

Aug. 4, 1964

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3,143,056

APPARATUS FOR DIFFUSION DEVELOPING

Filed Jan. 26, 1961

3 Sheets-Sheet 1

FIG. 1

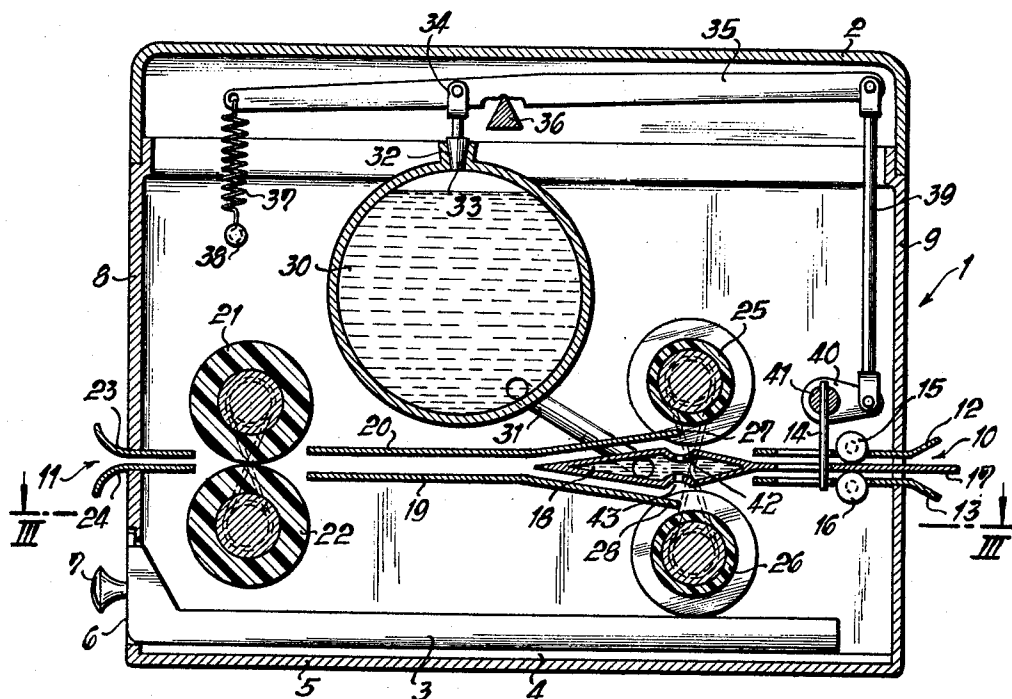


FIG. 2

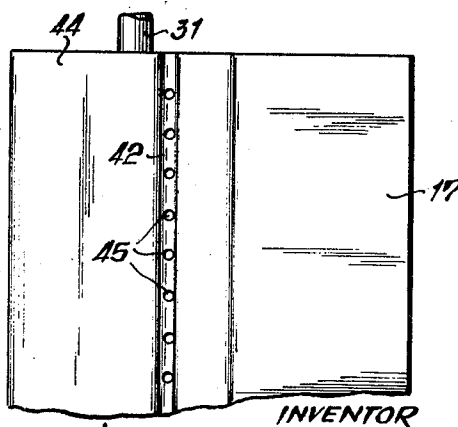
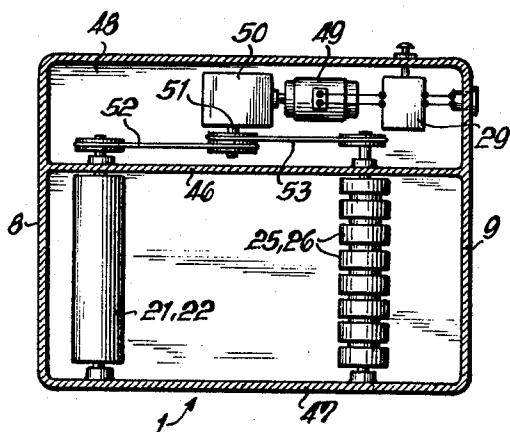


