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EUROPEAN PATENT SPECIFICATION

45 Date of publication of patent specification: **21.09.88**

51 Int. Cl.⁴: **B 41 J 27/00, B 41 J 3/04**

21 Application number: **84306916.2**

22 Date of filing: **10.10.84**

54 **Hydraulic systems for ink jet printers.**

30 Priority: **19.10.83 GB 8327999**

43 Date of publication of application:
22.05.85 Bulletin 85/21

45 Publication of the grant of the patent:
21.09.88 Bulletin 88/38

84 Designated Contracting States:
DE FR GB

58 References cited:
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Description

This invention relates to hydraulic systems, suitably to ink supply systems for ink jet printers.

In a continuous ink jet printer, ink is conveyed from a reservoir to a print head where the ink is forced through a nozzle at high pressure and broken up into droplets by an ultrasonic vibrator. Droplets emerging from the nozzle are charged by amounts which suit their print positions on a target and the charged droplets are then deflected on to the target by an electrostatic field. Uncharged droplets are returned to the reservoir.

During operation of the printer, volatile solvents are lost from the ink by evaporation so that the composition and physical properties of the ink are changed. It is desirable therefore that the composition of the ink should be monitored and that any deficiency in the proportion of solvents should be made good.

US-A-4,027,516 discloses a viscometer system which operates on the falling slug principle. In this system, a sample of a liquid flowing along a process line is pumped into an operating section which includes an upright tube containing a slug. There is first a purge phase, wherein liquid from a previous measuring cycle is returned to the process line and replaced by a new sample, and then a recirculation phase, wherein the sample is circulated until it attains a desired temperature. Finally, there is a measurement phase wherein the pump is switched off and the slug is allowed to fall through liquid in the tube. Viscosity is computed from the time taken for the slug to descend through a predetermined distance in the tube.

In DE-A-3,111,987 an ink jet printer is provided with a sub-tank containing a float. As the viscosity of ink in the printer rises the specific gravity of the liquid increases and the float moves upwardly in the sub-tank. When the float reaches a predetermined position a switch is operated and a control unit cause a valve to open. Diluent is then supplied to the ink. Operation depends upon a known relationship between viscosity and specific gravity so that a measurement of specific gravity is effectively converted into a viscosity measurement.

Problems arising from loss of solvents or other components arise in other hydraulic systems.

According to the present invention there is provided an ink jet printer comprising an ink reservoir, means for charging the ink in the printer with a component which causes a change in the viscosity thereof, a printing head, a pump means for supplying ink from the reservoir to the head and for returning unused ink from the head to the reservoir, means for sensing the temperature of ink in the printer or the ambient temperature, a viscometer connected to a supply line from the pump means, the viscometer including an upstanding tube and an element which is movable upwardly and downwardly within the tube and control means including a store containing data representing the relationship between the

desired viscosity of the ink and temperature, the control means being adapted, in use, first to allow an upwards flow of ink from the supply line to the tube sufficient to move the element to an upper part of the tube and then to terminate the upwards flow so that the element descends through the ink, and the control means being further adapted to determine the time taken for the element to descend through a predetermined distance, which time is representative of the viscosity of the ink in the tube, to effect a comparison between the desired viscosity at the temperature sensed by the temperature sensing means and the viscosity represented by the said time taken for the element to descend through the ink, and to generate a control signal for activating the charging means if the comparison reveals a difference between the desired and sensed viscosities, whereby the charging means operate to charge the ink with the said component and the difference between the two viscosities is reduced.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a schematic drawing of an ink jet printer including an ink system according to the invention;

Figure 2 is a viscometer included in the system of Figure 1;

Figure 3 is a block diagram of an electrical control circuit associated with the printer of Figure 1; and

Figure 4A to 4D are graphs relating to the operation of the printer of Figure 1.

Referring to Figure 1 of the drawings, an ink system according to the invention is designed to convey ink between a reservoir 1 and a print head 3 of an ink jet printer. Included in the head 3 is an ink container 5 having an inlet 7 at an upper end thereof, an outlet orifice 9 at a lower end, and a bleed outlet 11. A vibrator 13, connected to a piezoelectric transducer (not shown), extends downwardly into the container 5. As hereinafter described, ink in the container 5 is subjected to a pressure which forces a jet of ink through the orifice 9. Vibration of the vibrator 13 ensures that the jet breaks up into droplets of uniform size. Below the container 5 there is an electrode 15 for charging droplets by an amount which suits their print positions on a target and a pair of electrodes 17 for deflecting charged droplets on to the target (not shown). The charge applied to each droplet, and hence the location at which it strikes the target, depends of course upon the instantaneous magnitude of the potential applied to the electrode 15. This potential is determined by an output from a print microprocessor (not shown). A gutter 19 is provided for collecting uncharged droplets, which are not deflected on to the target.

In the present system, the reservoir 1 is provided with a cartridge 21 containing ink for replenishing the ink stored within the reservoir. Also mounted on the reservoir 1 is a make-up cartridge 23 containing solvents for adding to ink within the system, as hereinafter described.

A double ended pump 25 serves to pump ink from the reservoir 1 to the print head 3 and to return unused ink from the head to the reservoir. The pump 25 includes a first gear pump 27, which is connected into the high pressure side of the system, and a second pump 29, which is on the suction side. Rotary parts of the pumps 27 and 29 are coupled to respective opposed shafts of a motor 31.

The pump 27, which is a gear pump of the suction shoe type, has an inlet connected to the reservoir 1 and an outlet connected to the head 3 via a filter damper 33, a pressure regulator 35 and a jet run solenoid valve 37. The filter damper 33 serves both to filter ink from the reservoir 1 and to dampen cyclical variations in the rate of flow of ink from the pump 27. The pressure regulator 35 maintains the pressure of ink supplied to the head 3 at a predetermined value. A visual indication of this pressure is provided by a pressure gauge 34. To ensure that the pressure of ink does not rise above 412,800 Newtons/sq. metre (60 pounds per square inch), a pressure relief valve 41 connects the output of the pump 27 to the reservoir 1 by means hereinafter described.

