Aug. 5, 1952 P. KOLLSMAN 2,605,765

AUTOMATIC SYRINGE

Filed June 5, 1947 2 SHEETS—SHEET 1

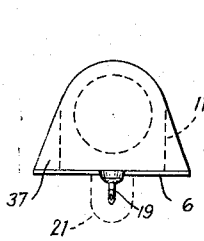


Fig. 3

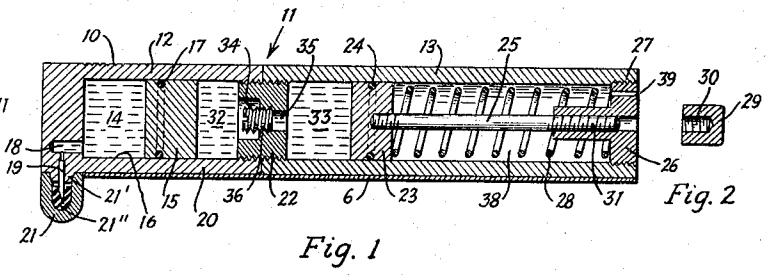


Fig. 1

Fig. 2

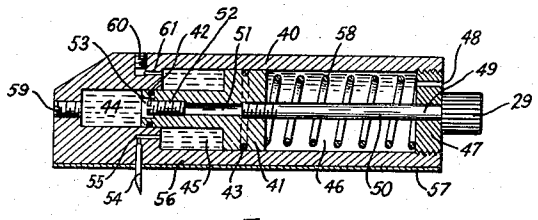


Fig. 4

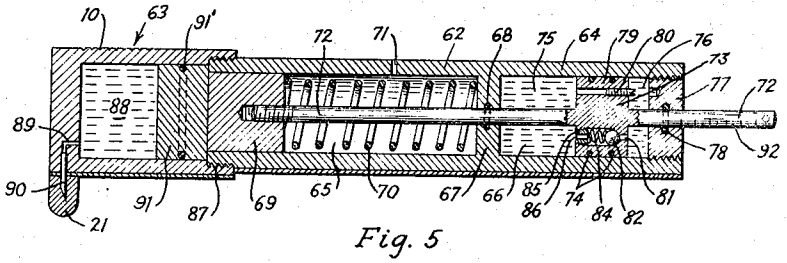


Fig. 5

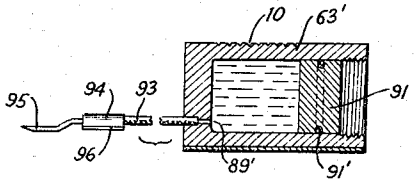


Fig. 6

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AUTOMATIC SYRINGE

Filed June 5, 1947 2 SHEETS—SHEET 2

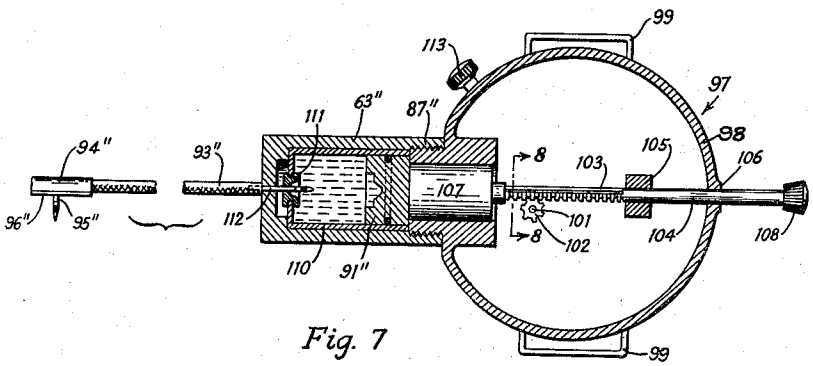


Fig. 7

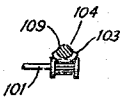


Fig. 8

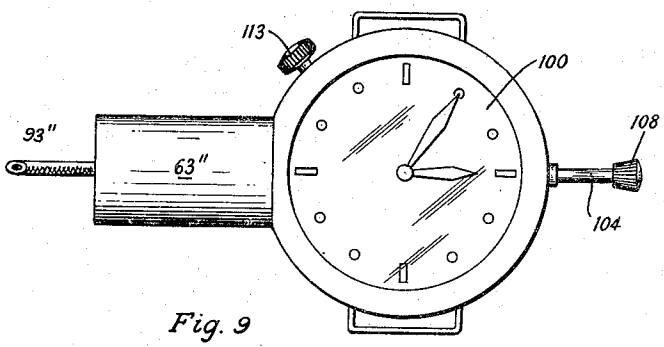


Fig. 9

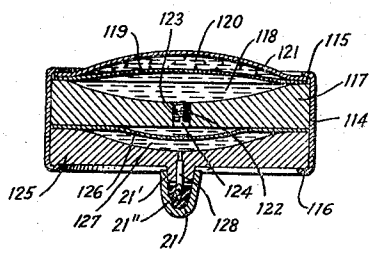


Fig. 10

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# UNITED STATES PATENT OFFICE

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## AUTOMATIC SYRINGE

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Application June 5, 1947, Serial No. 752,787

7 Claims. (Cl. 128—218)

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This invention provides a device for continuously and automatically administering medicinal compositions in fluid form to a patient's body.

In the treatment of disease by hypodermic or oral medication, it is frequently the aim to maintain a certain concentration of a medicinal composition in the body fluids of the patient over extended periods of time. The concentration must be sufficiently high to produce the desired beneficial effects, but should, at the same time, be as low as possible so that the total quantity of the medicinal composition which is administered and its toxic effects are small.

The body eliminates or inactivates at a certain rate medicinal compositions introduced into it. It is therefore evident that a dose of a medicinal composition administered sufficiently small to make its toxic effects tolerable soon loses its effectiveness.

In cases where, for the purpose of treatment, a certain concentration of medicinal compositions in the body fluids has to be maintained over extended periods of time, it has become the generally accepted practice to administer doses of medicine repeatedly within predetermined intervals of time in order to counteract the tendency of the body to eliminate or inactivate the compositions. As a result, the total of the individual doses of compositions is considerably in excess of the quantity needed if it were possible to maintain the concentration within the body fluids constant. A certain amount of the compositions is thus wasted. It is also evident that the toxic effect of individual periodic administrations of doses is relatively great since the concentration immediately following an administration must necessarily be greater than the required minimum in order that the effect of the dose be extended. The present practice of administering medicinal compositions therefore puts an unnecessary burden on the patient's system.

