

Aug. 6, 1968

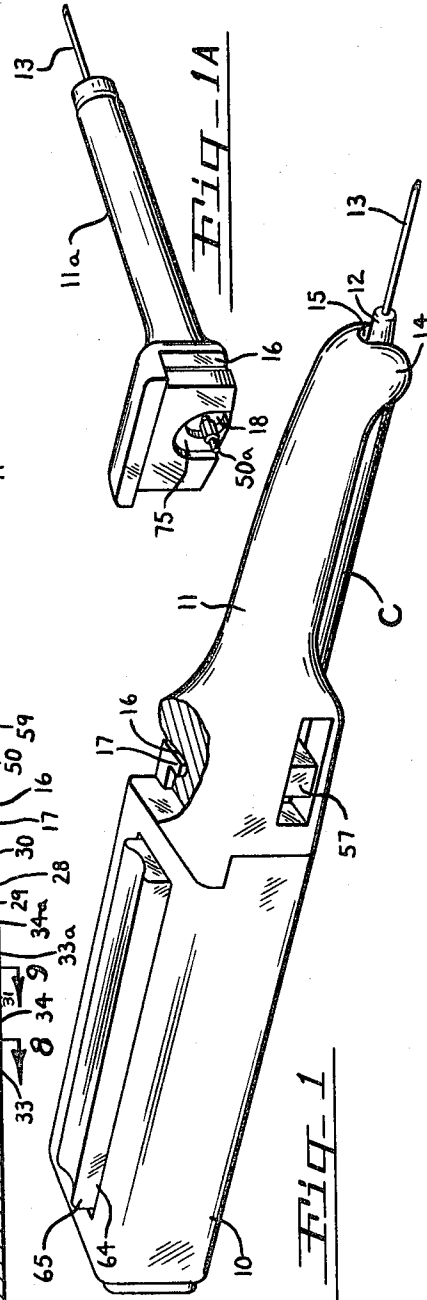
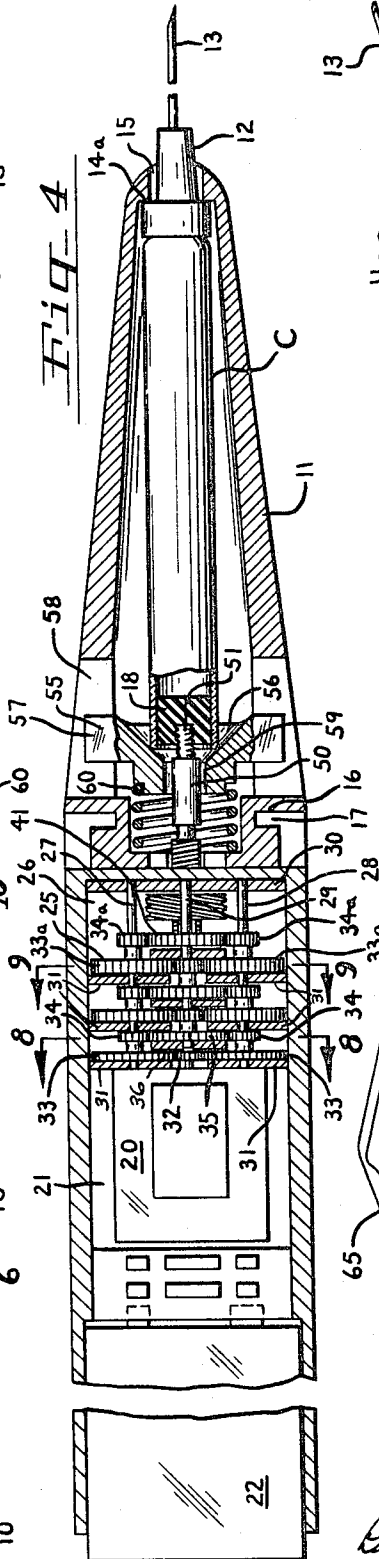
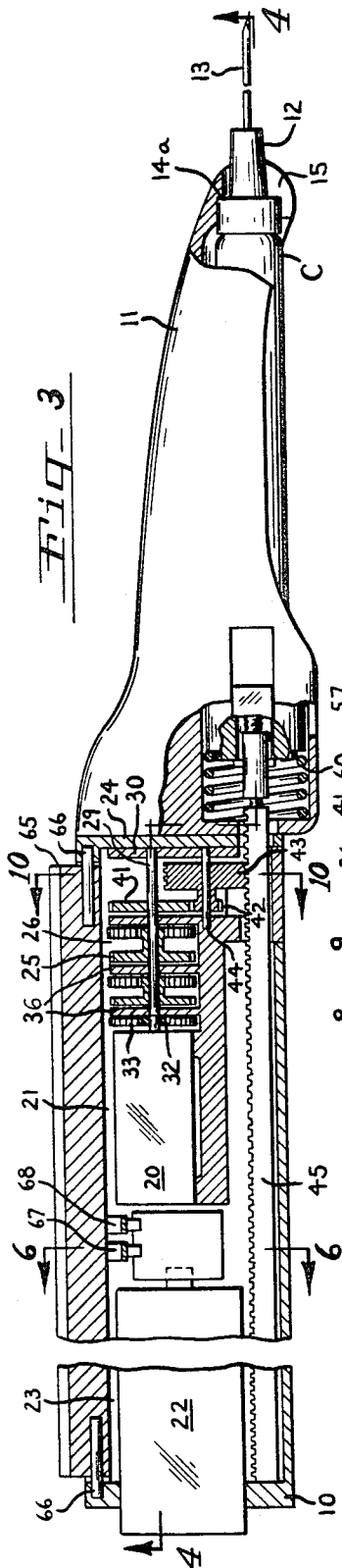
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3,395,704

