

[54] **SCREEN-LIKE LIQUID STREAM FORMING
DEVICE FOR DETERMINING
CONCENTRATION**

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[22] Filed: **Oct. 17, 1972**

[21] Appl. No.: **298,445**

[30] **Foreign Application Priority Data**

Oct. 20, 1971 Japan..... 46-83045

[52] U.S. Cl..... **356/201, 356/246**

[51] Int. Cl..... **G01n 21/22**

[58] Field of Search 356/246, 181, 207, 208,
356/244; 250/218; 137/801

[56]

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[57]

ABSTRACT

A device comprising a plurality of liquid stream regulating members having liquid flow regulating surfaces disposed close to each other in face-to-face relationship to define therebetween a slit through which a stream of liquid is discharged and forms a screen-like liquid stream below the slit.

8 Claims, 10 Drawing Figures

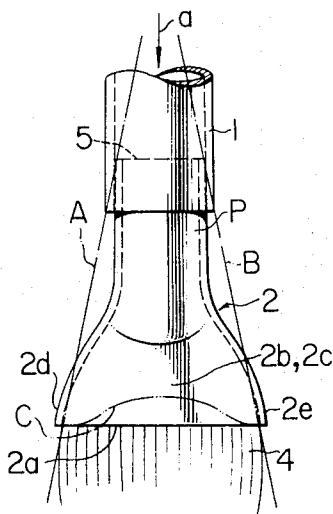


FIG. 1

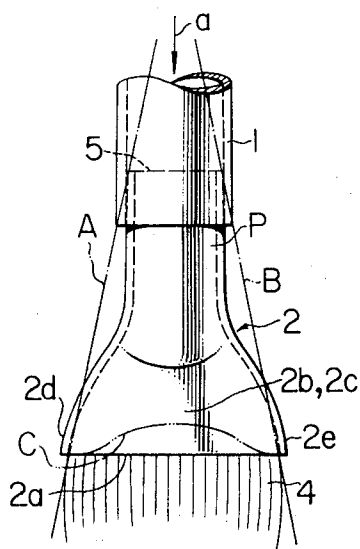


FIG. 3

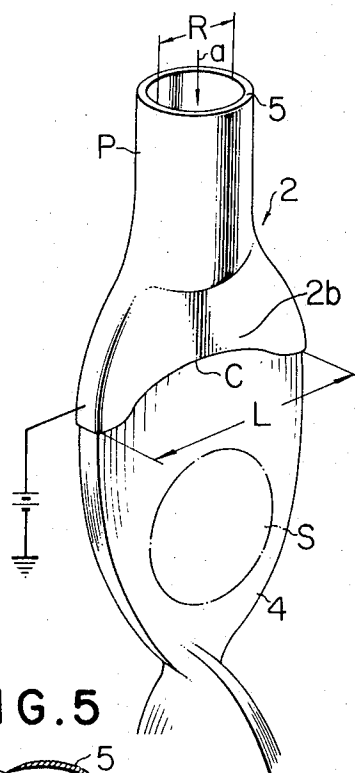


FIG. 2

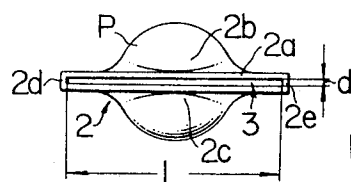


FIG. 5

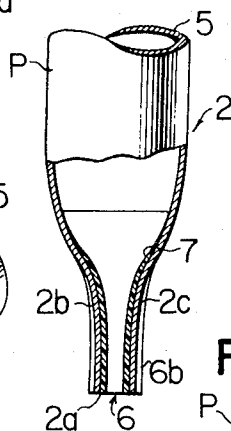


FIG. 4

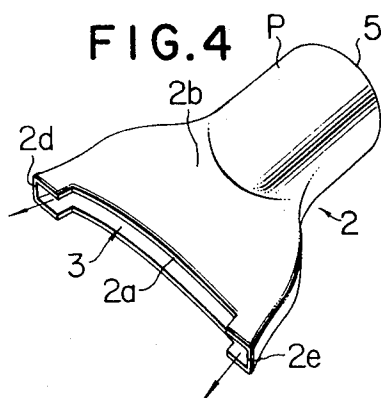


FIG. 6

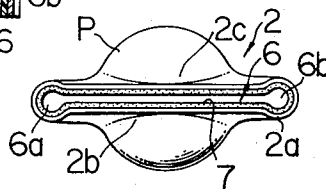


FIG. 7

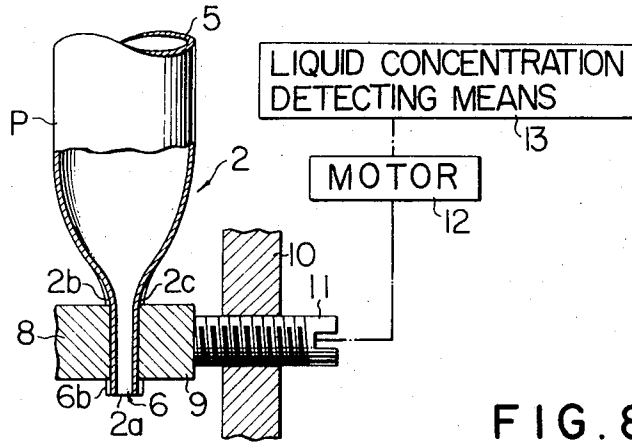


FIG. 8

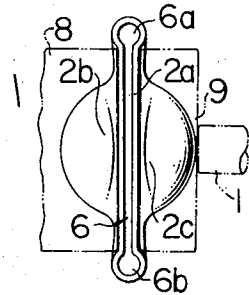


FIG. 9

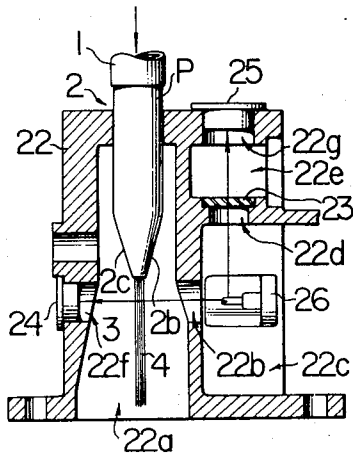
