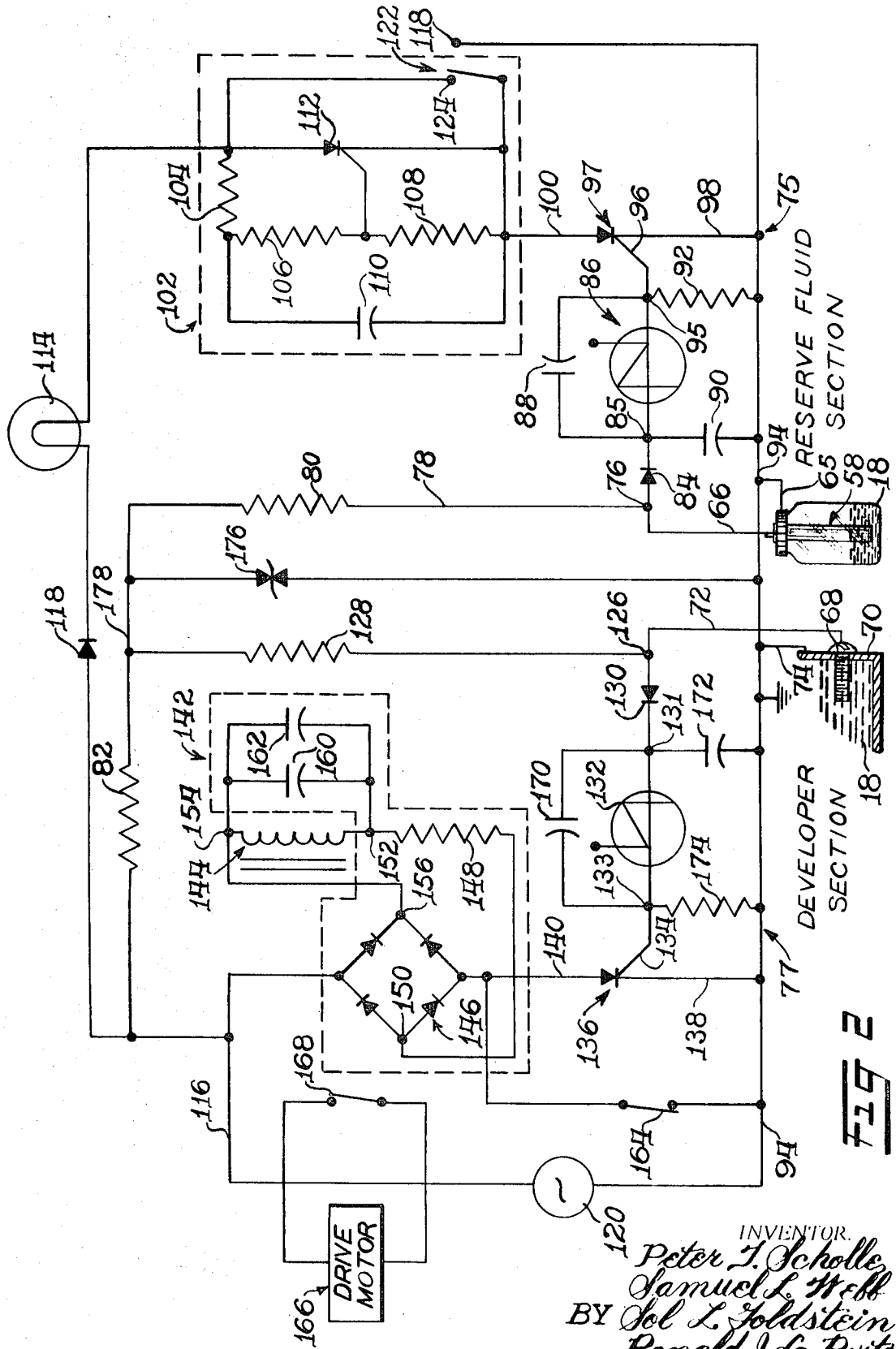


FIG 1

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LIQUID LEVEL SENSING DEVICE

BACKGROUND OF THE INVENTION

This invention relates generally to liquid level control arrangements and more particularly to liquid level sensing devices for use with copying machines employing liquid developing apparatus requiring a minimum level of developer fluid to be present at all times.

