

Nov. 6, 1951

W. E. HINDS

2,574,263

INJECTION APPARATUS

Filed Sept. 22, 1945

2 SHEETS—SHEET 1

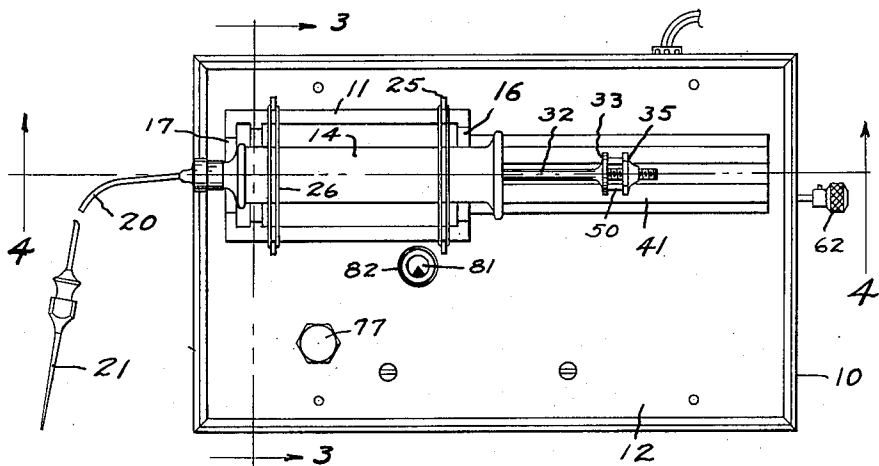


FIG. 1

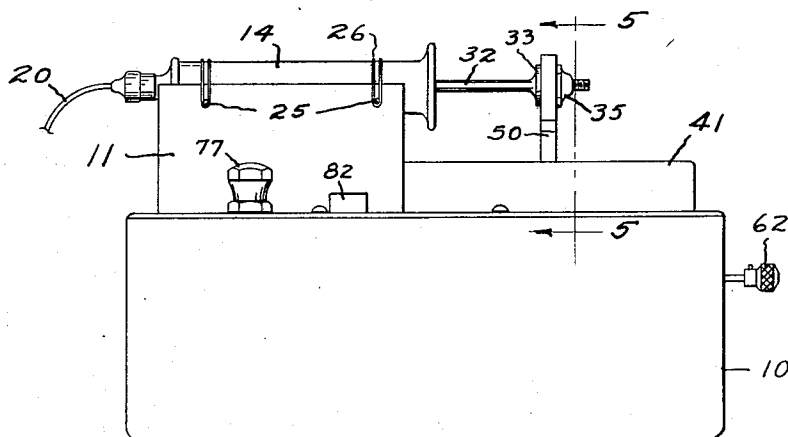


FIG. 2

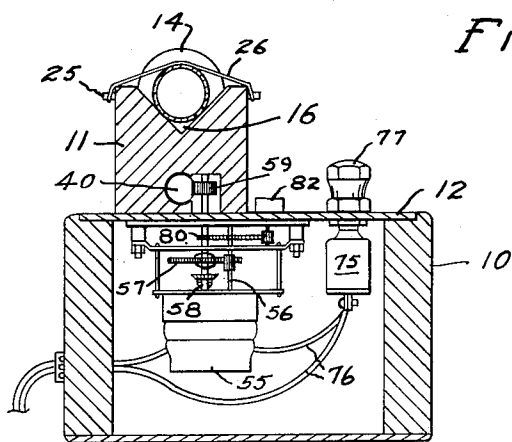


FIG. 3

William E. Hinds
INVENTOR.