If the time intervals between administration of individual doses is short, for example, of the order of two hours, and if the total time of treatment is relatively long, for example two to four days, the patient is robbed of the benefit of natural and uninterrupted sleep. Doses administered in the form of hypodermic injections may therefore add up to a total of 48 individual injections for a certain treatment. Such treatment is necessarily very painful to the patient. It is also very expensive since the services of a physician or trained nurse are required on forty-eight separate occasions.

The present invention overcomes the various

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disadvantages of the conventional practice of administration of medicinal compositions in providing an apparatus for the continuous administration of medicinal compositions at a predetermined rate over extended periods of time.

The novel device consists, in effect, of an automatic syringe including an injection needle, a charge of medicinal composition in fluid form, a self-contained source of power, and means for controlling the rate at which the composition is continuously discharged through the injection needle. The device is sufficiently small so that it may be attached to a portion of the patient's body. Once attached, it may be carried without interference or substantial annoyance of the patient over periods of the order of several days during which period a continuous rate of discharge of fluid composition is maintained.

The concentration of the composition and the rate of its discharge are so selected that a predetermined minimum concentration of the composition is maintained in the patient's body throughout the treatment. The volume is so selected as to be readily absorbable without forming pools or depots.

Since the volumetric quantity per hour is extremely small, it is not necessary to insert the injection needle deep into a muscle, but it is sufficient in most instances to insert it slightly below the skin. This particular property and feature of the present invention greatly reduces the discomfort of the patient. The injection needle can accordingly be made thin and relatively short.

Injection devices embodying the present invention may be made for single use, to be discarded after the treatment, or may be made as rechargable units suited for refilling. They may also be constructed of two units, a re-usable power unit to which a disposable injection unit is attached.

The various objects, features and advantages of this invention will appear more fully from the detailed description which follows accompanied by drawings showing, for the purpose of illustration, preferred embodiments of the invention. The invention also consists in certain new and original features of construction and combination of elements hereinafter set forth and claimed.

