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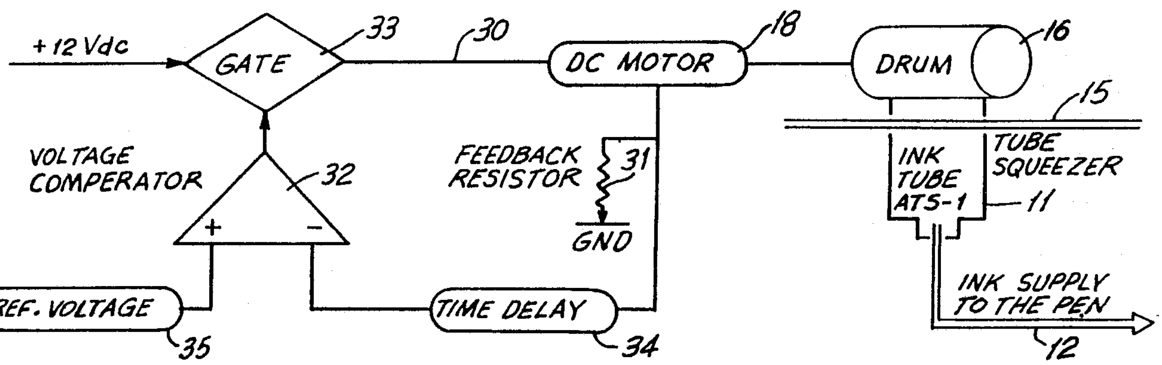
(54) Title: APPARATUS FOR AUTOMATICALLY DISPENSING FLOWABLE MATERIAL



(57) Abstract

An apparatus (10) for automatically dispensing flowable material which automatically ensures a substantially constant and even supply of flowable material from a source of the flowable material to some destination at which the flowable material is needed or is used. The flowable material may be any material that can be extruded from a collapsible tube upon the exertion of pressure on the tube and includes liquids or gels. The apparatus comprises a collapsible tube (11) having a nozzle end (13) and a sealed end and containing a flowable material; a tube squeezer (15); a rotatable drum (16) for pulling the collapsible tube through the tube squeezer as the drum rotates; a motor (18) for rotating the drum (16); and an electronic feedback mechanism (30) for disengaging the motor (18) so as to maintain pressure of the flowable material within a selected pressure range.

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+ Any designation of "SU" has effect in the Russian Federation. It is not yet known whether any such designation has effect in other States of the former Soviet Union.

APPARATUS FOR AUTOMATICALLY DISPENSING FLOWABLE MATERIAL

Background of The Invention

The present invention relates to an automatic flowable material dispensing apparatus which in a preferred embodiment relates to an apparatus for dispensing ink to a plotter.

Plotters require a steady and constant supply of ink for operation. An undersupply or oversupply of ink may render plotter operation unacceptable. An oversupply of ink is undesirable because the excess ink may cause blots on the plot or cause the plot to be inaccurate or illegible. An undersupply of ink is undesirable because without a sufficient ink supply, portions or all of a plot may be lost.

The use of disposable pen cartridges as the ink supply source is problematic because a plotter so equipped must be continuously monitored to ensure that the pen cartridge has not run out of ink. A worker is required to monitor the plotter and to replace the disposable pen cartridge when depleted. If a plotter is to be used over a long time when constant monitoring is not feasible, a new disposable pen cartridge must be installed as a precaution against a partially depleted cartridge being fully depleted at some point during the long time period. As the partially depleted cartridge is usually discarded, this method of operation is economically disadvantageous.

Pressurized ink supply systems are also known. However, such a system results in an uneven flow of ink to the plotter pen, thereby producing unacceptable plots. Such a pressurized ink supply system may render the plotter pen inoperable and may even cause the plotter pen to explode.

Summary of Invention

The present invention ennnnnnncompases an apparatus for automatically dispensing flowable material. It is an object of the present invention to automatically ensure a substantially constant and even supply of flowable material from a source of the flowable material to some destination at which the flowable material needed or is used.

