

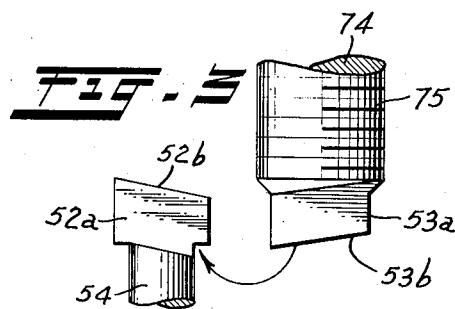
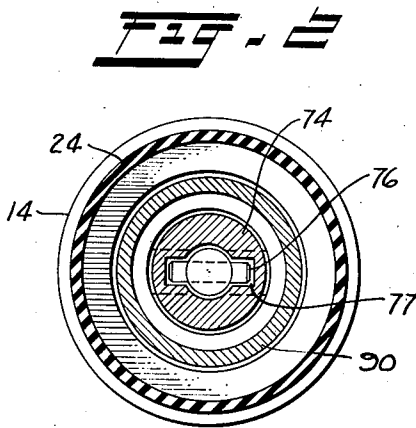
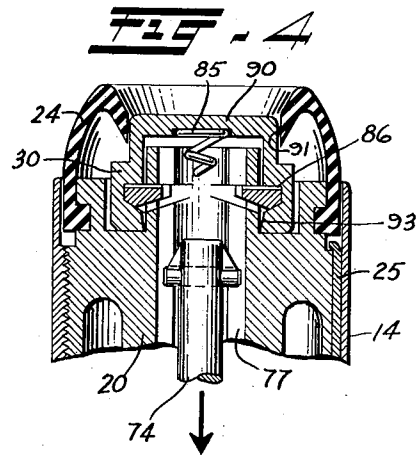
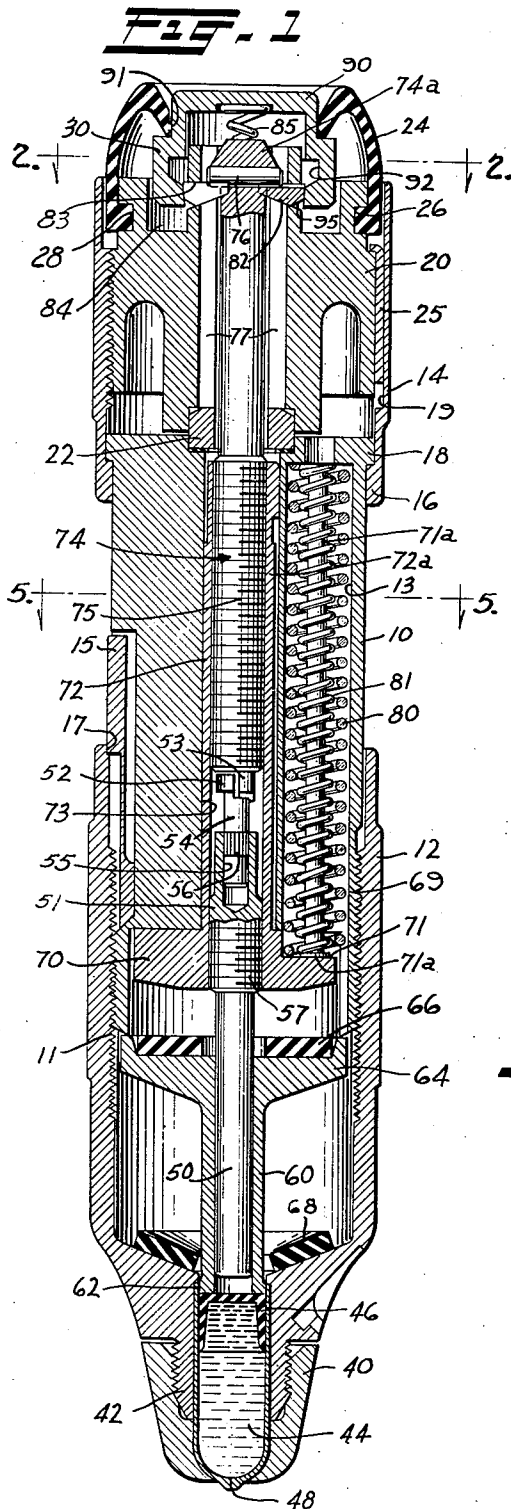
Sept. 11, 1956