A bleed line 43 is provided for returning a mixture of ink and air from the containers of the head 3 to the reservoir 1 at the beginning of a printing operation. Connected into the line 43 is a bleed solenoid valve 45.

On the suction side of the system, the pump 29 has an inlet connected to the gutter 19 via a gutter filter 47 and an outlet connected directly to the reservoir 1. The pump 29 is a gear pump of the cavity plate type.

To ensure that the pump 29 applies sufficient suction to the head 3 and is adequately lubricated, the inlet to the pump is connected to the outlet of the pump 27 via a bleed line 49 and the pressure relief valve 41. Included in the line 49 is a bleed control orifice 51 which is preset to allow a predetermined flow of ink to the pump 29. The junction between the bleed line 49 and the valve 41 is connected to the reservoir 1 by a further pressure relief valve 53, which opens if the pressure of ink in the line 49 exceeds 6,895 Newtons/sq. metre (1 pound per square inch).

Operation of the motor 31 and the valves 37 and 45 is controlled by a main microprocessor (not shown) which is linked to the print microprocessor.

In use of the present system, it is important to replace volatile solvents lost from the ink by evaporation in the head 3. Such loss of solvents is detected by detecting changes in the viscosity of the ink, which varies with changes in composition. Means are then provided for adding fresh solvents as necessary.

Referring now to Figures 1 and 2, a viscometer 55 has its inlet connected to the bleed line 49 by a normally closed solenoid valve 57 and its outlet directly connected to the reservoir 1. The viscometer 55 includes a stainless steel ball 58 which is movable upwardly and downwardly within an upstanding tube 59 of ground glass. At an upper

end of the tube 59 there is a flared portion 61, whilst a seat 63 for the ball 57 is provided near to a lower end of the tube. A ball detector coil 65 surrounds a section of the tube 59 immediately above the seat 63.

The ink make up cartridge 23, referred to above, contains solvents which are added to the ink when a loss of solvents is detected by the viscometer 55. Solvents from the cartridge 23 are supplied to the line between the pump 29 and the gutter 19 via a normally closed make-up solenoid valve 67.

Associated with the viscometer 55 and the valve 67 is an electrical control circuit, shown in Figure 3 of the drawings.

The control circuit of Figure 3 includes a single chip microcomputer 69 having inputs which are supplied with data representing the current and desired viscosities of ink in the system and outputs which supply control signals for removing any discrepancy between current and desired viscosities. Thus, a first input to the microcomputer 69 is connected to a cartridge memory device 71 which stores data relating to various kinds of ink and the viscosities thereof for optimum printing results. A second input to the microcomputer is connected to a sensor 73, whose input is connected to the ball detector coil 65, referred to above. Further inputs are connected to a temperature sensor 75 and associated analogue/digital converter 77 and to a timer 79. Outputs from the microcomputer 69 are connected to the make-up solenoid valve 67 and to the solenoid valve 57, respectively.

The microcomputer 69 is programmed to activate the viscometer 55, to interpret data relating to viscosity and associated parameters applied to the inputs thereof, and to provide control signals for actuating the make-up solenoid valve 67, as hereinafter described.

In using the present system, the solenoid valves 57 and 67 are normally closed and the jet run solenoid valve 37 is normally open. Initially the bleed solenoid valve 45 is also open.

Accordingly, when the motor 31 is first energised, ink from the reservoir 1 is pumped to the container 5 in the head 3 via the filter damper 33, the pressure regulator 35 and the jet run solenoid valve 37. The pressure applied to ink within the container 5 forces a jet of ink downwardly via the orifice 9 to the gutter 19. A mixture of ink and air is returned to the reservoir 1 via the bleed outlet 11 of the container 5, the bleed line 43 and the bleed solenoid valve 45. When all of the air has been exhausted from the container 5, the bleed solenoid valve 45 is closed.

Printing can now be commenced by energising the piezoelectric transducer so that the vibrator 13 causes the jet of ink from the orifice 7 to be broken up into droplets of uniform size and by energising the charging electrode 15 and the deflecting electrodes 17.

With the motor 31 energised, ink at an initial pressure of 6,895 Newtons/sq. metre (1 p.s.i.) is supplied from the outlet of the pump 27 to the

inlet to the pump 29 via the pressure relief valve 41, the bleed line 49 and the bleed control orifice 51. This supply of ink seals internal clearances within the pump 29. Accordingly, the efficiency of the pump 29 as an air pump is increased, a higher suction is applied to the gutter 19, and a mixture of air and unused liquid is drawn from the gutter. As described above, the orifice 51 is pre-set to allow a predetermined flow of ink along the bleed line 49, this predetermined flow being sufficient to ensure that the pump 29 is adequately lubricated.

Once every 15 minutes during operation of the system, the microcomputer 69 initiates a check on the viscosity of ink in the system. As a first stage in the check, a signal from the microcomputer 69 is applied to the solenoid valve 57, causing the valve to open and to allow ink to flow from the bleed line 49 to the viscometer 55. Ink flows upwardly through the tube 59 of the viscometer 55, forcing the steel ball 58 upwardly into the flared portion 61 at the top of the tube. The ball remains in the flared portion 61, supported by the upwards flow of ink whilst ink continues to flow upwardly past the ball and then outwardly from the tube 59 to the reservoir 1. The presence of the flared portion 61 means there is sufficient space for any solid particles in the ink to pass between the wall of the tube 59 and to return to the reservoir 1.

Approximately one minute after the solenoid valve 57 has been opened, the microcomputer 69 activates the timer 79 and at the same time applies a further signal to the valve 57, causing the valve to close. With the upwards flow of ink terminated, the ball 58 descends slowly within the tube 59 at a rate dependent upon the viscosity of ink in the tube. When the ball 58 has moved downwardly through a predetermined distance, it enters the ball detector coil 65. Movement of the ball 58 through the coil 65 is sensed by the sensor 73, which applies an input signal to the microcomputer 69.

Within the microcomputer 69, a computation of the viscosity of the ink is made from data representing the time between the closing of solenoid valve 57 and the arrival of the ball 58 at the coil 65, data representing the ambient temperature or the temperature of the ink, supplied by the temperature sensor 75 and the analogue digital converter 77, and data stored in the memory device 71 and representing the relationship between the viscosity of the ink, the time taken for the ball to descend through the tube 59 and the ambient temperature.