The flowable material is originally contained in a collapsible tube. Such collapsible tubes are well known and may be constructed from a number of different materials including for example, plastic, metal and rubber. The flowable material may be any material that can be extruded from a collapsible tube upon the exertion of pressure on the tube. Such flowable materials can be solids, liquids or gels and may include, for example, lubricants, paint, pigments, toothpaste and ink.

The apparatus of the present invention may be used, for example, to provide a constant and even supply of lubricant to the ball bearings of a rotatable apparatus or an even supply of any flowable material to the locus where such a material is used or required.

In a preferred embodiment of the present invention, ink can be dispensed from a collapsible tube to a plotter pen in a substantially steady and constant rate, for example, within the pressure range necessary to ensure acceptable plotter pen operation.

The apparatus of present invention comprises: a collapsible tube having a nozzle end and a sealed end and containing a flowable material; a tube squeezer; a rotatable drum for pulling the collapsible tube through the tube squeezer as the drum rotates; motor means for rotating the drum; and feedback means for disengaging the motor means so as to maintain pressure of the flowable material within a selected pressure range. The feedback means associated with the motor means regulates the operation of the motor means, controls the dispensing of the flowable material from the collapsible tube and allows for a substantially steady and relatively constant rate of extrusion of the flowable material from the tube.

A collapsible tube of a flowable material, which is connected to a suitable means for carrying the flowable material to the desired locus where the material is required or used, is loaded into the apparatus by inserting the sealed end of the tube through the tube squeezer and connecting the sealed end to the rotatable drum. The flowable material is extruded from the collapsible tube and to the locus of use or need by rotating the drum thereby pulling the collapsible tube through the tube squeezer. The drum is rotated by a motor means which can be, for example, a DC motor.

As the amount of flowable material being squeezed from the tube exceeds the amount needed at the locus where the flowable material is needed or used, the pressure of the flowable material in the tube will increase. The motor means which rotates the drum will be acting against this increased pressure and will draw an increasing amount of current. The current drawn by the DC motor is proportional to the pressure of the ink at the nozzle end of the tube. A feedback means monitors the current drawn by the DC motor and disengages the DC motor if the current equals or exceeds a preselected value corresponding to maximum desired ink pressure.

In the preferred embodiment of the present invention, a collapsible tube of ink is connected to the plotter pen by a flexible tubing and is loaded into the apparatus by inserting the sealed end of the tube through the tube squeezer and connecting the sealed end to the rotatable drum. The ink is forced from the collapsible tube to the pen by rotating the drum thereby pulling the collapsible tube through the tube squeezer. The drum is rotated by a motor means such as a DC motor and the feedback means controls the motor so as to ensure a substantially constant and steady supply of ink through the flexible tubing to the plotter.

The current drawn by the DC motor is proportional to the pressure of the ink at the nozzle end of the tube. A feedback means monitors the current drawn by the DC motor and disengages the DC motor if the current equals or exceeds a preselected value corresponding to maximum desired ink pressure.

Brief Description of the Drawings

Fig. 1 is a schematic illustration of an apparatus for dispensing ink to a plotter.

Fig. 2 is a rear view of the apparatus depicted in Fig. 1.

Fig. 3 is a block diagram of electrical circuit employed to monitor and control the dispensing of ink by the apparatus depicted in Figs. 1 and 2.

Fig. 4 is a rear view of the apparatus having another means for connecting the tube to the drum.

Detailed Description of The Drawing And The Invention

Figure 1 illustrates an apparatus **10** for dispensing ink to a plotter according to the present invention. The ink to be dispensed to the plotter pen is originally contained in a collapsible tube **11**, which is preferably on ATS-1 ink tube. Tubing **12** is connected to the nozzle end **13** of the collapsible tube **11** and to the plotter pen so as to provide a pathway for the ink to be dispensed from the collapsible tube **11** to the plotter pen.

