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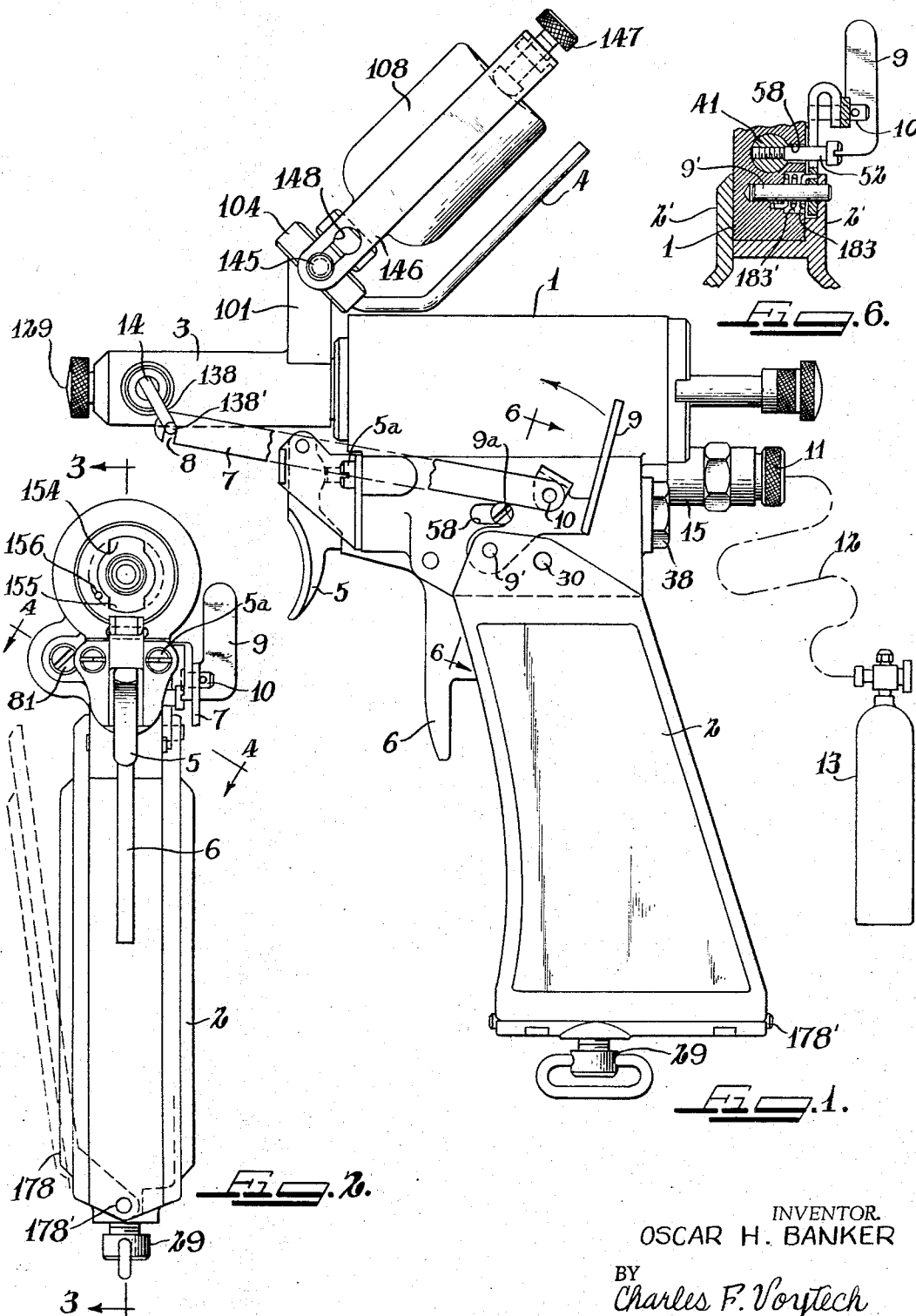
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3,292,622