BY *C. A. Beckham*
Attorney

Nov. 6, 1951

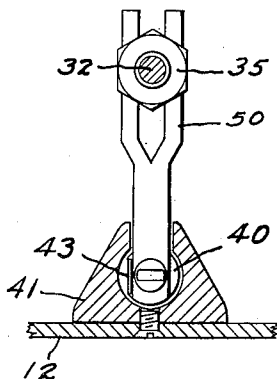
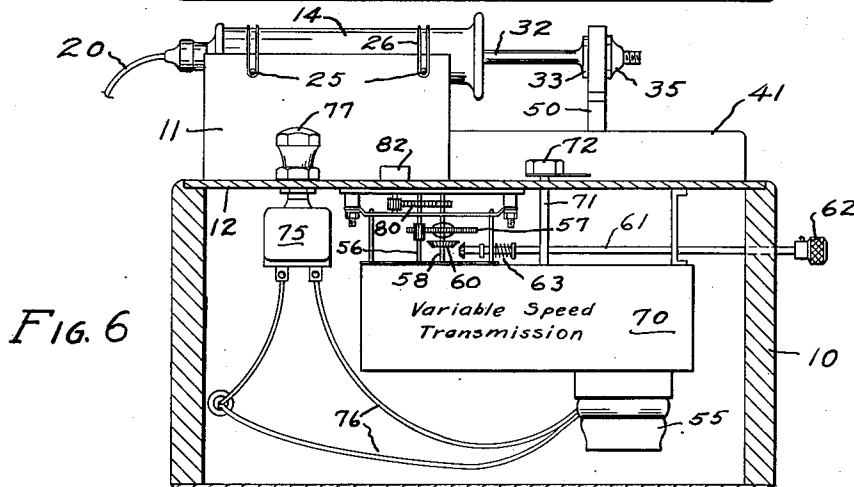
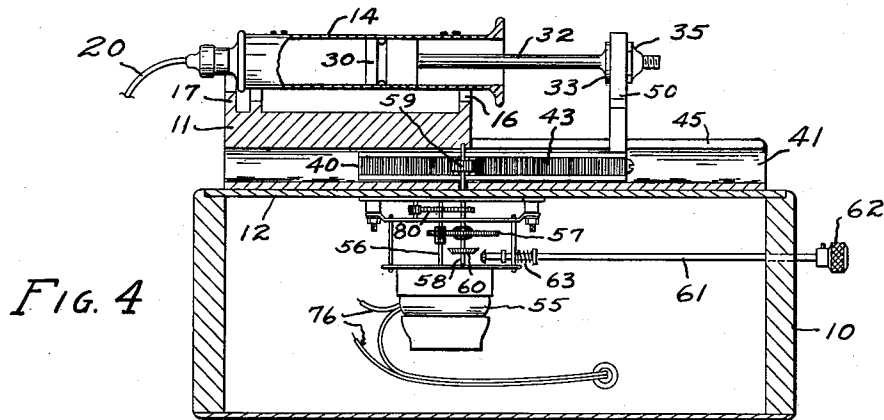
W. E. HINDS

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INJECTION APPARATUS

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2 SHEETS—SHEET 2



William E. Hinds

INVENTOR.

BY *C. A. Buchanan*

Attorney

UNITED STATES PATENT OFFICE

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INJECTION APPARATUS

William E. Hinds, Hillsboro, Oreg.; Mrs. William E. Hinds, special administratrix of said William E. Hinds, deceased

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12 Claims. (Cl. 128—216)

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This invention relates to injection apparatus and, more particularly to motor driven apparatus for operating a syringe.

A primary object of the present invention is to provide a new and improved apparatus for operating a syringe whereby a liquid medication may be administered to a patient continuously over a prolonged period of time and at a definite and positive rate.

In the treatment of patients suffering with certain diseases, liquid medications are sometimes administered by injection either subcutaneously, intravenously, intramuscularly, in either of which methods the active substance finds its way into the blood stream and acts upon the foreign bacteria therein. Rarely does a single injection prove sufficient for the reason that the active substance of the medication does not remain in the blood stream long enough to eliminate all of the bacteria therein, and, according to prior accepted medical practice, a plurality of injections are usually made at spaced intervals of time. Periodic injections are relatively inefficient for the reason that the blood titer, that is, the concentration of the active substance in the blood stream fluctuates along a curve of saw tooth characteristic. Immediately following one injection the blood titer rises relatively rapidly to maximum and then commences to drop as the active substance is removed from the blood stream in the kidneys, the bile, and other organs. The blood titer will thus be bactericidal only over a relatively short period of time for as it drops below a predetermined point, it will be only bacterostatic and as it drops to a still further point the bacteria may commence to multiply again before the next injection is administered. With the next injection the blood titer immediately rises to a maximum again and then proceeds to drop as previously described. Thus over an entire treatment period of periodic injections according to prior practice the medicament is in reality effective only over relatively short intervals. The length of the treatment period is then required to be extended over a relatively long time and, moreover, an attendant such as a doctor or a nurse must be constantly on duty throughout the entire period in order to administer the periodic injections. This usually requires hospitalization of the patient resulting in an excessively high cost for the treatment.