FIG. 3



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FIG. 5

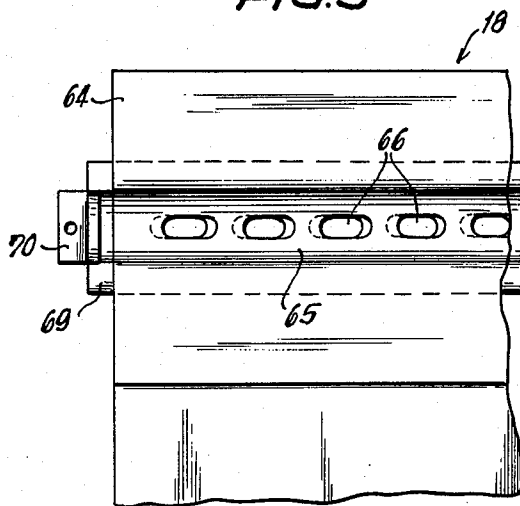


FIG. 4

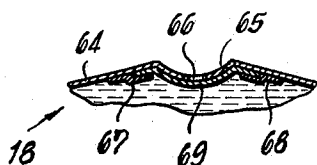
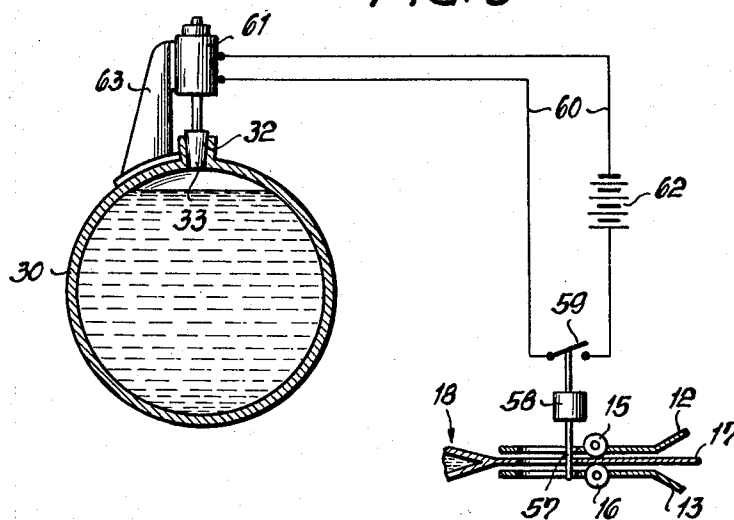


FIG. 6



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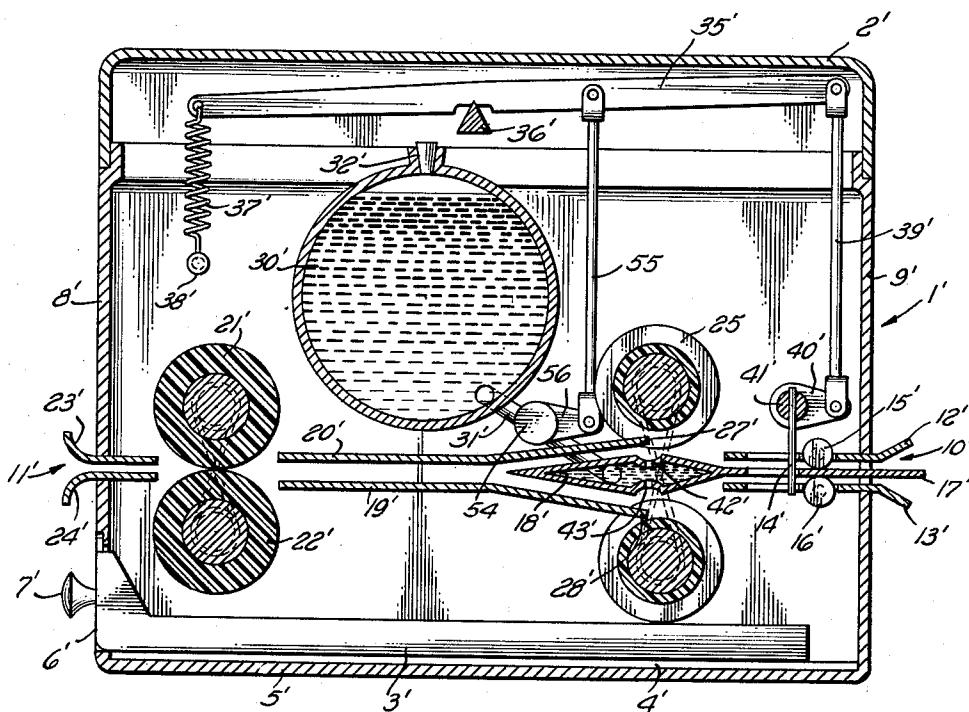