POWER OPERATED INOCULATOR

Filed Sept. 21, 1964

5 Sheets-Sheet 1



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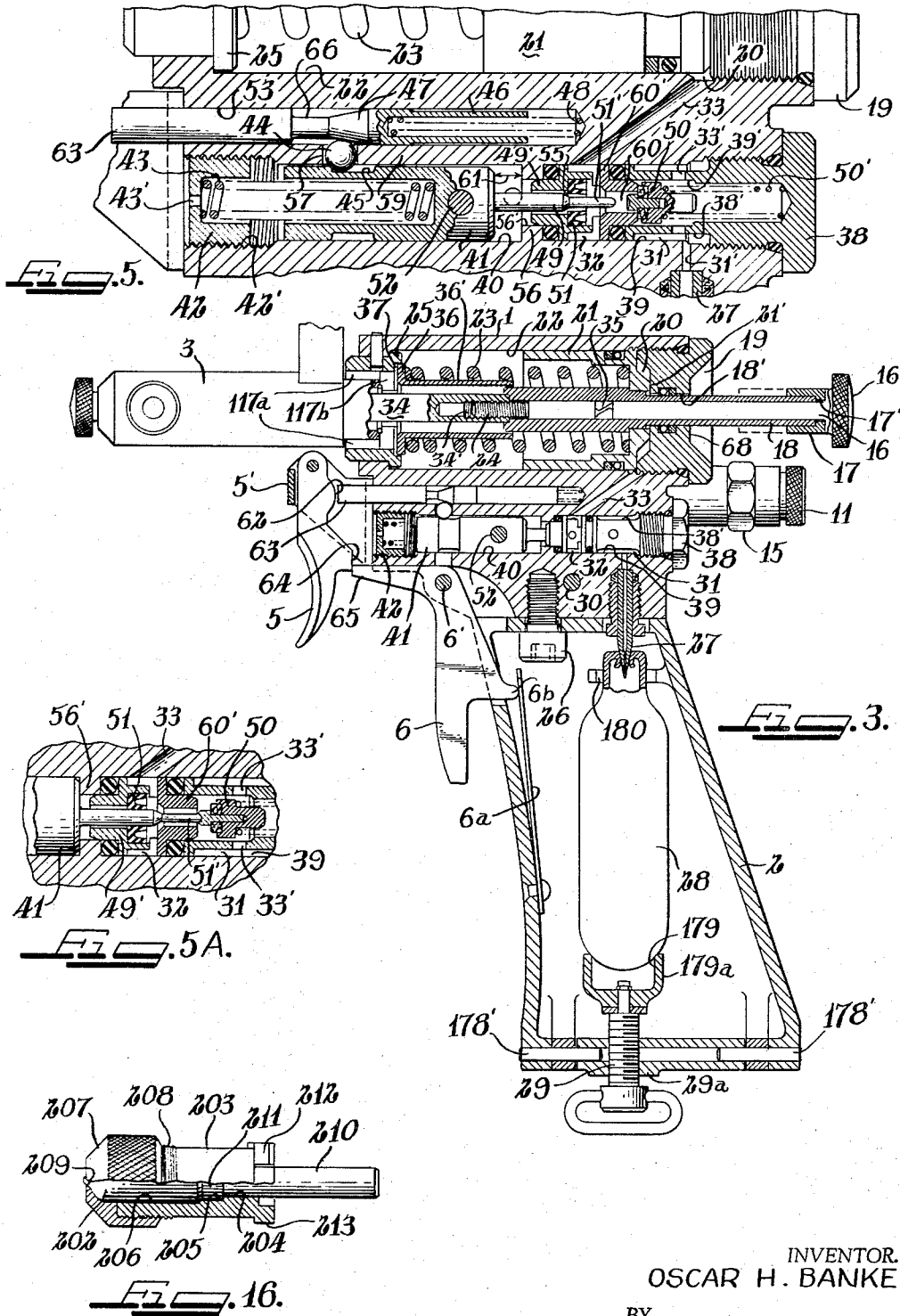
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5 Sheets-Sheet 2



