

[54] **ELECTROPHOTOGRAPHIC APPARATUS**

[72] Inventors: **Wilhelm Josef Knechtel**, Rodheim;
Detlef Schaffer, Wetzlar, both of
Germany

[73] Assignee: **Canon Kabushiki Kaisha**, Tokyo,
Japan

[22] Filed: **July 13, 1970**

[21] Appl. No.: **54,336**

[30] **Foreign Application Priority Data**

July 16, 1969 Germany.....P 19 36 167.2

[52] U.S. Cl.137/93, 137/5, 137/88

[51] Int. Cl.G05d 11/08

[58] Field of Search.....137/93, 88, 4, 5, 8, 9

[56] **References Cited**

UNITED STATES PATENTS

3,494,328	2/1970	Maloney.....	137/93
3,526,338	9/1970	Goodrich.....	137/93
3,548,855	12/1970	Fathauer	137/93
3,195,551	7/1965	Russell	137/5

3,299,787	1/1967	Kolb.....	137/93
3,217,729	11/1965	Ballestra.....	137/93
3,223,108	12/1965	Martz.....	137/93

Primary Examiner—M. Cary Nelson

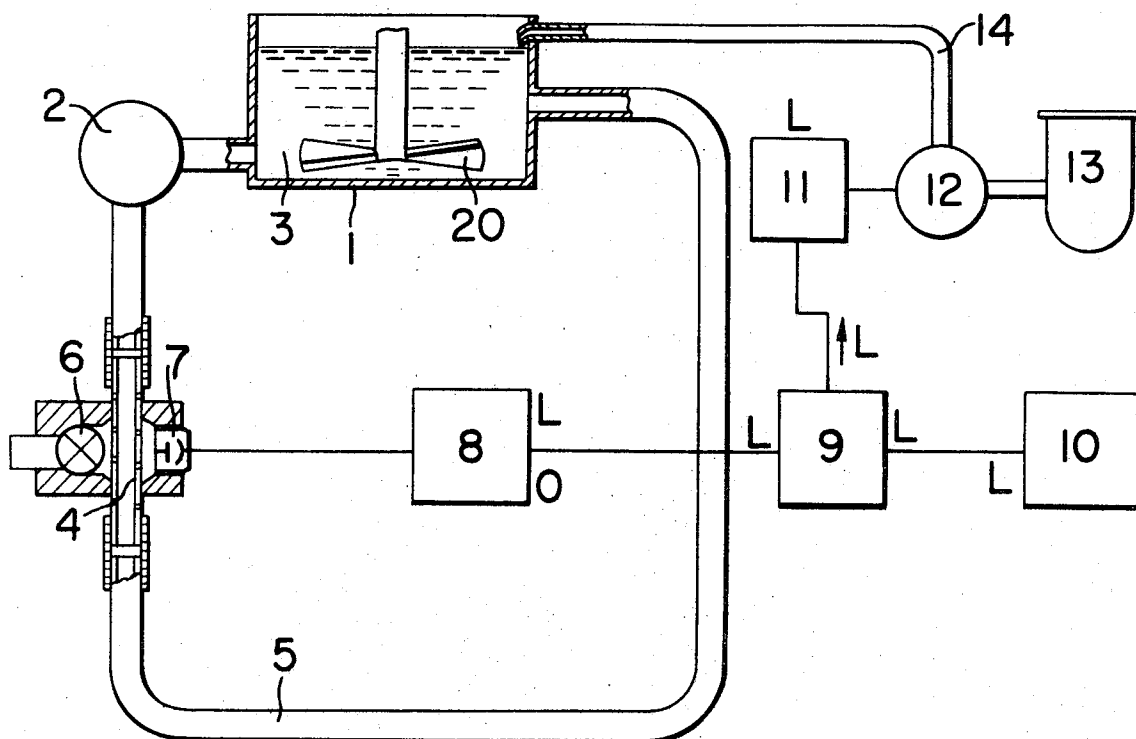
Assistant Examiner—William H. Wright

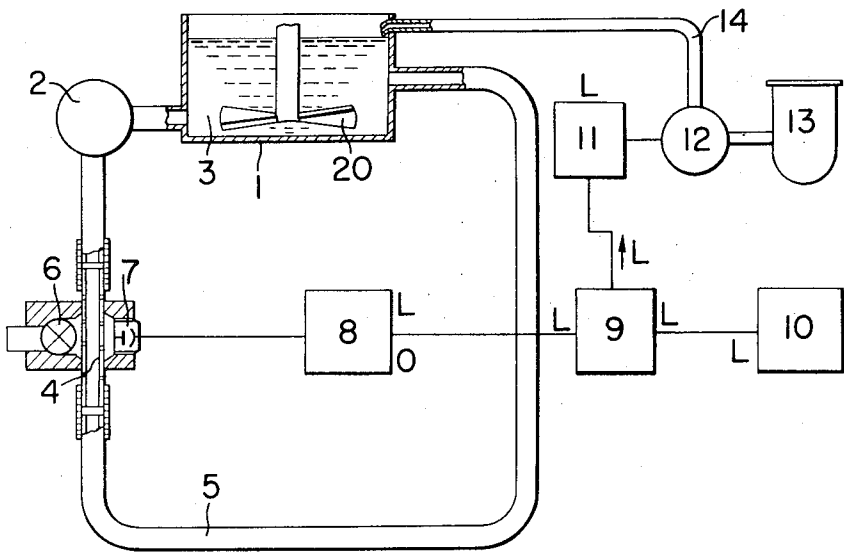
Attorney—Watson, Leavenworth and Kelton

[57] **ABSTRACT**

A photocopying apparatus which comprises supply means for supplying a predetermined quantity of concentrated developing agent to carrier liquid at a predetermined time interval, and measuring means for continuously measuring the concentration of the developing liquid. The measuring means controls said supply means so that the supply means supplies such measured quantity of concentrated developing agent to the carrier liquid only during predetermined time intervals and then only where the developing liquid has lower than a predetermined value of concentration. The carrier liquid is independently supplied in a quantity equal to the consumption of the carrier liquid, whereby constant concentration of the developing solution is maintained.

11 Claims, 1 Drawing Figure





ELECTROPHOTOGRAPHIC APPARATUS**BACKGROUND OF THE INVENTION****1. Field of the Invention**

This invention relates to photocopying apparatus for developing an electrostatic image which includes a container containing developing liquid and measuring means associated therewith for automatic control of developing liquid concentration.

2. Description of the Prior Art

In the production of copy, it is known that a developing agent, such as toner, must be taken in a variable quantity from carrier liquid in accordance with the contrast to be provided on the surface of the copy.