FIG. 7

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APPARATUS FOR DIFFUSION DEVELOPING
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16 Claims. (Cl. 95—89)

This invention relates to a method and an apparatus for diffusion developing using two layer carrier sheets and a jet arrangement for wetting one side of the layer carrier sheets. The apparatus is also provided with a supply container for the developing liquid and a pair of squeezing and transporting rollers disposed at the outlet. A particular problem in carrying out diffusion developing resides in the necessity of always using fresh developing liquid, as only under such conditions can uniform copies be made.

In the known apparatuses, in which the negative and the positive layer carrier are moved by guide elements through a trough filled with developing liquid, the developer becomes ineffective over a period of time thus causing a decrease of the quality of the copies, until the entire contents of the bath must be replaced by fresh developer.

The known jet arrangements are afflicted with the same drawbacks, because the jets are discharging developing liquid while the apparatus is operating. Liquid dripping off the layer carriers, or liquid being discharged from the jets before or after the layer carrier has passed the jets, is collected in these known apparatuses in a supply container and is recirculated by a pump to be used again. In this case also the developer will soon become spent to a great extent.

Other known surface developing methods in which one side of the layer carrier is wetted with developing liquid by a pair of wetting rollers are afflicted with the same disadvantage in that the developer becomes slowly spent, because the liquid adhering to the wetting rollers will mix with the liquid kept in the supply container.

Besides these drawbacks it is obvious that the known methods are uneconomical in operation, as the total supply of developing liquid must be renewed, before it has become spent entirely.

Furthermore it is pointed out that in the known apparatuses the developing liquid is subjected to oxidation to a much greater extent.

These drawbacks are overcome by the invention by using the advance movement of the sheets to be developed to cause a control force for feeding and interrupting the flow of developing liquid from a supply container to a jet chamber in accordance with the passage of the sheets in such a way that only the amount of developing liquid necessary for the development is discharged from the jet chamber.

According to the preferred embodiment of the invention the control for feeding developing liquid to the jet chamber will cause a force acting upon the developing liquid in such a way, as to retain the liquid within the jet chamber, this force preferably becoming effective as the last part of the layer carrier sheets is passing the jet arrangement.

The apparatus for carrying out this method comprises a jet arrangement disposed on opposed sides of a jet chamber which is arranged in the path of movement of the sheets, said jet chamber being connected with a supply container, preferably at its lowermost part, said supply container having a controllable opening, preferably in its upper part, which is actuated in dependence of the feeding and passage of the layer carrier sheets. This is the preferred embodiment of the invention. It is also possible however, to control a passage opening arranged within the

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connecting duct leading from the supply container to the jet chamber. The preferred embodiment has the advantage that an extremely small force is necessary for the control, and that a very fine adjustment of the liquid volume fed to the jet chamber is possible. The force acting to retain the developing liquid within the jet chamber is effected by the vacuum developing in the upper part of the supply container, after the controllable opening has been closed, while the layer carrier sheets are still passing the jet arrangement. Preferably the jet chamber has a rhomb-like configuration in longitudinal direction which is provided on each side with at least one row of jet openings extending transversely to the direction of movement of the sheets. At least one row of jet openings is disposed in a transversely extending groove, preferably arranged in the zone of the greatest depth of the jet chamber. It is to be noted that according to special embodiments several rows of jets may be arranged on each side of the jet chamber, said jets having openings which may be adjusted or partly closed by means of slides. The at least partly, constantly open jet openings are dimensioned according to a particular embodiment of the invention with respect to the height of fall between the supply container and the jet chamber, and with respect to the wall thickness of the latter in such a way that normally no liquid will be discharged when the supply container is closed.