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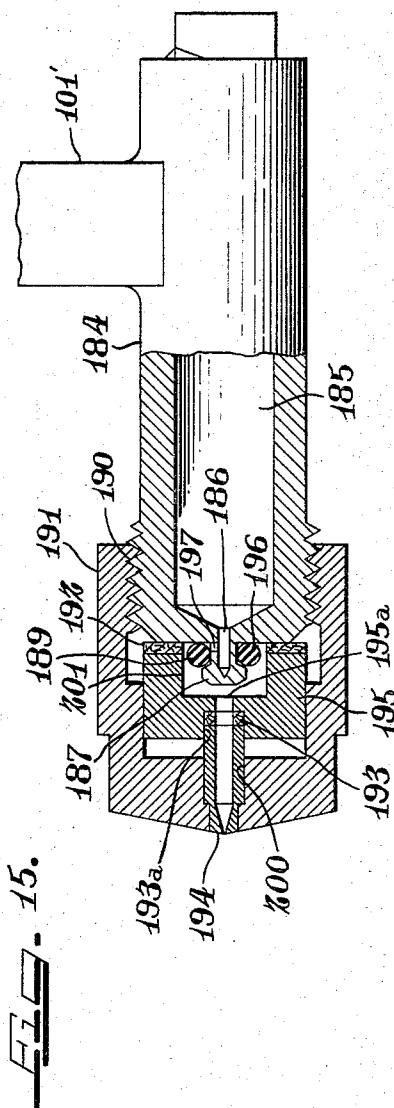
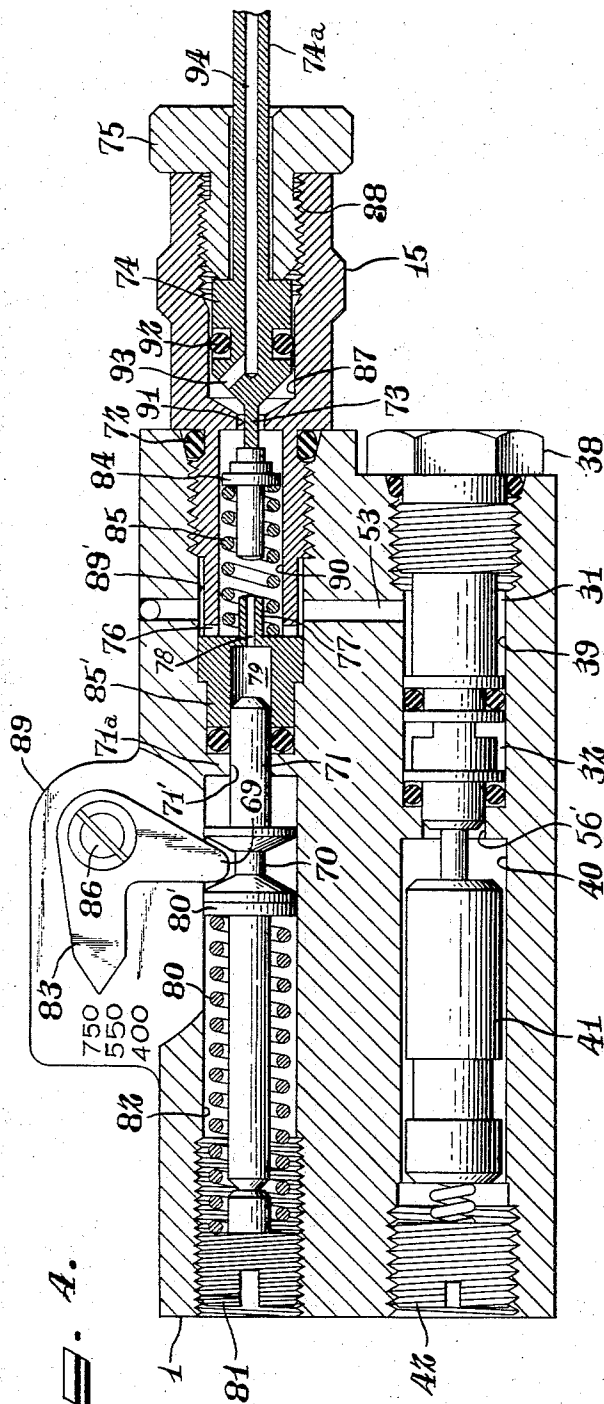
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5 Sheets-Sheet 3



