

# United States Patent

Swersey

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## [54] INFUSION MONITOR UTILIZING WEIGHT DETECTING MEANS

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[58] Field of Search ..... 128/214 R, 214 E, 214 F, 214.2, 128/2; 177/60, 144, 164; 222/56, 77; 141/83, 94, 95

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[57]

### ABSTRACT

The infusion monitor is adapted to operate at a high speed or a low speed in dependence upon a variable characteristic of the patient, such as weight. If during infusion, the weight of the patient deviates from a preset value the infusion monitor speed is changed. For example, with the infusion monitor operating at the normal low speed, if the weight decreases, the infusion monitor is switched to the high speed. When the weight subsequently returns to the preset value, the infusion monitor switches back to the low speed.

15 Claims, 3 Drawing Figures

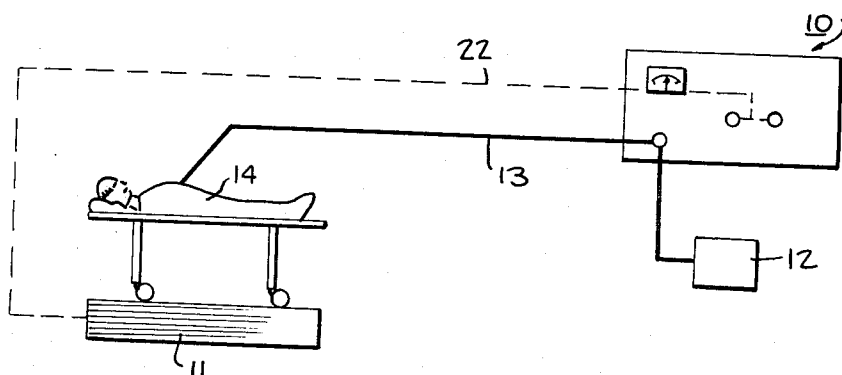


Fig. 1.

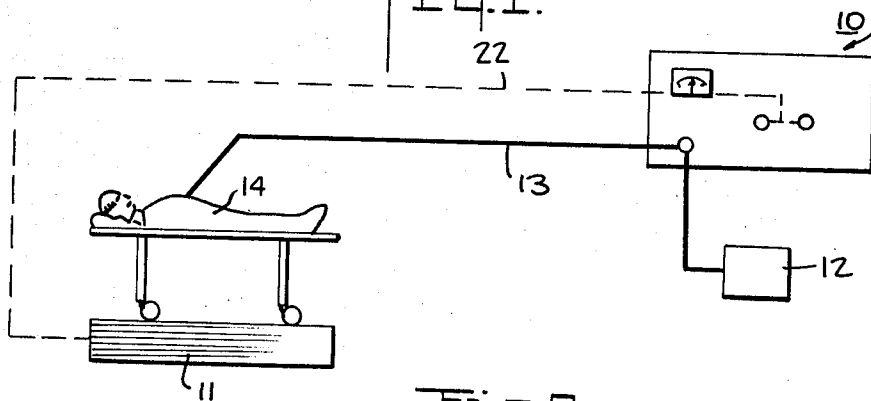


Fig. 2.

