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2,188,507

FLUID DISPENSING DEVICE

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2 Sheets-Sheet 1

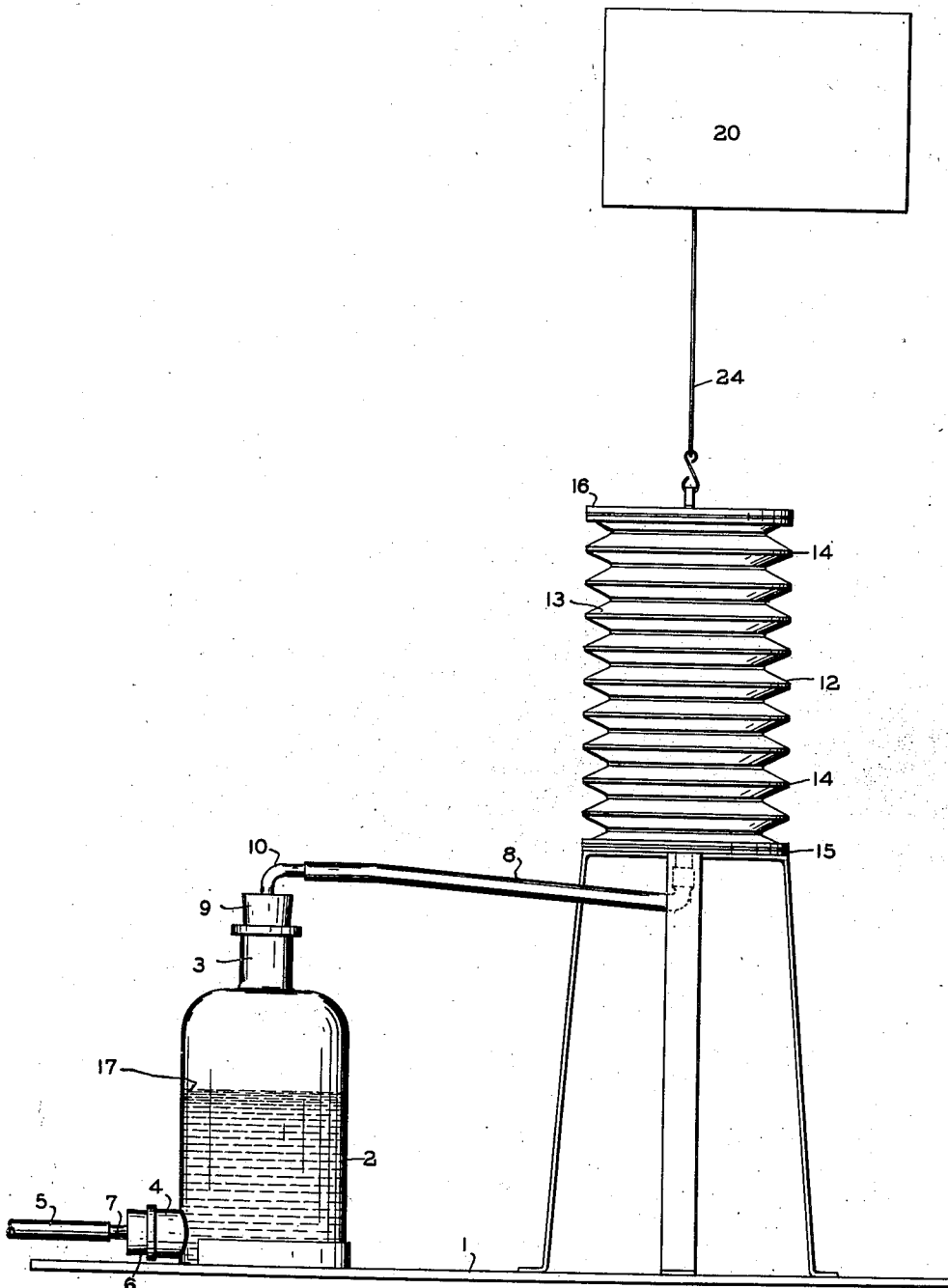


Fig. 1

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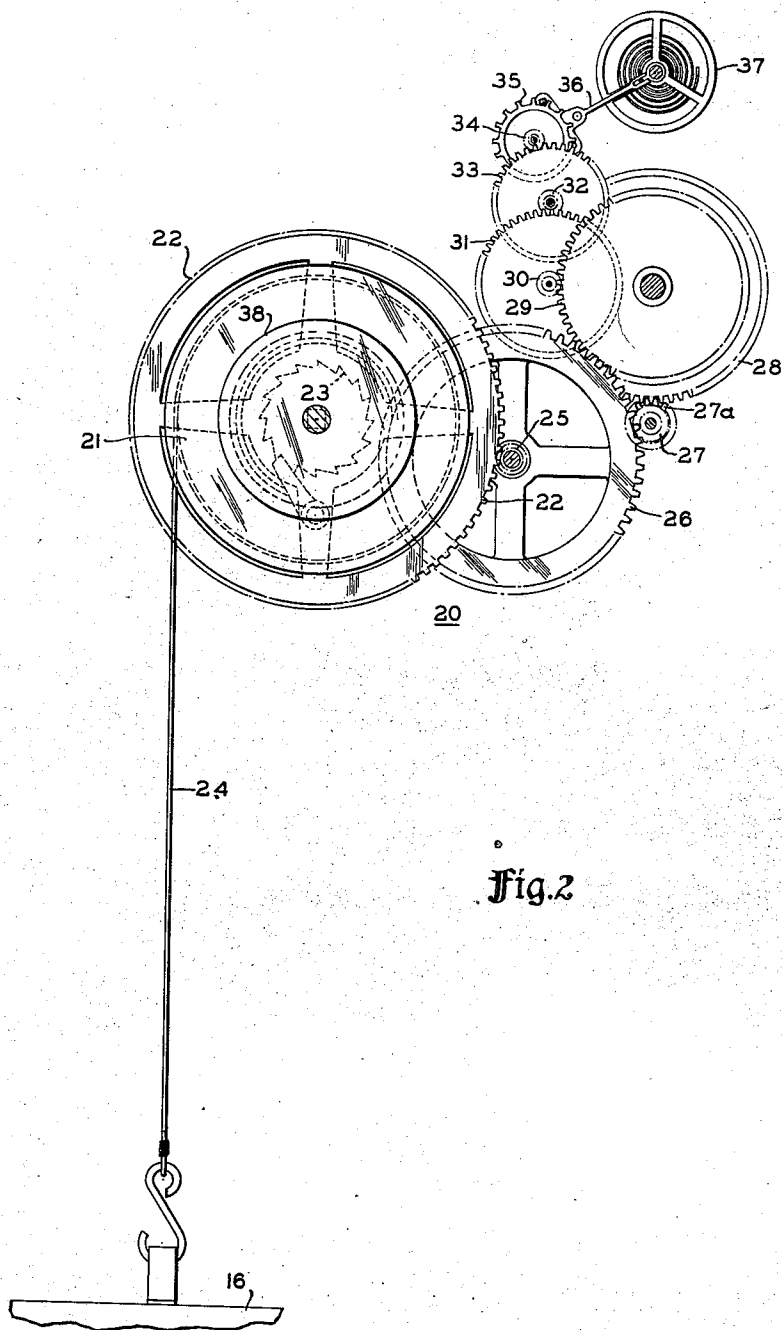
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2 Sheets-Sheet 2



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FLUID DISPENSING DEVICE

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5 Claims. (Cl. 221-147)

This invention relates to an apparatus for dispensing a quantity of fluid in small, uniform increments at regular intervals of time throughout periods of relatively long duration.

For the purposes of illustration, the preferred embodiment of invention is described herein in connection with the feeding or dispensing of medicinal liquids into the stomach of a patient for the treatment of stomach ulcers, its use in connection with the dispensing or feeding of other fluids or liquids, such, for example, as intravenous injections and the like, being readily apparent from the exemplary description.