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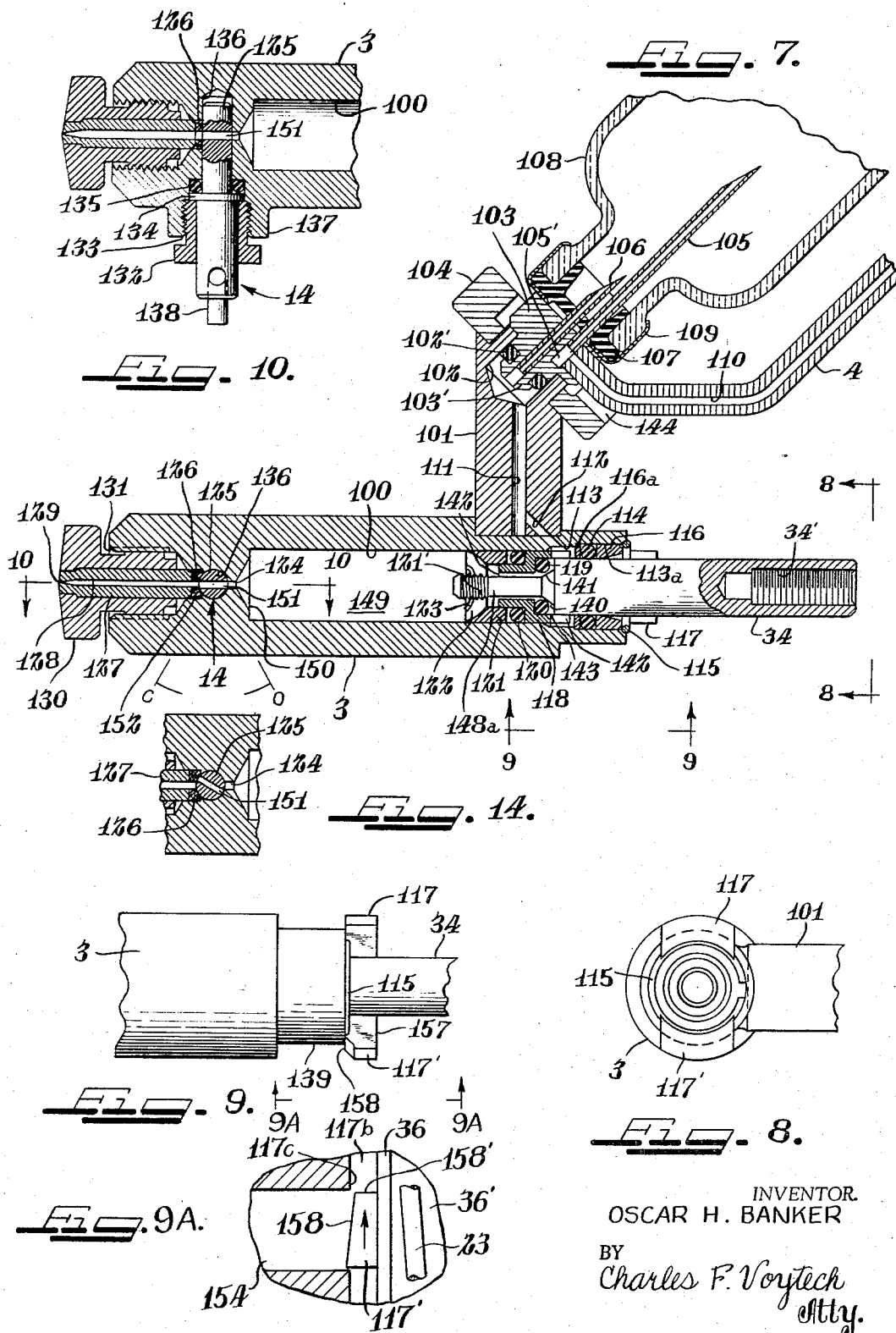
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5 Sheets-Sheet 4