A. VENDITTY
HYPODERMIC INJECTOR

2,762,370

Filed Sept. 7, 1954

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG. 6

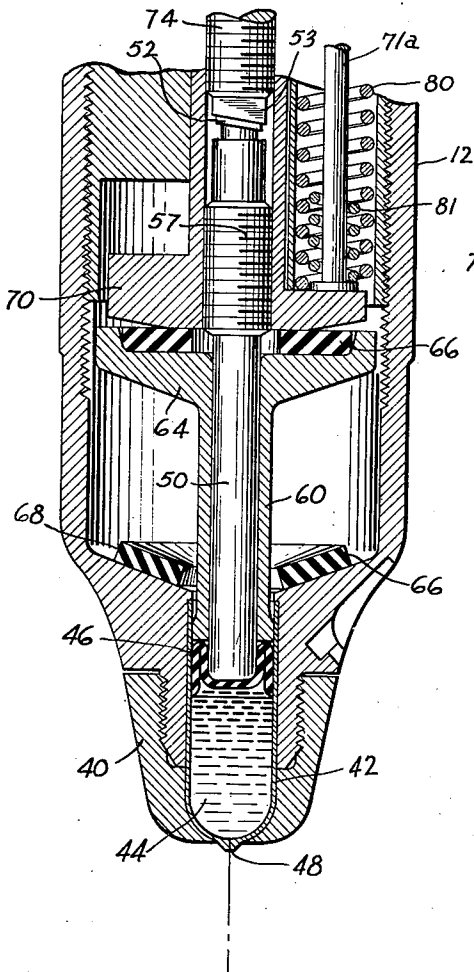
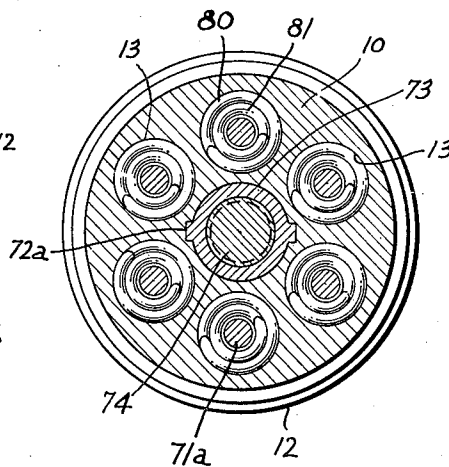


FIG. 5



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2,762,370

HYPODERMIC INJECTOR

Anthony Venditty, Detroit, Mich., assignor to The R. P. Scherer Corporation, Detroit, Mich., a corporation of Michigan

Application September 7, 1954, Serial No. 454,447

6 Claims. (Cl. 128—173)

This invention relates to an improved needleless hypodermic injector of the type shown and described in the copending application of R. P. Scherer, Serial No. 170,101, filed June 24, 1950. Instruments of this kind are adapted to discharge liquid medicament from an orificed ampule in the form of a minute stream or jet at two different pressure stages sequentially. The initial high pressure discharge causes the jet stream to distend the skin and force the liquid to a predetermined depth beneath the surface, depending upon the magnitude of the pressure. After the minute opening in the epidermis has been produced the pressure of the stream is immediately reduced to a lower second stage for completing transfer of the remaining liquid from the ampule.

The instrument shown and described in the application above referred to employs five coil springs as a source of power for driving a dual plunger assembly comprising a primary plunger of small diameter slidably mounted within a secondary plunger having a diameter equal to that of the flexible follower or stopper within the bore of the ampule. The follower is cup-shaped and is adapted to expel liquid through the minute orifice in the end of the ampule as it is advanced down the bore by the plunger. As the power springs expand, the primary plunger exerts a force against the central portion of the bottom of the follower to distend that portion a short distance and simultaneously eject a small amount of liquid from the orifice in the ampule under high pressure. The magnitude of the pressure during the first stage determines the depth of penetration of the jet stream below the surface. After the primary plunger has travelled to the end of its stroke, which is relatively short, the secondary plunger engages the entire area of the bottom of the follower and moves the follower down the bore of the ampule to complete the injection at reduced pressure. The reduction in pressure, of course, is due to the increase in the area engaged by the plunger. The pressure during the second stage is just sufficient to feed the liquid through the channel formed during the first pressure stage.