To avoid the high cost of hospitalization it is a common practice to administer a few properly timed injections to the patient at the physician's office during office hours. The patient then goes

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home and returns the next day for a further series of injections. Such a method of treatment is obviously inefficient and in many cases entirely ineffective.

- According to my invention an initial relatively large dose of the medication is injected into the patient to raise the blood titer to a predetermined desired value, after which the medicament is continuously injected at a calculated rate sufficient to maintain the blood titer at such value and for such a period of time as may be necessary to eliminate the bacteria from the blood stream. By this procedure, the total length of the treatment time is very greatly reduced while the amount of medicament used is much less than that which would be required if administered by periodic injections. For example, a single injection administered continuously so as to maintain a predetermined constant blood titer over a one hour period may be effective equally as a dozen separate injections administered at half-hour intervals, in which case the treatment time would be reduced from six hours to one hour while the quantity of medicament used would be cut down to about one-third.

It has been proposed, heretofore, to administer medications to patients by gravity flow from a container arranged a suitable height above the patient and from which the medication is conducted through a rubber tube to the injection needle. Such a method of administration is not satisfactory where the rate of dosage administered is required to be very low, such as one or two ccs. per hour. At such a low feeding rate a small internal diameter tube is required to be used and due to the frictional resistance and capillary attraction of the tube passage it is very difficult to regulate the flow of the liquid there-through. Furthermore the discharge through the needle could be very easily stopped accidentally either by a mere flexion of the muscles or movements of the body so as to cause an obstruction at the tip of the needle. Furthermore, it has been discovered that it is dangerous to leave a patient alone and unattended while medications are administered according to such method because of the danger of the tube becoming kinked and blood drawn up into the needle where it clots. Upon release of pressure the clot is forced back into the blood stream where it is apt to cause fatal results. In the administration of medications at a very slow rate as mentioned above it is desirable to use a very small internal diameter tube and it is difficult to force liquid there-through by any gravity system due to the

resistance of capillary attraction within the tube. For the same reason compressed air, spring means or motor means the speed of operation of which may vary with the resistance is unsuitable for use in operating a syringe for continuous injection.

A still further object of the present invention is to provide a new and improved apparatus for the continuous injection of medication to a patient whereby a positive pressure is maintained upon the medication so as to insure a continuous and positive flow through the needle.

And another object of the invention is to provide an apparatus of the type described in which the motive power for driving the syringe piston is provided by a motor having a constant speed characteristic.

It is also an object of the invention to provide an apparatus of the class described which does not require any attention once it is placed in operation until the end of the period when it may be disconnected and the injection needle removed from the patient.

Additional objects and advantages of the present invention will become apparent from the following description taken in connection with the accompanying drawings while the invention itself will be pointed out with greater particularity in the appended claims.

In the drawing, Fig. 1 is a plan view illustrating the invention according to one form thereof; Fig. 2 is a side elevation of the invention; Fig. 3 is a cross-sectional view taken along the line 3—3 of Fig. 1; Fig. 4 is a longitudinal sectional view taken along the line 4—4 of Fig. 1; Fig. 5 is a fragmentary detail view taken along the line 5—5 of Fig. 2; and Fig. 6 is a view, partly in section, illustrating a further modification of the invention.

Referring now to the drawings the invention comprises a housing 10 which is of a generally rectangular box like shape. A syringe holder 11 is mounted upon the top 12 of the housing and which is adapted for holding a syringe 14 in a predetermined and horizontally extending position. The holder 11 consists of a block having a V-shaped recess 16 in the upper surface thereof whereby syringes of different diameters may be seated therein and which, irrespective of their diameter will be held with their longitudinal axis in the same vertical plane. The holder is provided with a forward flange 17 which forms a stop for the forward end wall of the syringe. A feeding tube 20 is illustrated as attached to the syringe 14 and having an injection needle 21 affixed to the end thereof. The syringe 14 may be secured in any suitable manner into the V-shaped recess in the holder 11, the holding arrangement as shown in the drawing consisting merely of pairs of opposed pins 25 secured in the outer side walls of the holder about which heavy rubber bands 26 are adapted to be strung extending across the top of the syringe barrel. It will be obvious, however, that any other suitable means may be provided.