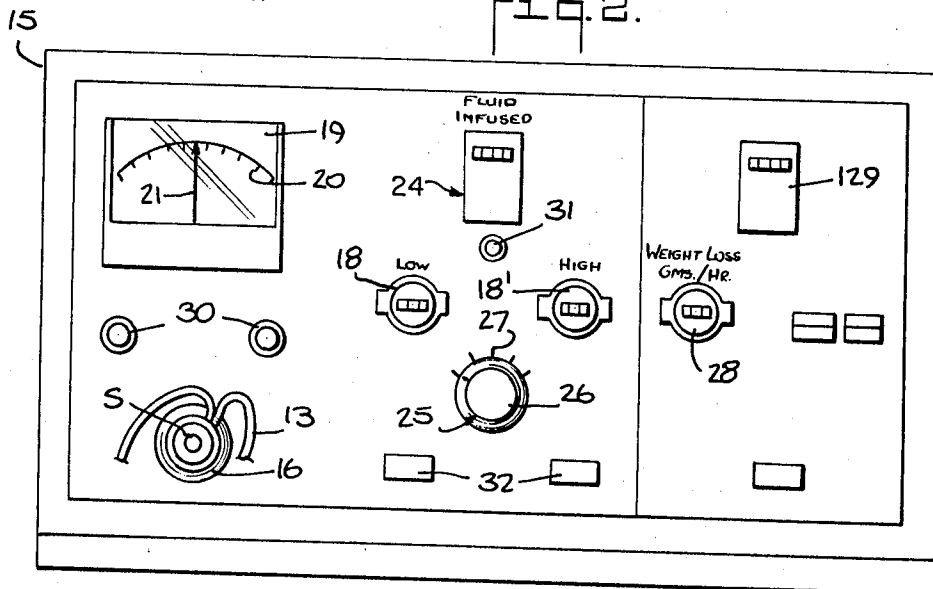
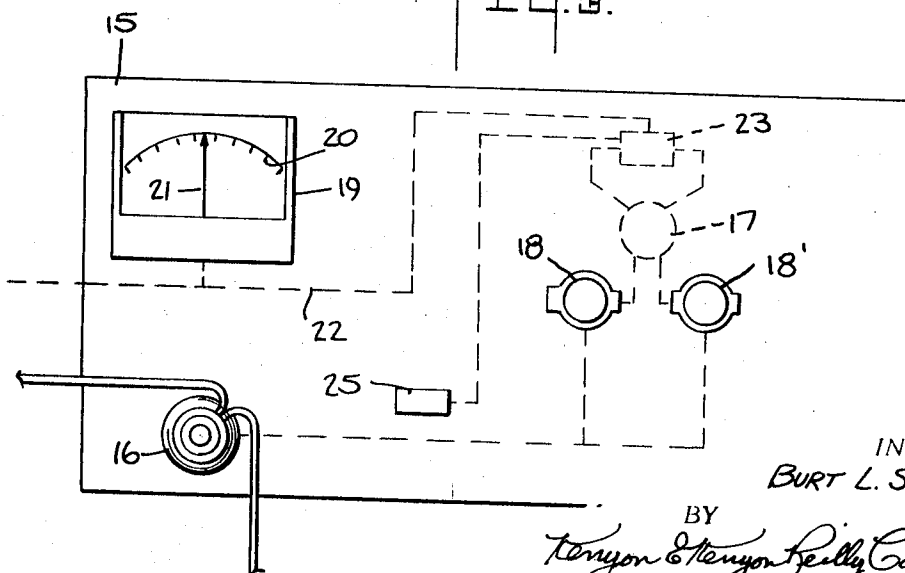


Fig. 3.



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# INFUSION MONITOR UTILIZING WEIGHT DETECTING MEANS

This invention relates to an infusion monitor. More particularly, this invention relates to an infusion monitor for infusing liquids into a patient.

Various devices have been known for infusing liquids or fluids, such as blood, glucose and the like into a patient for various purposes such as intravenous feedings, blood transfusions, and the like. For example, it has been known to mount a bottle of the fluid to be infused on a stand above a patient and to connect a tubing between the bottle and a vein of the patient. The fluid is then dripped from the bottle in the tubing to the patient. In order to regulate the flow of fluid into the patient, the rate of drops per minute from the bottle into the tubing is measured, usually visually, and a valve in the bottle outlet is adjusted in correspondence to the measured rate of drops to obtain the desired rate. In other instances, constant speed pumps or syringes pumps have been used to infuse the fluid into the patient. However, these various devices have not been totally accurate in all the cases. Further, as in the case of the pumps, such have required relatively expensive equipment.

Also, in the case of pumps where the rates of infusion have been set at constant rates, the infusion rates can sometimes be insufficient or excessive. For example, if a patient such as a premature infant is being fed intravenously and the infant's weight is to be maintained constant, deviations in weight can occur because the infant loses fluid at a different rate than the intake. In such cases, the constant rate pumps have been inadequate to compensate for such changes.

Accordingly, it is an object of the invention to provide a relatively simple method of infusing fluid into a patient.

It is another object of the invention to provide an automatic system for infusing fluid into a patient to maintain a constant weight of the patient.

It is another object of the invention to provide a relatively inexpensive automatic system for delivering fluids to a consumer.