POWER OPERATED SYRINGE

Filed Nov. 19, 1964

4 Sheets-Sheet 1



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Fig-6

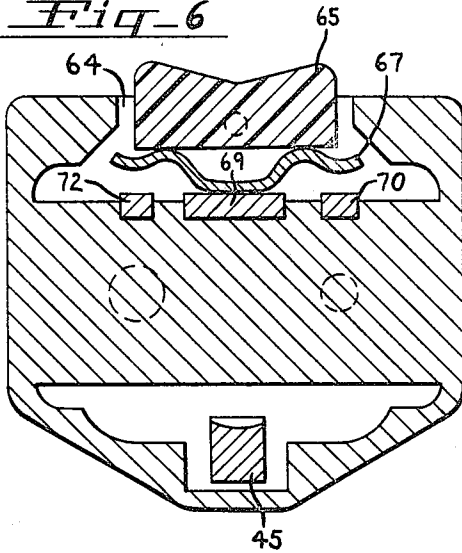


Fig-10

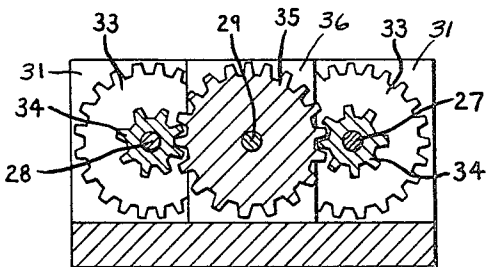
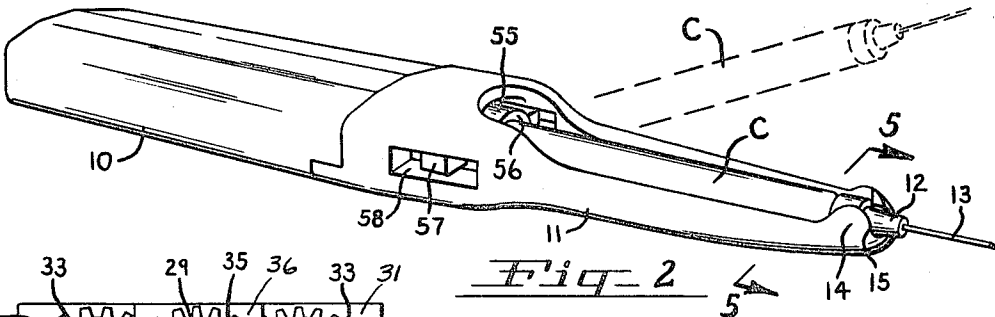
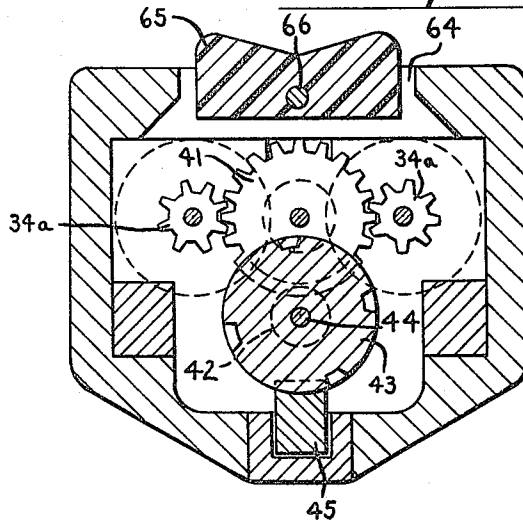


