United States Patent [19]

Doherty

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[54] **NEEDLELESS INOCULATOR**

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[52] **U.S. Cl.** ..... **128/173 H**

[51] **Int. Cl.** **A61m 31/00**

[58] **Field of Search** ..... 128/173 H, DIG. 1, 218 P, 128/218 A, 218 C, 218 F, 218 D, 218 R, 213, 216, 215; 124/32

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Assistant Examiner—Henry J. Recla
Attorney, Agent, or Firm—Leonard H. King

[57] **ABSTRACT**

A needleless injector is provided with a body portion having a chamber for receiving a vial containing a fluid material. Adjustable force applying means are positioned coaxially with the vial in order to discharge the contents thereof through a bore and into an injection head. Improved electrically operated means are provided for cocking a spring member which is released by a manually operable trigger for dispensing the fluid from the head.

10 Claims, 18 Drawing Figures

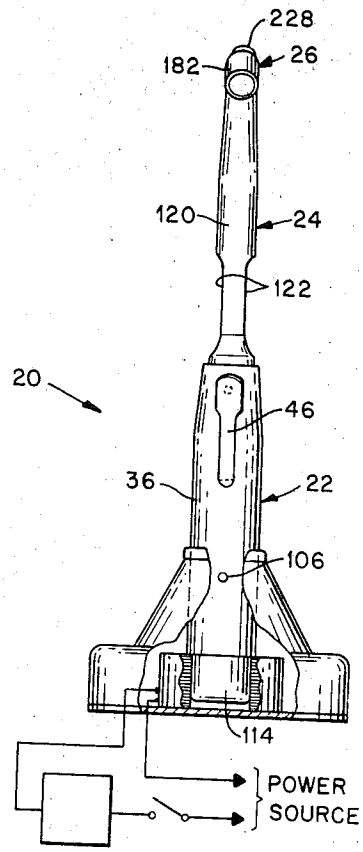


FIG. 1

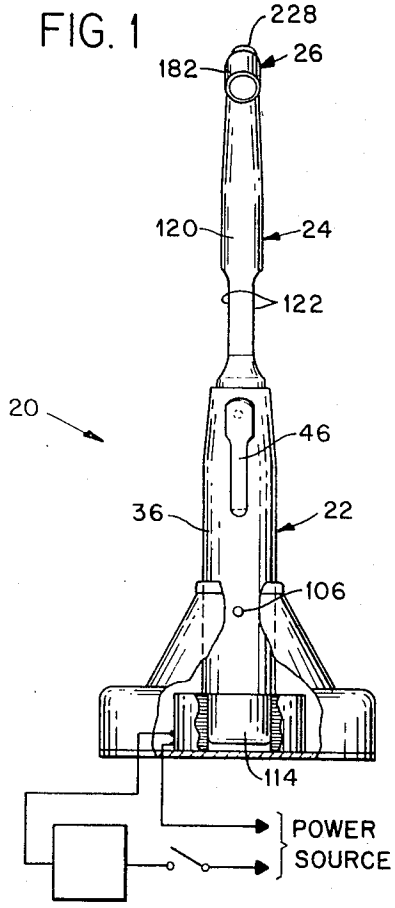


FIG. 2

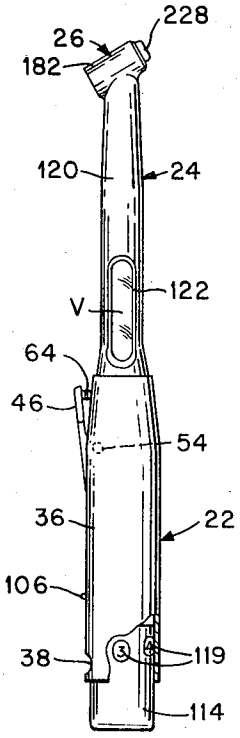


FIG. 3

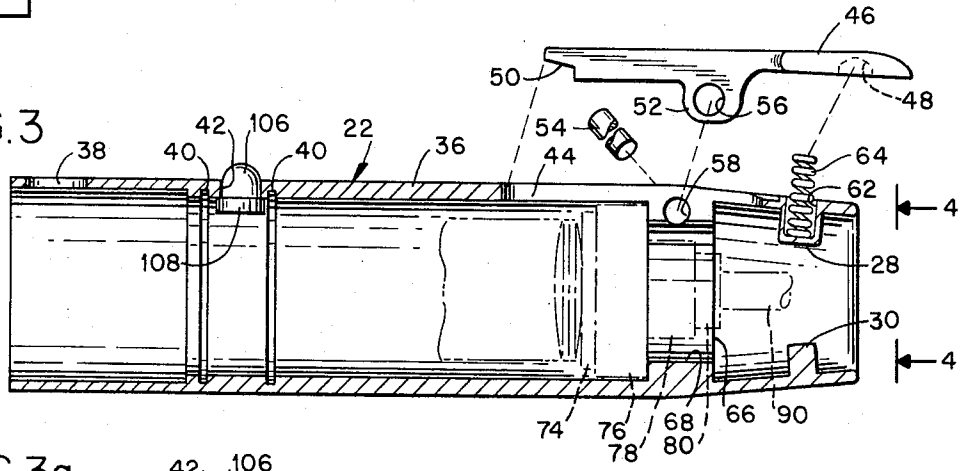


FIG. 3a

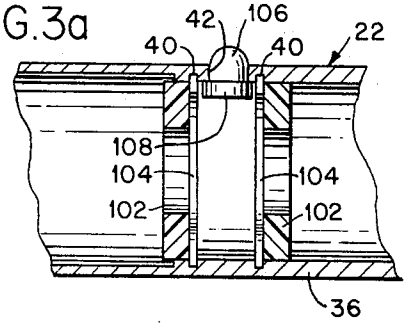
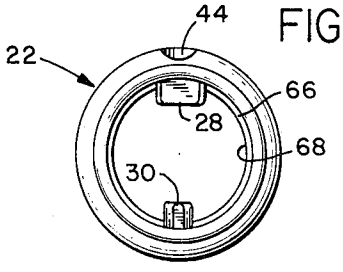