It has been found that the coil springs employed in the injector construction just described cause the liquid to be expelled in surges rather than at substantially uniform pressures. Some patients find such surges to be a source of pain. The amount of deviation from the desired pressure is not great, but the fluctuations occur very rapidly. Indications are that these undesirable rapid fluctuations in pressure are tied in with the natural frequencies of the springs. Coil springs made from braided wire and having a low natural frequency have been found to reduce the surge to a minimum with substantially complete elimination of pain to the patient due to rapidly fluctuating pressure. However, springs of braided construction are expensive and increase substantially the cost of the instrument. I now have found that the undesirable frequencies which apparently are responsible for the rapid surges in pressure may be sufficiently minimized or dampened by employing pairs of coil springs having different natural frequencies. By matching dissimilar fre-

quencies, the vibrations causing the pressure deviations may be dampened or cancelled out. In the construction of the instrument in accordance with this invention, therefore, power springs are used in pairs; the total number may range from 6 to 12.

Another object of this invention is to provide an instrument of the type described which is more economical to produce than those made previously, this object being accomplished by greatly simplifying the construction of the power release mechanism, and thrust bearing between the latch housing and the body.

A further object is the provision of a novel dual plunger assembly in which the primary plunger is fixed to the power means and is adjustable with respect to the follower in the ampule. By adjusting the distance between the primary plunger and the follower, the impact force with which the plunger strikes the follower may be varied, and this in turn results in variation in the pressure at which the liquid is ejected from the orifice in the ampule. In prior instruments capable of injecting at two pressure stages no provision was made for varying the impact of primary plunger.

Another object is the provision of a primary plunger which is axially adjustable with respect to the ampule follower by rotating the fast-lead lifting screw in the power mechanism, but which is not in axial engagement with said screw. By eliminating axial engagement between the plunger and the fast-lead lifting screw, the resulting torque on the threads of the screw, due to liquid resistance in the ampule, and the friction attendant thereto, is eliminated.

These and other objects of the invention will appear as the following description proceeds.

In the drawing:

Figure 1 is a longitudinal cross-sectional view through the instrument constructed in accordance with the invention;

Figure 2 is a sectional view taken along the line 2—2 of Figure 1;

Figure 3 is an elevational view of the mating heads employed for rotationally engaging the screw and the primary plunger for adjustment of the latter with respect to the ampule follower;

Figure 4 is a sectional view of the upper end of the instrument showing the latch wedges in retracted position;

Figure 5 is a sectional view along the line 5—5 of Figure 1; and

Figure 6 is a longitudinal cross-sectional view of the lower end of the instrument after the nut has engaged the secondary plunger.

The invention lies in the construction and arrangement of the various elements comprising the injector, particularly the novel latch mechanism and the dual plunger assembly.

Reference is now made to Figure 1 of the drawings in which the numeral 10 designates an elongated body housing most of the mechanism of the injector. A dosage sleeve 12 is screwed onto the threaded lower or ampule-containing end of the injector and a winding sleeve 14 is rotatable on the upper end thereof. The sleeve 14 has an intumed flange 16 coacting with an annular ring or ridge 18 on the body 10 to prevent longitudinal movement in one direction relative to the body. A combination latch housing and upper bearing support 20 is screwed into the upper end of the winding sleeve 14 with a thrust bearing 22 interposed between the body and the latch housing. A release button cap 24, which may be molded from a suitable thermoplastic resin, is assembled with the latch housing 20, being held in place by a conventional non-reversible bayonet connection. The entire assembly of the winding sleeve 14, latch housing 20 and the cap 24, is adapted to rotate as a unit since the sleeve 14 and the housing 20 are locked

together by a key 25 which fits into matching slots 19, as best shown in Figure 1.

The dosage sleeve 12 has threaded on its lower end an ampule holder 40 adapted to receive an ampule 42 containing medicament 44 and having a flexible cup-like follower 46 in the upper end thereof. The ampule is pierced with a minute orifice 48 in the lower end thereof. The ampule follower 46 may be made from a resilient plastic material or rubber, preferably an oil resistant rubber such as polychloroprene, Buna N, or the like. Other rubber parts employed in the construction of this instrument should likewise preferably be made from similar oil-resistant stocks.

The dosage sleeve 12 is locked against rotation by means of a latch 15 which fits into grooves 17 spaced circumferentially about the inside surface of the sleeve. By rotating the sleeve 12 liquid medicament 44 may be predischarged. The sleeve may be marked externally to indicate the exact volume predischarged when the sleeve is rotated through the arc defined by the successive grooves 17. This feature is conventional.