The collapsible tube **11** is loaded into the apparatus **10** by placing the nozzle end of the tube **11** on the tube holder **14** and inserting the sealed end **13** of the tube through the tube squeezer **15** and connecting the sealed end to the rotatable drum **16**. As depicted in Figure 2, the sealed end may be connected to the rotatable drum **16** by a tube catcher **17** which is pivotally connected to the rotatable drum **16**. The tube catcher **17** clamps the sealed end to the rotatable drum **16**.

By rotating the rotatable drum **16**, the collapsible tube **11** is drawn through the tube squeezer **15** thereby forcing the ink from the end portion towards the nozzle end **13** of tube **11**. The ink at the nozzle end **13** is consequently dispensed to the plotter pen (not shown) by way of tubing **12**. The rotation of drum **16** causes the depleted portion of tube **11** to wrap around drum **16**. Drum **16** is rotated by motorized means **18**, preferably a reversible twelve volt DC motor, which is connected to the drum **16** by a linkage **19**.

If the amount of ink squeezed from the end portion of tube **11** exceeds the amount of ink being used by the plotter pen, the pressure of the ink at the nozzle end of tube **11** will increase. This increased pressure poses a greater load for the motor **18**. Consequently, the motor **18** will draw an increasing current in proportion to the increasing ink pressure. A feedback means **30** monitors the current drawn by the motor **18** and disengages the motor **18** when the current exceeds a preselected value corresponding to the maximum desired ink pressure.

The feedback means **30** is depicted in Fig. 3. The current being drawn by the motor **18** is passed across a feedback resistor **31**, which preferably is a 4.7 ohm resistor. The obtained voltage is then compared to a reference voltage by voltage compensator **32**. Preferably, the reference voltage is 1.2 volts. If the voltage obtained across the feedback resistor **31** equals or exceeds the reference voltage, an electrical gate **33** disengages the power supply to the motor **18**. At that point, further pressurization of the ink ceases.

The feedback means **30** includes a time delay **34** whereby the power supply will be reconnected to the motor **18** after a time period selected by the user has elapsed. Preferably, the time delay period is fifteen minutes. As soon as the power supply (not shown) is reconnected to the motor **18**., the drum **16** will begin to rotate thereby displacing ink from the end portion of tube **11**. After a slight time lag, the feedback means **30** is re-engaged to monitor and control the pressurization of the ink supply. If the plotter pen has not dispensed ink and thereby relieved the ink pressure during the time delay period, an overpressurization condition may develop over numerous cycles due to the incremental pressure increased developed over each cycle because of the time lag for engaging the feedback means **30**.

A more preferred embodiment precludes the possibility of this overpressurization situation occurring by reversing the motor **18** for one or two seconds after the obtained voltage across feedback resistor **31** exceeds the reference voltage **35** but before the power supply (not shown) to the motor **18** is disengaged. The reversal of the DC motor **18** slightly unwinds the depleted portion of tube **11** from drum **16**. After the time delay has elapsed and the power supply is reconnected to the DC motor, the feedback mechanism **30** will be re-engaged before the unwinding of the depleted portion of tube **11** is compensated for. This more preferred embodiment will dispense a steady and even supply of ink to the plotter pen within a range of 10-20 pounds per square inch under all operating conditions.

A tube position monitoring means may be provided to notify the operator of the near complete depletion of ink from collapsible tube **11**. The ink is forced from tube **11** by drawing tube **11** through tube squeezer **15**. As the depleted portion of tube **11** is wrapped around drum **16**, the nozzle end **13** progresses towards the fixed tube squeezer **15**. A position indication circuitry will provide an alarm when the nozzle end **13** is in the immediate vicinity of the tube squeezer **15**.

An alternate method of connecting the collapsible tube **11** to the drum **16** is shown in fig. 4. In this embodiment, the means for holding the tube **11** on the drum **16** is a slot **21** in the drum into which the end of the tube **11** can be inserted and held as the drum **16** rotates. Additionally, fig. 4 shows the use of a modified linkage **22** in which the spring-loaded means of figs. 1 and 2 are not employed.