It is another object of the invention to infuse fluid into a patient at a low or high rate in dependence with a measureable characteristic of the patient.

It is another object of the invention to infuse a liquid into a consumer at selective rates in dependence upon a variable characteristic of the consumer.

Briefly, the invention provides an infusion monitor for infusing fluids at selective rates in dependence upon a variable characteristic. The infusion monitor, for example, is operable at either a low speed or a high speed to infuse a fluid and can be used, for example, to intravenously feed medical patients such that in dependence upon a measureable characteristic of the patient, such as weight, the rate of infusion is switched from the low speed to the high speed and vice versa.

The infusion monitor includes a pump for pumping fluid through a conduit to a consumer, means for selectively actuating the pump to deliver fluid at the high speed rate or the low speed rate through the conduit, and a means for indicating deviations of the variable characteristic of the consumer. Depending upon the sense of a deviation (i.e. plus or minus) about a predetermined value, the pump is switched from the one speed to the other speed so as to compensate for the deviation. For example, if the deviation falls below a predetermined value then the pump is switched from the low speed to the high speed.

In one embodiment, the means for indicating the deviations of the variable characteristic includes a scale, e.g. a scale as described in U.S. Pat. No. 3,338,323 which measures the weight of a patient to establish a preset value and subsequent deviations in weight from the preset value. The pump of the infusion monitor is interconnected with the scale so as to infuse fluid into the patient at a slow rate or a high rate in dependence upon a deviation of weight being detected while a read-out scale is mounted on the face of a housing of the infusion monitor to indicate the deviations. In operation, when the scale detects a weight deviation a suitable signal is transmitted

to the infusion monitor so that the pump is switched from the low speed to the high speed or vice versa. For example, should the indicating and measuring means indicate a decrease of weight of the patient, the pump is switched from the normally operating low speed to the high speed to compensate for this weight loss by increasing the fluid delivered to the patient. Once the weight of the patient returns to the predetermined value, the pump switches back to the low speed.

The infusion monitor is further provided with an adjusting means which is able to adjust the point at which the deviation measuring means actuates the pump to switch from the low speed to the high speed. For example, the adjusting means can be set for a predetermined loss of weight below a predetermined value before the pump is switched to the high speed. This will permit slight variations in weight loss to be accepted before switching to the high rate of infusion.

In another embodiment, the scale for measuring the weight of a patient can be coupled with a rate monitor which indicates a predetermined rate of increase or decrease in weight which is desired for a patient undergoing treatment. An example of this type of apparatus is described in U.S. patent application Ser. No. 815,722 filed Apr. 14, 1969. For example, should it be desired that a patient lose weight at a predetermined rate, the rate monitor automatically subtracts the weight loss due to the programmed rate of weight loss from the actual patient's weight during weighing so that the resultant differential, if any, is indicated on the read-out scale and the pump speed switched, if necessary. Thus, should a patient lose weight at a different rate from a desired rate of loss during an infusion operation, the rate of infusion is speeded up as above. Conversely, if a patient is to gain weight at a predetermined rate during an infusion process, such is also monitored in the same manner as above.

It is to be noted that it is not necessary to only measure the weight of the patient in order to actuate the infusion monitor. That is, any variable characteristic of a patient can be monitored such as blood pressure, pulse rate, temperature and the like. Furthermore, use of the infusion monitor is not limited to medical patients. That is, the infusion monitor can be used in any situation where a fluid is to be infused into a consumer, such as a container, at predetermined rates in dependence upon a measureable characteristic of the consumer.

These and other objects and advantages of the invention will become more apparent from the following detailed description and appended claims taken in conjunction with the accompanying drawings in which:

FIG. 1 illustrates an infusion monitor according to the invention interconnected with a patient weight measuring scale;

FIG. 2 illustrates a front view of a housing of an infusion monitor according to the invention; and

FIG. 3 schematically illustrates the interconnection between an infusion monitor of the invention with a scale as shown in FIG. 1.

Referring to FIG. 1, the infusion monitor 10 is interconnected with a scale 11 for feeding fluid such as a parenteral fluid from a fluid source 12 through a conduit 13 to a bed ridden patient 14 on the scale 11. The infusion monitor 10 is constructed so as to monitor the rate of fluid flow from the source 12 through the conduit 13 into the patient 14 and to vary the rate of flow between a low rate and a high rate in dependence upon a variation of weight of the patient as measured and indicated by the scale 11.