FIG. 4



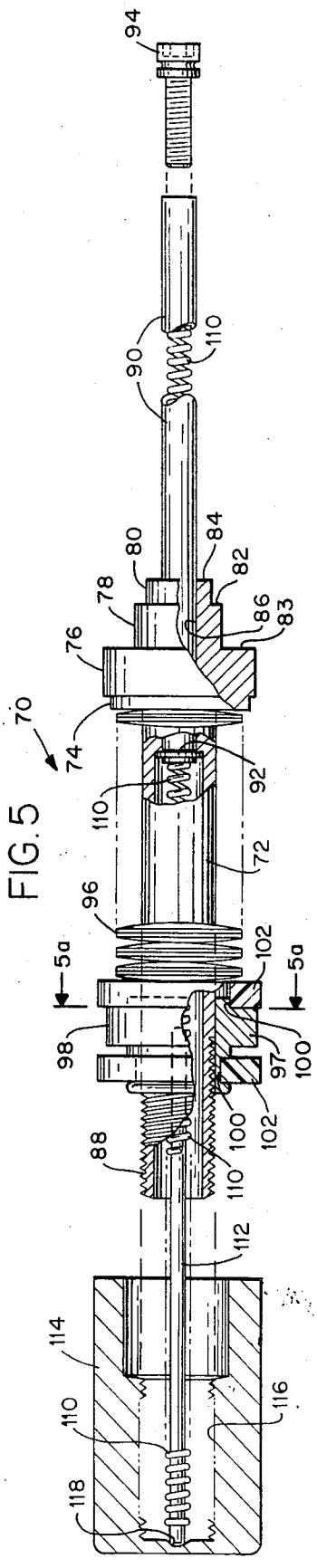


FIG. 5

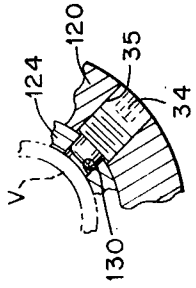


FIG. 12

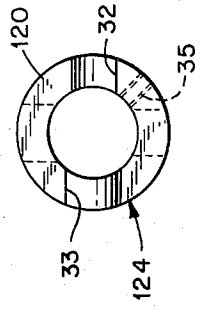


FIG. 7a

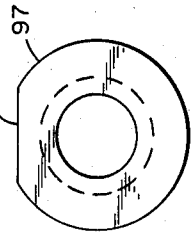


FIG. 5a

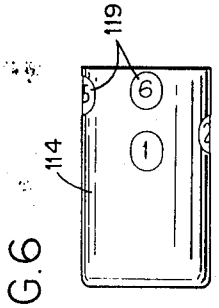


FIG. 6

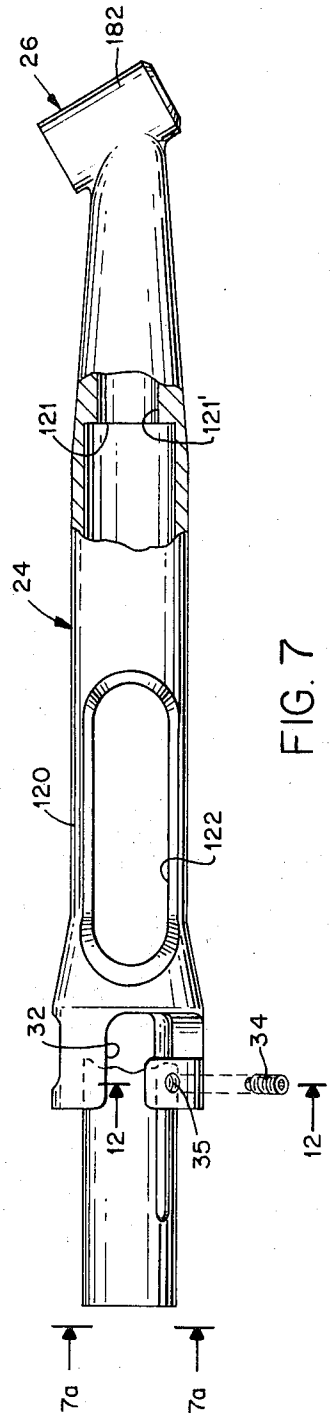


FIG. 7

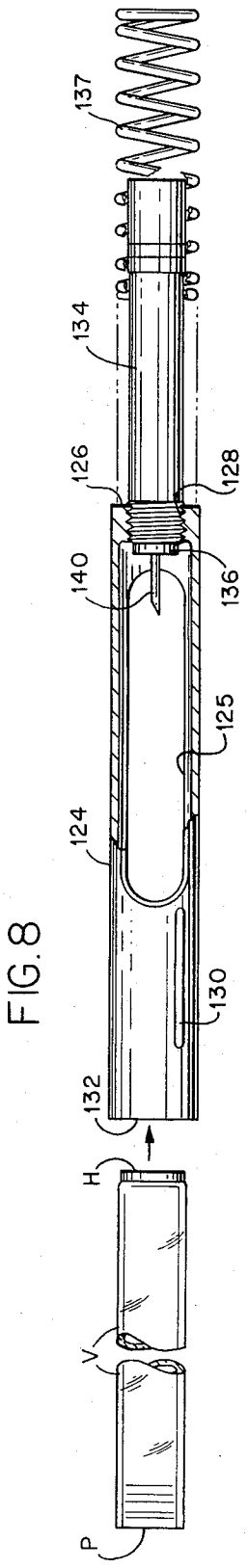


FIG. 8

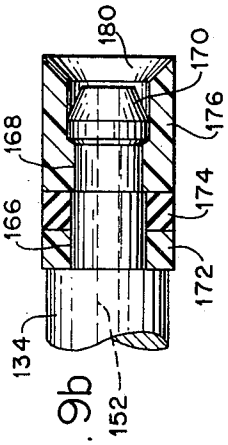


FIG. 9b

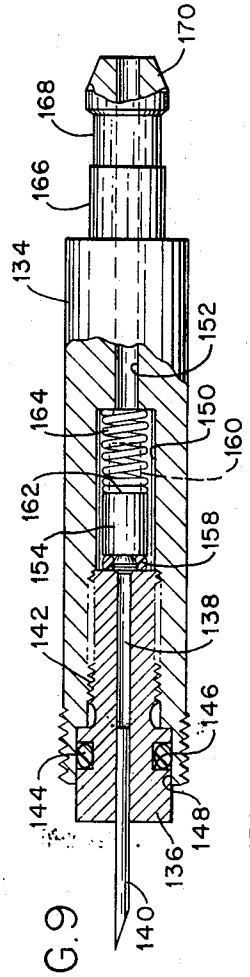


FIG. 9

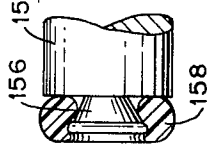


FIG. 9a

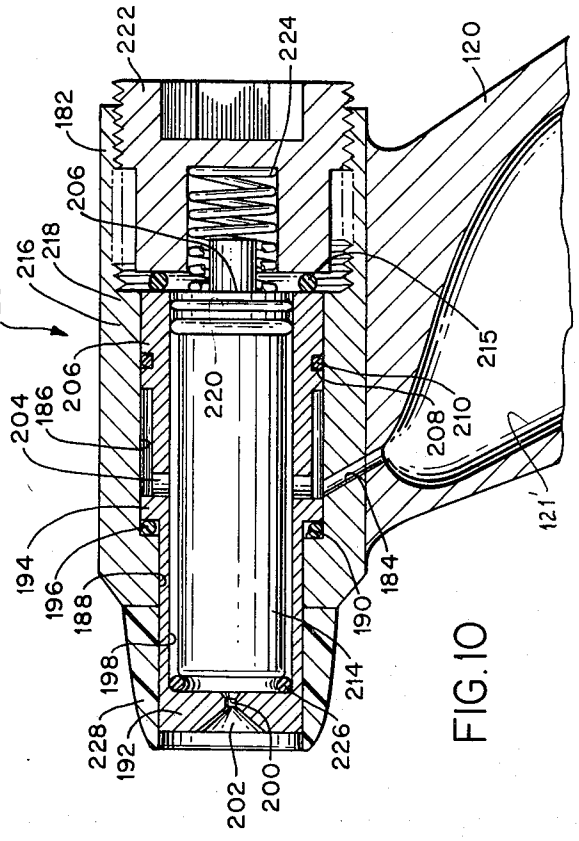


FIG. 10

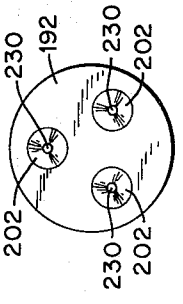


FIG. 11a

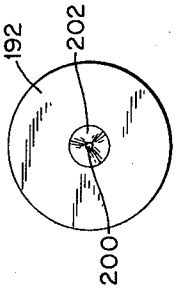


FIG. 11

NEEDLELESS INOCULATOR

The aforementioned Abstract is neither intended to define the invention of the application which, of course, is measured by the claims, nor is it intended to be limiting as to the scope of the invention in any way.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to fluid injection means but more particularly to an improved needleless injector.

2. Description of the Prior Art

The patent literature is replete with many examples of needleless injectors. Perhaps the best example of this type of device heretofore available is the structure shown in the Zimmet et al. U.S. Pat. No. 3,461,867, granted on Aug. 19, 1969. The Zimmet et al. patent teaches the use of a body member having means for supporting a vial and means coaxial with the vial for expressing the fluid therefrom. The injector is provided with means for controlling the fluid issuing from the vial under pressure. On a second and parallel axis there is also provided a chamber in