On the other hand, the carrier liquid is constantly removed from the developing solution container, and in this case the amount of carrier liquid removed is related to the size of copying paper sheet passing through the apparatus, because the liquid sticks to the surface of the paper sheet. Therefore, the toner concentration in the carrier liquid is continuously varying and this often results in unsatisfactory copies. To prevent this, there has been provided measuring means for constantly measuring the concentration of the developing agent in the carrier liquid and, if required, supplying developing agent in concentrated form to the carrier liquid.

In apparatus of the known type, a great time delay occurs between the measurement and the subsequent toner supply control, with a result that the concentration of the developing solution is greatly varied even if it is continuously monitored. In such apparatus, the developing liquid is supplied to a measuring station forming a part of a Wheatstone bridge. As the concentration varies, the photoresistance in the bridge varies in magnitude. The current driving a pump flow in the bridge and developing agent in concentrated form is supplied from a reservoir into the container by the pump. In such apparatus, the concentrated developing agent is supplied until the measuring station detects a new level of concentration. At this stage, saturation must apparently have become excessive. On the other hand, the supply means is of course responsive only when a low concentration initially appearing in the container is detected at the measuring station.

SUMMARY OF THE INVENTION

The object of the present invention is to continuously maintain the concentration of developing liquid substantially constant irrespective of great variation in load.

Such object of the present invention is achieved by providing supply means for supplying a predetermined quantity of concentrated developing agent to carrier liquid at a predetermined time interval, and measuring means for continuously measuring the concentration of the developing solution, said measuring means controlling said supply means so that the supply means supplies the quantity of concentrated developing agent to the carrier liquid at said time interval only when the developing solution has lower than a predetermined value of toner concentration and that said supply means is maintained inoperative when the developing solution exceeds or reaches said predetermined value of concentration, said carrier liquid for diluting the concentrated developing agent being independently

supplied in a quantity equal to the consumption of the developing agent.

