This invention relates to veterinary syringes and has for its principal object the provision of an electrically operated syringe primarily intended for giving a plurality of successive injections. An important object of the invention is to provide a hypodermic syringe in which the member carrying the needle is advanced hydraulically by the medication.

Further features of the invention reside in a hypodermic needle carried by a free piston and spring-pressed into firm engagement with the piston, whereby to prevent the usual hollow needle as it is withdrawn from the exit opening of the syringe, a central medicament chamber closed at one side by a power-operated plunger and closed at the other side by the needle-carrying piston; a simple dial for adjusting quickly and easily the amount of dosage at each injection; and an arrangement of parts which permits the syringe to be made smaller and more efficient than earlier models.

In the drawings:

FIG. 1 is a central section.
FIG. 2 is a section taken on line 2—2 of FIG. 1.
FIG. 3 is an end view of the casing cap.
FIG. 4 is a sectional detail on a larger scale.
FIG. 5 is a section taken on line 5—5 of FIG. 1.

The syringe is housed in a casing conveniently made of four parts, a handle and barrel section 10, a rear cap section 11, a cylinder section 12 and a nose section 14. Within the handle and barrel section 10 is located a solenoid coil 16 and within this an armature 18 which may slide rearwardly into contact with any one of a plurality of stops movable to stop position by a dial 20 at the rear of the cap section 11. The armature 18 advances a plunger 21 which forms the rear wall of a chamber 22, whereby when the solenoid 16 is energized the plunger will move forward in the chamber 22. As soon as the solenoid is de-energized the plunger 21 and its stem 23 are returned by means of a spring 25 confined between a retainer 26 pressed against a shoulder 27 at the rear and against a forward retainer 28 pressed against shoulder 29. This section also returns the armature 18 which is constantly in contact with the rear portion 17 of the stem. For convenience in cleaning, the plunger 21, its stem 23, and the retainer 26 are all made in one piece.

Thus, when the cylinder section 12 is unscrewed from barrel section 10, the rear portion 17 of stem 23 slides easily out of its bearing in the solenoid frame 19. The spring 25 is next released by slipping off snap ring 24 from the spring 25 and also angular stop 28 can then be moved forwardly out of the cylinder section with plunger 21.

The cylindrical casing section 12 has a third and smaller bore 24 in which a piston 30 slides with a snug fit insured by a quad ring rubber seal 67. This piston 30 has a central bore 33 normally closed by a ball 34 spring pressed as at 35 to its seat. At its front end the piston 30 receives, as by a threaded connection, an adapter 36, and an o-ring 37 insuring against leakage. The front end of the adapter has a tapered nose 38 (FIG. 4) which receives a hypodermic needle 40 of usual type being hollow as is the piston-adapter unit so that fluid at the proper time may readily pass from chamber 22 through the needle which is then in the exit opening 42. The needle head 43 is included in a thimble 44 having at its rear a circular flange 45 to form a stop for spring 46 anchored at the front end by shoulder 47 so that the thimble by its engagement at 48 holds the hypodermic needle 40 in firm contact with the tapered end 38 of the adapter thus preventing the needle from moving away from the adapter and preventing any leakage of air into the needle which might possibly occur if this joint were not firm.

In its preferred form the armature 18 is rectangular in cross section as best seen in FIG. 2. Current is supplied to the similarly shaped solenoid coil 16 which is energized by pressing the spring-pressed button or trigger 54 which moves actuating arm 55 about its pivot 56 so as to make contact with the button 57 of the micro-switch 58, thus completing an electric circuit of any desired voltage, either A.C. or D.C., as may be desired by the purchaser.

When the current is thus completed the armature 18 moves forward, the plunger 21 provided with the usual quad ring 31 moves toward the front end of the chamber 22. Such movement forces the piston 30 forwardly carrying with it the adapter and needle readily overcoming the spring 46 so that the point of the needle passes through the restricted orifice 42 which is the exit opening and penetrates the skin of the subject, normally an animal, but obviously the syringe by slight changes could be used on human beings.

It will be noted that as the piston moves forward no liquid passes through bore 33 closed by the ball 34 until the point of the needle has passed beyond the tip of the nose of the syringe. Continued movement, however, of the plunger 21 forces the selected dose of medicament from chamber 22 through the piston adapter and needle and discharges it into the subject.

Entry of fluid into the chamber 22 is taken care of in normal manner usually through a flexible tube 60 leading to a container (not shown) of any desired size. The intake valve 61 is normally closed by ball valve 62 spring-pressed as at 63 to closed position so that no fluid enters the syringe through plastic tubing 60 until the solenoid has been de-energized. When so de-energized, the plunger unit is promptly returned rearwardly, pushing the core or armature 18 in front of it in this travel. The piston 30-adapter 36-needle 40 combination is snapped back into initial position very fast. The rearward movement of the plunger creates a partial vacuum in chamber 22 whereby valve 62 opens and a further amount of fluid then passes to the chamber 22 to refill the same. The bore 24 is somewhat enlarged as at 66 so that fluid can readily pass around the rear end of piston 30 beyond the quad ring 67. This enlargement was made necessary as the inlet valve restricts the flow of incoming fluid. This restriction provides the vacuum pull to assist piston 30.