fluid communication with the vial, as well as a plunger for forcing the fluid from the second chamber into a discharge head that includes still another valve. A hand operated lever is provided for loading a spring that actuates the plunger into the second chamber.

While the Zimmet et al patent does teach relatively effective means for injecting fluid without a needle, there are several shortcomings in the device. First of all, the hand operated lever for loading the plunger spring is somewhat awkward to use in that two hands are required. That is, one hand must grip and securely hold the body of the device while the other hand must be used to pivot the lever about a pin. Secondly, separate forces on two different parallel axes must be applied in order to discharge the fluid from the vial and then discharge the fluid from the head.

SUMMARY OF THE INVENTION

By way of contrast, the present invention provides a relatively simple, hand-held device that may be cocked electrically and which requires the use of only one hand for this purpose. An elongated tubular body is provided with a spring-loaded, magnetizable core member that is adapted to be inserted within an electrically energizable coil. When current is passed through the coil, a magnetic field will be induced and the core member will be axially displaced thereby while a spring loaded trigger and latch will automatically lock the core member in its displaced position. The device is then operated merely by depressing the trigger so as to free the core member from the latch. When the core member is displaced a plunger carried thereby is coaxially inserted into a vial containing the fluid. A valve that is coaxial with and downstream of the vial controls the flow of fluid therefrom to a discharge head which is also provided with a vial for metering the quantity of fluid that is to be discharged.

One embodiment of the present invention was built to operate at nominal 120 volts A.C. and delivered a volume of fluid which was adjustable from 0 to 0.6 cc's. The device is completely divorced from electrical sources when applied to the patient and thus avoids accidental electrical shocks. The power pack section is readily removable and reattachable to the head and vial support sections. The use of a solenoid type device for cocking the instrument provides inherently durable structure.

Accordingly, it is an object of the present invention to provide improved injection apparatus that does not require the use of a needle for piercing tissue.

It is another object of the present invention to provide an improved electrical cocking structure for the needleless injector comprising the present invention.

A feature of the present invention is that the vial containing fluid and the plunger for discharging the fluid are located on a common axis.

Still another feature of this invention is that the vial support section and the discharge head are readily separable and interchangeable with respect to the power pack section.

These and other objects, features and advantages of the invention will, in part, be pointed out with particularity, and will, in part, become obvious from the following more detailed description of the invention, taken in conjunction with the accompanying drawing, which forms an integral part thereof.