It has been found desirable in the treatment of stomach ulcers to feed liquid medicines into the stomach through a tube which is inserted through the nasal passages a sufficient distance to enter directly into the stomach. The desired quantity of liquid medicine is then fed in very small increments, preferably a drop at a time and at the rate of about fifteen drops per minute into the stomach of the patient for a period of about ten days to two weeks. For best results, the treatment should be carried on continuously during the entire twenty-four hours of the day. Therefore, the dispensing means should be arranged to dispense the liquid medicine relatively uniformly throughout both the sleeping and waking hours of the patient. During the periods in which the patient is sleeping, however, his position often is changed unconsciously. Therefore provision must be made to dispense the liquid properly regardless of whether or not the patient has shifted his position relative to the apparatus. Heretofore, apparatus for this purpose has been provided but variation occurred in the rate of dispensing of the liquids as the patient changed his elevation or position. Furthermore, the tube leading to the patient's stomach must be extremely thin and flexible, for purposes of comfort, and therefore is apt to become pinched or blocked very easily. Under such conditions also provision must be made for dispensing the medicine properly, even though actual pressure must be applied to force the medicine through the tube.

One of the principal objects of the present invention, therefore, is to provide an apparatus by which a quantity of liquid or fluid can be dispensed in small uniform increments at regular intervals of time throughout periods of relatively long duration.

Another object is to provide an apparatus of this character which operates properly regardless of the relative elevation of the apparatus and the patient.

A correlative object is to provide an apparatus for dispensing liquids and assuring the proper flow thereof regardless of initial viscosity of the liquid or changes in viscosity tending to cause clogging of the apparatus, and an apparatus in which there is sufficient power to prevent blocking of the flow of liquid due to the accidental cramping or pinching of the tube leading to the stomach of the patient.

Another object is to provide a dispensing apparatus capable of both controlling the flow of gravity fed fluid and for causing and maintaining a controlled feed of fluid against the force of gravity.

Other objects and advantages will become apparent from the following specification, wherein reference is made to the drawings, in which—

Figure 1 is a front elevation of an apparatus embodying the principles of the present invention; and

Figure 2 is a fragmentary illustration of the timing mechanism showing its operative relation to the cooperating parts of the apparatus illustrated in Fig. 1.

Referring to the drawings, the apparatus may comprise a suitable frame or support 1 on which is carried a container for the fluid to be dispensed. The container preferably is a medicinal bottle 2 having a neck 3 at its upper end and a neck 4 at its lower end, both the necks 3 and 4 being arranged to receive the usual rubber stoppers. If the fluid to be dispensed is heavier than air, the neck 3 provides an inlet and the neck 4 provides an outlet. If the fluid is lighter than air the reverse is true.

A suitable connection is made between the neck 4 to the tube 5 which, when the apparatus is used for treating stomach ulcers, is arranged to be inserted into the stomach of the patient as through the nasal passages for dispensing liquid medicine into the stomach. The connection between the tube 5 and the neck 4 preferably is by means of a rubber stopper 6, having a central passage in which is accommodated a glass tube 7, the tube 7, in turn, being inserted into the inner end of the rubber tube 5. The discharge end of either the tube 5 or 7 is such as to permit the liquid normally to flow out by gravity while preventing infiltration of air into the bottle.

Leading from the inlet neck 3 of the bottle 2 is a suitable conduit 8, preferably in the form of a rubber tube connected to the neck 3 by the rubber stopper 9 and glass tube 10. The opposite end of the conduit 8 is connected to a control mechanism, indicated generally at 12, which com-

prises an air-tight contractible and expansible chamber. In the preferred form, the chamber 12 is a rubber bellows 13 which, in its normal condition, is collapsed or contracted. As will be described more fully hereinafter, the bellows 13 is arranged so that when it is expanded it reduces the atmospheric pressure within the bottle 2. To prevent radial collapse of the bellows due to the resultant sub-atmospheric pressure, each of the corrugations of the bellows is held in radially distended condition by suitable rigid rings 14 disposed within the bellows and fitting within the troughs on the internal corrugations.