In diazo developing arrangements of the type shown in copending U.S. Pat. applications, Ser. Nos. 831,399 and 831,685, assigned to the same assignee, in which a conductive developing fluid is applied to copy sheets in precise amounts by means of a unique applicator roller and wiper arrangement, it is of extreme importance that the applicator roller always be supplied with a sufficient quantity of developer fluid to maintain the surface of the roller in a wetted condition. If the roller surface is not maintained wetted, the pressure of the wiper against the dry roller surface could cause damage to the latter. In effect, the lack of lubricant, in this case the developing fluid, allows the wiper to ride directly on the surface of the roller, causing frictional drag therebetween.

In the particular developing arrangement described above, there is provided in addition to the main reservoir of developing solution in which the applicator roller is mounted, a second reservoir of developer fluid. Developer fluid is dispensed from the second reservoir to the first reservoir for the purpose of maintaining the latter filled to the proper level with fluid. Thus, the second reservoir is the first to run dry without the critical roller reservoir being effected for a time thereafter. However, if the second reservoir should go dry, unnoticed, the supply of fluid in the first reservoir could likewise be depleted and the roller surface would once again be damaged by the action of the wiper thereagainst.

SUMMARY OF THE INVENTION

Accordingly, it is a primary object of the present invention to provide a new and improved device for detecting the level of developer liquid in diazo developing apparatus of the type described.

It is a more general object of the present invention to provide a new and improved liquid level sensing device.

Briefly, a preferred embodiment of liquid level sensing apparatus according to the invention comprises first sensing circuitry for monitoring the level of diazo developing fluid in a reserve fluid tank or container used to feed a main fluid reservoir in which an applicator roller is mounted. Upon detecting the liquid level in the reserve tank to drop below a predetermined level, a warning light or alarm is activated by control means included in the circuitry. If the reserve container is refilled, the light is deactivated and the system is brought back to a normal condition.

In the event the alarm or warning light goes unheeded, second liquid level sensing circuitry monitoring the level of developer fluid in the main fluid reservoir serves to detect the depletion of fluid below a predetermined level therein. When the level of fluid in the main reservoir drops to a critical level, control means of the last-mentioned circuitry respond to shut down completely the developing apparatus, thereby protecting the apparatus from being damaged as described heretofore.

DESCRIPTION OF THE DRAWINGS

A better understanding of the present invention and its organization and construction may be had by referring to the description below in conjunction with the accompanying drawings, wherein:

FIG. 1 is a diagrammatical representation of a diazo-type developing apparatus in which a preferred embodiment of the liquid level sensing apparatus according to the invention is employed; and

FIG. 2 is a schematic diagram of a preferred embodiment of the liquid level sensing circuitry according to the invention.

DETAILED DESCRIPTION

Referring now to FIG. 1 of the drawings, there is shown therein a diagrammatic representation of a diazo-type developing arrangement 10 in which liquid level sensing apparatus according to the invention is employed. The developing arrangement includes a developer section 12 and a reserve fluid section 14.

The developer section 12 includes a reservoir 16 containing a quantity of conductive developer fluid 18. Rotatably mounted on the reservoir is a developer applicator roller 20. A fountain roller 21, mounted within reservoir 16 in driving engagement with roller 20, is immersed in the developer fluid 18 and provides roller 20 with developer fluid, thereby maintaining the surface of roller 20 in a wetted condition while roller 20 is being rotated. Above the applicator roller 20, also in driving engagement therewith, is a pressure applying roller 22. The upper roller pair 20, 22 form therebetween a copy sheet developing zone 24.