An advantageous feature of the invention resides in the arrangement of at least one transporting means in front of each jet arrangement, preferably formed by guide rollers being spaced from the jet arrangement, so as to form gaps therewith which are equal to the thickness of the layer carrier sheets. These guide rollers are suitably driven. The gap between the guide rollers and the jet chamber prevent the guide rollers from drawing liquid out of the jet arrangement when there is no layer carrier present.

For operating the controllable opening an important feature of the invention resides in providing a preferably mechanically or optically operated abutment arranged in the path of movement of the layer carrier sheets in front of the jet chamber. A mechanically operated abutment, for example a pivoting lever, is connected preferably by a leverage system with a valve member, suitably formed by a plug arranged in an opening disposed in the upper part of the supply container. The mechanical arrangement also includes, for example, the provision of an on-off-switch for actuating a solenoid.

For safeguarding the closed position of the valve a preferred embodiment of the invention provides a spring arrangement being dimensioned sufficiently for its purpose without influencing the proper functioning of the valve member.

Further advantages and features of the invention will become evident from the following description of one embodiment of the invention shown in the accompanying drawings in a schematical manner by way of example only.

In the drawings:

FIG. 1 is a sectional side elevation of the apparatus according to the invention showing the essential parts,

FIG. 2 is a part top view showing the jet chamber in accordance with FIG. 1,

FIG. 3 is a sectional top view taken along line III—III of FIG. 1 schematically showing the drive means,

FIG. 4 is a cross sectional part view of the jet chamber of another modified embodiment,

FIG. 5 is a part top view of the jet chamber shown in FIG. 4,

FIG. 6 is a part sectional side elevation similar to FIG. 1 showing another modified embodiment of the invention, and

FIG. 7 is an elevational, sectional view of a further embodiment of the invention.

The apparatus according to FIG. 1 comprises a lower housing part 1 provided with a removable cover 2. Within the lower housing part 1 a trough 3 is arranged which, for example, is guided on rails 4 formed on the bottom 5 of the housing part 1, and which may be removed in a drawer-like manner. In the embodiment illustrated in FIG. 1 an upwardly extending face wall 6 of the trough 3, which may be provided with a handle 7, is serving simultaneously to close the drawer opening of the housing wall 8.

Above the trough a transporting path for the layer carrier sheets is arranged. This transporting path begins in the housing wall 9 at an inlet slot 10 defined by guide elements 12, 13 and ends at an outlet slot 11 defined by guide elements 23, 24. In the zone of the guide elements 12, 13 of the inlet slot a movable abutment formed by a pivoting lever 14 extends into the guide path for the layer carrier. Transporting rolls 15, 16 may, for example, be arranged in front of the abutment acting through apertures in the guide elements 12, 13 upon the layer carriers, and serving to pull them into the apparatus, after they have initially been introduced through the slot.

A tongue 17 extending between the guide elements 12 and 13 ends in the zone of the inlet slot 10 forming separate guide paths for the layer carrier sheets. This tongue 17 with its inner end is forming an integral part of the widening jet chamber 18 having a rhomb-like sectional shape in the longitudinal direction. The jet chamber 18 is diverging to a zone of greatest depth whereupon it is converging gradually ending in a pointed edge.

Another guide path for the layer carrier begins at the jet chamber. This guide path is defined by the guide elements 19, 20. The front end of these guide elements is disposed approximately in the zone of greatest depth of the jet chamber 18 extending initially with spaced parallel relation to the walls of the jet chamber. Rearwardly of the jet chamber the guide elements 19, 20 extend parallel to each other ending in front of a pair of transporting and squeezing rollers 21, 22 which are driven and resiliently urged together. Preferably these rollers have a lining of rubber or plastic material. Behind the nip of this pair of transporting and squeezing rollers 21, 22 the front ends of the guide elements 23, 24 are disposed leading to the outlet slot 11.

Preferably the rollers 15, 16 are urged against the tongue 17.

Above and below the jet chamber 18 guide rollers 25, 26 are arranged. The guide rollers are preferably provided with a lining of rubber or plastic material, and are driven in the direction of advance of the layer carrier sheets. These rollers are supported in such a way that they do not contact the walls of the jet chamber. Preferably the gap formed between the circumference of the rollers and the walls of the jet chamber is equal to the thickness of the layer carrier sheets, so that the latter will be held in contacting engagement with the walls of the jet chamber by the rollers.