What Is Claimed:

1. An apparatus for automatically dispensing flowable material contained in a collapsible tube having a nozzle end and a sealed end, said apparatus comprising:

a tube squeezer;

a rotatable drum;

connecting means for connecting the sealed end of the collapsible tube to the rotatable drum so that the collapsible tube can be drawn through the tube squeezer as the drum rotates;

motor means for rotating the drum; and

feedback means associated with the motor means for regulating the operation of the motor means, and for controlling the dispensing of flowable material from the collapsible tube.

2. The apparatus of claim 1, wherein the connecting means is a tube catcher which is pivotally connected to the rotatable drum.

3. The apparatus of claim 1, wherein the connecting means is a slot into which the sealed end of the tube can be inserted.

4. The apparatus of claim 1, wherein the motor means is a DC motor linked to the rotatable drum.

5. The apparatus of claim 3, wherein the motor means is a reversible DC motor.

6. The apparatus of claim 1, wherein the motor means is a 12 volt reversible DC motor linked to the rotatable drum.

7. The apparatus of claim 1, further comprising a means for indicating near complete depletion of flowable material from the collapsible tube.

8. The apparatus of claim 1, wherein the feedback means comprises:

a feedback resistor across which current drawn by the DC motor is passed;

a reference voltage source;

a voltage comparator for comparing the reference voltage and voltage obtained across the feedback resistor;

an electrical gate for disengaging a power supply to the motor means if the voltage across the feedback resistor equals or exceeds the reference voltage; and

a time delay means for re-engaging the power supply to the motor means after a selected time period has elapsed.

9. The apparatus of claim 8, wherein the motor means is a 12 volt DC motor, the feedback resistor is a 4.7 ohm resistor, and the reference voltage is 1.2 volts.

10. The apparatus of claim 7, wherein the feedback means further comprises a means for reversing the DC motor for a short period of time after the voltage across the feedback resistor equals or exceeds the reference voltage and before the power supply to the DC motor is disengaged.