A wiper device, in this case an elongated blade member 26, extending the length of the roller 20 is provided adjacent the applicator roller 20 to remove excess developing fluid from the roller surface prior to the application of the developer fluid to a copy sheet 28 in the developing zone. In this manner it is possible to apply a minimum amount of fluid to a copy sheet 28 being developed so as to provide dry-to-the-touch copies and eliminate the need for further drying.

In operation, copy sheet 28 is fed in the direction of arrow 29 through the developing zone 24. A quantity of fluid, metered onto the surface of applicator roller 20 by wiper 26 is applied to the copy sheet as the roller 20 is rotated in a counter-clockwise direction as seen in FIG. 1. The copy sheet is developed as it passes through zone 24 and emerges therefrom in a dry-to-the-touch condition. For a more detailed description of the operation of a developer assembly similar to that described, see U.S. Pat. No. 3,446,620, assigned to the same assignee.

As copies are developed in the developer section 12 of the developing arrangement 10, the conductive developing fluid 18 in reservoir 16 eventually is depleted therefrom. If the fluid is not replenished, damage to the applicator roller 20 might occur.

To maintain a supply of developer fluid in reservoir 16 of the developer section 12, there is provided a reserve fluid section 14 comprising a container 30, herein illustrated as an insulative bottle 32 in which developer fluid 18 is present. The bottle 32 includes a cap member 34 of conductive material for sealing the mouth or opening 36 of the bottle. The cap member 34, as will be explained hereinafter, serves additional purposes other than merely sealing the bottle 32.

A conduit or tube 38 extends into bottle 32 through an aperture 40 in cap member 34. The conduit is connected to the inlet 42 of a pump 44. A second conduit 46 connected to the outlet 48 of pump 44 terminates at reservoir 16 of the developer section 12 at spout 50. Pump 44 serves to carry liquid developer from the reserve bottle or supply through conduits 38 and 46 to the developer section, thereby to replenish liquid developer 18 used in the development of copy sheets.

An overflow tube 52 connected to the container 16 in communication with the interior thereof, is provided to remove excess developer fluid 18 pumped from reserve bottle 32 to the reservoir. The overflow tube empties into a funnel 54 connected with the interior of the reserve bottle 32 by means of a tube 56 extending through an aperture 57 in cap member 34. Thus, any excess fluid is returned to the reservoir, preventing the waste of developer fluid. A filter (not shown) located within funnel 54 serves to remove impurities from the fluid as it is circulated.

The fluid in the reserve bottle 32 will eventually be depleted through continued copy making operations, and similarly the reservoir 16 will sometime thereafter become exhausted of developer fluid.

In order to protect against the unnoticed depletion of developer fluid or liquid from reserve container 30, as well as the depletion of fluid from reservoir 16, liquid level sensing apparatus according to the invention has been provided.

In the reserve fluid section 14 of the developing arrangement, there is connected to cap member 34 of reserve bottle 32, a sensing electrode 58. The electrode 58 extends a predetermined distance $d1$ through an aperture 59 in the cap member into the reserve bottle 32.

The electrode 58 is constructed with an inner conductive portion 60 which is insulated by means of insulative material 62 from outer conductive portion 64. The outer conductive portion 64 is connected to ground potential via lead 65 connected to conductive cap member 34, while the inner conductive portion 60 is connected via a conductor 66 to circuitry shown in FIG. 2 of the drawings. The circuitry will be explained in greater detail hereinafter.

As in the case of reserve fluid section 14, there is likewise provided in reservoir 16 of the developer section, an electrode 68. Electrode 68 herein shown in the form of a screw-type element is mounted through a conductive wall 70 of the reservoir and extends into the interior of reservoir 16. The electrode is mounted within the reservoir at a predetermined depth $d2$ from the top or upper opening 71 thereof. The distance $d2$ is calculated so that if the fluid level decreases therebelow, the fountain roller 21 will nevertheless be maintained somewhat immersed in the developer liquid in order that the surface of the applicator roller 20 is maintained in a wetted state. The electrode is insulated from the conductive wall of reservoir 16 and is connected to circuitry illustrated in FIG. 2 by means of a conductor 72. The reservoir wall 70 is connected to ground potential via lead 74.