The guide rollers 25, 26 are arranged adjacent the zone of greatest depth of the jet chamber 18. Within this range the jet arrangements of the jet chamber are disposed, which will be described later. In the embodiment illustrated in FIG. 1 the connecting line between the axis of the rollers 25, 26 is displaced with respect to the jet arrangement toward the inlet side of the apparatus.

Preferably the rollers 25, 26 are provided with radial grooves into which serrated ends 27, 28 of the guide elements 19, 20 are extending. By means of this arrangement the layer carrier sheets are prevented from being moved away from the jet chamber 18 by the rollers 25, 26. The guide elements 19, 20 may be formed by parallel gratings or they may be formed plate-like in their rearward zone. In the latter case the ends fac-

ing the inlet side of the apparatus are provided with the serrations 27, 28.

The described parts are mounted in a normal manner on the side walls 46, 47 of the lower housing part 1. A chamber 48 may, for example, be arranged on one of the side walls 46 in which the connecting means for the main power supply 29 with the drive motor 49 and the required gearing 50 are arranged. The drive of the different rollers 21, 22, 25 and 26 is preferably derived from a central shaft 51 by means of endless helical garter-like springs 52, 53 as shown in FIG. 3.

Above the guide elements a supply container 30 for the developing liquid is mounted in the lower housing part 1. The lowermost part of the supply container is connected by a duct 31 with the jet chamber 18. The supply container 30 is otherwise entirely closed, except for a bung-like opening 32 in its uppermost part. This bung-like opening 32 receives a plug-like valve member 33 being arranged to be liftable.

The valve member 33 is pivotally connected with a double armed lever 35 by means of a rod 34. This double armed lever 35 is pivotally supported in an antifriction manner on a rod 36 mounted in the side walls 46, 47 of the lower housing part 1. Preferably a fulcrum-like bearing is provided.

A tension spring 37 which is fastened with its one end to a stationary part of the housing 1 is acting with its other end upon that lever arm which is carrying the rod 34 with the valve member 33. This spring 37 is acting to pivot the lever 35 in such a manner that the valve member 33 is sealingly urged into the opening 32.

At the other end of the double armed lever 35 a rod 39 is pivotally connected; the other end rod 39 being pivotally connected with a crank 40. This crank is nonrotatably mounted on a shaft 41 supported in an antifriction manner in the lower housing part 1. The abutment lever 14 is nonrotatably mounted on the shaft 41.

The mechanical connection between the valve member 33 and the abutment lever 41 has been illustrated in its most simple form for the sake of clarity omitting all possible additional transmission or guide elements.

The jet chamber 18 of the illustrated embodiment is provided in both its upper and lower wall in the zone of its greatest depth with at least one concave groove 42 and 43. In FIG. 2 the groove 42 of the upper wall 44 of the jet chamber 18 has been shown. The jet openings 45 are evenly spaced along the groove. The grooves 42, 43 may extend with a uniform cross sectional shape to the side walls of the jet chamber. It is however also possible to flatten the grooves at their ends. The grooves are serving the purpose to evenly distribute the developing liquid over the entire width of the jet chamber.

This is the preferred form of embodiment, but it is also possible, without departing from the scope of the invention, to use slot-like jets with or without grooves. Furthermore it is also possible to provide additional transversely extending grooves, and to provide means for closing or adjusting the jet opening in these additional grooves in order to be able to adjust the amount of developing liquid required by different materials.

The cross section of the jet openings 45 is dimensioned with respect to the wall thickness of the jet chamber 18 in such a way that the developing liquid will be retained within the openings, as long as no force is active sucking the liquid outwardly.