For accuracy in control, it is desirable that the ends of the bellows 13 be relatively rigid and consequently the ends of the bellows are closed by suitable plates 15 and 16. The plate 15 is anchored so as to remain stationary and the plate 16 is preferably relatively heavy and forms in itself a suitable weight which urges the bellows to axially collapsed condition. Additional weights may be laid on the plate 16 for increasing the force urging the bellows to collapsed condition whenever desirable. Thus the bellows is urged to its collapsed condition not only by the plate 16 and any weights that may be superposed thereon, but also by the inherent resiliency of the rubber and the fact that the bellows is formed in a normally collapsed condition.

It is apparent that if, while the liquid in the bottle 2 is above the outlet neck 3, the bellows is expanded, the atmospheric pressure within the bellows 13 and within the bottle 2 above the level of the liquid, which is indicated at 17, is reduced. Consequently, the flow of the liquid 17 from the bottle 2 by gravity is retarded, the amount of retardation depending upon the degree of sub-atmospheric pressure within the bottle 2. If, therefore, the bellows is permitted to contract gradually under the influence of the weight of the plate 16, the sub-atmospheric pressure within the bottle 2 (or such other means as urge the bellows to contracted condition) will be relieved proportionately to the decrease in volume of the bellows. Thereupon, the liquid in the bottle 2, being held therein only by virtue of the sub-atmospheric pressure operating in opposition to gravity, tends to flow out of the bottle 2 through the tube 5. Since the flow is proportional to the rate of decrease of the volume of the bellows 13, the dispensing of the liquid may be controlled by controlling the rate of contraction of the bellows.

As mentioned in the objects, it is desirable to dispense the liquid in relatively small or minute increments at regular intervals over a long period of time. It becomes necessary, therefore, to control the rate of contraction of the bellows very accurately. For this purpose, a timing mechanism 20 is provided. This timing mechanism preferably comprises a winding drum 21 which is connected directly to a driving gear 22 for rotation therewith. A suitable ratchet mechanism 23 is provided on the shaft of the gear 22 for rotating only the drum in one direction, this mechanism being such as is commonly used for winding a clock. The drum and gear 22 are connected for rotation together in the opposite direction.

Wound on the drum 21 is a cable 24 which is connected to the upper end of the bellows 13, as illustrated. Thus the shaft of the drum may be rotated in the expanding direction for winding the cable on the drum and thereby expanding the bellows. The forces urging the bel-

lows to collapsed condition provide the source of power for rotating the drum, and consequently the gear 22, in the opposite or contracting direction permitting collapse of the bellows.

In order to time the rate of contraction of the bellows, the gear 22 is connected through gear train to an escapement such as is used in the ordinary balance wheel clock. In the form illustrated, the gear 22 drives a small gear 25. A gear 26 is mounted on the same shaft as the gear 25 and is rotated thereby. The gear 26, in turn, drives the gear 27 which, successively through 27a, 28, 29, 30, 31, 32, 33 and 34, drives the escapement wheel 35. The rate of rotation of the escapement wheel is controlled by the escapement lever 36 and hair spring balance wheel 37. Thus the rate of contraction of the bellows within a given range may be controlled finally with great accuracy by adjusting the balance spring of the wheel 37 in the same manner as in the adjustment of an ordinary balance wheel clock. Further adjustment for a wider or different range in rate of contraction of the bellows is provided for a number of steps on the drum 22, one smaller step 38 being shown for purposes of illustration. Thus if a faster rate of contraction of the bellows is desired, the larger step of the drum is utilized and successively smaller steps of the drum are used as slower operations are desired.

The operation of the apparatus is as follows: The bottle 2 may be placed at any desired elevation relative to the patient. Assuming that the bottle, placed as illustrated in Fig. 1, is slightly above the level of the patient, it is apparent that if the bottle is filled with liquid, the liquid will start flowing by gravity through tube 5, thus creating sub-atmospheric pressure in the bellows and in the bottle above the level of the liquid. The sub-atmospheric pressure increases as the liquid flows out until there is a substantial balance between the hydrostatic head due to the liquid and the restraining force of the sub-atmospheric pressure. Thereafter no more of the liquid can flow. Thereupon the timing mechanism may be started and the liquid flows out from the tube 5 as the contraction of the bellows proportionately relieves the sub-atmospheric pressure in the bottle. Thereafter, the liquid continues to flow at a uniform rate, for example, about fifteen drops per minute, uniformly distributed throughout the period of operation.