Although the characteristic features of this invention which are believed to be novel will be particularly pointed out in the claims appended hereto, the invention itself, its features and advantages, and the manner in which it may be carried out may be better understood by referring to the following description taken in connec-

tion with the accompanying drawing forming a part of it in which:

Figure 1 is a longitudinal section through an automatic syringe embodying the present invention;

Figure 2 shows in section a knob for maintaining the elements of the device in Figure 1 in ready-to-use position;

Figure 3 is an end view of the device of Figure 1;

Figure 4 is a longitudinal section of a modified form of automatic syringe;

Figure 5 is a longitudinal section of an automatic syringe comprising a re-useable power and timing unit to which a disposable injection unit is attached;

Figure 6 is a detailed view, partly in section, of an injection unit including a separate injection needle;

Figure 7 is a sectional view of an automatic syringe powered by a spring motor;

Figure 8 is a detailed view of elements of the device of Figure 7, a section being taken on line 8—8 of Figure 7;

Figure 9 is a plan view of the device shown in Figure 8; and

Figure 10 is a sectional view of an automatic syringe including a power unit operating with gas pressure.

In the following description and in the claims, various details will be identified by specific names for convenience. The names, however, are intended to be as generic in their application as the art will permit. Like reference characters refer to like parts in the several figures of the drawings.

In the drawings accompanying, and forming part of, this specification, certain specific disclosure of the invention is made for the purpose of explanation of broader aspects of the invention, but it is understood that the details may be modified in various respects without departure from the principles of the invention and that the invention may be applied to other structures than the ones shown. Any permissible changes in the constructions disclosed herein must fall within the purview of the claims appended hereto.

The syringe shown in Figure 1 comprises a housing 11 consisting of two tubular portions 12 and 13. A variable volume chamber 14 is formed in the preferably transparent housing portion 12 by a movable wall which, in the illustrated example has the form of a free movable piston 15 sealed with respect to the inner cylindrical surface 16 of the housing by a gasket 17. The variable volume chamber 14 has a discharge passage 18 leading to a hollow injection needle 19 which extends approximately at right angles with respect to the bottom surface 20 of the housing 11. During non-use of the syringe, the injection needle is protected by a removable cap 21 preferably seated on a knob-shaped projection 21'. The projection 21' besides forming a tight seat for the cap 21 facilitates insertion of the relatively short needle 19 through the skin which, were it not for the projection, would yield appreciably without being penetrated by the needle, or if punctured, would not permit the needle to penetrate to its full length.

The cap 21 is preferably made of relatively rigid material such as metal or a plastic and is lined on the inside with a relatively soft liner 21'' adapted to form a seal for the needle 19. The liner 21'' may be made of a soft or pliable material, for example soft rubber, into which the needle is pressed when the cap 21 is attached. The liner 21'' seals the point of the needle to prevent accidental discharge of medicinal fluid, if the fluid is under pressure, and provides mechanical protection for the needle. In addition, the cap maintains the needle sterile until its actual use.



The two portions of the housing 12 and 13 are secured together by a threaded plug 22 which also forms a partition in the housing, the threads being cemented for tightness.

A power piston 23 sealed by a gasket 24 is movable in the rearward housing portion 13 and has a piston guide rod 25 whose end passes through a collar 26 closing the end of the housing portion 13. The collar 26 is threaded or otherwise secured at 27 and forms the seat for a helical spring 28 whose other end bears against the power piston 23.

The power piston may be maintained in inactive position in which the spring 28 is compressed by a release cap 29 shown in Figure 2. The cap 29 has an internal thread 30 fitting on a corresponding thread 31 on the end portion of the piston guide rod 25.

The plug 22 forms a dividing wall between chambers 32 and 33. In the condition in which the device is ready for use, the chamber 33 is filled with a highly viscous liquid, preferably one having a low temperature coefficient of viscosity, for example a silicone liquid of appropriate viscosity which may range up to 750,000 centistokes or over, the viscosity being determined by the length of the period during which the syringe is to operate continuously. The liquid in the chamber 33 may be forced into the chamber 32 through a restricted passage of preferably laminar flow characteristics, for example a capillary passage. This passage may conveniently be formed by the fine threads of a screw 34 threaded into a cylindrical hole 35 in the plug 22, the diameter of the hole 35 being slightly less than the outside diameter of the screw but slightly more than its core diameter so that a helical passage 36 is formed along the root of the thread whose length may be adjusted by varying the depth to which the screw extends into the hole 35. A cylindrical hole, as shown in the drawing, has been found satisfactory for the purpose although it is, of course, possible to provide internal threads in the hole, the profiles of the threads being so selected as to provide for clearance resulting in a capillary passage along the core or crest of the screw 34.