If layer carrier sheets are fed into the slot 10 on both sides of the tongue 17 the layer carriers will move the abutment lever 14 in a clockwise direction out of their path of movement. Thereby the rod 39 is pulled downwardly by the crank 40 and the lever 35 is rotated around its fulcrum bearing on the rod 36 in a clockwise manner, thereby lifting and loosening the plug-like valve member 33 in the opening 32. Now air may enter into the upper part of the supply container, and consequently liquid can flow through the duct 31 into the jet chamber

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18. This causes liquid to flow out through the jet openings which will evenly distribute itself over the width of the layer carriers within the grooves in which the jets are arranged. In this connection it should be noted that the supply container has been opened at a time before the layer carriers have reached the jet arrangements, so that one of the forces acting upon the developing liquid, i.e. the force resulting from the vacuum developed in the closed supply container, is fading away until the layer carriers have reached the jet arrangements. On the other hand the passage of the layer carriers will cause a force sucking liquid outwardly due to the adhesive power.

After the layer carrier sheets have passed the lever 14 the valve member 33 is closed by the force of the spring 37, but developing liquid is continued to be drawn out of the jets until the rear edges of the layer carrier sheets reach the jet grooves 42, 43. When the wetted layer carrier sheets are passing the jet arrangement they are acting by adhesive power upon the liquid contained in the jet chamber, and consequently draw liquid out of the jet openings until the rear edges of the layer carrier sheets have passed the jets. By means of this the liquid volume drawn out of the jet chamber, after the supply container has been closed already, will cause a vacuum to develop in the upper part of the supply container, thereby avoiding with certainty that any further developing liquid will leak out of the jets after the layer carrier sheets have passed the jet arrangement.

The utilization of this adhesive power represents an important feature of the invention, as in this respect the advancing layer carrier sheets are causing a force acting upon the developing liquid in such a manner that the liquid in the jet chamber is attracted by the layer carrier sheets. This force is of particular importance for developing the vacuum, when the rear part of the layer carrier sheets is passing the jet arrangement, as thereby a dripping of liquid out of the jets is avoided, after the layer carrier sheets have passed.

An important feature is the spatial arrangement of the abutment lever 14 with respect to its movement for controlling the valve member 33 and relative to the jet arrangement, as well as the dimensioning of the jet openings with respect to the wall thickness of the jet chamber, in order to effect thereby that the supply container is closed in good time to allow the required vacuum to be developed in the upper part of the supply container, while the rear part of the layer carrier sheets is passing the jet arrangement. Preferably the control of the opening 32 is extremely sensitive. As the illustrated embodiment shows this may be achieved by choosing a very slenderly conically shaped valve member and valve opening, the diameter of which being approximately 0.02.

Furthermore practice has shown that the developing liquid will not form any deposits in the jet chamber, or the jet openings respectively, which is assisted by the forces acting upon the liquid causing surface tensions.

Under the aspects mentioned before it is evident that the opening 32 may be controlled according to the teaching of the invention by other means in a like or similar manner. Furthermore additional guide means for guiding the layer carrier sheets past the jet chamber may be provided. In this case the rollers 15, 16 may be omitted in certain embodiments. The rollers 15, 16 aid in defining the guidance of the layer carrier sheets in the zone of the abutment lever 14. Preferably the ends of the guide elements 12, 13 are serrated extending with tongue-like projections into annular grooves provided on the rollers 15, 16.

Liquid which may eventually drip-off is gathered in the trough 3. This liquid is not being used again. After the cover 2 and the lever 35 have been removed the supply container 30 may be filled through the opening 32, or another opening which must be airtight.

FIG. 7 illustrates another embodiment of a liquid flow control device, and components identical to those previ-

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ously described are indicated by primed numerals. In FIG. 7 the supply container 30' may be provided with a plug sealing opening 32' which performs no valving and would be used only to refill the container with liquid. A valve 54 is located in the duct 31' to control the liquid flow from supply container 30' to jet chamber 18'. Valve 54 is controlled by an actuating member 56 which is connected to lever 35' by a rod 55 whereby the liquid flow to chamber 18' is regulated by abutment lever 14' and valve 54 in accord with the need for liquid flow to the jet chamber.