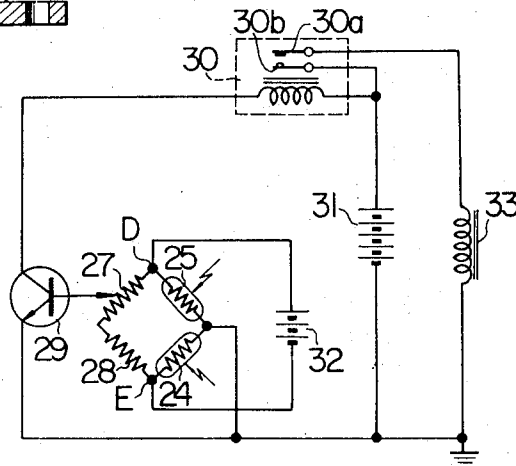


FIG. 10



SCREEN-LIKE LIQUID STREAM FORMING DEVICE FOR DETERMINING CONCENTRATION

BACKGROUND OF THE INVENTION

This invention relates to a device for forming a screen-like liquid stream for determining the concentration of a liquid.

In electrographic copying machines including facsimile machines, using a developing liquid, it is required to keep the concentration of such liquid constant at all times. In these machines, it has hitherto been customary to determine and adjust the concentration of the liquid by causing it to flow downwardly through a transparent tube which is illuminated and permits light to pass therethrough and to be incident on a photoelectric transducer element built in a bridge circuit, for example, to produce a signal for the solute to be supplemented when the quantity of light incident on the element reaches a predetermined level.

The use of the transparent tube has some disadvantages. When the liquid to be examined has an exceptionally high concentration, the solute adheres to the tube wall in a relatively short time interval, making it impossible to obtain accurate results in determining the concentration of the liquid. It is time consuming and requires additional hands to clean the tube to remove the solute adhering thereto.