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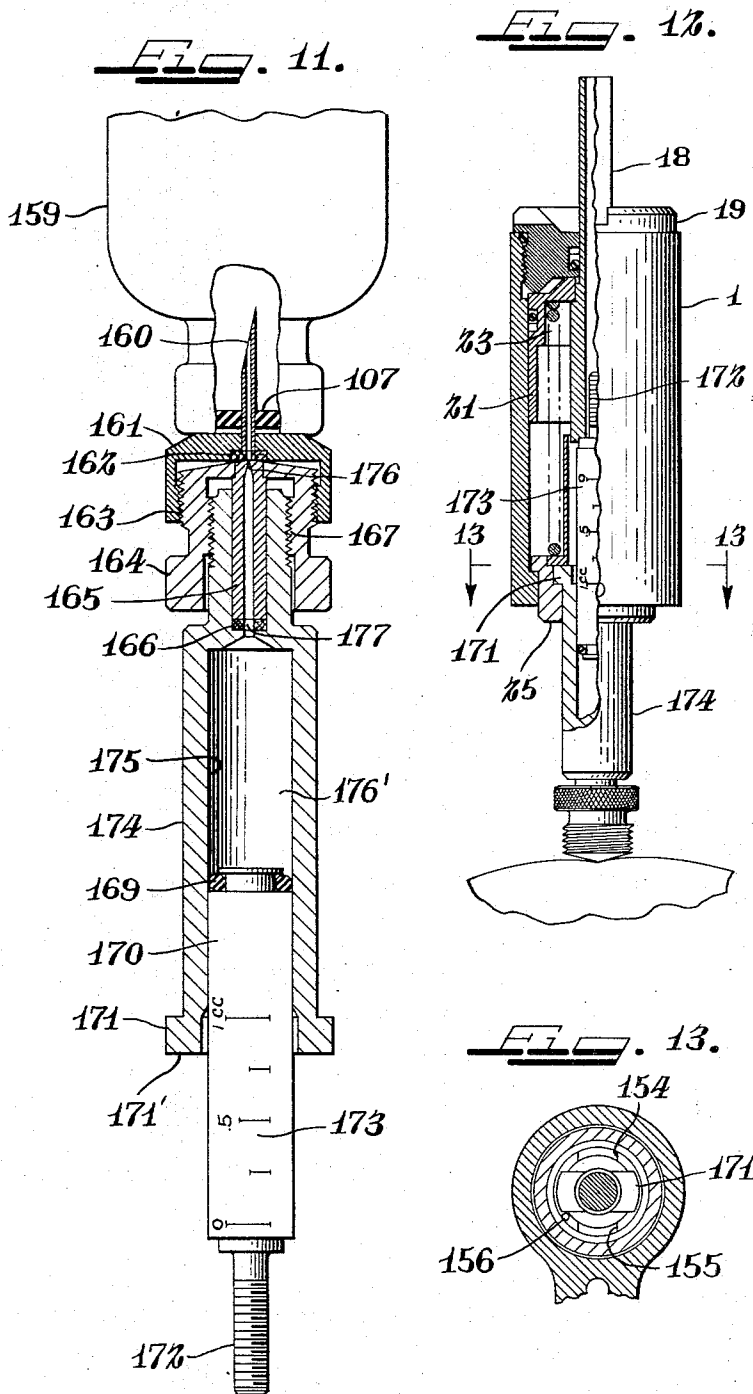
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5 Sheets-Sheet 5



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3,292,622

POWER OPERATED INOCULATOR

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21 Claims. (Cl. 128—173)

This application is a continuation in-part of my prior application for United States Letters Patent, Serial No. 200,411 for Universal Inoculator, filed June 6, 1942, now abandoned.