The variable volume chamber 14 is filled with a medicinal composition of fluid form to be injected and the chamber 32 contains normally, before the device is put in operation, just sufficient viscous liquid to result in immediate movement of the piston 15 if further liquid is displaced from chamber 33 into chamber 32.

The device is filled with a medicinal fluid at the chemical factory or laboratory distributing the device. The liquid in chamber 33 is so selected and the flow resistance of the capillary passage 36 between the chambers 32 and 33 is so selected that after release of the power piston 23 the piston will come to the end of its stroke after a predetermined period of time which may be of the order of 48 to 72 hours or more.

The device is applied to a portion of the body after removal of the protecting cap 21 from the injection needle. The housing has an appropriately shaped bottom surface 20 which may, for example, be flat and be provided with a tacky composition 6 similar to that used on adhesive tape in order to prevent shifting of the housing

after it is applied to the body. The housing may be provided with an enlarged head 37 to prevent tilting, and may be held in place by a bandage or adhesive tape.

Shortly before the device is applied, the release cap 29 is removed from the end of the piston guide rod 25, whereupon the spring 28 expands tending to move the power piston 23 towards the partition plug 22 against the resistance of the viscous liquid in chamber 33 which now flows slowly through the capillary passage 36 into chamber 32 and, in turn, moves the piston 15 which then displaces fluid from the chamber 14 through the injection needle 19.

Air is admitted into the space 38 in back of the power piston 23 through a vent passage 39 in order to prevent suction from being built up therein due to the movement of the power piston 23. For practical purposes, a loose fit of the piston guide rod 25 in the collar 26 is sufficient to provide this vent.

The spring 28 is preferably so dimensioned that only a fraction of its power is spent during the travel of the power piston 23 from one extreme position to the other in order to eliminate the effect of decreased spring power due to Hooke's law. However, in some instances, a slight decrease in the rate of injection towards the end of the treatment is desirable. It is evident that this can be accomplished very conveniently by providing for a corresponding drop in spring power.

The timing of the device is very accurate since changes in the viscosity of the liquid due to changes in temperature do not occur by reason of the fact that the injection device is worn on the body of the patient, whereby the device is maintained at a substantially constant temperature throughout the treatment.

The progress of the injection may be observed and the total volume of injected liquid be read at a graduation 10 printed or engraved on the transparent housing 12 cooperating with the edge of the piston 15.

The syringe shown in Figure 4 comprises a housing 40 in which a step piston 41 is movable. The step piston 41 has gaskets 42 and 43 and subdivides the interior space of the housing into chambers 44, 45, and 46. The chamber 46 is closed by a threaded plug 47 having a vent passage 48 therethrough and having a further centrally located hole 49 through which a release stem 50 extends.

The chamber 44 is filled with a charge of a highly viscous liquid which under pressure may flow into the chamber 46 through a cylindrical passage 51 in the piston including a capillary restriction 52 formed by a screw 53 threaded into the cylindrical passage 51, the inner diameter of the cylindrical passage 51 being slightly less than the outside diameter of the screw and slightly more than the core diameter of the screw.

The chamber 45 is filled with a charge of medicinal fluid to be injected which is discharged through an injection needle 54 communicating with the chamber 45 through a passage 55. The injection needle 54 extends substantially normal with respect to the bottom surface 56 of the housing 40 which may have a layer of tacky material 57 applied to it.

A helical spring 58 bears against the piston 41 with one end and against the threaded plug 47 with the other. The power of the spring 58 may be released by unscrewing the release stem 50 from the piston 41 and thus removing it from the device. Removal of the stem 50 opens the passage 51 through the piston and permits viscous liquid to flow from chamber 44 into chamber 46 while at the same time the piston 41 moves in a direction to force medicinal fluid from the chamber 45 out through the needle 54.

The device may be initially filled by feeding viscous liquid into the chamber 44 through a filler plug 59 and by filling the chamber 45 with medicinal fluid through a similar plug 60 leading to a passage 61.

The syringe of Figure 4 is applied and used in the same manner as the form of syringe shown in Figure 1. It is fixed in place by the tacky composition 57 on its under surface 56 and is secured by bandages or tape. The form of syringe shown in Figure 4 is particularly suited for one-time use, to be discarded after use. The step arrangement of the piston provides for a relatively large chamber for medicinal fluid and a relatively small one for the viscous liquid so that only a small quantity of viscous liquid is required.