Fig-8

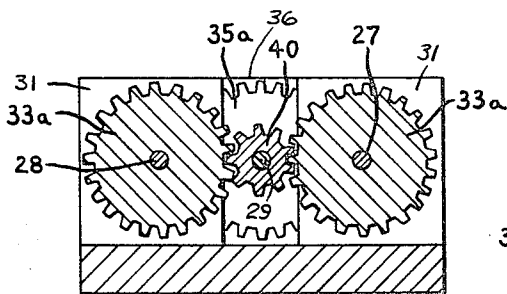
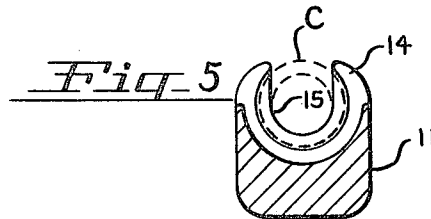
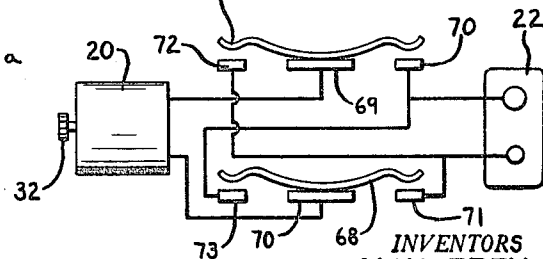


Fig-9

Fig-7



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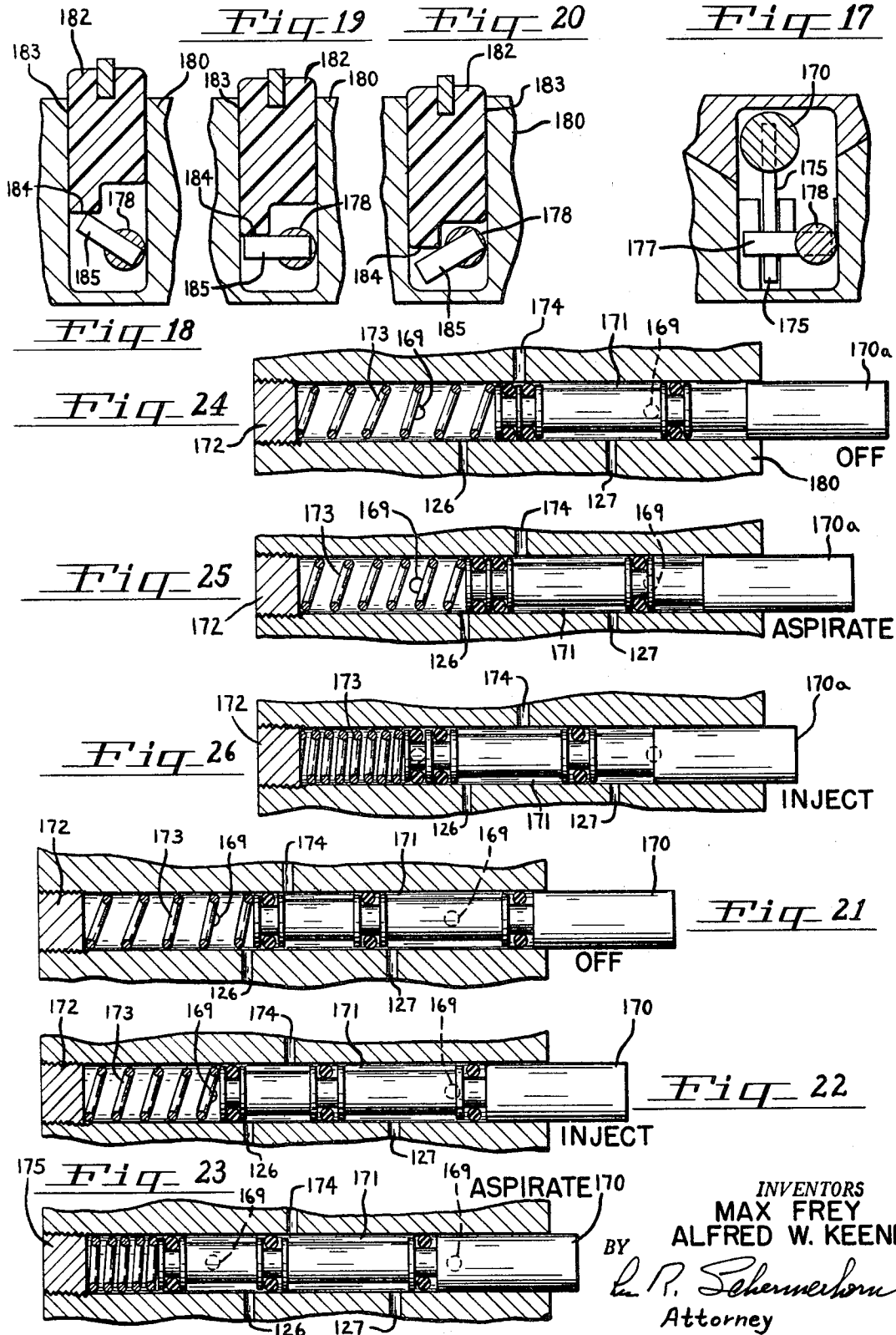
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POWER OPERATED SYRINGE