Proposals have been made to use a U-shaped wire frame disposed below a slit-shaped discharging port to form a screen-like liquid stream by the frame so as to detect light transmitted through the screen-like liquid stream, in place of using a transparent tube. The use of such frame also has some disadvantages. It is wobbly and likely to cause disruption of the liquid screen when it is subjected to mechanical vibration, no matter how small it is. This makes it difficult accurately to determine the concentration of the liquid, because the liquid screen is disrupted more often than not. Thus, the results obtained by this process do not often square with the actual concentration of the liquid.

SUMMARY OF THE INVENTION

An object of the invention is to provide device for forming a screen-like liquid stream for determining the concentration of a liquid by a simple and inexpensive construction which obviates the disadvantages of the prior art methods using a transparent tube or a U-shaped frame.

To this and other ends, the present invention contemplates the provision of a stream-forming device comprising a plurality of liquid flow regulating members each having a liquid flow regulating surface, the liquid flow regulating surfaces of the regulating members being disposed close to each other in face-to-face relationship and defining therebetween a slit serving as a discharging port through which a stream of liquid is discharged to form a screen-like stream from which the concentration of the liquid can be readily and positively determined.

According to the invention, there is provided a device which is of simple and inexpensive construction and which permits a uniform screen-like liquid stream continuously to be formed at all times from which the concentration of the liquid can be determined directly. The device offers advantages in that the concentration of the liquid can be determined accurately and that the

level of concentration to be determined can be readily adjusted by varying the dimension of the slit when the reference concentration of the liquid is changed.

When the invention is incorporated in electrographic duplication equipment, it permits the concentration of all types of developing liquid to be determined accurately. An ordinary developing liquid containing a high concentration toner obtained by kneading a toner and a resin in a solvent at a high concentration at a rate of 0.5 to 5.0 grams per 1 liter of a supporting liquid can have its concentration readily determined by this device. Even a higher concentration developing liquid, containing a high concentration toner at a rate of 5 to 200 grams per 1 liter of a supporting liquid (adapted to be used for developing an electrostatic latent image of low surface potential or for use in an electrographic duplicating method including a transfer printing step), can have its concentration determined accurately by this device, although the concentration of such developing liquid has hitherto been difficult to determine by conventional devices.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front view of a device for forming a screen-like liquid flow for determining concentration, embodying the present invention in a particular form;

FIG. 2 is a bottom plan view of the device shown in FIG. 1;

FIG. 3 is a perspective view of the device shown in FIG. 1;

FIG. 4 is a perspective view of another embodiment of the screen-like liquid flow forming device of the invention;

FIG. 5 is a side view, with certain parts being broken away, of still another embodiment of the screen-like liquid flow forming device of the invention;

FIG. 6 is a bottom plan view of the device shown in FIG. 5;

FIG. 7 is a side view, with certain parts being broken away, of a further embodiment of the screen-like liquid flow forming device of the invention;

FIG. 8 is a bottom plan view of the device shown in FIG. 7;

FIG. 9 is a sectional side view of a concentration determining device incorporating an embodiment of the present invention therein; and

FIG. 10 is a wiring diagram of a concentration determining circuit adapted for use in the device shown in FIG. 9.

DESCRIPTION OF PREFERRED EMBODIMENTS

Preferred embodiments of the invention will be described with reference to the drawings.

In FIG. 1, a tubular member P is used as a conduit 1 for conveying a liquid to be examined, and is connected to a screen-like liquid flow forming device generally designated 2 according to this invention.

As shown in FIG. 2, the device 2 having a discharging port 2a at its bottom has a portion near the discharge port 2a gradually flattened in going from an upper portion of the device 2 toward the discharging port 2a till large width liquid flow regulating members 2b and 2c are formed at the bottom of the device. The liquid flow regulating members 2b and 2c each have a liquid flow regulating surface, the liquid flow regulating surfaces of the members 2b and 2c being disposed close to each

other and in face-to-face relationship to define therebetween a slit 3.

When a liquid flows through the conduit 1 in the direction of an arrow *a*, the liquid flow is regulated by the liquid flow regulating members 2*b* and 2*c* cooperating with the slit 3 and discharged through the discharging port 2*a* as a screen-like liquid stream 4. The widthwise expanse of the screen-like liquid stream 4 is only limited by lines A and B tangential to inner sides of liquid flow guides 2*d* and 2*e* respectively for guiding the liquid stream on opposite ends of the discharging port 2*a*.