BRIEF DESCRIPTION OF THE DRAWING

In the various figures of the drawing like reference characters designate like parts.

In the drawings:

FIG. **1** is an elevational view, partially broken away and partially in section, illustrating the structure of the present invention;

FIG. **2** is an elevational view, partially broken away and partially in section, illustrating the injector comprising the present invention;

FIG. **3** is a longitudinal, sectional view illustrating a portion of the power pack section of the present invention;

FIG. **3A** is a fragmentary, longitudinal, sectional view illustrating a constructional feature of the power pack section of this invention;

FIG. **4** is an end elevational view taken along the line **4—4** of FIG. **3**;

FIG. **5** is a longitudinal, exploded view, partially broken away and partially in section, illustrating the components of the power pack section comprising this invention;

FIG. **5A** is a transverse, sectional view, taken along line **5A—5A** of FIG. **5**;

FIG. **6** is a view in elevation of one of the components of the power pack section of the present invention;

FIG. **7** is a longitudinal, elevational view of the combined vial support section and discharge head of the present invention;

FIG. **7A** is an end elevational view taken along line **7A—7A** of FIG. **7**;

FIG. **8** is a longitudinal, exploded view, partially broken away, illustrating internal structure of the vial support section;

FIG. **9** is a longitudinal, sectional view illustrating additional internal structure of the vial support section;

FIG. **9A** and FIG. **9B** are fragmentary, longitudinal views on an enlarged scale and partially in section, illustrating further details of the structure shown in FIG. **9**;

FIG. **10** is an enlarged, sectional view of the discharge head comprising this invention;

FIG. 11 and FIG. 11A are end elevational views of alternative embodiments of the discharge head of this invention; and

FIG. 12 is a transverse, sectional view taken along line 12—12 of FIG. 2.

Referring now to the drawing and specifically to FIG. 1, there is shown an improved, needleless, hypodermic injector 20 comprising the present invention. The injector 20 is comprised of three basic sections. The first section is the power pack 22, the second or intermediate section is the vial support 24 while the third section is the discharge head portion 26. The power pack section 22 and the vial support section 24 are removably coupled to each other by means of a bayonet arrangement comprising radially inwardly directed pins 28 and 30 of different sizes (FIG. 3) that mate with suitably sized, shaped and located L-shaped slots 32 and 33 (FIG. 7). For purposes to be disclosed subsequently, there is also provided a guide pin 34 extending radially outward. In the embodiment illustrated the guide pin 34 is a screw that is threadably received in a tapped hole 35.

Turning now to FIGS. 3–6, it will be seen that the power pack section 22 is comprised of a tubular housing 36, which, for purposes to be disclosed hereinafter, includes an aperture 38 through one wall thereof, a pair of internal, axially spaced apart annular grooves 40, a second aperture 42 formed in one wall thereof intermediate the annular grooves 40 and an elongated, axially extending slot 44. A trigger 46 is provided that includes a recess 48 on the underside thereof at one end, a transversely extending lip 50 at the other end and a downwardly depending ear 52 intermediate the recess 48 and the lip 50. The trigger 46 is pivotally mounted within the slot 44 by means of a pin 54 that extends through a hole 56 formed in the ear 52 and a chordally directed pair of aligned holes 58 formed in the wall of the housing 36. The axis of the pin 54 is substantially parallel to the transversely extending lip 50. A blind recess 62 is formed in the wall of the housing 36 in order to receive one end of a generally radially oriented, external compression spring 64. The other end of the compression spring 64 is received in the recess 48 formed in the underside of the trigger 46. For esthetic reasons, the ends of the holes 58 may be plugged after the mounting pin 54 is inserted therethrough. Finally, the housing 36 is provided with an internal, transverse wall 66 positioned approximately at the location of the pair of holes 58. An axially extending bore 68 is formed in the transverse wall 66 for reasons which will become apparent hereinafter.

Continuing with the description of the power pack section 22, there is also provided, as shown in FIG. 5, a central, tubular core, generally designated by the reference character 70, which is located within the housing 36. The tubular core 70 is comprised of an elongated, axially extending cylindrical portion 72 terminating in a first transversely enlarged diameter portion 74. There is also provided a second enlarged diameter portion 76 as well as two additional portions 78 and 80 having relatively smaller diameters. A pair of transverse walls 82 and 83 are defined between the diametrical portions 78 and 80 and between the diametrical portions 76 and 78, respectively. The core member 70, as shown, for example, in FIG. 5, terminates at one end in a transverse wall 84 having an axially oriented bore 86 therethrough. The opposite end of the core 70 is provided with external threads 88.