Referring now to FIG. 2 of the drawings there is illustrated therein a schematic diagram of the circuitry included in a preferred embodiment of liquid level sensing apparatus according to the invention.

As is shown in FIG. 2, a first circuit portion 75 of the schematic is provided for monitoring or sensing the level of conductive developer fluid maintained in the Reserve Fluid Section 14 (bottle 32) of the developer arrangement 10, and a second circuit portion 77 is provided for sensing the level of liquid developer in the developer section 12 reservoir 16 of the developing arrangement 10.

Turning attention to the reserve fluid section circuitry 75, included in the level sensing circuit according to the invention, it is seen that, as mentioned heretofore, electrode 58, immersed a predetermined distance $d1$ into the bottle 32 of developer fluid 18, is connected via conductor 66 to junction 76. Connected also at junction 76 by means of a lead wire 78 is a first resistor 80 of a voltage divider configuration comprising resistors 80 and 82 and a bypass diode 84 which in turn is connected to a trigger diode or silicon unilateral switch (SUS) 86. Connected in parallel relation with SUS 86 is a first capacitor 88 and a second capacitor and resistor combination 90, 92, respectively, each connected to the grounded side of an AC 50 volt power source 120 of the level sensing circuit via lead 94. Capacitor 90 serves to smooth direct current at the anode of SUS 86 and provides a time delay which prevents erratic operation of the SUS. Capacitor 88 also aids in preventing erratic operation of SUS 86 by bypassing remaining alternating current, and resistor 92 limits the voltage input to the silicon-controlled rectifier 97.

The gate electrode of silicon-controlled rectifier (SCR) 97 mentioned above, is connected to the cathode 95 of SUS 86 and related circuitry described heretofore. The other electrodes 98, 100 of the SCR are connected to ground lead 94 and to a lamp flasher circuit 102 (shown in dotted lines) including resistors 104, 106, 108, capacitor 110 and silicon controlled rectifier (SCR) 112. The flasher circuit is connected to a lamp 114 which is connected in turn to one of the power input conductors 116 of 50 volt AC power source 120 via diode 118. The other power input lead 94, connected to AC power source 120 is the ground side thereof and is connected to a normally open terminal of a pair of break-make relay con-

tacts 122 comprising normally closed terminal 124 and open terminal 118, which will be discussed hereinafter.

The developer section circuitry 77 is similar to that used in the reserve fluid section, including an electrode 68, connected at junction 126 to a first resistor 128, which in combination with resistor 82, forms a voltage divider configuration like that formed by resistors 80, 82. Also connected at junction 126 is a diode 130 which in turn is connected to the anode 131 of a trigger diode or SUS 132. SUS 132 is connected at its cathode 133 to the gate electrode 134 of a silicon controlled rectifier (SCR) 136. The SCR is itself connected at electrodes 138, 140 between the grounded side of AC power source 120 and a relay driver circuit 142 (shown in dotted lines) for operating relay 144.

The relay driver circuit includes a full wave bridge 146, a resistor 148 connected at one side thereof to an output terminal 150 of the bridge and at the other terminal to relay terminal 152. The other relay terminal 154 is connected directly to bridge output terminal 156. A pair of capacitors 160, 162, connected in parallel relation with respect to each other, is connected in parallel relation with relay coil 144. In addition to the above, a normally closed set of contacts 164 of relay 144 is connected across SCR 136. The drive motor 166 used to operate the applicator roller 20 (FIG. 1) of the developer section 12, is also connected across a pair of normally closed contacts 168 of relay 144.