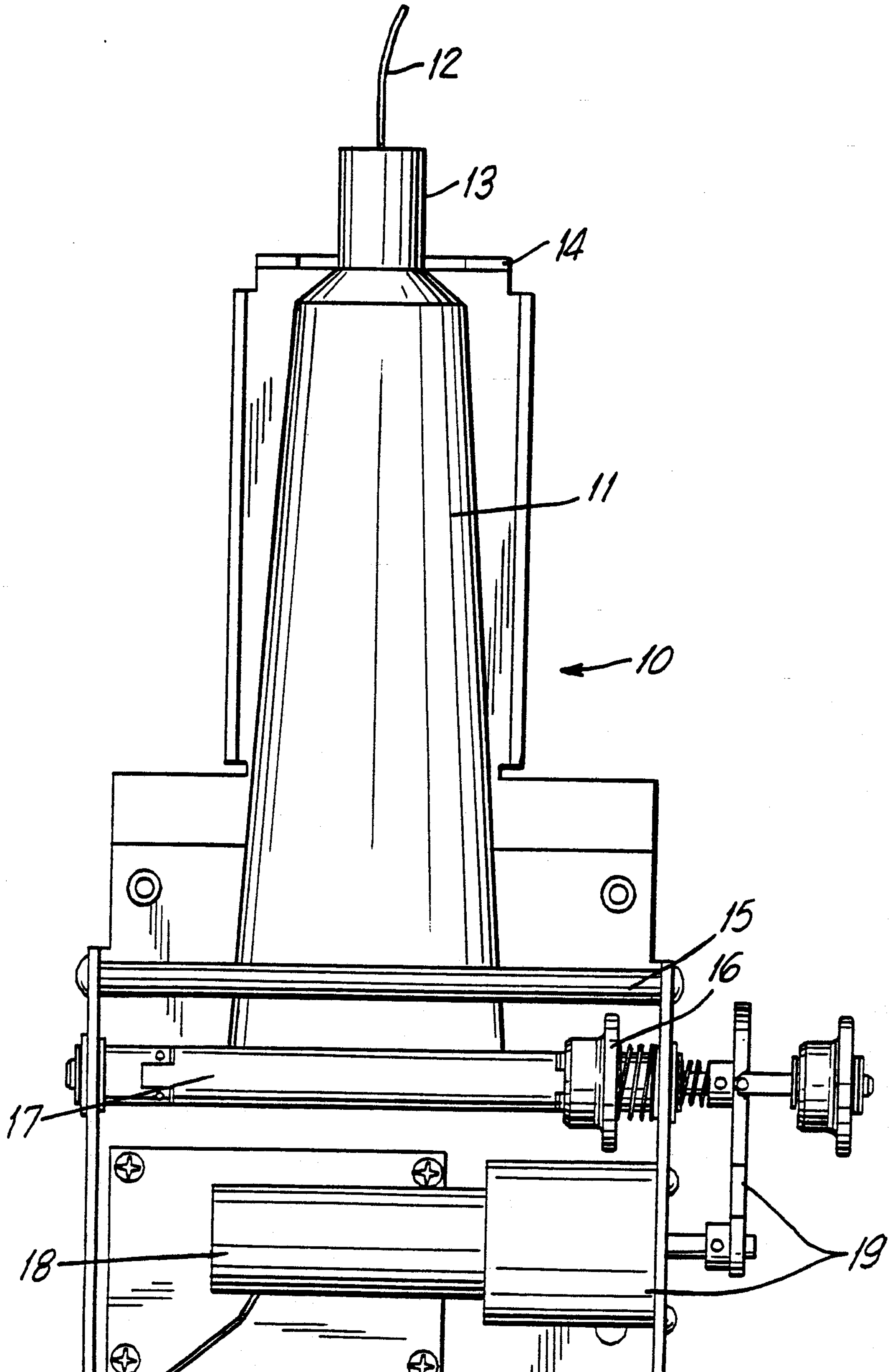

FIG.1

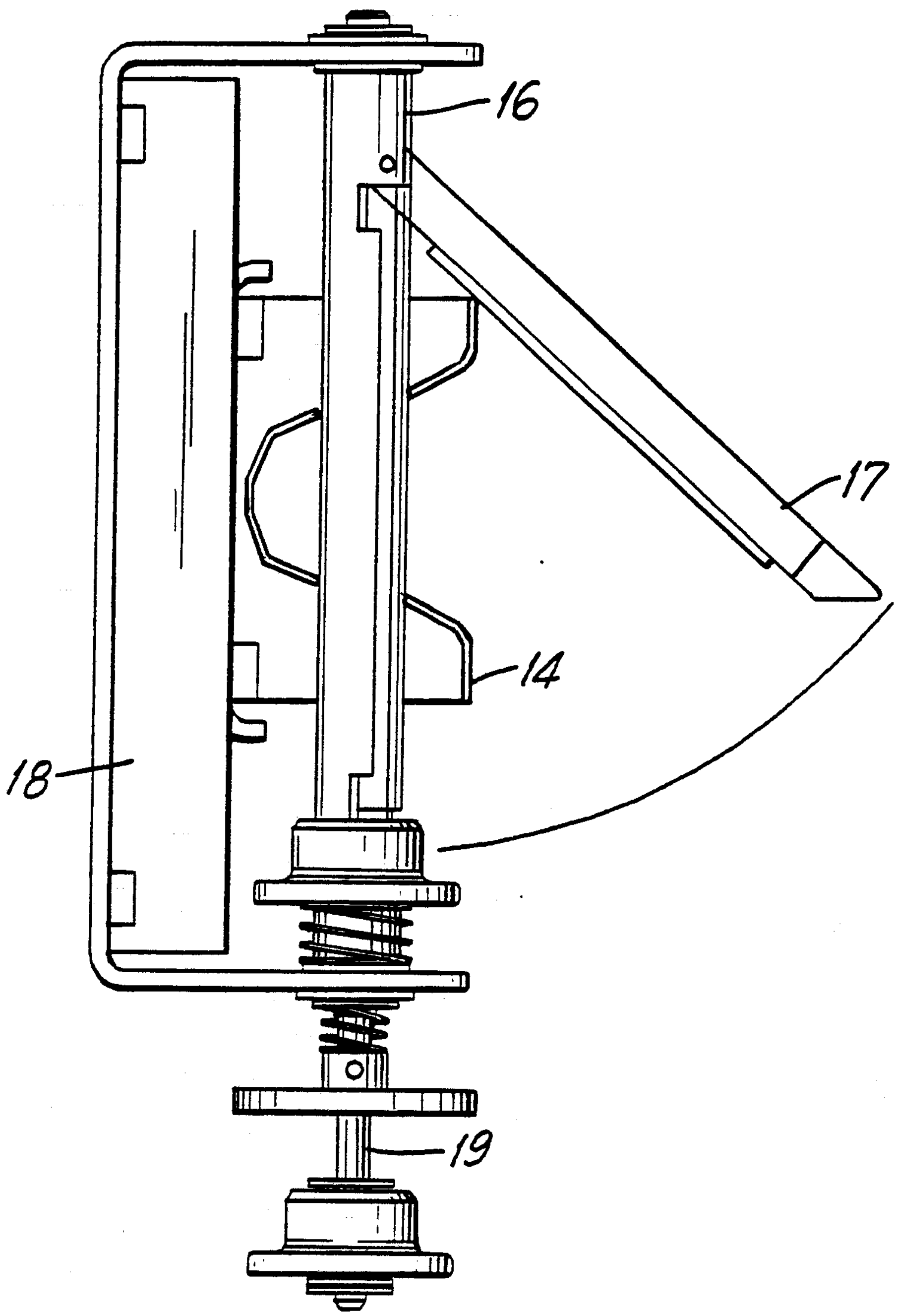

FIG.2

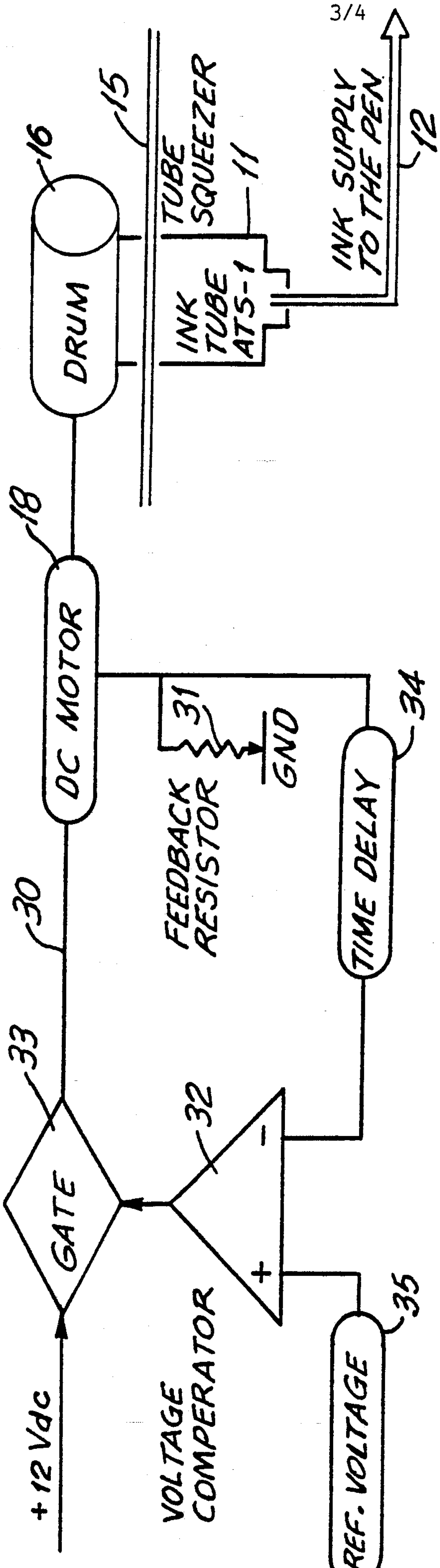
DRUM
16
15
TUBE SQUEEZER
11
INK TUBE ATS-1
INK SUPPLY TO THE PEN
12
18
DC MOTOR
31
FEEDBACK RESISTOR
GND
TIME DELAY
34
30
33
GATE
32
VOLTAGE COMPERATOR
+ 12 Vdc
REF. VOLTAGE
35