The automatic syringe shown in Figure 5 comprises a re-useable power unit 62 to which a disposable injection unit 63 may be attached. The injection unit is preferably transparent and may be provided with a graduated scale 10. The power unit 62 consists of a housing 64 divided into chambers 65 and 66 by a wall or a partition 67 having a gasket 68 therein. A power piston 69 is movable in the chamber 65 in the housing and is acted upon by a helical spring 70 bearing against the piston with one end and against the wall 67 with the other. A passage 71 provides communication of the chamber 65 with the atmosphere.

The power piston 69 has a piston rod 72 attached to it which passes through the partition wall 67 and is attached to, or integral with, a damping piston 73 provided with gaskets 74. The damping piston divides the chamber 66 into further chambers 75 and 76. The end of the chamber 76 is closed by a plug 77 through which the piston rod 72 extends. The piston 73 is sealed against the plug 77 by a gasket 78.

The damping piston 73 has a restricted capillary passage 79 through it formed by a screw 80 threaded into the passage so that a helical capillary passage is formed along the screw surface.

A second passage 81 is normally closed by a check valve shown as a ball 82 forced against its valve seat by a spring 84. The spring bears against the ball with one end and against the threaded plug 85 with the other. The threaded plug 85 has a passage 86 therethrough.

The end of the housing 64 is threaded at 87 and may be connected to the injection unit or cartridge 63 containing a charge of medicinal fluid in a chamber 88. A discharge passage 89 leads from the chamber 88 to an injection needle 90. The chamber 88 is sealed by a movable piston 91 having a gasket 91'. The piston 91 is in contact with the power piston 69 and may be mechanically moved by it in order to force fluid out of the chamber 88 through the needle 90.

The device is put in operation by moving the piston rod in a direction to compress the spring 70. During this movement damping liquid flows from the chamber 76 into the chamber 75 through the passage 81 and past the check valve 82. An injection unit is then attached to the power unit 62 whereafter the device is ready for immediate use. The power piston 69 slowly urges the piston 91 in the injection unit in the direction

to discharge fluid therefrom, the rate of discharge being determined by the viscosity of the damping liquid in chamber 75, the flow resistance of the capillary passage 79 and the force of the spring 70.

The housing of the power unit or of the injection unit, or both, may be provided on its under surface with a coating of tacky material to maintain the syringe fixed against the surface of the body of the patient to which it is attached. Progress of the discharge of medicinal liquid may be observed by reading a graduation 92 on the piston rod 72 against the end surface of the plug 77.

The injection unit 63' shown in Figure 6 has a flexible tube 93 connected to its discharge passage 89' leading to a needle head 94 carrying an injection needle. The head 94 is a small housing having on its other side a layer of an adhesive substance 96. The injection unit 63' may be used in place of the unit 63 shown in Figure 5 and permits insertion of the needle 95 at a point remote from the power and injection unit to which it is attached. The head 94, after insertion of the needle 95, is taped or otherwise secured to the patient's skin, the adhesive 96 serving to prevent small movements of the head thereby preventing irritation at the point of injection.

Figures 7 to 9 illustrate an injection device comprising basically an escapement controlled spring motor or watch movement. A power unit 97 is housed in a casting 98 resembling the case of a wrist watch having lugs 99 to which securing straps may be attached. The movement of the watch is conventional and comprises the usual main spring, gears, and escapement. Because of this conventional construction, these elements are not shown in detail. The watch may be provided with the conventional dial 100. The power shaft 101 of the main spring barrel is extended and carries a pinion 102 meshing with a rack 103, the teeth of the rack being formed in a shaft 104 which is longitudinally movable and also rotatable in spaced bearings 105 and 106. A power piston 107 is connected to one end of the shaft 104 and a crown 108 is connected to the other end permitting turning of the shaft 104 until its flat top portion 109 faces the pinion. In inverted position the shaft 104 may be longitudinally moved with respect to the pinion 102 and be re-engaged in a different longitudinal position by turning the shaft 104 so that its teeth re-engage the pinion 102.

The power piston 107 bears against a piston 91'' movable in a cylindrical cartridge 110 inserted into the housing 63'' of the injection unit. The cartridge 110 has a normally sealed rubber plug 111 at the bottom which, upon insertion of the cartridge into the housing 63'' is pierced by a hollow needle 112 to establish communication with a tube 93'' leading to a head 94'' from which an injection needle 95'' projects. The head 94'' may be provided with an adhesive layer 96'' at its lower surface.