Such method of control has, on the one hand, the advantage that the quantity of liquid in the container can always be maintained constant by the supply of carrier liquid. Such supply means is known as the chicken watering place.

Thus, a small quantity of concentrated toner liquid is supplied at a time interval which may be 30 seconds only when the concentration of the liquid in the container becomes lower than a reference value, whereby the concentration is maintained constant, because the time interval at which the measured quantity is supplied provides a sufficient length of time to allow, on the one hand, the concentrated developing agent to be well mixed with the carrier liquid by a stirrer in the container and to allow, on the other hand, a good mixture to be supplied to the measuring station.

The concentration is continuously measured by photoconductive means, for example. For this purpose, a pump continuously takes solution out of the developer container and supplies it to a transparent tube having a source of light and a photocell mounted forwardly and rearwardly thereof respectively.

The supply of developing agent may conveniently be effected by a measuring pump which is operated at a controlled time interval and supplies concentrated developing agent from a reservoir to the developing solution container.

In another form of the present invention, the measuring pump is connected to an AND gate, which is controlled by the measuring means on the one hand and by a pulse generator on the other hand. A Schmitt trigger may preferably be provided between the measuring means and the AND gate.

When the concentration is reduced to cause the voltage in the photocell to exceed a value determined by the Schmitt trigger input threshold, the trigger applies an enabling signal to the AND gate. When a pulse is coincidentally applied to the gate from a pulse generator, the measuring pump is operated, preferably by an operational amplifier. The operation of the measuring pump only continues for a short time, because the pulse generator applies a short pulse, say, of one-tenth second, to the AND gate. At the moment when the pulse has passed through the gate, the pulse generator discontinues applying a pulse to the AND gate. As a result, the AND gate does not pass any signal, whereby the measuring pump is no longer operated. This is also the input case where the voltage of the Schmitt trigger is low because of sufficient concentration of developing agent in solution and the Schmitt trigger does not apply an enabling to the AND gate. In this case, no pulse is applied from the AND gate to the measuring pump in spite of the presence of pulses produced by the pulse generator. When the Schmitt trigger does apply an enabling signal to the AND gate, the measuring pump is again operated for a short time by coincident pulse from the pulse generator.

The pulse generator can be controlled in an ordinary manner so that pulses can be successively generated at a time interval of 3 for 30 seconds. The time interval can be adjusted to each apparatus in use in accordance with the time required for the circulation of developing liquid and the time required for mixing.

The apparatus according to the present invention accurately operates and maintains the concentration substantially constant.

In a further form of the present invention, the circulation means and the pump for constantly supplying liquid to the measuring portion are time-controlled so that developing liquid may be circulated at a time interval of 20 to 30 minutes, for example, when the apparatus is not operated but is in standby position. Thus, the apparatus is always ready for operation even after it has not been used for a long time. If such circulation does not take place, the concentrated toner will be deposited on the bottom of the developing solution container. In this case, the apparatus will not be ready for operation until concentrated developing agent is newly mixed with carrier liquid. Furthermore, the separation of the concentrated toner will prevent the mixed toner from being supplied to the measuring station when the apparatus is started, while either the concentrated toner itself or the carrier liquid will be supplied to the measuring station, thus resulting in a wrong measurement which would dangerously hamper the supply of concentrated toner.

The present invention will now be described by way of example with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

The drawing diagrammatically shows an embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawing, developing solution 3 in a developer container 1 is pumped out by a pump 2 and forced through a transparent tube 4 into a conduit 5 and again into the container 1.

A source of light 6 is provided to illuminate the transparent tube 4. When the developing solution passing through the tube 4 has a high concentration of developing agent, a photocell 7 receives a small quantity of light and, when the concentration is low, receives a large quantity of light. A voltage produced in the photocell 7 is applied as an input output signal to a Schmitt trigger 8. When the photocell 7 produces a high voltage, i.e., when the concentration of the developing liquid is low, the trigger produces an output signal L. An output signal 0 is produced in the opposite case.