The screen-like liquid stream B is fairly in good shape when opposite edges of the discharging port 2*a* are horizontal. However, it has been found that, if the end edges of the discharging port 2*a* are rounded by cutting inwardly along a dash-and-dot line C shown in FIG. 1 into an arcuate shape shown in FIG. 3, it is possible to form the screen-shaped liquid stream 4 in better shape.

In the embodiment shown, when a liquid introducing port 5 of the device has a diameter R of 6 millimeters and the slit 3 has a width *d* of 0.8 millimeter and a length L of 11 millimeters, the screen-like liquid stream 4 has an effective area S of about 12 millimeters.

In FIG. 4, the screen-like liquid flow forming device 2 is shown as having its guide members 2*d* and 2*e* formed to diverge outwardly downwardly. This form of guide members permits opposite end portions of the liquid stream 4 to flow in the direction of arrows with a greater vigor, thereby improving the shape of the screen-like liquid stream.

The screen-like flow forming device 2 shown in FIG. 5 and FIG. 6 has in place of the slit 3, a slit 6 formed at the discharging port 2*a* to include larger width portions 6*a* and 6*b* at opposite ends. This arrangement offers the same advantage as the arrangement shown in FIG. 4.

The liquid flow regulating surfaces of the liquid flow regulating members 2*b* and 2*c* are each formed thereon with a water-repellent coat 7 of a fluorine resin or silicone resin or a metal applied by plating over a considerably large area. The coat 7 can be provided in all the embodiments of the invention. The liquid flow regulating members may be made of metal or other electrically conducting material, and a bias voltage having a polarity opposite to the polarity of the toner may be impressed thereon as shown in FIG. 3.

In FIG. 7 and FIG. 8, there is shown a slit 6 of the same shape as the slit shown in FIG. 5 which is formed by pressing a lower portion of the tubular member P made of plastic or other flexible material by means of an immovable bolster member 8 and a movable presser member 9.

A screw 11 is loosely fitted in the pressure member 9, and is threadably connected to an immovable support member 10. By moving the screw 11, it is possible to adjust the force with which the presser member 9 presses against the bolster member 8, thereby permitting the width of the slit 6 to be adjusted. This enables adjustments of the width of the slit to be varied readily when the reference level of concentration is changed.

The screw 11 can be connected to a motor 12 which is controlled by liquid concentration detecting means 13 as shown in FIG. 7. This arrangement enables automatic control of the width of the screen-like liquid flow formed by the device according to this invention. This

arrangement can be incorporated in all the embodiments.

FIG. 9 shows a concentration determining device, incorporating the screen-like liquid flow forming device 2 according to this invention, for illuminating the screen-like liquid stream 4 formed thereby and measuring the intensity of light passing through the screen-like liquid stream 4 by means of photoelectric transducer elements. As shown, a housing 22 comprises a chamber 22*a* for mounting therein the device 2, a chamber 22*c* mounting therein a light source lamp and maintained in communication with the chamber 22*a* through a window 22*b* formed in a wall separating the two chambers 22*a* and 22*c* from each other, and a chamber 22*e* disposed above the chamber 22*c* and maintained in communication therewith through a window 22*d* formed in a wall separating the two chambers 22*c* and 22*e* from each other. The chamber 22*a* is completely cut off from the chamber 22*e*, and a filter 23 showing a reference concentration indicating the standard for comparison is mounted in the window 22*d*.

An opening 22*f* is formed in a portion of a wall of the chamber 22*a* corresponding to the window 22*b* in the opposite wall for mounting therein a photoelectric transducer element 24 for determining the concentration of the screen-like liquid stream 4. An opening 22*g* is formed in a portion of a wall of the chamber 22*e* corresponding to the window 22*d* in the opposite wall for mounting therein a photoelectric transducer element 25 for comparison.