Referring to FIGS. 1 and 2, the infusion monitor 10 includes a housing 15 in which a pump 16 and control means for actuating the pump 16 at a low speed or high speed are mounted. The pump 16, for example, an eccentric wobble plate pump, is disposed in the conduit 13 so as to pump the flow of fluid through the conduit 13 to the patient 14. The control means includes a suitable motor 17 (FIG. 3) for running the pump 16 as well as a suitable means for running the pump 16 at a low speed or a high speed. For example, the motor 17 can be a variable speed motor such as a stepper motor which can be set to operate at either of a predetermined low speed or high

speed. In order to set the operating speeds of the motor 17, a pair of readout means 18, 18' such as digital read-out pots are mounted on the face of the housing 15 and are connected, e.g. electrically, to the motor 17. One pot 18 serves to set the motor 17 to run at a low speed while the other pot 18' sets the motor 17 to run at a high speed. Both pots 18, 18' can be manually adjusted as is known to set the desired rates. The control means further includes a suitable switching means 23 such as an electrical switching contact for switching the pump 16 between the low and high speeds.

In addition, a readout scale 19 is mounted on the face of the housing 15. This readout scale 19 includes a graded scale 20 having plus and minus gradations about a zero point as well as a pointer 21 which is normally over the zero point. The zero point is used as a norm or null point to establish a point on the scale 20 which corresponds to a predetermined weight for the patient. Thus, when the pointer 21 moves, the scale 19 indicates whether or not the weight of the patient on the scale 11 is more or less than the predetermined weight. The patient 14 is connected via suitable means (not shown), as is known to the scale 11 so as to indicate measurements of, e.g. D.C. microamperes.

The scale 11 is connected to the infusion monitor 10 for example, over an electrical line 22 which connects the scale 11 electrically to the motor 17 as well as to the readout scale 19. The scale 11 is of any construction, such as described in U.S. Pat. No. 3,338,323 in order to determine variations in weight of a patient about a predetermined constant weight. For example, after taring out or balancing the weight of the various items, such as clothing, bed, and the like and obtaining the weight of the patient, the scale 11 indicates and measures any subsequent deviation in the patient's weight and emits a signal in correspondence with the deviation to a read-out means. In the present case, the initial weight of the patient will be reflected on the read-out scale 20 as the zero point. Thereafter, should the patient gain or lose weight, the deviation weight will cause the scale 11 to emit a signal over line 22 in correspondence to the deviation to the pointer 21 of the read-out scale 19 to deflect the pointer 21 an amount corresponding to the deviation. To this end, the graded scale 20 of the readout scale 19 can be graded in D.C. microamps to indicate the intensity of the deviation or can be graded directly in grams to indicate the amount of the deviation. In addition, the line 22 is connected to a suitable switching means 23 in the motor 17 so as to switch the motor 17 from a normally operating low speed to a high speed in response to the measured deviation exceeding a predetermined negative value representing a loss in weight. In addition, the switching means 23 is operable to switch the motor from the high speed back to the normal low speed in response to the absence of a signal from the scale 11 or upon receiving a signal corresponding to a deviation representing a positive increase over the zero point.

The infusion monitor 10 further includes a digital readout 24 for indicating the amount of fluid actually infused into a patient. This digital readout 24 can be connected to the pump 16 in any suitable manner so as to count the number of pump revolutions and thus the amount of fluid infused. Alternatively, the digital readout 24 can be interconnected with the source 12 of the fluid so as to indicate the amount of fluid flowing therefrom. Further, the infusion monitor 10 is provided with an adjusting means 25 having a knob 26 projecting from the face of the housing 15. This adjusting means 25 is interconnected with the switching means 23 for the motor 17 so as to delay the actuation of the motor 17 from the low speed to the high speed until the negative value signal from the scale 11 via line 22 exceeds a predetermined amount. For example, the adjusting means 25 can be set so that the motor 17 does not switch from the low speed to the high speed until there is a weight loss of more than one, two, three, four or five grams in the patient. Such differentials can be set by turning the knob 26 a sufficient extent as indicated by a scale 27 on the monitor housing 15. This, in turn, effects the switching means 23. Also,

the adjusting means 25 can be set so that the motor 17 can only run at the high speed.