A comparison is then made between the computed viscosity and data representing the optimum viscosity, also stored in the memory device 71.

Assuming there is a difference between the computed and optimum viscosities, an output signal is applied from the microcomputer 69 to the solenoid valve 67. The valve 67 is then opened for a predetermined interval of time and a predetermined volume of solvents flows from the

make-up cartridge 23 to the line connecting the pump 29 to the gutter 19.

A similar computation of viscosity is made at intervals of 15 minutes. Each time there is a discrepancy between the computed and optimum viscosities, a fresh volume of solvents is supplied from the make-up cartridge 23. If the computed viscosity equals the optimum viscosity, the solenoid valve 67 remains closed so that no solvents are added.

One ink suitable for use in the ink jet printer of Figures 1 to 3 is known as "Coates Black MEK".

As shown in Figure 4A, this ink has a viscosity which varies linearly with temperature between 20°C and 45°C, the viscosity falling from approximately 3.8 c.p. at a temperature of 20°C to approximately 2.0 cp at 45°C. There is also a linear relationship between the viscosity of this ink and the time taken for the ball to fall through the predetermined distance within the tube 59 of the viscometer 59, as shown in the graph forming Figure 4B.

Referring now to Figure 4C, the printer of Figures 1 to 3 was first operated over a period of 12 hours with the microcomputer 69 disconnected from the solenoid valve 57. This meant that the valve 57 remained closed so that there was no checking of the viscosity of ink in the system and no supply of fresh solvents from the make-up cartridge 23. As shown in Figure 4C, the viscosity increased at a fairly constant rate throughout the 12 hour period, starting at approximately 3.85 c.p. and ending at approximately 4.65 c.p.

Referring now to Figure 4D, the printer was then operated over a second 12 hour period with the microcomputer 69 re-connected to the solenoid valve 57. The valve 57 was therefore opened and the viscosity checked in the manner described above. It will be seen from Figure 4D that the effect of periodically checking the viscosity and adding fresh solvent, when necessary, is to restrict variation in the viscosity to values between 3.9 and 4.0 c.p.

In a further printing operation carried out by the above printer the ambient temperature was 28°C and the time for the ball to fall through the predetermined distance, assuming the viscosity was at its optimum value, was 72 secs. In practice, the measured time of descent was 74 secs. Accordingly, a charge of 8 ccs of solvent was added to the ink after the first check by the control means. This reduced the viscosity by 0.04 c.p. and reduced the ball descent time to 73 secs, as measured at the next check.

In operation at normal running temperatures it was found that approximately 16 ccs out of a total volume of solvent of 1.75 litres were lost from the system during each hour. The control means described above compensate by adding the appropriate additional volumes of solvent.

Claims

1. An ink jet printer comprising an ink reservoir

(1), means (23) for charging the ink in the printer with a component which causes a change in the viscosity thereof, a printing head (3), a pump means (25) for supplying ink from the reservoir (1) to the head (3) and for returning unused ink from the head (3) to the reservoir (1). means (75) for sensing the temperature of ink in the printer or the ambient temperature, a viscometer (55) connected to a supply line (49) from the pump means (25), the viscometer (55) including an upstanding tube (59) and an element (58) which is movable upwardly and downwardly within the tube (59) and control means (69) including a store containing data representing the relationship between the desired viscosity of the ink and temperature, the control means (69) being adapted, in use, first to allow an upwards flow of ink from the supply line (49) to the tube (59) sufficient to move the element (58) to an upper part of the tube and then to terminate the upwards flow so that the element (58) descends through the ink, and the control means (69) being further adapted to determine the time taken for the element (58) to descend through a predetermined distance, which time is representative of the viscosity of the ink in the tube (59), to effect a comparison between the desired viscosity at the temperature sensed by the temperature sensing means and the viscosity represented by the said time taken for the element (58) to descend through the ink, and to generate a control signal for activating the charging means (23) if the comparison reveals a difference between the desired and sensed viscosities, whereby the charging means (23) operate to charge the ink with the said component and the difference between the two viscosities is reduced.

2. An ink jet printer as claimed in claim 1, wherein the control means (69) are adapted, in use, periodically to cause a flow of ink from the supply line (49) to the tube (59), whereby the element (58) is moved to an upper part of the tube (59), then to terminate the upwards flow, whereby the element (58) descends through the ink, to determine the time taken for each descent of the element (58) through the predetermined distance, to effect a comparison between the desired viscosity and the viscosity represented by the time taken for each descent of the element (58), and to generate a control signal each time a comparison reveals a difference between the desired and sensed viscosities.

3. An ink jet printer as claimed in claim 2, wherein the control means (69) are adapted to activate the charging means (23) periodically so that the viscosity of the ink assumes a value within a predetermined range of values which includes the desired viscosity at the temperature sensed by the sensing means (75).

4. An ink jet printer as claimed in claim 1, 2 or 3, wherein the tube (59) has a circular section and the element (58) is a ball.

5. An ink jet printer as claimed in any one of the preceding claims, wherein a small clearance is provided between the element (58) and a side wall of a lower part of the tube (59) whilst there is

sufficient space for solid particles in the liquid to pass between the element and a side wall of said upper part (61) of the tube (59).

6. An ink jet printer as claimed in any one of the preceding claims, wherein the control means (69) include a coil (65) disposed coaxially of the tube (59), means for supplying an electrical current to the coil, and means (73) for sensing a change in the said current caused by a movement of the element downwardly through the coil (65).

7. An ink jet printer as claimed in any one of the preceding claims, wherein the control means (69) include a store containing data relating to various liquids which can be used in the system and the viscosity of each liquid which ensures optimum operation of the system, and means for effecting a comparison between the stored data and the viscosity represented by the said time taken for the element (58) to descend through the predetermined distance.