A hollow, axially movable rod 90 is positioned within the core 70 and is provided with an enlarged, first head portion 92 at one end thereof. The opposite end of the rod 90 is also provided with a second head portion 94. In the embodiment illustrated the second head portion 94 is formed by a screw that is threadably received within the end of the rod 90. Thus, the rod 90 is axially slidable within and relative to the core 70 but, by virtue of the head portions 92 and 94 at its opposite ends, is captured and the axial movement thereof is limited.

A plurality of belleville washers 96 are mounted on the tubular portion 72 in abutment at one end with the diameter 74 in order to form a resilient, spring-like biasing member. A collar 97 having a single flat surface 98 formed on the periphery thereof, is loosely mounted on the tubular portion 72 in order to capture the belleville washers 96. Undercuts 100 are formed on axially opposite sides of the collar 97 and receive resilient washers 102. In the assembled condition within the housing 36, the enlarged diameter portion 76 abuts the transverse wall 66 and two retaining rings 104 that are received in the annular grooves 40, are mounted about the collar 97 proximate the axially spaced ends thereof. Thus, the collar 97 is prevented from moving axially. A radially extending pin 106 extends through the opening 42 in the housing 36 and is provided with a headed inner end 108 that bears against the flat peripheral surface 98 of the collar 97. This construction also prevents rotational movement of the collar 97. However, the core 70 is slidable in an axial direction relative to the collar 97.

An elongated compression spring 110 is positioned within the tubular rod 90 and also extends through the tubular core 70 for biasing the rod 90 with respect to the core 70. The left hand end of the compression spring 110 is provided with an internal stiffening rod 112 as shown in FIG. 5. A magnetizable cap member 114 is provided with internal threads 116 that mate with the threads 88 formed on the core member 72 in order to form an integral but separable unit. A conical seat 118 is also provided in the cap member 114 in order to receive the left hand end of the stiffening rod 112. In the assembled condition the cap member 114 bears against one of the resilient washers 102 and is telescopingly positioned within the housing 36. On the outside surface of the cap member 114 there is provided a plurality of indicia 119 which, in the embodiment illustrated, take the form of consecutive numbers. The indicia 119 are positioned along a helical path and are arranged to register through the opening 38 formed in the housing 36 so as to provide an indication of the dosage to be discharged. This setting determines the travel of member 70 when the spring pressure is released as described hereinafter. As shown in FIGS. 7 and 8, the vial supporting section 24 is comprised of a housing 120 on one end of which the bayonet slots 32 and 33 are formed. The bayonet type coupling renders it a simple matter to uncouple the vial support section 24 from the power pack section 22 when the vial V must be replaced. This construction also facilitates sterilization of the discharge head section 26. The housing 120 is further provided with an internal, annular lip 121 and a pair of diametrically opposed, axially extending slots 122 through which the contents of a vial V are visible. Internally of the housing there is provided

a tubular sleeve **124** having a pair of diametrically opposed, axially extending slots **125** aligned with slots **122** and a transverse wall **126** formed at one end thereof. A threaded opening **128** is formed in the wall **126.** The sleeve **124** is further provided with a relatively narrow and relatively short axially extending slot **130** near the end opposite the wall **126.** The slot **130** is angularly offset from the diametrically opposed slots **122** and receives the guide pin **34** for preventing rotation of the sleeve **124.** As shown in FIG. **12,** the guide pin **34** does not touch the vial V which has a pierceable head end H, an axially movable integral plug P and which is positioned internally of the sleeve **124.** In the assembled condition, the left hand end surface **132** of the sleeve **124** abuts the transverse wall **82** formed between the diametrical portions **78** and **80** of the member **70.**

A tubular rod **134** (FIG. **9**) is provided with external threads at one end thereof that mate with the threads **128** formed in the sleeve **124.** A plug **136,** having a fine, central bore **138,** is provided with a tubular piercing member **140** that is in fluid communication with the bore **138.** An elongated compression spring **137** is positioned about the tubular rod **134.** One end of the spring **137** bears against the end wall **126** of the sleeve **124** while the other end of the spring **137** bears against the annular lip **121** of the housing **120.** In the assembled condition, the piercing member **140** extends through the end H of the vial V in order to receive the fluid therein. At this time, it should be noted that the head portion **94** of the rod **90** bears against and axially pushes the plug P within the vial V so as to force the fluid into and through the piercing member **140** and the bore **138.** The plug **136** is captured within the tubular rod **134** by means of mating threads **142** and is also provided with a sealing ring **144** that is secured in an annular groove **146** formed on the outside surface of the plug **136.** The sealing ring **144** is positioned within a counterbored recess **148** formed in the left hand end of the tubular rod **134** as shown in FIG. **9.**