A further crown 113 on the watch casing permits winding of the main spring and setting of the hands in conventional manner.

The use and operation of the device shown in Figures 7, 8, and 9 is as follows:

Preparatory to the insertion of a filled cartridge 110 into the injection unit, the power piston 107 is moved into its extreme position by withdrawing the shaft 104 into the position shown in Figure 7. This is accomplished by grasping the crown 108, turning the shaft approximately 180° until the teeth of the rack 103 disengage from the pinion 102, moving the shaft 104 longitudinally and re-engaging the teeth of the rack 103 with the pinion 102. A filled cartridge is then inserted into the housing 63'' and the housing is screwed onto the power unit at 87'' whereby the bottom plug 111 of the cartridge is automatically pierced.

The running watch mechanism causes the shaft 101 and its pinion 102 to turn slowly urging the power piston 107 against the piston 91'' whereby the medicinal fluid in the cartridge is gradually discharged through the injection needle 95'' at a constant rate. When the piston 91'' reaches the bottom of the cartridge 110, the cartridge is empty and the watch comes to a stop. The total time of the treatment may be read at the dial which also furnishes a continuous indication of the progress of the treatment while the device is in operation.

In the hereinbefore described forms of syringes the power for operating the mechanism is derived from springs initially placed under tension. There are, of course, other forms of power available which lend themselves to use in syringes according to the invention.

Motive power may, for example, be derived from gas or vapor pressure. A self contained disposable unit utilizing gas or vapor pressure as operating power is illustrated in Figure 10. It consists of a substantially cylindrical shell 114 of sheet metal shaped to provide inwardly extending flanges 115 and 116 for holding the elements of the device in pressure tight assembled position.

A dish-shaped upper disk 117 is filled with a charge of a highly viscous liquid 118 covered and sealed by a metal diaphragm 119. A chamber 120 is formed above the diaphragm 119 by a pressure resistant dome-shaped sheet metal wall 121. The chamber 120 contains a charge of propane, methyl chloride or other liquid which at body temperatures partly develops sufficient operating pressure.

A restricted passage 122 leads through the upper disk 117 and is formed by a screw 123 threaded into an aperture 124 with sufficient clearance to provide a helical passage of capillary flow characteristics about the screw 123. The lower disk 125 also substantially of dish shape lies arranged below the upper disk 117 and is sealed with respect to the capillary passage 122 by a flexible diaphragm 126 of rubber or other resilient material. The diaphragm 126 separates the viscous liquid entering through the restricted passage 122 from the charge of medicinal fluid contained in the cavity of the lower disk at 127. The medicinal fluid may be discharged through an injection needle 128.

The device of Figure 10 is assembled under pressure and is closed by a pressuretight cap 21 fitting on a knob-shaped seat 21' through which the needle 128 projects. The viscous liquid which transmits pressure from the upper side of the upper disk to its lower side, is wholly contained in the space above the disk 117 and the medicinal liquid is in the chamber 127.

Shortly before application of the device to the body of a patient, the cap 21 is removed causing medicinal fluid to be discharged through the needle 128. Viscous liquid is now being forced through the restricted passage 122 and causes further fluid to be discharged through the needle 128. The action of the device continues until all

of the viscous liquid has passed through the restricted passage 122, whereafter the diaphragm 119 rests against the dish-shaped upper surface of the disk 117.

The device is attached to the body of the patient by bandages or tape and may again be provided on its under side with an adhesive substance to keep it firmly in place.

Because of the slow rate of injection provided by the devices embodying the present invention, it is not necessary to use long or relatively thick injection needles, but needles as small as one-sixteenth of an inch in length and one-sixty-fourth of an inch in diameter are satisfactory. Such needles need not extend into the muscular tissue, but insertion into the skin is sufficient. This greatly reduces the discomfort of the patient who may move about and even go about his regular business without being disturbed by the needle.

Compared to conventional methods of injection, the invention provides various advantages. Whereas, according to conventional injection practices, the location of an injection needle is relatively critical, for example in a muscle or vein, it is sufficient in practicing the invention to insert the needle into the skin, the location of the specific point of injection being not critical because of the slow injection rate. Thus, any portion of the body may be selected where the automatic device is most convenient to carry.