The related circuit components, comprising a capacitor 170 in parallel relation with SUS 132 and the combination capacitor 172 and resistor 174 connected on opposite sides of SUS 132 and to the grounded side of power source 120 via lead 94 are also provided in the developer section circuitry portion of the liquid level sensing apparatus according to the invention. These components serve the same purpose as the counterpart components of the reserve fluid section described heretofore. A clipping (Zener) diode 176 is connected across the output of AC Power Source 120 to leads 178 and 94 to prevent spurious signals from the line, etc., from causing false operation of the circuit components included in the level sensing circuitry.

For purposes of affording a more complete understanding of the invention, it is advantageous now to provide a functional description of the mode in which the component parts thus far described cooperate.

In the normal state or condition, wherein a sufficient amount of developer fluid is provided in both reserve bottle 32 and reservoir 16, a small current flow is maintained between electrodes 58, 68 and respective conductive developer fluid 18 within the receptacles. The circuit path in the reserve fluid section (FIG. 2) is along lead 116 through the voltage divider network comprising resistors 80, 82, to the inner conductor 60 of electrode 58, through conductive fluid 18, back through outer conductor 64, to cap member 34 and ground potential at lead 94. The circuit path in the developer section (FIG. 2) is similar, along lead 116 through the voltage divider network comprising resistors 80, 128 to screw-type electrode 68, through developer fluid 18, to conductive wall 70 and ground potential at lead 94.

The maintenance of a small current through the conductive developer fluid 18 in each receptacle in turn maintains a low voltage at respective trigger diodes, SUS 86 and SUS 132; too small to cause conduction therethrough. When, however, the fluid quantity is depleted to a point below the depth of placement of the respective electrodes (i.e. below distance $d1$ in reserve fluid container 30 and below distance $d2$ in reservoir 16) the current flow through the fluid 18 also ceases. At this time, the voltage at the respective trigger diodes, SUS 86, SUS 132 increases beyond the predetermined trigger point of the diodes and the diodes conduct. Conduction through the diodes SUS 86, SUS 132 in turn fires controlled rectifiers 97, 136, respectively, and provides an output across the SCR leads 98, 100 and 138, 140, respectively.

The above description has been directed to both the circuitry of the reserve fluid section and the developer section to prevent the need for repetition; however, under normal condi-

tions both the circuit portions do not operate simultaneously since the fluid 18 is not normally depleted from within the receptacles at the same time.

Normally, if fluid is depleted without replenishment, the fluid developer 18 of reserve fluid container 30 (FIG. 1) is the first to be depleted beyond the depth of the electrode 58. As explained above, when this occurs, the current flow through fluid 18 ceases and trigger diode SUS 86 conducts, causing SCR 97 to fire. A resulting output voltage across SCR 97 serves to operate flasher circuit 102, to in turn flash lamp 114, indicating the need for the replenishment of developer fluid in bottle 32.

If the flashing lamp 114 should go unheeded, and copies continue to be made in developer section 12 (FIG. 1), the conductive developer fluid 18 in reservoir 16 soon will also be depleted below the operating level. When this occurs, the current flow in the developer section between electrode 68 and the developer fluid 18 ceases, causing the conduction of trigger diode, SUS 132 and the firing or conduction of SCR 136. The latter provides an output voltage at leads 138, 140. The last-mentioned output voltage is sufficient to operate relay driver circuit 142 which in turn operates relay 144. The operation of relay 144 operates contacts 122, breaking the connection at terminal 124 and making a connection at terminal 118. This prevents further operation of the flasher circuit 102 and lamp 114. In addition, the operation of relay 144 closes contacts 164 which serve to maintain the relay in an operated state, and most important, breaks contacts 168 to drive motor 166, preventing further operation thereof. The cessation of operation of drive motor 166, in turn stops the rotation of applicator roller 20 (FIG. 1) preventing any damage to the surface thereof which might occur if the roller continued to operate with no fluid 18 in reservoir 16.