An internal chamber or cavity **150** is provided in the tubular rod **134** so as to be in communication with the bore **138.** A bore **152** is also formed in the tubular rod **134** and is in fluid communication with the cavity **150** and thus with the bore **138.** A rod **154** is slidably positioned within the cavity **150** and, at one end thereof, is provided with a conical neck portion **156** on which is mounted a resilient sealing member **158.** As shown in FIG. **9A,** the left hand end of the neck **156** abuts the right hand end of the plug **136** and the sealing member **158** is positioned about the bore **138.** At the opposite end of the rod **154,** as shown in FIG. **9,** there is provided a reduced diameter portion **160** that forms a transverse wall **162** in combination with the body portion **154.** A compression spring **164** that normally urges the rod **154** and the sealing member **158** to the left (FIG. **9**), is positioned about the reduced diameter portion **160** and extends between the transverse wall **162** of the rod **154** and the transverse end wall of the cavity **150.**

The right hand end of the tubular rod **134** (FIG. **9**) terminates in a first diametrical portion **166,** an annular undercut **168** and a conical tip **170.** The bore **152** extends through the tip **170.** A first plastic washer **172,** which may be made of Teflon, is positioned about the diametrical portion **166** and a resilient, elastomeric washer **174** is mounted on the undercut **168.** A plastic cap member **176,** which also may be made of Teflon, is slipped over the washer **174.** As shown in FIG. **9B,** the cap member **176** is also captured within the undercut **168.** The conical tip **170** serves to capture the cap member **176** which is provided with a conically diverging bore **180.** As shown in FIG. **9B,** the cap member **176** extends axially beyond the conical tip **170.**

The head portion **26** comprising the present invention may best be seen in FIG. **10.** A housing **182** having a channel **184** formed therein is secured integrally to the housing **120** by any convenient means such as brazing or the like whereby the channel **184** is in fluid communication with the bore **152.** A counterbored hole, defined by bores **186** and **188** as well as a transverse interface **190** therebetween, is formed in the housing **182** with the bore **186** being in communication with the channel **184.**

A first tubular sleeve **192,** having a transverse flange **194** is positioned within the housing **182** such that a sealing ring **196** is captured between the flange **194** and the transverse wall **190.** The sleeve **192** is further provided with an internal chamber **198** that communicates with a fine bore **200** having a conical orifice **202.** A plurality of radially extending holes **204,** for example three, are formed in the sleeve **192** so as to be in communication with the chamber **198.** The head end of the sleeve **192** is defined by an end portion **206** in which an undercut **208** is formed in order to receive a resilient sealing ring **210.**

A piston **214** is slidably received within the sleeve **192** and includes a piston head **220.** A pair of sealing rings **216** and **218** are located near the head end **220** A plug **222** is threaded into the housing **182** in order to capture a spring **224** that is arranged to bear against the head end **220** of the piston **214.** Plug **222** captures O-Ring **215** and squeezes it against head end **220** and also forces sleeve **192** to squeeze O Ring **196** against wall **190** thereby sealing off the contents of sleeve **192.** A sealing ring **226** is positioned within the chamber **198** about the bore **200** and adjacent the left hand end of the piston rod **214** as shown in FIG. **10.** An elastomeric sleeve **228** is mounted on the outer end of the piston **192** and surrounds the conical orifice **202.** It will be noted that the sleeve **228** extends axially to the left of the orifice **202** as shown for example in FIG. **10.**

Alternative embodiments of the present invention are shown in FIG. **11** and FIG. **11A.** Instead of providing a single, centrally located bore such as shown by reference character **200** in the first embodiment (FIG. **11**), there may also be provided a plurality of bores **230** that are equally spaced apart on a common radius (FIG. **11A**). In both embodiments the bores **200** or **230** are in the order of 0.003 inches diameter.

MODE OF OPERATION

Reference may be had once again to FIG. **1** for a better understanding of the means used for cocking the injector **20.** There is provided a housing **232** comprised of a base member **234** and an integral, vertically extending support column **236.** A bore **238** extends through the column **236** and the base member **234** and has concentrically positioned thereabout, in the vicinity of the base member **234,** a coil **240** that is suitably secured in the base member **234.** The coil **240** is connected in series with an electrical power source. A manual switch **242** and a conventional trigger circuit **244** for generating large pulses of current. A suitable fuse **246** may also be provided.

