PORTABLE INFUSION PUMP

Charles A. Blumle, 2968 S. Moreland, Cleveland, Ohio 44120, and Leo J. Blumle, 12300 La Plata, Silver Spring, Md.

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ABSTRACT OF THE DISCLOSURE

Infusion pumps are devices for pumping intravenously or intra-arterially through a catheter drugs of one type or another. Often it is desirable to continuously inject carefully metered quantities of drugs into an ambulatory human. This invention provides an infusion apparatus, which may be portable, in which a battery may be employed to drive an electric motor through an electronic timing circuit.

BRIEF DESCRIPTION OF THE INVENTION

In this infusion apparatus, the timing circuit energizes the motor at accurately controlled intervals. The motor drives the infusion pump at a uniform rate throughout the life of the battery. The apparatus includes an arrangement for de-energizing the motor after the measured dosage has been delivered. The electronic timing circuit includes a simple arrangement for accurately manually controlling the frequency with which a volume of fluid is delivered by the pump.

It is an object of this invention to provide an infusion apparatus, which may be portable, in which the frequency with which a volume of fluid is delivered can be selectively controlled.

Another object of this invention is to provide an infusion apparatus, which may be portable, which delivers uniform quantities of fluid into a patient's body throughout the life of the battery or portable power source.

Still another object of this invention is to provide an infusion apparatus, which may be portable, which can be quickly, accurately and easily controlled to thereby adjust the total quantity of fluid delivered to the body in a given period, such as a day.

These and various other objects, features and advantages of the invention will be more clearly understood from a reading of the detailed description of the invention in conjunction with the drawings in which:

FIGURE 1 is a combined schematic and block representation of one illustrative embodiment of this invention.

FIGURE 2 is a pictorial and schematic representation of a cam and switch employed in FIGURE 1; and

FIGURE 3 is a diagrammatic illustration of the upper part of a human body with the infusion apparatus of the instant invention shown operatively associated therewith.

Referring now to the drawing, there is depicted in block form a pump 10 which is of any convenient type employed in the infusion of liquids into the body and may be of the type disclosed in such patents as Vibber et al. Patent 2,925,814 or Corbin et al. Patent 3,252,623. The pump 10 is to be driven by a motor 16 through suitable mechanical coupling, as indicated by the dotted line 17 and has a discharge path 18 for infusing liquids into the body of an ambulatory patient as shown in FIGURE 3.

The motor 16 is driven by the battery 12 and actuated by an electronic control system including a pair of resistors 20, 21 serially connected across the battery 14 and having inserted between them a diode 23. A variable resistor 25 has one terminal connected to terminal 15 of battery 14 and the other terminal connected to the emitter of a transistor 27. The base of transistor 27 is connected intermediate diode 23 and resistor 21. The collector of transistor 27 is connected to a capacitor 28, the opposite electrode of which is connected to common terminal 11 of batteries 12 and 14. The collector of transistor 27 is also connected to the emitter of a unijunction transistor 30. One of the bases of the unijunction transistor 30 is connected through a resistor 32 to terminal 15 of the battery 14. The other base of transistor 30 is connected through a resistor 34 to terminal 18 of battery 14. This second or other base electrode of the transistor 30 is also connected to a gate electrode 35 of a silicon controlled rectifier 36. The silicon controlled rectifier has its cathode-anode path serially connected between a brush 38 of the motor 16 and terminal 11 of batteries 12 and 14. The other brush of the motor 16 is connected to the terminal 13 of the battery 12. A resistor 40 is connected between the brushes of the motor 16 for the purpose of reducing the arcing of the motor and for maintaining the minimum sustaining current through the silicon controlled rectifier 36 during motor start up. Transistor 27 is biased to act as a constant current source to control the charging of capacitor 28. The current is fixed by the biased resistors 25, 20, 21 and diode 23. Diode 23 provides temperature compensation for transistor 27.

As this constant current generator charges the capacitor 28, the voltage across capacitor 28 rises until the unijunction transistor 30 triggers. Once transistor 30 has triggered, resistor 34 provides a discharge path for capacitor 28 to permit it to discharge at a rapid rate. Resistor 32 provides temperature compensation for the transistor 30.

When transistor 30 triggers, a pulse is produced across resistor 34 and this pulse triggers silicon controlled rectifier 36. Once silicon controlled rectifier 36 is triggered or gated, the controlled rectifier remains conducting as long as current through it is above a certain level required to maintain this conduction as is well known in the art. Motor 16 continues to drive until a cam control, mounted on the motor shaft, closes switch 44 which cam control is indicated by a dotted line 45. The closing of switch 44 shorts the cathode-anode path of the silicon controlled rectifier 36 and the current through the controlled rectifier is dropped to zero and the controlled rectifier becomes non-conducting. The motor 16 continues to run until the cam control, indicated by the dotted line 45, opens switch 44. Meanwhile, capacitor 28 has begun to charge and the entire sequence is repeated. The accuracy of the metering function is dependent only upon the constant current generator, capacitor 28 and the unijunction transistor 30. The cam actuation of the switch 44 preserves the precise dosage for each pulse or each period of drive of the motor 16 since the shaft rotates exactly the same amount each time it is driven. The temperature compensation 23 and the resistor 32 enable high stability of the timing interval to be maintained over a wide temperature range.

In conclusion, the important features of this invention include the precise control of the linearity of the system by means of a timing circuit which is linear over a wide range of battery voltages and temperatures. Too, the use of a cam actuated switch accurately controls the dosage per gating pulse or per duty cycle. Also, the cyclic feature provided by the timing circuit extends the life of the portable power source and hence provides increased reliability. The infusion system produces a linearity of dosage with respect to time and this linearity remains constant regardless of the rate of discharge of the batteries thus eliminating the possibility of a dosage due to electrical or mechanical transients as may be experienced in a device which injects continuously.

In accordance with the patent statutes, the principles of the present invention may be utilized in various ways, numerous modifications and alterations being contemplated, substitution of parts and changes in construction being resorted to as desired.
We claim:

1. Portable infusion apparatus for dispensing a measured amount of fluid to an ambulatory patient comprising:
   a battery, controlled rectifier means coupled to said battery, a motor connected to said controlled rectifier means, a portable infusion pump having a discharge path to said patient coupled to said motor to be driven thereby during a predetermined amount of rotation of said motor, said pump dispensing a measured amount of fluid during said predetermined amount of rotation, unijunction oscillator means coupled to said controlled rectifier means for generating a series of pulses, each of said pulses triggering said controlled rectifier means into conduction to initiate said predetermined amount of rotation of said motor, said pulses occurring at predetermined equal intervals of time, said interval between pulses including the time required for said motor to complete said predetermined amount of rotation, whereby dispensing of fluid by said pump is initiated at predetermined equal intervals of time irrespective of the time required for said motor to complete said predetermined amount of rotation, and means for de-energizing said motor at the end of said predetermined amount of rotation.

2. The apparatus of claim 1 wherein said means for de-energizing said motor comprises a switch connected across said controlled rectifier means for conducting current around said controlled rectifier means and to said motor when said switch is actuated, and a cam associated with said motor for momentarily actuating said switch at the end of said predetermined amount of rotation of said motor, whereby at the end of said predetermined amount of rotation said controlled rectifier means is rendered receptive to the next pulse from said oscillator means.

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WILLIAM L. FREEH, Primary Examiner

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