Patentansprüche

1. Tintenstrahldrucker bestehend aus einem Tintenbehälter (1), einer Vorrichtung (23) zur Versorgung der im Drucker vorhandenen Tinte mit einer die Viskosität beeinflussenden Komponente, einem Druckerkopf (3), einer Pumpe (25) zur Förderung der Tinte vom Vorratsbehälter (1) zum Druckerkopf (3) und für den Rückfluß der nicht benutzten Tinte vom Druckerkopf (3) zum Vorratsbehälter (1), einem Temperaturfühler (75) zur Erfassung der Tintentemperatur im Drucker oder der Umgebung, einem mit der von der Pumpe (25) kommenden Speiseleitung (49) verbundenen Viskosimeter (55), dadurch gekennzeichnet, daß das Viskosimeter (55) mit einem Standrohr (59) und einem innerhalb des Standrohres (59) auf und ab beweglichen Element (58) versehen ist, daß Daten über die Relation zwischen der gewünschten Tintenviskosität und der Tintentemperatur in einem Datenspeicher festgehalten sind, daß eine Steuerung (69) vorgesehen ist, die im Betrieb zunächst einen aufwärtsgerichteten Tintenstrom von der Speiseleitung (49) zum Standrohr (59) in solchem Maße bewirkt, daß das Element (58) sich zu einem oberen Teil des Standrohres bewegt, um dann anschließend den aufwärtsgerichteten Fluß zu beenden, so daß das Element (58) durch die Tinte hindurch nach unten sinkt, daß die Steuerung (69) des weiteren so ausgelegt ist, daß sie die Zeit erfaßt, die das Element (58) benötigt, um über einen zuvor festgelegten Weg abzusinken, wobei dann diese Zeit kennzeichnend ist für die Viskosität der im Standrohr (59) vorhandenen Tinte, daß die Steuerung anschließend einen Vergleich anstellt zwischen der gewünschten Viskosität bei der Temperatur, die der Temperaturfühler erfaßt hat und der Viskosität, die sich aus der Zeit ergibt, die das Element (58) benötigte, um durch die Tinte hindurch abzusinken, und das letztlich bei erfaßter Differenz zwischen der gewünschten und der erfaßten Viskosität ein Steuersignal von der Steuerung erzeugt wird, welches die Versor-

gungsvorrichtung (23) in solchem Maße aktiviert, daß der Tinte die genannte Komponente in solchem Maße zugeführt wird, daß sich die Differenz zwischen den zwei Viskositäten vermindert.

2. Tintenstrahldrucker nach Anspruch 1 dadurch gekennzeichnet, daß die Steuerung (69) so ausgelegt ist, daß sie in Betrieb periodisch einen Tintenfluß von der Speiseleitung (49) zum Standrohr (59) verursacht, so daß das Element (58) in einen oberen Teil des Standrohres (59) bewegt wird, worauf dann der nach oben gerichtete Fluß unterbrochen wird, so daß das Element (58) durch die Tinte absinkt, und daß für jedes Absinken des Elementes (58) über die zuvor festgelegte Weglänge die Zeit gemessen wird, um dann jedes Mal ein Steuersignal zu erzeugen, wenn sich aus einem Vergleich ergibt, daß zwischen der gewünschten und der erfaßten Viskosität eine Differenz besteht.

3. Tintenstrahldrucker nach Anspruch 2, dadurch gekennzeichnet, daß die Steuerung (69) so ausgelegt ist, daß sie die Versorgungsvorrichtung (23) periodisch so aktiviert, daß die Tintenviskosität einen Wert annimmt, der innerhalb eines zuvor festgelegten Wertebereiches liegt, der auch die gewünschte Viskosität enthält, die zu der vom Temperaturfühler (75) gemessenen Temperatur gehört.

4. Tintenstrahldrucker nach Anspruch 1, 2 oder 3, dadurch gekennzeichnet, daß das Standrohr (59) einen kreisförmigen Querschnitt hat und als Element (58) eine Kugel enthält.

5. Tintenstrahldrucker nach irgendeinem der vorangehenden Ansprüche, dadurch gekennzeichnet, daß zwischen dem Element (58) und einer Seitenwand im unteren Teil des Standrohres (59) ein kleines Spiel vorgesehen ist, während zwischen dem Element und einer Seitenwand im oberen Teil (61) des Standrohres (59) ausreichend Spiel vorhanden ist, um feste Partikel in der Flüssigkeit durchzulassen.

6. Tintenstrahldrucker nach irgendeinem der vorangehenden Ansprüche, dadurch gekennzeichnet, daß zur Steuerung (69) eine Spule (65) gehört, die das Standrohr (59) koaxial umgibt, daß der Spule elektrischer Strom zugeführt wird und daß eine Fühleranordnung (73) vorgesehen ist, die die Stromänderung erfaßt, die durch eine Bewegung des Elementes nach unten durch die Spule (65) hindurch verursacht ist.

7. Tintenstrahldrucker nach irgendeinem der vorangehenden Ansprüche, dadurch gekennzeichnet, daß zur Steuerung (69) ein Speicher gehört, welcher Daten von verschiedenen Flüssigkeiten enthält, die man im System verwenden kann, und auch Daten über die Viskosität einer jeden Flüssigkeit, mit der ein optimaler Betrieb des Systems zu ermöglichen ist, und daß eine Vorrichtung vorgesehen ist, die die gespeicherten Daten mit der Viskosität vergleicht, die sich aus der Zeit ergibt, die das Element (58) benötigte, um über den zuvor festgelegten Weg abzusinken.