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4 Sheets-Sheet 4



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POWER OPERATED SYRINGE

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12 Claims. (Cl. 128—218)

ABSTRACT OF THE DISCLOSURE

A power operated syringe arranged to actuate a carpule piston for injection or aspiration. The power source may be an electric motor with a self-contained battery or a piston motor operated by a self-contained compressed gas cartridge or external air pressure supply. The control features an elongated actuator bar movable to inject and aspirate without changing the position of the instrument in the operator's grasp. The instrument is equipped with a detachable side loading carpule holder.

This invention relates to a power mechanism for operating a syringe to inject a fluid into the body or remove a fluid from the body through a hollow needle.

Conventional manually-operated, hollow needle syringes have a number of disadvantages. In making an injection through a fine needle, considerable physical force is required to discharge the liquid thereby impairing the tactile sense of the operator. The conventional form of construction is not convenient to use for aspiration purposes. Ordinarily, a different grip on the instrument is required for aspiration whereby the operator must change the positions of his hands if both injection and aspiration are to be performed in sequence. Also, manually-operated syringes require a particular grasp, particularly for injection, which may not be the most convenient grasp for insertion of the needle, or for aspiration, thereby requiring the operator to change the positions of his hands one or more times during the use of the instrument. Another objection to conventional manually-operated syringes is that they induce considerable psychological fear in the patient because usually the plunger and its operating handle are in full view of the patient during use.

Objects of the present invention are, therefore, to provide a power-operated syringe for injection and aspiration, to provide an instrument which is more convenient to use than conventional syringes, to provide an instrument which will apply more force than a conventional syringe thereby permitting use of a finer needle, to provide an instrument having a control key which is accessible in a variety of different holding positions, to provide an instrument which will increase the operator's tactile sense, to provide an instrument which does not require a change of grasp for injection and aspiration operations and to provide an instrument of the type described which is relatively small and compact and can be substantially concealed in the hand of the operator to avoid psychological fear in the patient.

The operating mechanism of the present device is incorporated in a relatively small and compact housing which may be pretty well concealed in the hand of the operator. The operating parts are not exposed to the view of the patient whereby the element of fear is appreciably reduced. The injection and aspirating functions are accomplished by a readily accessible control key which does not require the operator to change his grip after inserting the needle. He does not have to grasp the instrument in the manner required for exerting physical force in producing injection or aspiration. This makes the entire operation faster and easier for the operator and easier on the patient. The operating mechanism may be actuated by

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compressed air or gas or it may be operated electrically by a battery contained within the instrument.

The invention will be better understood and additional objects and advantages will become apparent from the following description of two preferred embodiments illustrated in the accompanying drawings. Various changes may be made, however, in the details of construction and arrangement of parts and certain features may be used without others. All such modifications within the scope of the appended claims are included in the invention.

In the drawings:

FIGURE 1 is a perspective view with parts broken away, showing an electrically operated syringe embodying the principles of the invention, using a conventional carpule;

FIGURE 1A is a perspective view of a special carpule which may be used with a portion of the device in FIGURES 1 to 4;

FIGURE 2 is a perspective view showing the opposite side of the device in FIGURE 1;

FIGURE 3 is a side elevation view of the device in FIGURES 1 and 2 with parts shown in section;

FIGURE 4 is a view approximately on the line 4—4 of FIGURE 3;

FIGURE 5 is a view on the line 5—5 of FIGURE 2; FIGURE 6 is a sectional view on the line 6—6 of FIGURE 3;

FIGURE 7 is a wiring diagram showing the reversing switch for the motor;

FIGURE 8 is a sectional view on the line 8—8 of FIGURE 4;

FIGURE 9 is a sectional view on the line 9—9 of FIGURE 4;

FIGURE 10 is a sectional view on the line 10—10 of FIGURE 3;