When the power pack section **22** of the injector **20** is inserted in the bore **238** and the switch **242** is closed, the magnetizable core **70** will be drawn downwardly as would be the armature of a solenoid. This causes the belleville washers **96** to be compressed between the axially movable diametrical portion **74** and the axially secured collar **97.** Energy is thus stored in the belleville washers **96.**

At the same time the spring **64** urges the trigger **46** in a counterclockwise direction (as seen in FIG. **3**) about the pin **54,** so that the lip **50** of the trigger **46** abuts the transverse wall **83** whereby the core **70** is secured in its loaded or cocked position. It should be noted at this time that the spring **110** normally urges the head portion **94** longitudinally to the right into coaxial engagement with the plug P of the vial V. At the same time the spring **137** longitudinally urges the sleeve **124** that contains the vial V to the left in coaxial opposition to the spring **110.** The spring **164** is simultaneously urging the rod **154** to the left in the same direction as the sleeve **124** so that the sealing member **158** will prevent fluid leakage to the bore **138.**

When the trigger **46** is depressed, or moved in a clockwise direction, the lip **50** is removed from the transverse wall **83,** thus permitting the belleville washers **96** to drive the core member **70** to the right, moving member **124** forward thereby pushing fluid through bore **121** and through the channel **184** formed in the discharge head **26.**

Upon entering the discharge head **26** the fluid traverses the radially oriented holes **204** formed in the housing **192.** It should be noted at this time that while two holes **204** are shown as being diametrically opposed to each other, this is done primarily for convenience of illustration. It will be evident that more than two holes may be provided, and in fact in one embodiment of the invention there are three equally spaced apart radially extending holes **204.** The fluid then enters the chamber **198** formed intermediate the tubular housing **192** and the piston **214.** This action causes the piston head **220** to be moved to the right against the force of the spring **224.** This action also causes the piston **214** to move axially away from the sealing member **226** to thereby open the fine bore **200** and the conical orifice **202** so that fluid may be discharged. When all of the fluid has been discharged the spring **224** returns the piston **214** back into sealing engagement with the ring **226.**

There has been disclosed heretofore the best embodiment of the invention presently contemplated. However, it is to be understood that various changes and modifications may be made thereto without departing from the spirit of the invention.

What I claim as new and desire to secure by Letters Patent is:

1. A needleless injector for discharging fluid from a sealed vial having a puncturable member at one end and an axially displaceable plug at the other end, said injector comprising:

a. a power pack section;

b. a magnetizable core slidably mounted in said power pack section for axial movement between a latched position and an actuated position;

b'. means for magnetizing said core for axial movement thereof;

c. latch means for holding said core in said latched position;

d. trigger means for disengaging said latch means;

e. first spring means for positively driving said core from said latched position to said actuated position after said trigger means disengages said latch means;

f. means coaxial with said core and axially displaceable as a result of the movement thereof for axially displacing the plug in the vial to thereby displace the fluid to the vial;

g. a vial support section and a discharge head coupled to said power pack section, said vial support section being coaxial with said core and including a piercing member for puncturing the end of the vial opposite the plug; and

h. means for providing fluid communication between the vial and said discharge head.

2. The injector in accordance with claim **1** wherein said power pack section includes means for preventing rotation of said core.

3. The injector in accordance with claim **1** wherein said power pack section includes means for varying the force of said first spring means.

4. The injector in accordance with claim **3** wherein said force varying means comprises a cap rotatably mounted on said core and having a plurality of indicia that are registrable with a non-rotatable portion of said power pack section.

5. The injector in accordance with claim **1** wherein said plunger is coaxially slidable within said core and second spring means are further included for urging said plunger against the axially movable plug of the vial for displacing the fluid therein.

6. The injector in accordance with claim **1** wherein said first spring means comprises a plurality of belleville washers positioned about said core.

7. The injector in accordance with claim **1** further including means for removably coupling said vial support section and said discharge head to said power pack section.

8. The injector in accordance with claim **1** wherein said vial support section comprises a sleeve, a tubular rod coupled to said sleeve, said piercing member being tubular and integral with said rod, first valve means in said rod, a bore in said rod for providing fluid communication between said piercing member and said discharge head, and third spring means for urging said piercing member into the puncturable member of the vial.

9. The injector in accordance with claim **8** further including means for preventing relative rotation between said sleeve and said vial support section.

10. The injector in accordance with claim **1** wherein said discharge head comprises a hollow body portion; a passageway for providing fluid communication between the interior of said body portion and the vial, piston means slidable within said body portion, at least one discharge orifice in said body portion, second valve means intermediate said discharge orifice and said piston means and fourth spring means for biasing said piston means to a position normally closing said second valve means.

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