Revendications

1. Imprimante à jet d'encre comprenant un réservoir d'encre (1), des moyens (23) d'apport d'un composant dans l'encre de l'imprimante pour entraîner un changement de la viscosité de l'encre, une tête d'impression (3), des moyens de pompage (25) pour envoyer l'encre du réservoir (1) à la tête (3) et pour ramener l'encre inutilisée de la tête (3) au réservoir (1), des moyens (75) de détection de la température de l'encre dans l'imprimante ou de la température ambiante, un viscosimètre (55) raccordé à une conduite d'alimentation (49) venant des moyens de pompage (25), le viscosimètre (55) comportant un tube vertical (59) et un élément (58) qui est mobile vers le haut et le bas à l'intérieur du tube (59), et des moyens de commande (69) comportant une mémoire qui contient des données représentant la relation entre la viscosité désirée de l'encre et la température, les moyens de commande (69) étant prévus, en utilisation, d'abord pour permettre une circulation ascendante d'encre venant de la conduite d'alimentation (49) dans le tube (59) qui est suffisante pour déplacer l'élément (58) à une partie supérieure du tube, puis pour arrêter la circulation ascendante de sorte que l'élément (58) descend à travers l'encre, et les moyens de commande (69) étant en outre prévus pour déterminer le temps mis par l'élément (58) pour descendre d'une distance prédéterminée, ce temps étant représentatif de la viscosité de l'encre dans le tube (59), afin d'effectuer une comparaison entre la viscosité désirée à la température détectée par les moyens de détection de température et la viscosité représentée par ledit temps mis par l'élément (58) pour descendre à travers l'encre, et afin de générer un signal de commande pour activer les moyens d'apport (23) si la comparaison fait apparaître une différence entre la viscosité désirée et la viscosité détectée, de sorte que les moyens d'apport (23) fonctionnent pour ajouter le dit composant à l'encre et réduire la différence entre les deux viscosités.

2. Imprimante à jet d'encre suivant la revendication 1, dans laquelle les moyens de commande (69) sont prévus, en utilisation, pour engendrer périodiquement une circulation d'encre de la conduite d'alimentation (49) vers le tube (59), de sorte que l'élément (58) est déplacé à une partie supérieure du tube (59), puis pour arrêter la circulation ascendante, de sorte que l'élément (58) descend à travers l'encre, de manière à déterminer le temps mis pour chaque descente de l'élément (58) de la distance prédéterminée, afin d'effectuer une comparaison entre la viscosité désirée et la viscosité représentée par le temps mis par l'élément (58) pour chaque descente, et afin de générer un signal de commande chaque fois qu'une comparaison fait apparaître une différence entre la viscosité désirée et la viscosité détectée.

3. Imprimante à jet d'encre suivant la revendication 2, dans laquelle les moyens de commande (69) sont prévus pour activer les moyens d'apport

(23) périodiquement, de sorte que la viscosité de l'encre prend une valeur à l'intérieur d'une plage prédéterminée de valeurs qui comprend la viscosité désirée à la température détectée par les moyens de détection (75).

4. Imprimante à jet d'encre suivant la revendication 1, 2 ou 3, dans laquelle le tube (59) a une section circulaire et l'élément (58) est une bille.

5. Imprimante à jet d'encre suivant l'une quelconque des revendications précédentes, dans laquelle un petit jeu est laissé entre l'élément (58) et une paroi latérale d'une partie inférieure du tube (59), de sorte qu'il y a un espace suffisant pour le passage des particules solides, contenues dans le liquide, entre l'élément et une paroi latérale de ladite partie supérieure (61) du tube (59).

6. Imprimante à jet d'encre suivant l'une quelconque des revendications précédentes, dans

laquelle les moyens de commande (69) comprennent une bobine (65) disposée coaxialement au tube (59), des moyens d'amenée d'un courant électrique à la bobine, et des moyens (73) pour détecter une variation dudit courant provoquée par un mouvement de descente de l'élément à travers la bobine (65).

7. Imprimante à jet d'encre suivant l'une quelconque des revendications précédentes, dans laquelle les moyens de commande (69) comprennent une mémoire contenant des données relatives à divers liquides qui peuvent être utilisés dans le système et la viscosité de chaque liquide qui assure un fonctionnement optimal du système, et des moyens pour effectuer une comparaison entre les données stockées et la viscosité représentée par ledit temps mis par l'élément (58) pour descendre de la distance prédéterminée.