FIGURE 11 is a perspective view showing a modification operated by gas pressure;

FIGURE 12 is an end view of the device shown in FIGURE 11;

FIGURE 13 is a longitudinal sectional view on the line 13—13 of FIGURE 12;

FIGURE 14 is a fragmentary sectional view on the line 14—14 of FIGURE 12;

FIGURE 15 is a view of the pressure regulating adjuster;

FIGURE 16 is a fragmentary sectional view showing an adapter for external pressure connection;

FIGURE 17 is a view on the line 17—17 of FIGURE 14;

FIGURE 18 is a view on the line 18—18 of FIGURE 14 showing the key in off position;

FIGURE 19 is a view similar to FIGURE 18, showing the key in a first operated position;

FIGURE 20 is a view similar to FIGURES 18 and 19, showing the key in a second operated position;

FIGURE 21 is a fragmentary sectional view showing an inject valve plunger in off position;

FIGURE 22 is a similar view showing the plunger in inject position;

FIGURE 23 is a similar view showing the plunger in aspirate position;

FIGURE 24 is a similar view showing an aspirate valve plunger in off position;

FIGURE 25 is a similar view showing the plunger in aspirate position; and

FIGURE 26 is a similar view showing the plunger in inject position.

ELECTRICALLY OPERATED EMBODIMENT, FIGURES 1-10

Referring first to FIGURES 1 and 2, this embodiment comprises a body member 10 having a detachable carpule

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holder 11 for a conventional carpule C. The carpule has a reduced plastic end fitting 12 carrying a hollow steel needle 13. Carpule holder 11 is of channel shape in cross section as shown in FIGURE 5 for convenient insertion and removal of the carpule. The holder has a reduced outer end portion 14 with an internal shoulder 14a to seat the end of the barrel of the carpule and an end slot 15 through which the plastic fitting 12 projects as shown in FIGURE 4. For detachable mounting on body 10, the carpule holder has a pair of transverse slots 16 in its opposite sides for sliding engagement with inturned angular lugs 17 on the end of the body 10. The conventional carpule as supplied by the manufacturer contains a rubber or plastic piston 18 within its glass barrel. The purpose of the operating mechanism to be described is to reciprocate piston 18 in the carpule.

The reciprocating mechanism is operated by a small electric motor 20 in a motor chamber 21, which motor is energized from a battery 22 in a battery chamber 23 as shown in FIGURE 3. The motor is a relatively high speed low torque type, and the speed is reduced and the torque increased many times by means of reduction gearing 25 in a gear chamber 26 which extends from the motor chamber 21 to the end wall 24 of the body unit. The efficiency of a small battery-operated motor in developing usable torque requires the elimination of as much friction as possible in the drive system. For this purpose unbalanced bearing loads in the motor and gear train are minimized by arranging duplicate sets of reduction gears on two parallel shafts 27 and 28 on opposite sides of a central shaft 29 which is coaxial with the motor shaft. All three of these shafts are stationary.

Shafts 27 and 28 are mounted in end support plate 30 and additional support plates 31 on opposite sides of the gear chamber as shown in FIGURES 4 and 9. Central shaft 29 is mounted in end support plate 30 and additional central support plates 36 as shown in FIGURES 3 and 8. Side plates 31 are clear of the central shaft 29 and central plates 36 are clear of the shafts 27 and 28.

Motor pinion 32 drives a pair of large gears 33 having pinions 34 integral therewith on the shafts 27 and 28. The two pinions 34 drive a center gear 35 as shown in FIGURE 8. Gear 35 is integral with another pinion which drives another pair of gears similar to the gears 33. These gear combinations repeat in several stages as shown in FIGURES 4, 8 and 9. In FIGURE 9 the pinion 40 is integral with a gear 35a, similar to gear 35 in FIGURE 8, and drives a pair of gears 33a similar to the gears 33 in FIGURE 8. The gears 33a are integral with pinions 34a which drive the last central gear 41 in FIGURES 3 and 4. Gear 41 drives a pinion 42 which is integral with a worm 43 on a different shaft 44. Worm 43 meshes with the teeth on a longitudinally slidable rack bar 45. The rack bar extends through end wall 24 and is equipped with a coupling 50 having internal threads in its outer end for detachable connection with a threaded stud 51 in piston 18 as shown in FIGURE 4.