FIG. 6 shows another possibility for actuating the valve member 33. In this embodiment like parts used in FIG. 1 are denominated with like reference numerals, in order to clearly show the arrangement of these parts. The actuating member 57 of an on-off-switch 58 is extending into the guide path within which the rollers 15, 16 are arranged, and which is defined by the guide elements 12, 13. The contact arm 59 of this switch is arranged in a circuit 60 having an actuating magnet 61 arranged therein and being connected for example to a battery 62. The actuating magnet 61 is carried by a supporting member 63 mounted on the supply container 30. The valve member 33 disposed in the opening 32 of the supply container 30 is connected with the armature of the magnet. When the magnet 61 is energized the valve member 33 is lifted in the manner described already, and upon deenergizing the magnet the valve member will be sealingly replaced into the opening 32. It is for example also possible to arrange a spring on the magnet acting either in the direction of closing or in lifting direction. Thereby a perfect seal is assured.

Obviously a corresponding actuating magnet 61 may also be used in connection with the valve 54.

In FIGS. 4 and 5 another embodiment of the jet chamber is illustrated. In these figures the upper wall of the jet chamber is denoted by reference 64. In accordance with the embodiment shown in FIG. 1 this wall 64 is provided with a groove 65 the bottom of which being provided with jet openings 66. The openings have, for example, the form of elongated longitudinal slots. L-shaped guides 67, 68 laterally spaced in parallel relation to the groove 65 are arranged on the inner side of the wall 64 said guides serving to guide a slide 69, which is fitted to the shape of the wall 64 so as to have a sealing contact therewith. The slide 69 is provided with openings having substantially equal dimensions as the openings 66. An extension 70 is arranged on the slide 69 which may be connected with an actuating member not shown in the drawing. The slide 69 may be adjusted in such a manner that the openings 66 of the jet chamber either register with the openings of the slide or partly cover each other by moving the openings of the slide out of registry with the openings 66 in the jet chamber.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the embodiments shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed is:

1. A device for diffusion developing using two layer carrier sheets, the layer sides of which are wetted prior to being pressed together, comprising a guide path for two layer carrier sheets; inlet means arranged at the entrance side of said guide path formed by three guide elements, each two adjacent elements defining inlet slots; a jet chamber arranged in spaced relation to said inlet means within said guide path and disposed behind the middle of said three guide elements; fourth and fifth guide elements extending in spaced relation above and below, respectively, of said jet chamber, said fourth and fifth guide elements extending at least partly in spaced parallel

relation to said jet chamber in the zone of said jet chamber thus defining the top and bottom of said guide path; a pair of squeezing and transporting rollers arranged at the ends of said fourth and fifth guide elements remote from said jet chamber, said pair of squeezing and transporting rollers being power driven and forming outlet means; a supply container for developing liquid; duct means connecting said supply container with said jet chamber; an opening in said supply container; valve means arranged in said opening; actuating means for opening or closing said opening, thereby controlling the feed of developing liquid to said jet chamber; an actuating element pivotally arranged between said inlet means and said jet chamber and extending through said guide path as to be pivoted by said sheets moving through said guide path; connecting means between said actuating means and said actuating element for controlling the movement of said actuating means when said actuating element is pivoted, said jet chamber having side walls and an upper and a lower wall, a first arrangement of jets disposed in said upper wall and extending substantially normal to the longitudinal direction of said guide path, and a second arrangement of jets disposed in said lower wall and extending substantially normal to the longitudinal direction of said guide path, said sheets moving through said guide path past said jet arrangements, whereby the feed of liquid from said supply container to said jet chamber is opened when said actuating element is pivoted by said sheets, while the feed of liquid is interrupted, when said actuating element returns to its normal position, due to the passage of said sheets beyond said actuating element, whereupon the rear zones of said sheets, as they are passing said jet arrangement, will continue in drawing liquid out of said jet arrangements.

2. A device according to claim 1, in which said opening and said valve means are arranged in the top part of said supply container, said connecting duct between said supply container and said jet chamber communicating with the lower part of said supply container, so that a vacuum will be generated within said supply container, when said opening is closed and liquid is withdrawn from said jet arrangement by said rear zones of said sheets.

3. A device according to claim 2, in which said controllable opening is slightly conical, its mean diameter being in the range of 0.02".