According to conventional injection practices, relatively large volumes of fluid are injected per unit of actual injection time, for example, a volume of one or two cc. over a period of five or ten seconds. This ratio is favorably altered by the present invention where the quantity of liquid injected within the same period of time is infinitesimal and can only be expressed in terms of milligrams. The reduced injection rate makes the process of injection far less uncomfortable than present practices where the forming of pools of liquid in the tissue is frequently very painful.

According to the best of my information the drip method of intravenous injections is the only continuous injection practice used at present. In this method relatively large volumes of diluent are employed which, after injection, must be eliminated from the system of the patient. The present invention does not impose on the patient the burden of eliminating large volumes of a diluent since none is employed. Medicinal preparations of relatively high concentration may be used with safety because of the exceedingly slow injection rate.

The invention thus provides a greatly improved injection device which opens up an advanced form of treatment techniques having numerous advantages. The introduction into a patient's system of medicinal compositions continuously and at a substantially constant slow rate requires considerably less medication than if individual doses are injected periodically and the total toxic effect is correspondingly reduced.

The invention is particularly suited for the injection of liquids, semi-liquid fluids, and suspensions, for example penicillin suspensions including beeswax and peanut oil. Penicillin is difficult to administer because of its limited stability in liquid form. In suspension it is admirably suited for administration according to the present invention.

The invention provides great economy in that the services of a physician or trained nurse are required only once when the injection device is applied resulting in a corresponding saving in professional services. According to conventional practice, the elements of a syringe have to be sterilized repeatedly, once for each injection. According to the invention, a sterile, ready-to-use injection syringe takes the place of the great number of single-shot syringes.

The present invention permits medication at a substantially constant rate as well as at gradually increased or decreased rates by proper selection of the source of operating power, for example by selection of a spring or spring assembly or other source of power of predetermined characteristics.

The temperature coefficient of the viscous liquid employed by the various types of syringes or the temperature coefficient of the hair spring in the escapement of the power unit of the device shown in Figures 7 to 9, or the temperature coefficient of other time controlling means may be so selected as to provide a compensating action, for example, to cause an increase or a decrease in the rate of injection in accordance with the change in the patient's body temperature.

Other variations in the injection rate are possible. Referring, for example, to the device illustrated in Figure 4, introduction of a small gas or air bubble in chamber 44 which contains the viscous damping liquid will cause an initial large dose of fluid to be discharged. When this is desired, the syringe is first applied to the body of the patient and injection is then initiated by removal of the release stem 50. The piston 41 advances immediately under the action of the spring 58 due to compressibility of the air bubble in the chamber 44 and an initial relatively large volume of medicinal fluid is injected. After compression of the air bubble, the rate of injection is reduced and remains substantially constant during the remainder of the operation of the syringe.

In the various forms of automatic syringes illustrated in the drawings, the operating power available for expelling the medicinal fluid is vastly greater than the actual power required for moving the movable wall which reduces the volume of the chamber containing the medicinal fluid. The pressure in the chamber containing the viscous fluid is for this reason much greater than the pressure in the chamber containing the medicinal fluid. For example, the pressure in the chamber containing the viscous fluid may be of the order of eighty pounds per square inch, whereas the pressure in a chamber containing the medicinal fluid may be of the order of one-half pound per square inch. This relationship of pressure provides an ample safety margin, so that variations in the friction of the piston in the chamber containing the medicinal fluid will not affect the functioning of the device. Assuming, for example, that a pressure of approximately four pounds per square inch is required for moving the poston and the chamber containing the medicinal liquid, and assuming that due to unfavorable circumstances, the friction increases 100% so that eight pounds are temporarily needed, it is easily seen that such increases in required power are still far below the available motive power, that is eighty pounds in the specific example. This relationship also exists in the clock-work operated form of syringe where the power moving the piston is vastly in excess of the power required for expelling the medicinal fluid.

Obviously, the present invention is not limited to the particular embodiments herein shown

and described. Various changes, modifications, substitutions, additions, omissions will suggest themselves to persons skilled in the art as a result of the teaching of the invention. Such changes therefore do not involve a departure from the spirit and the teachings of this invention.