A cross head 55 has a conical seating surface 56 for centering the ends of carpules of different lengths and diameters. This cross head has a pair of oppositely directed tongues 57 slidable in guide slots 58 in the holder 11 as shown in FIGURES 2 and 4. The cross head has a central opening 59 to receive the coupling 50 and is backed up by a compression spring 60 which urges the cross head outwardly. Spring 60 is contained in a recess in holder 11 and compressed between the cross head 55 and the end wall of the holder. The carpule is inserted and removed as shown in broken lines in FIGURE 2. By pressing the large end of the carpule against cross head 55 and compressing the spring 60, the reduced end portion 12 may be inserted in and removed from the slot 15 of the holder.

The motor is controlled by the elongated rockable key member 65 which projects through a slot 64 and extends substantially the full length of body member 10, preferably on the side opposite the open side of holder 11 as

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shown in FIGURES 1 and 3. This key member is pivotally mounted on a pair of pins 66 in the body member. Opposite sides of this key member bear against opposite end portions of a pair of spring contact fingers 67 and 68 which are centrally mounted on terminal plates 69 and 70. Spring fingers 67 and 68 normally hold the key member 65 biased in open circuit or off position as shown in FIGURES 6 and 7. When the key member is rocked to one side, the spring fingers 67 and 68 engage stationary contacts 70 and 71 for driving the motor in one direction, and when the key member is rocked to the opposite side, the spring fingers 67 and 68 engage contacts 72 and 73 for driving the motor in the opposite direction. The motor 20 has a permanent magnet field whereby only the armature has circuit connections with battery 22.

This arrangement of the switch key member 65 makes it accessible to a thumb or finger of the operator, regardless of how he may grasp the body 10 to insert the carpule needle 13 through the skin. Then, without changing his grasp, the operator may rock the key switch member one way or the other to inject or aspirate. There is no shifting of the hand and no muscular effort to reduce the tactile sense during injection or aspiration.

FIGURE 1A illustrates a special form of carpule 11a to fit body member 10 and eliminate the carpule holder 11. The base of the carpule is equipped with a slot 16 to fit the bracket tongue 17 as in FIGURES 1 and 4, and the syringe piston 18 is equipped with a coupling device 50a for detachable connection with the end of rack bar 45. The base of the holder has a slot 75 which is open on one side of the holder to provide access for screwing the threaded end of stud 50a into coupling 50.

GAS PRESSURE OPERATED EMBODIMENT, FIGURES 11-26

In FIGURE 11 the body 100 has an integral channel-shaped forward extension 101 to hold the carpule C. The carpule has a reduced end 102 carrying a hollow needle 103. The end of the carpule barrel seats against a shoulder 104 with the reduced portion 102 disposed in a slot 105. The carpule is held in this seated position by an annular end clamp member 110 having a conical seating surface 111 to center the end of the carpule barrel as shown in FIGURE 13. Clamp member 110 is mounted on the outer end of a piston rod 112 and urged against the carpule by a compression spring 113 which bears against an end member 114 in a cylinder 115. When there is no carpule in the holder, the outward movement of clamping member 110 is limited by a stop 116. The outer end of the piston rod carries a coupling nut 117 for connection with a screw threaded stud 118 in the carpule piston 120.

The inner end of piston rod 112 is equipped with a piston 125 which is slidable in cylinder 115. Passageways 126 and 127 communicate with opposite ends of the cylinder for admitting gas pressure to reciprocate the piston in either direction for operating the carpule piston 120 in an injection stroke or an aspiration stroke as may be desired. The source of pressure for the cylinder 115 may be either a rechargeable, high pressure air or other gas container 130 mounted on the body 100 or a hose connector fitting 131 in FIGURE 16 for obtaining gas pressure through a hose connection from a source outside of the body 100.

When the high pressure gas container 130 is utilized as a source of pressure, a pressure reducing and regulating valve must be employed to reduce the pressure to the value desired in cylinder 115. For this purpose, the end of container 130 is equipped with a special valve body 135 having a threaded end 136 or quick disconnect coupling for mounting the container in the forward end of a bore or chamber 137. Valve body 135 has an internal chamber 138 with an inlet passage 139 from container 130 and an outlet passage 140 leading to chamber 137 in body 100. The outlet passage is closed by a ball valve 141 which

is normally held in seated position by the gas pressure in chamber 130 and a spring 142.

The pressure regulator comprises a plunger 145 which is biased inwardly by atmospheric air pressure and a regulator spring 146. The opposite end of spring 146 seats on the inner end of a regulating knob 150 in a pressure regulator body 151 which is screw threaded at 152 into the rear end of chamber 137. An atmospheric pressure chamber 156 is formed inside the chamber 137 by a tube of a flexible material 153 connected between plunger 145 and the inner end of body 151. A supporting spring 154 prevents collapse of the tube 153 from the higher pressure in chamber 137. Chamber 156 communicates with atmosphere through a passage 157 in regulating knob 150. A valve stem 155 on the valve 141 projects into chamber 137 for engagement by the plunger 145.