Once the latter circumstances occur, the operation of the developing apparatus of developer section 12 (FIG. 1) is discontinued until the fluid developer in reservoir 16 is replenished. The replacement of fluid in reservoir 16 once again allows a current flow to be maintained between the electrode 68 through the developer fluid 18, to return the trigger diode, SUS 132 to a nonconducting state. Relay 144 however, remains in an operative condition through contacts 164. To return relay 144 to an inoperative condition the power source 120 must be deenergized allowing relay contacts 164 to open. The completion of the latter steps allows drive motor 166 to once again become operable.

If the developer fluid of reserve fluid section 14 is not replenished, flasher circuit 102 will continue to function, flashing lamp 114 to indicate the need for developer fluid in reserve fluid container 30. The flasher circuit will cease to function when the fluid in container 30 is replaced to the proper level.

While a preferred embodiment of the subject liquid level sensing circuit has been described in relation to a diazo-type developer apparatus including both a developer section and a reserve fluid section, only a portion of the circuitry, need be used in a situation wherein it is required only to detect the level of conductive fluid in a single reservoir or container in any type of copying or other machine using a conductive liquid wherein the level of liquid is critical to the functioning of the machine. In such a case, the basic circuitry including an electrode such as 58, 68, a trigger diode (SUS) and associated

components and an SCR connected as illustrated in either the developer section or the reserve fluid section circuitry (FIG. 2) would be used. The output across the SCR would, in the same fashion as illustrated in FIG. 2 be connected to circuitry for either energizing an alarm circuit, as in the case of reserve fluid section 14, or for performing a control function of some sort, as in the case of developer section 12.

We claim:

1. Apparatus for developing diazo-type copy sheets by the application of an electrically conductive developing fluid to said copy sheets, comprising in combination, a developer section including a main reservoir containing a quantity of said conductive developer fluid and developer means mounted at said reservoir and operable to apply to the copy sheets said fluid, said developer means including a liquid applicator roller having a surface adapted to carry a predetermined quantity of developer fluid, mounted for rotation within said main reservoir, drive means for rotating said roller, means for supplying developer fluid from said main reservoir to the surface of said applicator roller, and wiper means mounted in wiping engagement with said roller surface for removing excess developer fluid therefrom prior to the application of said fluid to said copy sheets by said roller, a reserve reservoir also containing a quantity of said conductive developer fluid, connected to said main reservoir, from which fluid is dispensed to maintain the supply of developer fluid in said main reservoir at an operating level, pump means for dispensing developer fluid from said reserve reservoir to said main reservoir, and liquid level sensing means comprising first sensing circuit means including a first sensing electrode positioned within said reserve reservoir at a predetermined level and normally immersed in said conductive fluid for monitoring the level of developer fluid present in said reserve reservoir, said first sensing circuit means including a source of electrical power connected to said electrode providing a current flow between said electrode and said conductive fluid, circuit means operable to a first state while current flows between said electrode and fluid and to a second state when the flow of current between said electrode and fluid ceases due to the depletion of developer fluid in said reservoir below said predetermined level, and indicating means for indicating the depletion of developer fluid from said reservoir below said predetermined level upon the operation of said circuit means from said first to said second state, and second sensing circuit means including a second sensing electrode positioned in said main reservoir at a predetermined level, and normally being immersed in said developer fluid for monitoring the level of developer fluid present in said reservoir, said second sensing electrode connected to said source of power with the latter providing a current flow between said electrode and said conductive fluid in said main reservoir, and further including circuit means operable to a first state while current flows between said electrode and fluid and to a second state when the flow of current between said electrode and fluid ceases due to the depletion of said fluid in said main reservoir below said predetermined level, and means connected to said applicator roller drive means, responsive to the change of state of said circuit means from said first to said second state to prevent further operation of said developer means, including the prevention of the further operation of said applicator roller drive means, thereby to avoid damage to said roller surface.