In event the tube becomes partially clogged, due to viscosity of the liquid or change in the viscosity of the medicine, the flow may be temporarily prevented but eventually the sub-atmospheric pressure becomes so relieved that the hydrostatic head forces the liquid to relieve the clogged condition. Thereafter, the flow will continue rapidly until the sub-atmospheric pressure in the bottle 2 is reduced to a degree slightly less than sufficient to balance the hydrostatic head. In case of severe clogging, the bellows contracts sufficiently so that a positive super-atmospheric pressure is built up in the bellows and bottle and forces the liquid out to re-establish the flow.

Instead of draining out the liquid in the manner specified for initially establishing the balance, the bottle may be substantially filled and placed in condition for operation with the bellows partially expanded so that after all connections are made, the bellows may be additionally expanded sufficiently to prevent the dis-

charge of the liquid by gravity and thus more quickly establish the controlled flow. Thereupon the timing mechanism is started for permitting the bellows to contract and the controlled flow is soon established.

For those conditions necessitating the placing of the bottle below the level of the patient, the bellows is capable of providing a positive super-atmospheric pressure head for forcing the liquid to a higher elevation than the bottle and out through the tube 5 while controlled by the timing mechanism. Thus the apparatus may operate by retarding the flow by sub-atmospheric pressure or by positively ejecting the liquid. Again, for controlled pumping, as in the case of bladder disorders, the cable 24 may be connected to the bottom of the bellows 13, the top of the bellows being held stationary. Weights are secured to the bottom of the bellows and, starting with the bellows in contracted condition and the cable wound on the drum 21, the bellows expands at a rate controlled by the timing mechanism 20. For this use the bellows is preferably connected to the neck 3, the pumped liquid being trapped in the bottle 2. Among the desirable features of the present apparatus is the fact that it will operate properly even though it is not in any exact position relative to the patient. Furthermore, it does not have to be placed perfectly level as do the prior water-operated structures. Again, it is so simple to operate that any chance of improper operation or a failure to operate during the long periods desired are prevented.

Having thus described my invention, I claim:

1. A device for discharging gradually a quantity of liquid and comprising a container for the liquid, and having a discharge passage and an inlet passage, control means having walls capable of approaching each other and spreading apart to provide a contractible and expansible fluid cavity, said cavity being connected with said inlet, means tending to urge the cavity to contracted condition, and timing mechanism operatively connected to the control means and operative to

constrain said cavity to predetermined gradual contraction.

2. A device for discharging gradually a quantity of liquid and comprising a container for the liquid, and having a discharge passage and a fluid inlet passage, control means comprising a fluid reservoir having relatively movable walls, said reservoir being connected with said inlet passage, constantly acting means tending to contract the reservoir whereby dispensation of liquid from the container is controlled by contraction of said cavity, means acting on one of the walls in a manner to govern the rate of contraction of the cavity.

3. A liquid dispensing device comprising a container for liquid to be dispensed, said container having an outlet, a collapsible fluid-tight chamber having its interior connected to the container in a fluid-tight manner, means tending to urge the chamber to collapsed condition, and escape-ment mechanism operatively associated with said container in a manner to govern its rate of collapse by said means.

4. A device for the purposes described and comprising a container having a discharge passage and an inlet passage, means having walls movable relatively toward and away from each other to provide a cavity capable of being operated into contracted condition and expanded condition, respectively, said cavity being connected with one of said passages, means tending to urge the cavity into one of said conditions, and timing mechanism operatively connected to the control means and operative to constrain said cavity to predetermined gradual operation into said one condition.

5. A device for the purposes described and comprising a container having a discharge passage and an inlet passage, a bellows connected with one of said passages, continuously acting means tending to operate the bellows, and timing means operatively connected to the bellows and operative in a manner to govern the rate of operation of the bellows.

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