The infusion monitor 10 can also be provided with suitable alarms 30 so to indicate when the weight of a patient falls below a certain value or exceeds a certain value. Also, various reset buttons 31 can be placed on the housing for resetting the readout for the total fluid infused to a patient so that a zero reading can be obtained at any time. Also, various signals 32 such as lights can be provided on the housing 15 so as to indicate when the infusion monitor is in operation.

Referring to FIGS. 1 and 3, in operation, should it be desired to infuse a fluid into a patient 14 so as to maintain the weight of the patient at a constant level, the patient is initially placed on the scale 11 and weighed. This weight then corresponds to the zero point on the readout scale 19. The digital readout pots 18, 18' are then set to the desired low and high rates. Next, the infusion pump 16 is then switched on via a switch S so as to operate at a normal low rate to infuse fluid at a steady rate of, e.g. from 0 to 10 millimeters per hour, as set by one pot 18. This rate is provided so as to keep the intravenous route to the patient open and can usually be set, e.g. for an infant, at 1 millimeter per hour. In the event that the weight of the patient should subsequently decrease during operation of the infusion monitor 10, the scale 11 measures and indicates this decrease in weight and transmits a signal via line 22 to the infusion monitor 10. The deviation is indicated by the pointer 21 of the read-out scale 19, for example, by deflecting to the left as viewed. At the same time, the signal is transmitted to the switching means 23 for the motor 17. Should the signal be greater than the desired deviation as determined from the adjusting means 25, the motor is then switched to the high speed. The rate of infusion then increases, e.g. to 60 millimeters per hour. This fast rate provides for a generally rapid correction of the patient's weight loss. As soon as the patient's weight returns to the predetermined amount, the scale 11 ceases to transmit a signal so that the pointer 21 of the read-out scale 19 returns to the zero point. At the same time, the switching means 23 for the motor 17 switches the motor 17 from the high speed back to the low speed. The low rate of operation then continues until a subsequent decrease in weight of the patient occurs.

Referring to FIG. 2, in the event that a patient is to lose or gain weight at a predetermined rate during an infusion operation, the infusion monitor 10 is further provided with a digital readout 28 such as a pot which is connected, for example, electrically to a rate monitor (not shown) in the scale 11. To this end, the readout 28 is manually operated to set the rate monitor so that a predetermined rate of increase or decrease in weight is superimposed on the scale readings. For example, if it is desired to have a patient increase in weight at a particular rate over a period of time, the readout 28 is adjusted to the desired rate so as to control the rate monitor to obtain this rate. Thus, so long as the patient is actually increasing in weight in accordance with the rate of programmed increase no signal will be transmitted via a line 22 through the infusion monitor 10. The readout point 21 of the read-out scale 19 will therefore remain at zero. However, should the patient be increasing in weight at an amount less than the desired rate, a signal would be transmitted via line 22 to the infusion monitor 10 to indicate a negative differential. This will cause the infusion monitor to actuate the pump 16 to operate at the higher speed. When the actual weight of the patient catches up to the predetermined rate so that the weight differential disappears, the pump 16 will be switched back to the low speed. In the event that a patient exceeds a rate of desired increase in weight, the infusion monitor will remain at the low speed; however, the alarm signal indicating the excessive weight as indicated on the read-out scale 19 will be actuated. Attention can then be given to the patient to compensate for this fast increase in weight.

In this latter embodiment, a suitable digital readout 29 is also mounted in the face of the housing 15 of the infusion monitor 10 so as to give a reading of the actual gain or loss of a

patient with respect to the programmed rate of increase or decrease.

The invention thus provides an infusion monitor which is capable of infusing fluids into a patient in an automatic manner depending upon changes of weight in the patient. Furthermore, the infusion monitor can also be actuated in dependence upon other variable characteristics of the patient such as pulse rate, body temperature, heart beat or any other suitable characteristics or combination of characteristics.

The invention further provides an infusion monitor which can be used to regulate flow of a fluid into any suitable consumer.