The internal mechanism of the instrument includes a novel plunger assembly consisting of a primary plunger 50 having an externally threaded upper end 51 screwed into the nut 70, and a secondary plunger 60 in which the primary plunger 50 is slidably mounted. The threads 57 on the upper end 51 of the plunger 50 are single threads as distinguished from double threads which are employed within the sleeve-like portion of the nut 70 for purposes to be explained presently. The lower end 62 of the secondary plunger 60 is adapted to slide within the ampule 42 to advance the follower 46, while the lower end of the primary plunger 50 is adapted to bear against the central portion only of the top of the follower 46. The upper portion of the secondary plunger 60 terminates in an integral circular head 64 adapted to slide axially within the sleeve 12, its upward stroke being limited by the lower end 11 of the body 10. A washer 66 made from rubbery material is seated in a counterbore in the top surface of the head 60 to dampen vibrations that might be transmitted through the secondary plunger 60 from the nut 70. A similar rubber-like washer 68 is adhered to the bottom of the sleeve 12 to cushion the blow of the head 64 when the instrument is operated without the ampule in place. Washer 66 further serves this purpose.

The means for propelling the primary plunger 50 comprises coil springs 80, 81 inserted in blind axially-extending openings 13 spaced circumferentially within the body 10. Single springs may be employed in each opening 13, but preferably, I use springs in pairs as shown in Figures 1 and 5, internal spring 81 being of smaller diameter and of opposite helix to external spring 80. Each pair of springs in diametrically opposite openings 13 must generate equal total force to prevent the tendency to cock. It is preferred that the springs in the same opening and in adjacent openings be of different natural frequencies, which tends to cancel out vibrations that result in rapid fluctuations in the pressure of liquid 44 expelled from the ampule. Springs 80 (or springs 81) in diametrically opposite openings need not be of the same natural frequency.

The bottom surfaces of the springs seat in recesses 71 in the surface of the nut 70, and concentric with the openings 13. The tops of the springs seat against the body 10. Pins 71a, fixed at their lower ends to the nut 70, extend upwardly within the openings 13 along the axes thereof and serve to prevent the springs from buckling.

The nut 70 has a long sleeve-like extension 72 projecting upwardly into a central bore 73 in the body 10, and is keyed thereto as indicated at 72a (Figure 5) to prevent rotation. The sleeve 72 is internally threaded with two styles of threads. Approximately the lower one-quarter has single threads and the remaining upper por-

tion has double threads. A lifting screw 74 is adapted to turn within the sleeve 72 for lifting the nut 70 to compress the springs 80, 81 seated therein. The screw 74 has double threads 75 to match those in the upper portion of the sleeve 72. Thus, one revolution of rotation within the sleeve 72 will cause the screw 74 to travel twice the distance of the single threaded primary plunger 50 when the latter is rotated one revolution within the lower end of the sleeve 72. The screw 74 serves the dual purpose of lifting the nut 70 to compress the springs and of adjusting the primary plunger 50 to a certain predetermined position with respect to the follower 46 by rotating the plunger to move it along its threads 57.

To prevent a tendency of the screw 74 to "spin back" due to the reactive force of the follower 46, and thus eliminate friction or torque load between the threads of the screw and the sleeve 72, axial engagement of the end of the screw and the primary plunger is avoided in the present construction. Adjustment of the primary plunger 50 by rotation of the screw without axial engagement is possible because of a special coupling arrangement best shown in Figure 3. Screw 74 carries a head 53 integral therewith and primary plunger 50 carries a complementary head 52 on the end of shaft 54 which is swaged into opening 55 in the end of the plunger 50 and held therein by serrations 56. Vertical faces 52a and 53a are adapted to engage so that primary plunger 50 rotates with the screw 74. Since the threads 75 are double and the threads 57 are single the screw travels twice the distance of the plunger and the coupling heads 52 and 53 will separate and disengage within two revolutions. The end faces 52b and 53b of the heads may abut when the screw is moving toward the plunger due to the fast lead of the screw threads 75. To avoid jamming, the faces 52b and 53b are bevelled at an angle equal to or greater than the pitch of the screw threads 75. By this arrangement the heads 52 and 53 engage so that the primary plunger may be adjusted with respect to the follower without moving the secondary plunger 60.