While other methods of determining the quantity of fluid to be discharged at each cycle may be applied, I find the following specific form highly advantageous:

The rear cap 11 is generally cylindrical and joined to the adjacent portion 10 of the casing by threaded engagement such as 69. A disk 70 with a shaft 71 is eccentrically mounted in the base of the cap and carries, as best seen in FIG. 2, at 72" apart four pins or stop members of successively longer lengths, these being numbered respectively, 73, 74, 75 and 76. The fifth position indicated by the cross 78 is formed by the smaller recesses 79 of the core or armature 18 striking the face of the disk 70. Concentric with the pivot shaft 71 is a series of detent recesses such as 80, corresponding to stops 78, 73, 74, 75 and 76 which might for example represent 5, 4, 3, 2 and 1 cc of fluid to be admitted to the chamber 22 for the next dose.

By having the needle piston actuated hydraulically, which is unique in the field of hypodermic syringes, its relation to the rear plunger makes it a hydraulic servo system.
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The operation of the dial is quite simple, but obviously the stop pins 73, etc. must be free of the core 18 when changing the dosage. This could be arranged by unscrewing the cap but in a much simpler manner is to press the trigger button 54 moving the core forward well beyond any of the pins and then turning the dial 29 so that the dosage numeral such as "50" is opposite the zero mark 82 shown in FIG. 3. At this time the armature 18 will press against the disk 70 at the point 76, the fifth position, and the stem 17 of plunger 21 will always be in contact with the armature. As seen from FIG. 2 the pins 73 to 76 will all be out of the path of the armature 18. Should a dosage of 3 cc. be indicated, the dial would be rotated until pin 74 is in the position indicated by the cross 78 and by the numeral "3" on the dial.

The sequence of operation is as follows: Assuming that the dial 29 has been turned to indicate the correct dosage: with the end of the nose 14 placed against the subject to be injected, the operator presses trigger button 54 which energizes the coil of the solenoid thus advancing the armature 18-plunger 21 unit, which includes the retainer 26 and the stem 17-23. The fluid in chamber 22 is now put under pressure which advances the piston 30, adapter 36, and needle 40 in a forward direction, this unit advancing until the adapter 36 strikes shoulder 85 at which time the needle passing through the exit orifice 82 will have penetrated the skin of the subject being treated. At such a time the needle unit in contact with it will not have completed its full stroke, having moved only such portion of its travel as is required to advance the piston 30 fully. Since the solenoid coil 16 is still energized, further movement of the plunger 21 will for the first time force the fluid through the bore 33 diaphragm 34 and allowing the chosen dosage of medication to flow through the needle into the subject.

As soon as pressure on the trigger button 54 is released, the spring 88 will restore it to its initial position, shutting off current to the micro-switch 58 and de-energizing the solenoid. This permits the spring 25 to expand, thus moving the core to the rear as far as permitted by the appropriate pin or stop on the disk 70. While spring 46 is returning the piston 30 and the spring 35 by seating ball 34 closes the passage 33 a partial vacuum within chamber 22 is created with the consequence that ball 62 overcomes its spring 63 and admits fluid into chamber 22 until the piston 30 is still resting or even after its full return movement because of the enlarged portion 66.

What we claim is:

1. In a hypodermic syringe of the type in which a hollow needle is electrically projected beyond the syringe to pierce the epidermis followed by injecting a fluid through the needle and into the underlying tissues, a casing having therein a pair of communicating coaxial bores of unequal diameters, the larger bore forming a chamber, means for admitting fluid into the chamber, said casing having an exit opening, a power driven plunger fitting the chamber, a hollow hypodermic needle within the casing coaxial with the plunger and adapted to be projected through the exit opening and beyond the casing, means for closing communication between the chamber and the hollow needle when the plunger is in operative position and means for returning the plunger and needle to initial position, said last mentioned means being such as to make these admitting means operable.

2. The combination of claim 1 in which the needle is carried by a piston slideable within the bore communicating with the chamber, the piston at all times being spaced from the bore resulting in the needle and having an exit port, said exit port being enlarged proximate the chamber to form an annular space around the piston and the fluid admitting means discharges into such enlargement.

3. The combination of claim 2 in which said communicating bore is enlarged proximate the chamber to form an annular space around the piston and the fluid admitting means discharges into such enlargement.

4. The combination of claim 2 in which the passage is closed by a one-way valve, which when closed prevents passage of fluid from the chamber to the bore of the needle.

5. The combination of claim 2 in which the piston has a conical forward end and the needle is spring-pressed into firm contact with said end.