The trigger output signal is applied to an AND gate 9. The AND gate 9 is in turn connected to a pulse generator 10, which selectively generates pulses (L-signals) at a time interval of 5 to 30 seconds, each pulse continuing for approximately 0.1 second. This short-time pulse enters the AND gate 9 as an L-signal. Only when an L-signal from each of the Schmitt trigger 8 and the pulse generator 10 coincide at the common AND gate 9, is an L-signal supplied to an operation amplifier 11, which in turn operates a measuring pump 12 and maintains it in operation while the AND gate 9 receives two coincident L-signals. An O-signal is applied to the AND gate between each pair of successive pulses generated by the pulse generator. In this case no pulse is applied to the operation amplifier 11. This also holds true at any time when the Schmitt trigger applies a dis-

abling O-signal to the AND gate 9. Thus, no L-signal is applied to the operation amplifier 11 in the last-mentioned instance even if the pulse generator 10 then applies an L-signal to the AND gate. The pump 12 supplies concentrated toner from a reservoir 13 through a pipe 14 into the container 1. In the container 1 a stirrer 20 is provided to sufficiently mix the concentrated toner with carrier liquid and a sample of the mixture is supplied to the measuring station 4 by the pump 2.

What is claimed is:

1. Apparatus for use in developing electrostatic images comprising:

- a. a tank containing developing solution comprising carrier liquid admixed with developing agent;
- b. means circulating said developing solution;
- c. sensing means generating first output signals during operation of said circulating means, said first output signals being indicative of the concentration of developing agent in said developing solution;
- d. means generating time-spaced signals during operation of said circulating means;
- e. means receiving said first output signals and said time-spaced signals and operatively responsive thereto to generate second output signals exclusively upon the concurrent occurrence of said time-spaced signals and first output signals indicative of developing agent concentration of magnitude less than a preselected magnitude; and
- f. developing agent supply means operatively responsive to said second output signals to supply developing agent to said tank during the time extents of said second output signals.

2. The apparatus claimed in claim 1 wherein said developing agent supply means comprises a container containing concentrated developing agent, conduit means connecting said container and said tank and a pump disposed in said conduit means and operatively responsive to said second output signals.

3. The apparatus claimed in claim 2 wherein said second output signal generating means includes a coincidence circuit receiving said first output signals and said time-spaced signals.

4. Apparatus for use in developing electrostatic images comprising:

- a. a tank containing developing solution comprising carrier liquid admixed with developing agent;
- b. means circulating said developing solution;
- c. sensing means generating first output signals during operation of said circulating means, said first output signals being indicative of the concentration of developing agent in said developing solution;
- d. means generating second output signals at predetermined periods during operation of said circulating means exclusively upon the occurrence during said periods of first output signals indicative of developing agent concentration of magnitude less than a preselected magnitude, said second output signal generating means comprising first circuit means generating pulses time-spaced from one another and each of time extent defining a one of said predetermined periods and second circuit means including a coincidence circuit operatively responsive to said pulses and said first output

5

signals, said coincidence circuit providing output signals constituting said second output signals; and

- e. developing agent supply means operatively responsive to said second output signals to supply developing agent to said tank during the time extents of said second output signals.

5. The apparatus claimed in claim 3 including a voltage-sensitive bistable circuit connected between said sensing means and said coincidence circuit.

6. The apparatus claimed in claim 5 wherein said coincidence circuit comprises an AND gate receiving a first input from said bistable circuit and a second input from said means generating said time-spaced signals.

7. The apparatus claimed in claim 6 further including an operational amplifier receiving said AND gate output signal, said amplifier output signals constituting

6

said second output signals.

8. The apparatus claimed in claim 1 wherein said circulating means includes a conduit and wherein said sensing means includes a light source and a photocell disposed in opposing relation in said conduit.

9. The apparatus claimed in claim 1 further including a rotating stirrer disposed in said tank.

10. The apparatus claimed in claim 8 wherein said circulating means further includes a pump connecting said tank and said conduit.

11. The apparatus claimed in claim 8 wherein said conduit comprises a transparent section, said light source and said photocell being mounted on said transparent conduit section.

* * * * *

20

25

30

35

40

45

50

55

60

65