The invention also provides an infusion monitor which can be used to selectively infuse one of a number of fluids into a patient in dependence upon different measureable characteristics of the patient. For example, the monitor can be provided with two pumps, as above, each of which is selectively connected over suitable motors and digital readouts to a means for measuring the characteristics of the patient such as weight or blood pressure. Should one of the measured characteristics deviate from a programmed norm, the respective motor is switched over to deliver the appropriate fluid at the high rate. Thus, should a patient require blood at the high rate, the fluid needed to maintain a preset weight need only be infused at the low rate if the added blood also supplies the function of the other fluid.

What is claimed is:

1. An infusion monitor comprising  
a conduit for connection to a consumer;  
a pump for delivering fluid through said conduit to the consumer;  
first means connected to said pump for actuating said pump to deliver fluid at a low rate through said conduit;  
second means connected to said pump for actuating said pump to deliver fluid at a high rate through said conduit;  
and  
a scale means for indicating deviations of weight of the consumer about a predetermined value, said scale means being connected to said first means and said second means to selectively actuate one of said first and second means in response to predetermined deviations of the weight about said predetermined value whereby in response to a deviation in excess of said predetermined value said scale means actuates said first means and in response to a deviation less than said predetermined value said scale means actuates said second means to maintain the consumer at a constant weight.
2. An infusion monitor as set forth in claim 1 wherein said predetermined value is a variable value.
3. An infusion monitor as set forth in claim 1 wherein said pump is an eccentric wobble plate pump.
4. An infusion monitor as set forth in claim 1 further comprising means connected between said scale means and said second means for adjusting the value of said predetermined deviation.
5. An infusion monitor as set forth in claim 1 which further comprises one digital read-out for indicating a low pumping rate and a second digital read-out for indicating a high pumping rate.
6. An infusion monitor as set forth in claim 1 which further comprises a digital read out connected to said pump means for indicating the total amount of fluid pumped therethrough.

7. An infusion monitor as set forth in claim 1 further comprising an adjusting means in said housing for adjusting said switch means to switch the operation of said pump means from one rate to the other rate in response to the measured deviation exceeding a preset amount.

8. An infusion monitor comprising

a pump for pumping fluid through a conduit to a consumer;  
first means connected to said pump to selectively actuate said pump at one of a high speed and a low speed to pump different rates of fluid flow through the conduit;  
a read out scale for determining the weight of a consumer, said scale being connected to said first means to cause said first means to actuate said pump at said low speed in response to said weight exceeding a predetermined value and to actuate said pump at said high speed in response to said weight falling below the predetermined value.

9. An infusion monitor as set forth in claim 8 wherein said predetermined value is variable.

10. An infusion monitor as set forth in claim 8 which further comprises an adjustable means for adjusting the predetermined value for actuation of said pump at said high speed.

11. In combination

a scale for weighing a patient;  
first means for infusing fluid into the patient at one of two rates of infusion, and

second means connected to said scale and said first means for determining deviations in weight of the patient and selectively actuating said first means to one of said two rates of infusion in response to predetermined deviations of weight from a preset value of weight, said second means actuating said first means to infuse fluid into the patient at the lower of said two rates in response to the weight of the patient exceeding the preset value and said second means actuating said first means to infuse fluid into the patient at the higher of said two rates in response to the weight of the patient falling below the preset value.

12. The combination as set forth in claim 11 wherein said second means actuates said first means to infuse fluid into the patient at the higher of said two rates in response to the weight of the patient falling a predetermined amount below the preset value.

13. In combination

a scale for measuring the weight of a patient including a line for emitting a signal in response to a deviation in weight from a predetermined value;

a rate monitor for changing said value during a measurement of weight of the patient; and

an infusion monitor connected to said scale for infusing a fluid into the patient at least one of a low speed rate and a high speed rate, said infusion monitor having means therein for selectively infusing fluid into the patient at the high speed rate in response to a decrease in weight of the patient from said value and at a low speed in response to an increase in weight of the patient from said value, and means for adjusting said rate monitor to change said value at a predetermined rate.

14. The combination as set forth in claim 13 wherein said means for adjusting said rate monitor includes a digital readout.

15. The combination as set forth in claim 14 wherein said digital readout is manually adjustable.

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