The syringe 14 may be of any conventional form though, as shown in the drawings, it is provided with a rubber flanged piston 30 which is adapted to wipe snugly against the inner surface of the syringe barrel in order to prevent any leakage of fluid therepast. It will be understood that in cases where medication is to be administered at an extremely low rate, such as one or two ccs. per hour, the medication may seep by capillary attraction past a glass or metal piston having

even a very minute clearance between it and the syringe barrel. Suitably anchored in the piston 30 is a stem or push rod 32 which is provided with a shoulder 33 and a threaded end portion having a nut 35 threadably arranged thereupon.

A reciprocating means is provided upon the top of the housing and which comprises a rack bar 40 slidably arranged within a guide member 41 secured to the upper surface of the cover 12 and integral with the adjacent end of the holder 11. The rack bar 40 is of a round cross-section having a flattened side provided with teeth 43. The rack bar 40 is slidable within the guide 41 and through the lower part of the syringe holder in a direction longitudinally parallel with the axis of the syringe mounted in the holder 11. Secured to the rack bar 40 and extending upwardly through the elongated slot 45 in the guide member 41 is a bifurcated lever arm 50 which is adapted to be secured relatively to the piston 30 of the syringe between the shoulder 33 and the nut 35 on the end of the stem 32.

Operatively connected to the rack bar 40 for driving the same is a constant speed electric motor such as a small synchronous motor 55 and which is mounted within the lower part of the housing 10. The motor 55 is connected by suitable gearing to the rack bar, the gearing arrangement as shown comprising a drive shaft 56 extending from the motor having a pinion thereon meshed with the gear 57 arranged upon the shaft 58. The gear 57 on shaft 58 is held between a pair of opposed friction clutch discs, the pressure of which upon the gear 57 being sufficient for transmitting torque for driving the rack bar 40 and the piston of the syringe during normal operation. However, if the motor 55 should not be de-energized before the piston 30 reaches the end of the syringe barrel then upon movement of the piston to its limit position the clutch will slip on the opposite sides of the gear 57 to prevent damage to either the motor, the gearing or to the syringe. The upper end of the shaft 58 extends through the cover 12 and has a pinion 59 mounted thereon which is meshed with the teeth on the rack bar 40.

Secured to the shaft 58 is a bevelled gear 60 and which is adapted to be cooperatively engaged by another bevelled gear provided upon the end of a shaft 61 extending to the outside of the housing. Mounted on the outer end of the shaft 61 is a knob 62 by means of which the shaft may be pushed in against the bias of spring 63 to cause engagement of the bevelled gears and whereupon the rack bar may be manually adjusted such as for aligning the lever 50 against the shoulder of the piston stem 32 when initially assembling the syringe into the holder and prior to placement of the apparatus in operation. The knob 62 may also be employed for injecting an initial dosage to the patient immediately prior to the administration of the injection on a continuous feed basis through operation of the motor 55.

The motor 55 and the connection gearing between the motor and the rack bar may be so arranged as to provide any desired rate of feed from the syringe into the patient. The rate of feed may be adjusted by using syringes of different diameters, it being obvious that by increasing or decreasing the diameter of the syringe the rate of feed may be correspondingly varied even with a constant rate of movement of the rack bar by the motor.

The energization of the motor may be controlled by a suitable switch 75 mounted within

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the housing and connected in the supply conductors 76 leading to the motor, the switch being provided with a knob 77 extending above the top of the housing. Because of the fact that the rate of movement of the rack bar will be so slow as not to be noticeable, I provide a suitable means for indicating the rotation of the motor. Mounted upon shaft 56 is a large gear 80 which is meshed with a small pinion which in turn is mounted upon a shaft having an indicator disc 81 provided on the upper end thereof. The disc may be viewed through a window provided in the top of a small enclosure 82 mounted on the housing cover.