4. A device according to claim 3, in which said actuating means comprises a pivoting lever arranged above said supply container and laterally thereof, a pivot bearing supporting said lever, said connecting means engaging the one end of said lever, a spring being provided engaging with its one end the other end of said lever, while the other end of said spring is fixedly arranged with respect to said supply container, a connecting rod being provided connected with one end with said valve means, while the other end is pivotally connected with said lever in such a way that upon pivoting said actuating member, due to the passage of sheets, said lever is pivoted for pulling said valve means out of said opening, while it is pivoted for pushing said valve means into its sealing position by said spring, as soon as said actuating member is released by said sheets.

5. A device according to claim 2, in which an actuating magnet is fixedly arranged adjacent said opening of said supply container, the armature of said magnet carrying said valve means, a switch being provided connected with said actuating member in said guide path, a circuit connected to a source of power for energizing said actuating magnet disposed in said circuit and connected with said switch, said switch being automatically resettable and operable, in dependence on the movement of said actuating member in such a way that pivoting of said actuating member due to passing sheets will close said circuit, and that after said sheets have passed said actuating member it will return to its normal position, thereby opening said switch.

6. A device according to claim 1, in which said controllable opening is arranged within said connecting duct between said supply container and said jet chamber, a valve being provided for opening and closing said opening, an actuating rod extending between said actuating member in said guide path and an actuating element of said valve, thereby opening or closing said valve in dependence of the pivoting movement of said actuating member.

7. A device according to claim 1, in which said jet chamber has a rhomb-like cross sectional shape, the jet arrangement in said upper and said lower wall comprises at least one row of jet openings, being arranged transversely to the direction of movement of said sheets, and being disposed substantially in the zone of greatest height of said jet chamber.

8. A device according to claim 7, in which a concave groove is formed in said upper and said lower wall of said jet chamber, said grooves extending in a transverse direction relative to the advance movement of said sheets, said jet opening being disposed at least partly within said grooves.

9. A device according to claim 7, in which said upper and said lower wall of said jet chamber is provided each with two guides extending parallel to at least one row of jet openings provided in one wall, said guides being open to said at least one row of jet openings, a slide being arranged on said upper and said lower wall, the edge portions of which engaging the respective guides, said slides being profiled corresponding to the shape of said upper and said lower wall in the range of said jet openings, said slide being provided with openings corresponding with respect to arrangement and dimensions to said jet openings, so that by moving said slide in its guides will cause at least a partly superposing of said jet openings.

10. A device according to claim 7, in which said jet openings are arranged in a first imaginary plane being disposed below a second imaginary plane forming a tangent with the bottom of said supply container, the distance between said two planes being dimensioned in such a way that no liquid will flow out of said jet openings, when the latter are open and the supply container is closed.

11. A device according to claim 7, in which said jet openings are round.

12. A device according to claim 7, in which said jet openings are formed by slots.

13. A device according to claim 8, in which said grooves in which said jet openings are arranged are flattening towards their ends.

14. A device according to claim 1, in which at least one rotating transporting means is arranged in front of each jet arrangement adjacent the end of said guide elements, said transporting means being spaced from said jet arrangement the space corresponding substantially to the thickness of said layer carrier sheets, drive means being provided driving said transporting means in a direction for moving said sheets from said inlet means to said outlet means.

15. A device according to claim 14, in which said transporting means is formed by a roller being displaced toward said inlet means with respect to said jet arrangement.

16. A device for diffusion developing in which two layer carriers are used, comprising a housing, inlet means in one wall of said housing, outlet means in another wall of said housing, upper guide means defining the upper side of a guide path between said inlet and said outlet means, lower guide means defining the lower side of said guide path, a chamber within said guide path intermediate said guide means, said chamber having openings defined therein of such size normally preventing a free flow of liquid out of said openings but allowing such flow if a pressure is exerted upon the liquid within said chamber, a pair of squeezing and transporting rollers rotatably supported within said housing and disposed within said guide path between said chamber and said outlet means, drive means

actuating said pair of squeezing and transporting rollers, a supply container for developing liquid within said housing above said chamber, duct means connecting said supply container with said chamber, liquid flow control means regulating flow of liquid from said container to said chamber, actuating means for operating said control means, said actuating means extending at least partly into said guide path intermediate said chamber and said inlet means and being operable by the layer carriers so as to operate said

control means in dependence on the passage of layer carriers, said layer carriers engaging said chamber and being wetted on one side by liquid flowing from said openings.

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