The latch mechanism for locking the screw 74 against axial movement by the springs until such time as it is released by pressing button 90 is best shown in Figures 1, 2 and 4. A pin 76 extending through the upper end of the screw 74 is adapted to slide axially within slots 77 provided therefor within the latch housing 20. Latch wedges 82 project through the openings 83 provided therefor within the latch housing 20. The outer ends of the wedges 82 are cut out to embrace the surface of the screw 74 while the upper surfaces contain grooves 86, which embrace the ends of the pin 76 when the screw is in locked position, as shown in Figure 1. The latch wedges 82 are tapered toward the inner ends, the slope of the taper preferably being about 20° from horizontal. The cup-shaped button 90 is provided with an inwardly turned flange 93 adapted to bear against the outer ends of the latch wedges 82 normally to prevent them from retracting into the grooves 84 in the latch housing. Button 90 may be depressed, causing the side walls thereof to move downwardly into the grooves 84 against the compression of the spring 85, whereupon grooves 92 in the side wall of the button become aligned with the latch wedges 82. Because of the slope on the bottom of the wedges 82, they move outwardly into the groove 92 under the influence of the springs 80, 81, which are tending to thrust the screw 74 downwardly, whereupon the screw 74 is released.

The inside edge 95 of the inturned flange 93 on the button is tapered to control button pressure. An angle of about 4° or 5° is enough to prevent the button from freeing due to thrust on wedges 82 from the screw pressure. The button pressure may be controlled by changing this angle.

To keep the button 90 depressed while the wedges 82 are in the slot 92, a pair of small opposed bosses 91 are provided on the inner surface of the button cap 24. By

preventing the button from moving up to its normal position due to the friction of the bosses the wedges 82 remain in place while the screw is in a position below the wedges, as shown in Figure 4. The bosses are raised sufficiently to provide just enough friction so that the button will remain in place until the top 74a of the screw 74 bears against the spring, whereupon the wedges are pushed back under the pin 76.

The upper end of the screw 74 terminates in a pointed portion 74a which facilitates retracting the screw past the wedges 82.

In operation, the winding sleeve 14 is rotated counterclockwise to turn the screw 74 out of the sleeve 72 preparatory to compressing the springs 80 and 81. (It is assumed that the instrument at this point has just been discharged and the plunger assembly is in the lower position within the dosage sleeve 12.) As the pointed end 74a of the screw 74 contacts and compresses the spring 85, the button moves upwardly and forces the wedges out of the slot 92 and underneath the pin 76 to latch the screw 74. The spring 85 then snaps the button to its normally raised position. The winding sleeve 14 is then rotated in a clockwise direction to turn the screw 74 within the sleeve 72 and lift the nut 70 to compress the springs 80, 81.

As the nut 70 moves up the threads of the screw 74 the head 52 fixed to the plunger 50 engages the head 53 on the lower end of the screw and the mating faces 52a and 53a slide into rotational engagement. If the button 90 is depressed when the springs are fully compressed, the maximum depth of penetration of the jet stream discharged from the ampule 42 will result because the impact of the primary plunger 50 on the follower 46 is greatest. The magnitude and duration of the first stage pressure is determined by two factors: (1) the distance between the end of the plunger 50 and the follower 46, which determines the amount of impact, and (2) the distance the primary plunger 50 moves into the ampule beyond the end of the secondary plunger 60. In the present construction distance (1) is variable and distance (2) is constant. To reduce the pressure of the first stage of the injection the winding sleeve 14 may be "backed off," that is, rotated in a counterclockwise direction, to decrease the distance between the end of the plunger 50 and the follower. This causes the nut 70 to be lowered, but due to the style of screw threads 75 and 57, the plunger 50 descends at half the rate of the nut 70. Therefore, if the nut 70 descends .10 inch, the plunger 50 descends only .05 inch. By adjusting the rotation of the winding sleeve in a counterclockwise direction the distance between the primary plunger 50 and the follower 46 may be reduced from the maximum to any distance down to zero, at which point the plunger and the follower are engaged and there is no impact at all. This arrangement makes possible very accurate control of the pressure during the first stage of the injection, since the plunger 50 moves only a small distance per unit rotation of the winding sleeve 14. Complementary graduations on the winding sleeve and the body 10 may be provided to designate to the physician using the instrument the magnitude of the initial stage pressure, just as in prior instruments.

A new ampule is then fitted into the nose of the instrument and secured in place by means of the screw cap 40. To discharge the medicament the button 90 is depressed, causing the wedges 82 to slide into the slot 92 provided therefor, which releases the screw 74, permitting the springs the propel the nut downwardly at a rapid rate. Primary plunger 50 strikes the follower 46 with a force determined by the impact distance, turns the follower inside out and pushes it down into the bore of the ampule to the point indicated in Figure 6. At this point the nut 70 engages the secondary plunger 60 as it travels downwardly causing the remaining liquid in the ampule to be expelled at reduced pressure.