According to the modification of the invention illustrated in Fig. 6 I provide a variable speed transmission 70 between the motor 55 and the gearing arrangement as previously described. Extending from the transmission 70 is a control shaft 71 the upper end of which extends through the housing cover 11 and provided with a knob 72 on the upper end thereof by means of which the speed ratio of the transmission 70 may be varied as desired. In an apparatus provided with a variable speed transmission between the driving motor and rack bar a syringe of any available size may be used and the speed of the reciprocating rack bar adjusted accordingly so as to provide the desired rate of feed of medication to the patient.

While the invention has been described with particular reference to an apparatus designed for continuous injection of a medicament into a patient at a very low rate, it will be obvious that the invention is not to be necessarily so limited in that it may equally well be adapted for injection of ordinary solutions, plasma, and the like which are sometimes administered in a large quantity over a relatively short period of time. In such applications, the holder will be adapted for holding a large capacity syringe.

Having described the invention in what are considered to be certain preferred embodiments thereof, it is desired that it be understood that the specific details shown and described are merely illustrative and that the invention may be carried out by other means.

What I claim is:

1. In a low speed continuous injection apparatus, the combination comprising a housing, a syringe holder mounted on said housing and adapted for holding a syringe in a predetermined horizontally extending position, a constant speed motor mounted within said housing, reciprocating operating means extending from the top of said housing and adapted operatively to engage the syringe piston, said operating means being movable in a direction parallel with the longitudinal axis of said syringe, unidirectional drive means including a releasable connection connecting said motor and said reciprocating means whereby said reciprocating means may be driven by said motor in the direction to force the piston inwardly of said syringe, said driving means including a variable speed gearing between said motor and said releasable connection, and manual operating means operatively associated with said drive means between said releasable connection and said reciprocating means for permitting manual actuation of said reciprocating means independently of said motor.

2. In a low speed continuous injection apparatus, the combination comprising a syringe holder for supporting a syringe in a predetermined fixed position, a reciprocating means mounted

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at one end of said holder and adapted operatively to engage the syringe piston, motor means mounted adjacent said holder, unidirectional drive means including a clutch extending between said motor means and said reciprocating means whereby said reciprocating means may be driven by said motor means in the direction to force said piston inwardly of said syringe, said drive connection including a variable speed power transmission, means connected to said transmission whereby the driving rate of speed for said reciprocating means may be selectively controlled, and manual operating means operatively associated with said drive means between said clutch and said reciprocating means whereby said reciprocating means may be manually adjusted independently of said motor means.

3. In a low speed continuous injection apparatus, the combination comprising a housing, a syringe holder mounted on said housing, said holder defining an elongated V-shaped recess adapted for receiving a syringe barrel and positioning the axis of said barrel in a predetermined plane, means for securing said syringe in said recess, a rack bar arranged adjacent said holder for longitudinal sliding movement in a direction parallel with said plane, means for securing the piston of said syringe to said rack bar, and constant speed motor means arranged within said housing, unidirectional drive means connecting said motor and said rack bar for driving said rack bar in the direction to force the piston inwardly of said syringe.

4. In a low speed continuous injection apparatus, the combination comprising a housing, a syringe holder mounted on the top of said housing and adapted for holding the syringe in a predetermined position, a rack bar slidably mounted adjacent said holder, a guide member for said rack bar, said rack bar being movable in said guide member in a direction parallel with the longitudinal axis of said syringe, an upstanding lever secured to said rack bar, an elongated slot in said member through which said lever extends, means for securing a syringe piston to said lever, a constant speed motor mounted within said housing, and unidirectional gear driving means connecting said motor and said rack bar whereby said rack bar is driven in the direction to force said piston inwardly of said syringe.

5. In a low speed continuous injection apparatus, the combination comprising a housing, a syringe holder mounted on said housing and adapted for holding a syringe in a predetermined position, a rack bar mounted for longitudinal sliding movement adjacent the end of said holder, said rack bar being movable in the direction parallel with the line of syringe piston movement, an upstanding lever secured to said rack bar and adapted to be secured relative to the syringe piston, a constant speed electric motor mounted within said housing, unidirectional drive gearing between said motor and said rack bar for driving said bar in the direction to force said piston inwardly of the syringe, a releasable connection between said motor and said rack bar, and manual operating means connected to said gearing between said releasable connection and said rack bar for operating said rack bar independently of said motor.