The mechanism just described operates to release gas from container 130 from time to time as may be necessary to keep the pressure in chamber 137 at a predetermined constant value above atmospheric pressure. When the pressure in chamber 137 falls below such value, the atmospheric pressure in chamber 156 plus the force exerted by spring 146 cause plunger 145 to press against valve stem 155 and unseat the valve 141. Gas then flows from container 130 into chamber 137 until the gas pressure therein is sufficient to depress the plunger 145 and allow the valve 141 to seat.

Pressure regulating knob 150 has a cylindrical barrel portion 160 which is slidable and rotatable in a bore in the body 151. This barrel portion has a longitudinal groove 161 which receives the end of a guide pin 162 in the body 151. The rear end of this groove branches into a low pressure notch at 163 and a high pressure notch at 164 to provide a choice of two different operating pressures in chamber 137. Notch 164 is closer to the rear end of barrel 160 than notch 163 so that when pin 162 is placed in the notch 164, the spring 146 is compressed to a greater extent to increase the spring force applied to plunger 145.

When the gas supply is obtained from an external source, its pressure is regulated to the desired value and the pressure regulating mechanism just described is not necessary. In such case, the pressure regulating body 151 is removed and the external supply fitting 131 in FIGURE 16 is inserted in its place and the container 130 and valve body 135 are replaced by a plug. An air or gas hose is then connected to fitting 131.

A spool-type valve plunger 170 admits gas to one end or the other of cylinder 115 to control the reciprocating movements of piston 125. This valve plunger is mounted for reciprocation in a bore 171. The rear end of the bore is closed by a threaded plug 172 which seats one end of a valve spring 173 acting against the valve plunger. The bore has side ports communicating with passages 126 and 127 to opposite ends of cylinder 115 and a side port communicating with a passage 174 to the chamber 137. The bore also has a pair of exhaust ports 169 which discharge to atmosphere.

Valve plunger 170 is reciprocated by one arm of a bell crank lever 175 in FIGURES 14 and 17 which is pivotally mounted at 176 in the body 100. The other arm of the bell crank lever may be depressed by a pin 177 in a shaft 178. The ends of the shaft are mounted for rotation in grooves 179 in the body 100. The shaft ends are retained in these grooves by a removable body section 180 which mates with the main body 100 in a V-shaped parting line 181 as shown in FIGURE 12. The valve bore 171 is in body section 180 close to the vertex of the V. Passages 126, 127 and 174 pass through removable section 180.

Shaft 178 is rotatable by an elongated key 182 which extends for a substantial distance along one side of the device as shown in FIGURE 11. Key 182 is mounted for in and out sliding movement in a slot 183 in body section 180 as shown in FIGURE 18. A pair of lugs 184 on the inner side of the key at each end thereof are arranged to engage and depress pins 185 which form arms on the

shaft 178 whereby the shaft is rotated to actuate the bell crank 175 and depress the valve plunger 170. Key 182 is retained in its slot 183 by end lugs 186 as shown in FIGURE 14.

The valve plunger 170 has three different positions for off, inject and aspirate as shown in FIGURES 21, 22 and 23 and the valve operating mechanism is arranged so that the operator can feel these different positions when he depresses the key 182. For this purpose the inner ends of lugs 184 are made flat and the parts are arranged so that in inject position, as shown in FIGURE 19, the inner surfaces of the lugs 184 will bear flat against the sides of pins 185. FIGURE 18 shows the off position of the key with the key 182 fully extended to the limit permitted by its stop lugs 186. When the key 182 is depressed through a first range of movement, the inner ends of lugs 184 bear against the ends of pins 185 providing a long lever arm for maximum mechanical advantage in depressing the valve plunger against the force of its spring 173.

When the valve plunger reaches inject position in FIGURE 22, the flat ends of lugs 184 bear flat against the sides of pins 185 producing a detent effect which resists further inward movement of key 182. When it is desired to aspirate, the key must be depressed with a greater force because then not only is the spring 173 compressed to a greater extent but, also, the corners of lugs 184 bear against the sides of pins 185 at points closer to the axis of shaft 178 with a marked reduction in mechanical advantage as shown in FIGURE 20. Aspirate valve position is shown in FIGURE 23. By reason of this arrangement, a light pressure on the key moves it from its off position in FIGURE 18 to its inject position in FIGURE 19 but, for further movement to its aspirate position in FIGURE 20, a considerably greater force is immediately necessary. The key may be depressed in this manner by applying finger or thumb pressure at either end or in the middle of the elongated key without changing the grasp of the instrument used in piercing the skin with the needle.