What is claimed is:

1. An automatic syringe for the injection of fluids into body tissues comprising, in combination, a housing adapted to be carried by the patient; a movable wall in said housing forming a variable volume chamber therein for containing a charge of fluid to be injected; means for forming a discharge passage from said chamber including an injection needle; a source of motive power in said housing for moving said movable wall in a direction to reduce the volume of said chamber and discharge fluid therefrom; means for retarding the rate of movement of said wall said retarding means including two further chambers communicating with each other through a restricted passage, at least one of said two further chambers having a movable wall acted upon by said source in a direction to reduce the volume of said one chamber, and a charge of viscous liquid in said last named one chamber.

2. An automatic syringe for the injection of fluids into body tissue comprising, in combination, a housing adapted to be attached to a portion of the patient's body; a movable wall in said housing forming a variable volume chamber therein for containing a charge of fluid to be injected; an injection needle mounted on said housing and communicating with said chamber through a passage; a source of motive power in said housing for acting on said movable wall to reduce the volume of said chamber and discharge fluid therefrom; means for controlling the rate of movement of said wall including a further chamber having a movable wall acted upon by said source in a direction to reduce the volume of said further chamber and having a restricted passage leading therefrom, and a charge of viscous liquid in said further chamber; and means for releasing said source of motive power at will, the charge of viscous liquid, and the restricted passage, being on the same side of said movable wall in the direction of movement thereof by the motive power source.

3. An automatic syringe for the injection of fluids into body tissue comprising, in combination, a housing adapted to be attached to a portion of the patient's body; a piston movable in said housing forming the movable wall of a variable volume chamber therein for containing a charge of fluid to be injected; means forming a discharge passage from said chamber including an injection needle; a spring in said housing adapted to act on said piston for moving said piston in a direction to reduce the volume of said chamber and discharge fluid therefrom; and means for controlling the rate of movement of said piston, said rate controlling means including a further chamber having a movable wall acted upon by said spring in a direction to reduce the volume of said further chamber by said spring, said further chamber having a restricted passage leading therefrom, and a charge of viscous liquid in said further chamber, the charge of viscous liquid, and the restricted passage, being on the same side of said piston in the direction of movement thereof by said spring.

4. An automatic syringe for the injection of fluids into body tissue comprising, in combination, a housing adapted to be carried by the patient; a movable wall in said housing forming a variable volume chamber therein for containing a charge of fluid to be injected; means forming a discharge passage from said chamber including an injection needle; a source of motive power in said housing for acting on said movable wall in a direction to reduce the volume of said chamber and discharge fluid therefrom and means responsive to lapse of time for retarding the movement of said movable wall under influence of said source to a predetermined controlled substantially constant rate.

5. An automatic syringe for the injection of fluids into body tissue, comprising, in combination, a first and a second housing attachable together to form a unit, the unit being adapted to be attached to a portion of the patient's body; a movable wall in said first housing forming a variable volume chamber therein for containing a charge of fluid to be injected; means forming a discharge passage from said chamber including an injection needle; a source of motive power in said second housing adapted to act on said movable wall in said first housing to reduce the volume of said chamber and discharge fluid therefrom; and means in said second housing responsive to lapse of time for automatically retarding said source of power to a predetermined controlled substantially constant rate, whereby a substantially uniform rate of fluid discharge from said chamber may be obtained over an extended period of time.

6. In a syringe for the injection of fluids into body tissue, the syringe containing a housing, a variable volume chamber in said housing for containing fluid to be injected, an injection needle communicating with said chamber, and power means including a source of motive power in said housing for reducing the volume of said chamber to discharge fluid from said chamber through said needle, the improvement which comprises a housing having a substantially flat surface adapted to be placed against a portion of the patient's body and to be attached thereto; and means in said housing responsive to lapse of time for automatically retarding the action of said housing for automatically retarding the action of said power means to a predetermined controlled substantially constant rate to obtain a predetermined slow rate of fluid discharge over an extended period of time.

7. In a syringe for the injection of fluid into body tissue, the syringe containing a housing, a variable volume chamber in said housing for containing fluid to be injected, an injection needle communicating with said chamber, and power means including a source of power in said housing for discharging fluid from said chamber through said needle, the improvement which comprises a housing having a flat surface adapted to be placed flat against a portion of the patient's body and to be attached thereto, said needle being mounted on said housing and projecting above said surface in a direction substantially normal with respect to said surface; and, in said housing, means responsive to lapse of time for automatically retarding the action of said power means to a predetermined controlled substantially constant rate to obtain a predetermined slow rate of fluid discharge over an extended period of time.

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