6. In a low speed continuous injection apparatus, the combination, a housing, a syringe holder mounted on the top of said housing, said holder being adapted for receiving a syringe and for holding the same in a fixed position, a con-

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stant speed electric motor mounted within said housing, lever means extending from the top of said housing and adjacent the end of said holder, said lever means being adapted to operatively engage the syringe piston, reciprocating means operatively connected to said lever means for moving said lever means in a direction longitudinally of said syringe, and unidirectional driving means including a friction clutch extending between said motor and said reciprocating means whereby said reciprocating means may be driven to force said piston inwardly of said syringe.

7. In a low speed continuous injection apparatus, the combination comprising a supporting base member, a syringe holder mounted on the top of said base member, said holder being adapted for supporting a syringe, actuating means mounted on said base member for movement in a direction parallel with the direction of movement of the syringe piston, means for operatively connecting said actuating means to said syringe piston, constant speed motor means mounted on said base member and unidirectional drive means operatively connecting said motor means to said actuating means, the connection between said motor means and said actuating means including a friction clutch adapted to slip upon predetermined abnormal resistance to movement of the syringe piston.

8. In a low speed continuous injection apparatus, the combination comprising a syringe holder, a motor means, unidirectional drive means including a friction clutch connecting said motor means to the syringe piston to drive said piston inwardly of the syringe, and manual operating means connected to said drive means between said clutch and said piston whereby the syringe piston may be manually adjusted independently of said motor means.

9. The combination comprising a support, a syringe holder mounted on said support and adapted for holding a syringe in a predetermined horizontally extending position, a constant speed motor mounted within a housing, reciprocating operating means extending from said housing and adapted to operatively engage the syringe piston, said operating means being movable in a direction parallel with the longitudinal axis of said syringe, variable speed gearing connecting said motor and said reciprocating means whereby the speed of travel of said reciprocating means may be selectively controlled, a releasable connection between said motor and said reciprocating means, and manual operating means operatively associated with said reciprocating means for actuating said reciprocating means independently of said motor.

10. In a low speed continuous injection apparatus, the combination comprising a support, a syringe holder mounted on said support and adapted for holding a syringe in a predetermined horizontally extending position, a constant speed motor mounted within said housing, reciprocating operating means extending from said housing and adapted to operatively engage the syringe piston, a unidirectional driving connection including a friction clutch between said motor

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and said operating means whereby said operating means may be driven by said motor in the direction to force the piston inwardly of the syringe, said operating means being movable in a direction parallel with the longitudinal axis of said syringe, and manual operating means operatively associated with said reciprocating means between said clutch and said piston whereby said reciprocating means may be actuated manually in either direction of travel independently of said motor.

11. In a low speed continuous injection apparatus, the combination comprising a support, a syringe holder fixedly mounted on said support and adapted for holding a syringe in a predetermined fixed position, a constant speed motor mounted within a housing, operating means extending from said housing and adapted operatively to engage the syringe piston for effecting longitudinal movement thereof in either direction, a unidirectional drive connection including a friction clutch extending between said motor and said operating means for driving said syringe piston solely in the direction inwardly of said syringe, stationary guide means on said support cooperatively associated with said operating means for guiding the movement thereof in a direction parallel with the longitudinal axis of said syringe, and manual operating means operatively connected with said first operating means whereby said syringe piston may be actuated in either direction of travel independently of said motor.

12. In a low speed continuous injection apparatus, the combination comprising a syringe holder for stationarily supporting a syringe, a reciprocating means mounted at one end of said holder and adapted operatively to engage the syringe piston, means supporting said reciprocating means for movement in a direction parallel with the line of movement of said piston, a constant speed motor, a unidirectional driving means connecting said motor to said reciprocating means for driving said reciprocating means in a direction to force the piston inwardly of said syringe, said driving means including a resistance clutch permitting stoppage of said reciprocating means upon occurrence of abnormal resistance to movement of the syringe piston while permitting continued operation of said motor.

WILLIAM E. HINDS.

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