6. In a hypodermic syringe, a casing having an exit opening, a bore communicating therewith, and a fluid chamber communicating with the bore; a plunger within the fluid chamber for discharging fluid through the exit opening, means for drawing fluid into said chamber as the plunger is retracted, a hollow piston slidably and snugly fitting the bore and having a tapered end, means for limiting rearward movement of the piston, a flow of fluid fitting said tapered end of the piston, spring means pressing the needle against said tapered end to prevent leakage of air into the needle as the latter is withdrawn into the casing and to move the piston to said limited movement position; and means to move the piston forward to project the needle beyond the exit opening before starting discharge of fluid through the needle.

7. The syringe of claim 6 in which the piston has a central bore closed by a one-way valve, and the means for moving the piston forward includes means for driving liquid through the piston and needle after the needle is projected beyond the casing.

8. A hypodermic syringe comprising a casing having a cylindrical fluid chamber, a coaxial bore communicating therewith, and an exit opening; a plunger fitting the chamber, a hollow piston slidably fitting the bore, means for limiting forward and rearward movement of the piston, a hypodermic needle secured to the piston and projecting into the exit opening, said piston having a central elongated bore closed by a spring pressed one-way valve, the rear end of the piston being in contact with the liquid in the chamber so that increased pressure on the fluid in the chamber advances the piston, and electro-magnetic means to move the plunger to discharge fluid from the chamber, thereby moving the piston and the needle and when the piston has reached its forward position to force the fluid through the needle when projected beyond the casing.

9. The combination of claim 1 with means for determining the amount of dosage by restricting the rearward travel of the plunger, said last mentioned means comprising a rotatable disk carrying a plurality of stop elements of different lengths all but a selected one of which lie outside of the path of movement of the armature when the disk is turned to indicate that dosage.

10. In a hypodermic syringe of the type in which rearward movement of a plunger draws in a fluid and forward movement of the plunger discharges said fluid through an exit opening, a casing having a refillable fluid chamber and an exit passageway, a plunger carrying unit within the casing to drive fluid from the chamber upon forward movement, means for drawing fluid into said chamber upon rearward movement of the plunger, a rotatable disk in the path of rearward movement of the unit, a plurality of stop members of different lengths carried by the disk at equal radial distances from the center of the disk for selective placement of said stop members in the path of rearward movement of the plunger carrying unit, and a dial on the outside of the casing for rotating the disk in order to select the proper amount of fluid to be drawn into the syringe.

11. The syringe of claim 10 in which the portion of the plunger carrying unit at rear thereof is rectangular in cross section, there are four stop members, and the disk is eccentrically mounted with respect to the axis of the unit where said passage through through which fluid is conveyed to the needle.

12. In a hypodermic syringe, a casing having four portions joined by threaded connections, namely a rear cap portion, a main body portion, a cylinder portion and a nose portion having an exit port, a solenoid and its arma-
ture in the body portion, a plunger and a piston in the cylinder portion both coaxial with the solenoid and spaced apart, means for connecting the plunger to move with the armature and for moving both together rearwardly upon de-energizing of the solenoid, means for admitting fluid between the plunger and the piston as these members are moved apart, a hollow needle in the nose section spring-pressed into firm connection with the piston, and dosage-regulating means in the cap portion to limit selectively the rear travel of the armature and the plunger.

13. In a hypodermic syringe of the type in which an electro-magnetically controlled plunger discharges liquid from a chamber through a hollow needle projected outwardly beyond the syringe by the flow of liquid and spring means urge the plunger back to initial position; a casing having four successive coaxial communicating bores of different diameters so that shoulders are formed, the fourth bore communicating with an exit opening, an electro-magnetically driven plunger head in the second bore which forms a chamber for the fluid to be injected into the patient, a plunger head carrying stem in the first bore, spring means surrounding the stem to urge the plunger head inwardly toward the first bore, a piston having a central bore controlled by a one-way valve and having an annular flange in the fourth bore, and an elongated body in the third bore, the rear end of which body is in contact with the fluid in the chamber, whereby forward movement of the fluid will cause a forward movement of the piston, moving the flange away from the shoulder between the third and forth bores, means for selectively limiting inward movement of the plunger head whereby to select a suitable volume of injected fluid, means operable upon inward movement of the plunger head for drawing fluid into the chamber, a hollow needle movable into and out of the exit opening of the casing and having frictional conical wedging engagement with the piston, and spring means for holding the annular flange of the piston against the proximate shoulder and insuring frictional wedging, thus avoiding the use of a threaded connection.

14. In a syringe, a casing having a cylindrical section containing a fluid chamber and a coaxial bore, a nose section readily separable from the cylindrical section and having hollow space and a discharge opening both coaxial with said bore, a unit slideable in said bore and having central passageway affording communication between the chamber and the space, said unit including an adapter having a tapered nose and having a central bore coaxial with the nose, a hollow hypodermic needle having a head recessed to fit the tapered nose, a flanged thimble having an opening to receive the needle, and a spring surrounding the thimble and engaging the flange, said unit insuring a leak preventing mounting of a hypodermic needle allowing faster assembly than when a screw connection is used.

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