Sometimes it is desired to provide a different valve sequence of off, aspirate and inject. In order to effect this change all that is necessary is to substitute a different valve plunger 170a as shown in FIGURE 24. The off position of the parts is then shown in FIGURES 18 and 24. The first range of movement of key 182 to its FIGURE 19 position shifts the valve plunger to aspirate position as shown in FIGURE 25. Then in the final range of movement of the key to its FIGURE 20 position, the valve plunger is moved to inject position as shown in FIGURE 26. This valve sequence is particularly desirable for withdrawing specimens of blood and the like, the inject valve position being used to discharge the specimen from the carpule. The valve plungers 170 and 170a are readily removable by merely taking out plug 172.

In order to provide a smooth retract movement of piston 125 for aspiration, it is desirable to provide resistance means for the piston to work against during its retract motion. This is shown in FIGURE 13. Piston rod 112 is a hollow tube which has a sliding fit on a stationary rod 190 mounted in the rear end of body 100. Rod 190 contains a small bore 191 opening at its forward end into the hollow piston rod and opening at its rear end into an expansible and contractable chamber 192 formed by an elastic rubber diaphragm 193. Bore 191 and chamber 192 are filled with a suitable liquid.

When piston 125 moves forward the elasticity of diaphragm 193 displaces the liquid from chamber 192 through bore 191 into the hollow piston rod 112. Then during aspiration the incompressible liquid is displaced from the piston rod back to chamber 192, stretching the diaphragm. The resistance offered by the small bore 191 and the elasticity of the diaphragm impose sufficient resistance to the rearward travel of the piston to prevent a jerky and erratic movement so that aspiration may be accomplished smoothly at a steady rate.

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Having now described our invention and in what manner the same may be used, what we claim as new and desire to protect by Letters Patent is:

1. A syringe mechanism comprising an elongated body member having a carpule holder, a slidable member arranged to engage and reciprocate the carpule piston in inject and aspirate movements, a motor in said body member to reciprocate said slidable member a control key on said body member movable to three different positions for operating said motor in opposite directions and stopping said motor, said control key comprising an elongated bar extending a substantial distance along said body member for manipulation at any point along the length of the bar, said bar being movable into said body member from a normal off position to two different depressed positions for energizing said motor for operation in said opposite directions, and means to abruptly increase the resistance to movement of said bar in moving from the first depressed position to the second depressed position.

2. A mechanism as defined in claim 1, including in said body member a source of energy for said motor.

3. A mechanism as defined in claim 2, said motor being a pneumatic motor and said source of energy being a compressed gas cartridge.

4. A mechanism as defined in claim 3, including a pressure regulating valve between said gas cartridge and said motor.

5. A machine as defined in claim 4, said pressure regulating valve and gas cartridge being removable, and an external gas pressure supply fitting arranged for mounting on said body member in place of said regulating valve.

6. A mechanism as defined in claim 1, including means for operating said motor to inject in said first depressed position of said key and for operating said motor to aspirate in said second depressed position.

7. A mechanism as defined in claim 1, including means for operating said motor to aspirate in said first depressed position of said key and for operating said motor to inject in said second depressed position.

8. A mechanism as defined in claim 1, said carpule holder comprising a channel member having a shouldered and slotted end portion to receive the needle end of the

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carpule, and an annular spring actuated clamping member having a conical seat for engaging and centering the opposite end of the carpule barrel, said slidable member being movable through said annular clamping member.

9. A mechanism as defined in claim 1, said slidable member being a piston rod having a piston in said body member.

10. A mechanism as defined in claim 9 including resistance means opposing the movement of said piston rod in the aspirate direction.

11. A mechanism as defined in claim 10, said resistance means comprising a liquid chamber in said piston rod, an expansible elastic chamber, and means for displacing liquid from said piston rod chamber into said elastic chamber during the aspirate movement of the piston rod.

12. A syringe mechanism comprising a body member arranged to hold a carpule, a cylinder having a piston rod for reciprocating the carpule piston, a gas pressure chamber in said body member, means for supplying gas under pressure to said chamber, a reversing valve connected between said cylinder and said chamber, a rotary shaft for shifting said valve, a radial arm on said shaft, and a depressible key engageable with the end of said arm to rotate said shaft and shift said valve to a first operating position, further depressing movement of said key transferring the point of engagement to an intermediate point on said arm to rotate said shaft and shift said valve to a second operating position.

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