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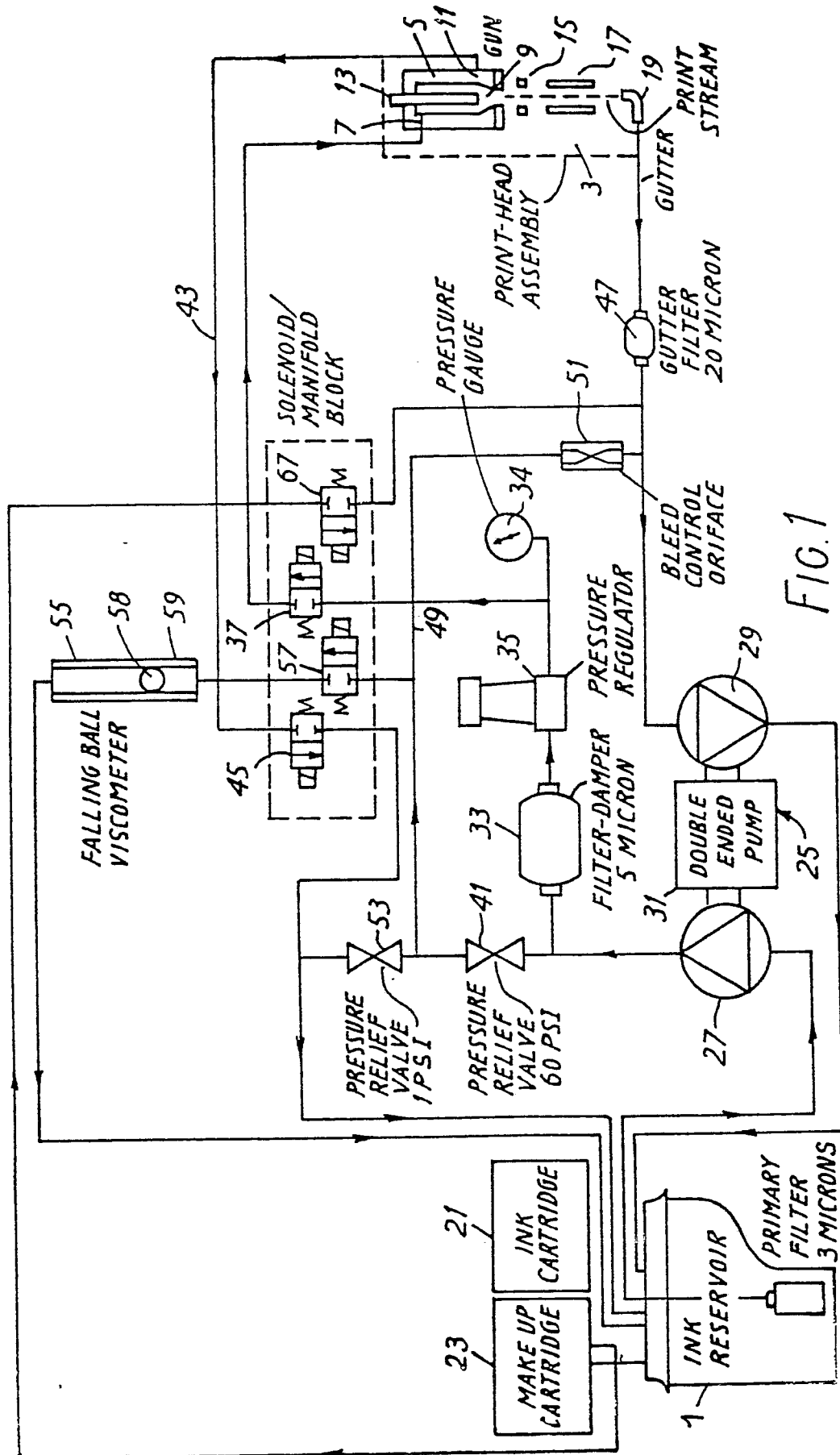
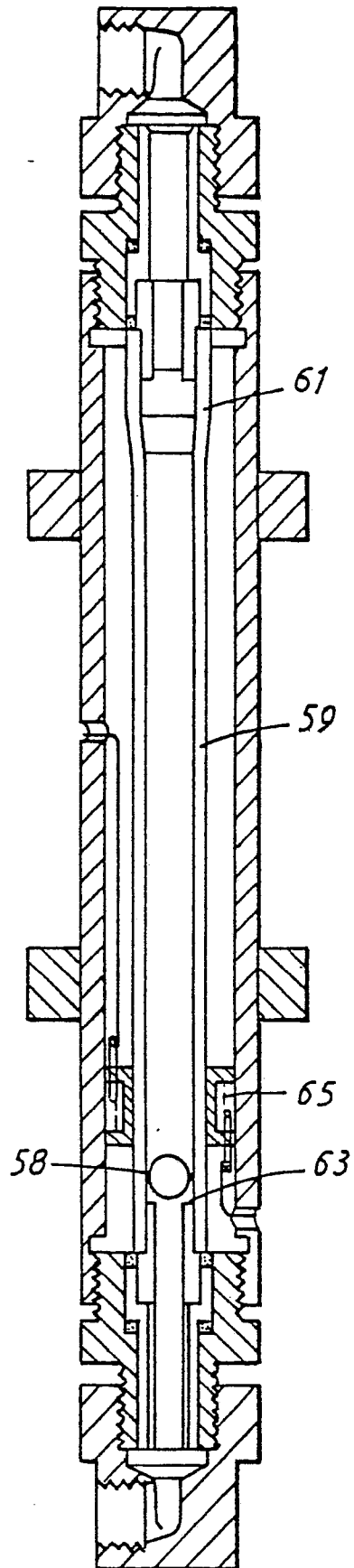