FIG.3

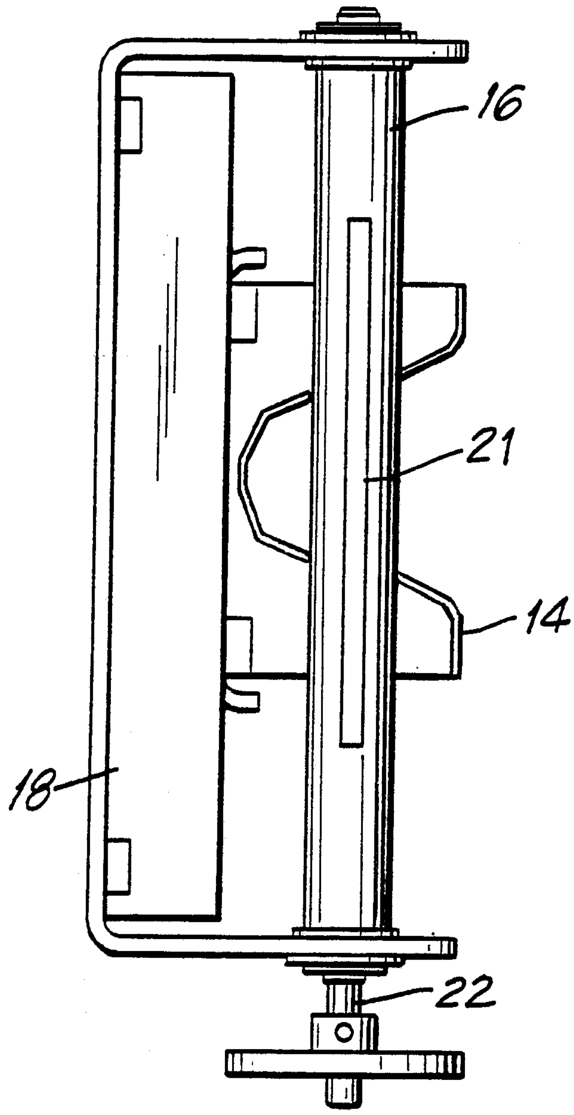

FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US92/02098

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC (5): B65D 35/28
U.S.Cl.: 222/63,98,333

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S.	222/63,97,98,99,101,102,333,638,644

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [*]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	US, A, 4,421,251 (NAMDARI ET AL.) 20 December 1983 See the entire document.	1-10
Y	US, A, 4,850,513 (PORTER) 25 July 1989 See col. 4, lines 42-66.	1,2,4,5,6,8,9, 10
Y	US, A, 4,998,645 (PEARSON) 12 March 1991 See Fig. 5.	3
y	US, A, 4,234,104 (APUZZO, JR. ET AL.) 18 November 1980. See col. 2, lines 27-31.	7
A	US, A, 4,258,864 (KARAMANOLIS ET AL.) 31 March 1981	
A	US, A, 4,264,021 (DAVIS, JR.) 28 April 1981	
A	US, A, 4,473,175 (DeGRAFF ET AL.) 25 September 1984	
A	US, A, 4,955,507 (KIRSCHNER ET AL.) 11 September 1990	
A,P	US, A, 5,050,773 (CHOI) 24 September 1991	

* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
28 May 1992	29 JUN 1992
International Searching Authority	**Signature of Authorized Officer**
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