Mounted in the chamber 22*c* is a lamp 26 serving as a light source and emitting light which is transmitted on the one hand through the window 22*b* to be incident on the screen-like liquid stream 4 and on the other hand through the window 22*d* to be incident on the filter 23. The light passing through the screen-like liquid stream 4 is incident on the photoelectric transducer element 24 while the light passing through the filter 23 is incident on the photoelectric transducer element 25.

The screen-like liquid stream forming device 2 according to this invention may be mounted in the chamber 22*a* by inserting the tubular member P in an opening formed in a top wall of the casing and threadably or otherwise connected therein. When the device 2 is of the form shown in FIG. 7, the screen-like liquid stream 4 may be permitted to flow directly into the chamber 22*a*.

The two photoelectric transducer elements 24 and 25 on which the light passing through the screen-like liquid stream 4 and light passing through the filter 23 are incident respectively are built in a bridge circuit together with resistors 27 and 28 as shown in FIG. 10 in which a transistor 29 includes a base connected to the resistor 27 and a collector connected to a power source 31 through a relay 30. Connections D and E in upper and lower portions of the bridge as shown are connected to a power source 32 which impresses a voltage on the base of the transistor 29 when the bridge becomes unbalanced.

Thus, when the value detected by the photoelectric transducer element 24 shows a change as the concentration of the screen-like liquid stream 4 varies and the bridge is unbalanced, the transistor 29 is fired and a current flows from the power source 31 to the relay 30. This closes contacts 30*a* and 30*b* and actuates an electromagnet 33 connected thereto and adapted to close and open a valve (not shown) for delivering a supply of

concentrated toner or other solute so as to automatically adjust the concentration of the liquid.

The motor 12 shown in FIG. 7 may be connected to the relay 30 to be controlled thereby.

When the screen-like liquid stream forming device 2 according to this invention is made of the tubular member p, the tubular member may be made of metal, plastic or other suitable material for making a flexible tube.

It is to be understood that the invention is not limited to the features and embodiments hereinabove specifically set forth, but may be carried out in other ways without departure from its spirit.

I claim:

1. A screen-like liquid stream forming device for determining concentration comprising a plurality of liquid flow regulating members each having a liquid flow regulating surface, said liquid flow regulating surfaces being disposed close to each other in face-to-face relationship to define therebetween a slit serving as a discharging port through which a stream of liquid is discharged and forms a screen-like liquid stream below the slit, wherein said plurality of liquid flow regulating members have a width which becomes larger in going from the upstream portions of the flow regulating members toward the discharging port to thereby define a slit whose width diverges in going towards the discharging port.

2. A device as set forth in claim 1 wherein said plurality of liquid flow regulating members have their end edges rounded by cutting inwardly in arcuate shape from opposite sides of the discharging port toward its central portion.

3. A device as set forth in claim 1 wherein said plurality of liquid flow regulating members each have a water-repellent material layer formed on the liquid flow regulating surfaces.

4. A device as set forth in claim 1 wherein said plurality of liquid flow regulating members are made of an electrically conducting material and have a bias voltage impressed thereon, said bias voltage having a polarity opposite to that of a toner.

5. A device as set forth in claim 1 wherein said slit has opposite end portions which have a larger area than the remainder of the slit.

6. A device as set forth in claim 1 wherein said plurality of liquid flow regulating members are made of a flexible material and formed integrally as a flexible tubular member having an outlet end, and further including presser means for compressing said tubular member adjacent said outlet end to form said slit.

7. A device as set forth in claim 6 wherein said presser means comprises a movable presser member and an immovable bolster member, and further including a motor connected to said presser member for adjusting the width of the slit.

8. A device for forming a screen-like stream of liquid, comprising

a. conduit means for conducting a flow of liquid and

b. stream-forming means comprising flow guide structure for receiving a flow of liquid from the conduit,

c. said flow guide structure including a pair of opposed, facing, closely spaced, flow-guiding surfaces cooperatively defining an elongated narrow slit which opens as a correspondingly elongated narrow outlet port for discharging a flow of liquid forming a screen-like liquid stream beyond the slit, wherein the width of each of said surfaces becomes larger in going from the conduit to the slit to thereby define a slit whose width diverges in going toward the outlet port.

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