FIG. 1

FIG. 2



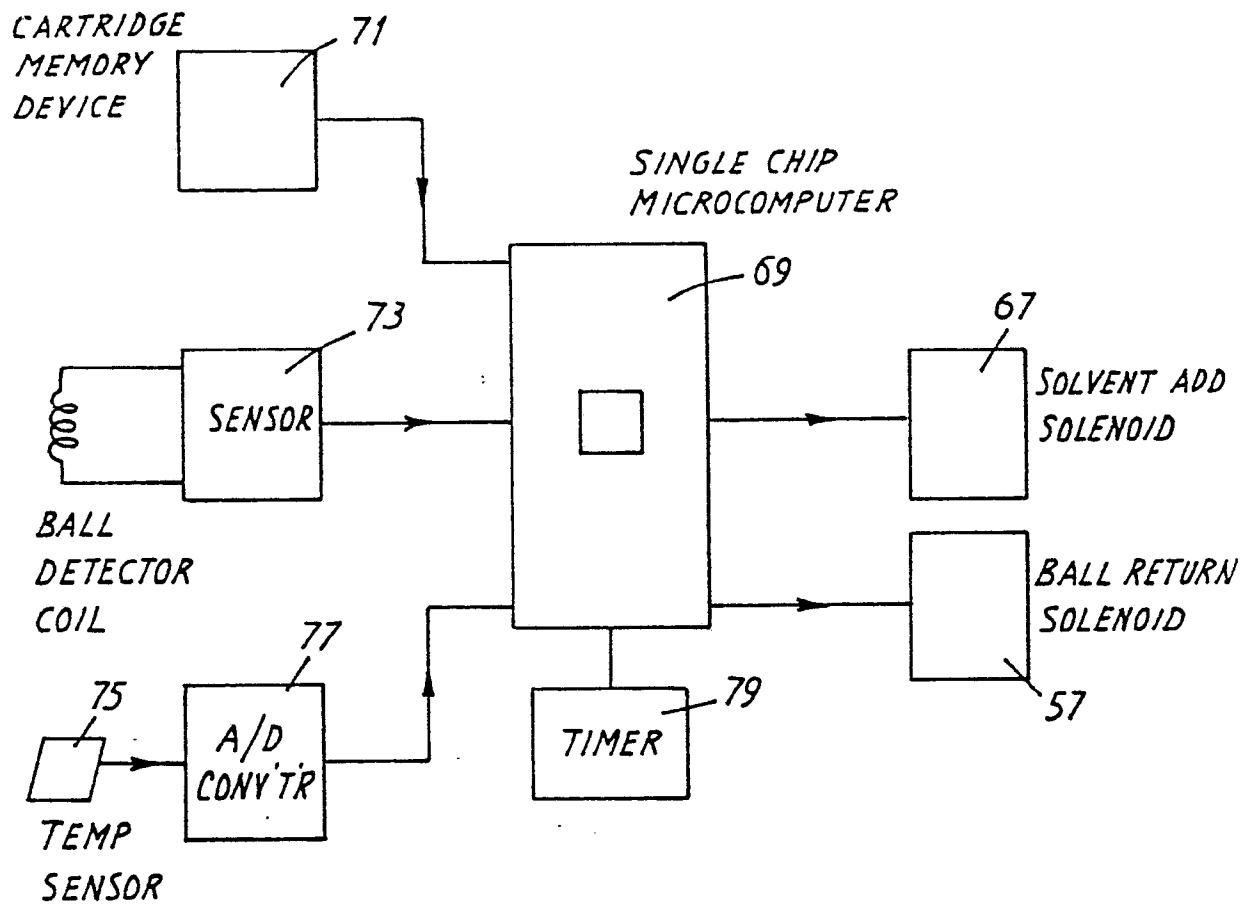
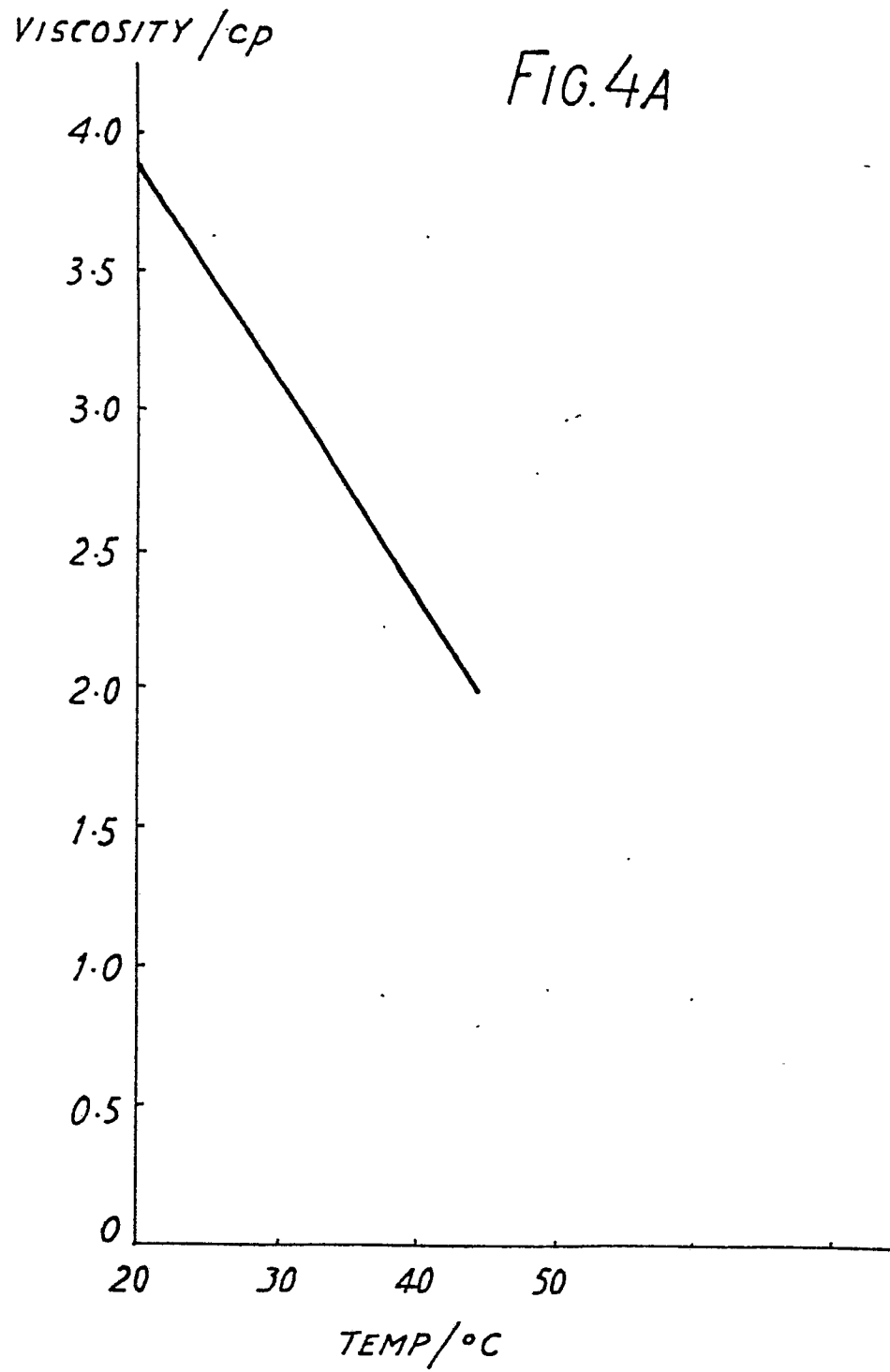
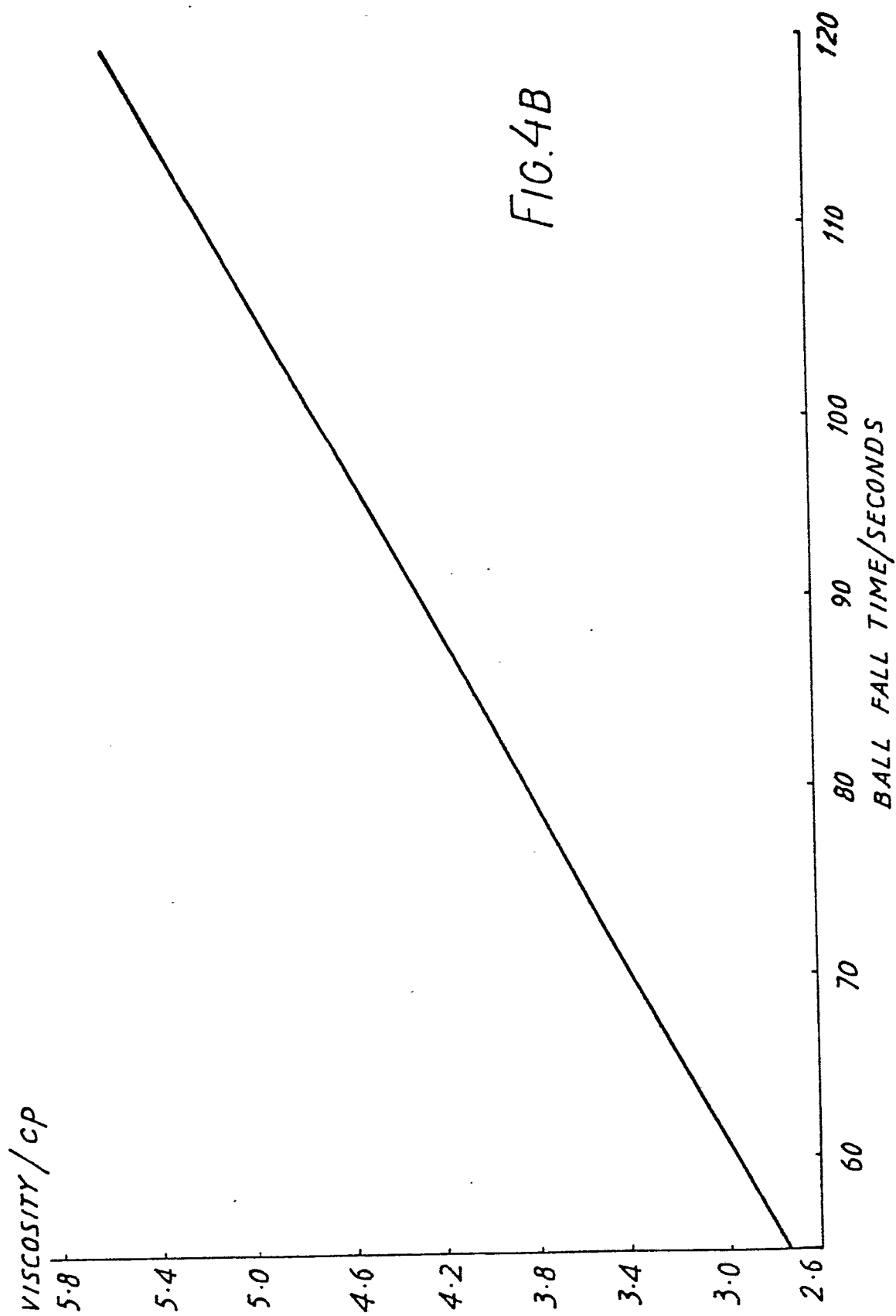