It has been found that the combination of springs 80

and 81 used in pairs in diametrically opposite bores within the body cancels out the objectionable high frequencies, or at least minimizes them to the extent that the injection is virtually painless.

Various modifications in the structure of the instrument will occur to those skilled in the art without departing from the spirit and scope of the invention. It is, therefore, not my intention to limit the invention to the forms illustrated other than as necessitated by the scope of the appended claims.

I claim as my invention:

1. In a hypodermic injector, an assembly comprising an elongated body, an ampule holder detachably connected to one end thereof and adapted to hold an orificed ampule, a plunger slidably mounted within said body and adapted for engaging and propelling a follower within the bore of said ampule to discharge liquid contents through the orifice, power means for propelling said plunger including coil springs mounted concentrically in pairs within the body, each of said springs comprising a pair having different natural-frequencies, means for compressing said springs, and means for suddenly releasing the compressed springs to perform propulsion of the plunger and follower.

2. In a hypodermic injector, an assembly comprising an elongated body, an ampule holder detachably connected to one end thereof and adapted to hold an orificed ampule, a plunger assembly mounted within said body comprising a primary plunger and a sleeve-like secondary plunger slidably mounted on said primary plunger, the end of said primary plunger being adapted to engage the central area of a flexible follower within the bore of said ampule and the end of said secondary plunger being adapted to engage the area surrounding said central area, power means including a flanged sleeve-like nut, a screw threadedly engaged in the upper portion of said nut, and pairs of coil springs seated on said nut, said primary plunger being threaded into the lower portion of said nut and rotationally engageable with said screw to permit varying the distance between the lower end of the primary plunger and said follower, and means for latching said screw against the compressive force of the springs and for suddenly releasing the latch to propel said nut and plunger assembly.

3. The injector of claim 2 in which the latching means for the screw comprises a pair of wedges adapted to support projections extending from the screw near the top end thereof, said wedges being radially slidably mounted in slots provided therefor in the body, and an axially movable release button of inverted cup shape mounted in the top of the body having an inwardly extending flange and a circumferential groove above the flange, said groove being adapted to receive said wedges when the button is depressed and said flange being adapted to force the wedges from the groove and beneath said projections and prevent them from moving outwardly when the button is in raised position.

4. In a hypodermic injector, an assembly comprising an elongated body, an ampule holder detachably connected to one end thereof and adapted to hold an orificed ampule, a plunger assembly mounted within said body comprising a primary plunger and a sleeve-like secondary plunger slidably mounted on said primary plunger, the end of said primary plunger being adapted to engage the central area of a flexible follower within the bore of said ampule and the end of said secondary plunger being adapted to engage the area surrounding said central area, power means including a flanged sleeve-like nut, a screw threadedly engaged in the upper portion of said nut, and pairs of coil springs seated on said nut, said primary plunger being threaded into the lower portion of said nut and rotationally engageable with said screw to permit varying the distance between the lower end of the primary plunger and said follower, the cooperating threads of said screw and said upper nut por-

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tion having a faster lead than the cooperating threads of said primary plunger and said lower nut portion, and means for latching said screw against the compressive force of the springs and for suddenly releasing the latch to propel said nut and plunger assembly.

5. In a hypodermic injector, an assembly comprising an elongated body, an ampule holder detachably connected to one end thereof and adapted to hold an orificed ampule, a plunger slidably mounted within said body and adapted for engaging and propelling a follower within the bore of said ampule to discharge liquid contents through the orifice, power means for propelling said plunger including coil springs disposed within diametrically opposed bores circumferentially spaced within the body, each bore containing two concentric springs having the same natural frequencies as the corresponding springs in the bore diametrically opposed thereto, but different natural frequencies from corresponding springs in adjacent bores.

6. In a hypodermic injector, an assembly comprising

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an elongated body, a cylindrical chamber in one end thereof having a bore terminating in a minute orifice and adapted to hold liquid to be discharged from the injector, a follower within the bore of said chamber, a plunger slidably mounted within said body and adapted for engaging and propelling said follower to discharge liquid contents through said orifice, power means for propelling said plunger including coil springs mounted concentrically in pairs within the body, each of said springs comprising a pair having different natural frequencies, means for compressing said springs, and means for suddenly releasing the compressed springs to perform propulsion of the plunger and follower.

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