FIG.3





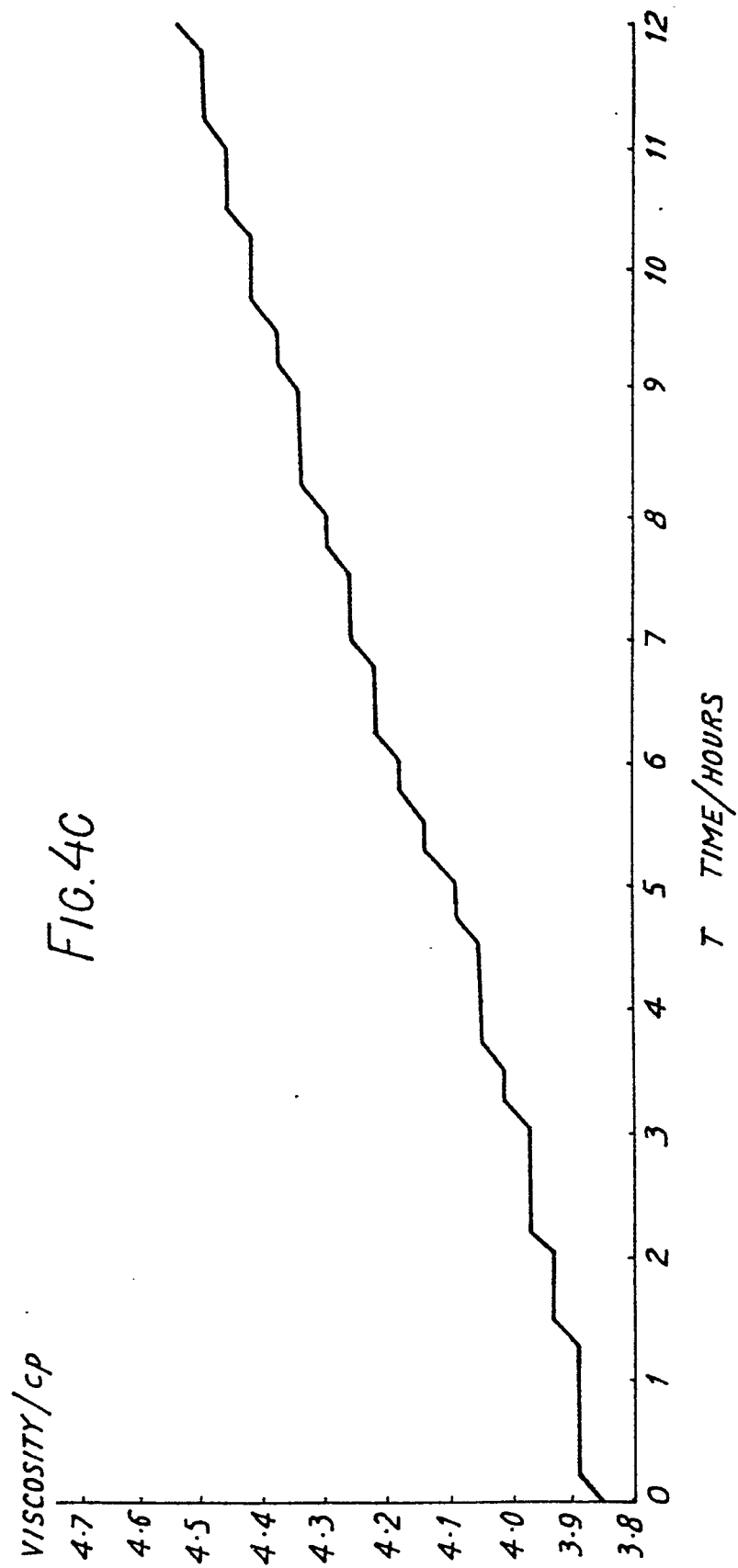


FIG. 4D