This invention relates to a power operated device for inoculating persons against various diseases, by introducing the inoculant into the skin of a person.

An object of this invention is the provision of an inoculator which is operated directly by gas pressure, such as may be supplied from a commercially available 8.5 gram cartridge of carbon dioxide, or from a 50-pound tank of carbon dioxide connected to the inoculator by a flexible high pressure hose.

Another object of this invention is the provision of an inoculator which is made in two principal parts, one of which is a power unit and the other is a pump unit having a vial of medicament attached, the pump unit being readily removable from, or attached to, the power unit by a quarter turn of a locking element.

Another object of this invention is the provision of an inoculator which, instead of having a vial of medicament attached to it, can be adapted to receive a single shot pump or injector unit, the latter being chargeable from the vial of medicament directly through the orifice which normally serves as the outlet or discharge end of the inoculator.

A further object of this invention is the provision of an inoculator having a power unit which is adapted for use with interchangeable discharge heads, each of which may be fully charged and remain so while stored awaiting a demand for its use, said heads being either alike, or alternatively some being adapted for use with single, 1 cc. ampules of medicament, some removable and rechargeable with single doses from a vial, and some with automatic pumps for continuously recharging, without removal from the inoculator, with doses of varying size.

As a more specific object, this invention has within its purview the provision of an inoculator provided with a new and more efficient pump, together with an oscillatable valve for regulating the charging and discharging cycles, whereby to permit locating the holder for the vial of medicament and its feeder at the most remote point on the pump from the injection head and from the patient receiving the inoculation.

A further object of this invention is the provision of an inoculator which is safe to operate, despite the extremely high pressures at which the inoculation takes place, said safety being provided by a pair of sequentially operable triggers, one of which locks and unlocks the other.

A further object of this invention is the provision of an inoculator for making a plurality of inoculations from a single vial of medicament wherein the vial and discharge head are removable as a unit quickly and simply by a quarter turn of the attaching means, said head being firmly held in place by a resilient element of the power device used to effect the discharge of the medicament.

A further specific object of this invention is the provision of a gas powered inoculator provided with a novel triggering mechanism which always operates the gas control valve in a uniform manner, regardless of the manner in which the trigger is manipulated by the physician or operator of the inoculator.

An additional object is the provision of an inoculator

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which is equipped with positive-acting, easily changed gauges for determining precisely the dose or quantity of medicament to be injected, the gauges having a range of from 0.1 cc. to 1.0 cc.

It is among the general objects of this invention to provide an inoculator which is light in weight, compact and perfectly balanced for ease of handling.

These and other objects of this invention will become apparent from the following detailed description of a preferred embodiment thereof when taken together with the drawings of such embodiment accompanying the detailed description and in which

FIG. 1 is a side elevational view of an inoculator embodying this invention, showing the removable discharge head and vial holder mounted thereon;

FIG. 2 is a front elevational view of the inoculator of FIG. 1 with the discharge head and vial and vial holder removed;

FIG. 3 is an elevation in cross section of the inoculator of FIG. 1, taken along line 3—3 of FIG. 2 and looking in a direction of the arrows at the end of said line;

FIG. 4 is a cross section through the valves of the inoculator taken along line 4—4 of FIG. 2 and looking in the direction of the arrows at the ends thereof;

FIG. 5 is a fragmentary elevational view in cross section of the valves of the inoculator, taken along the plane of FIG. 3, but showing the detailed construction of certain of the valves thereof;

FIG. 5A is a fragmentary elevational view in section corresponding to FIG. 5 showing the valves in a different stage of operation.

FIG. 6 is a fragmentary end elevational view in cross section of the inoculator taken at an angle to the vertical substantially along the line 6—6 of FIG. 1 and looking in the direction of the arrows at the ends of said line;

FIG. 7 is an enlarged side elevational view in cross section of the removable discharge head and of the vial and vial holder forming a part thereof;

FIG. 8 is a rear elevational view of a fragment of the discharge head of FIG. 7 taken in the direction of the arrows 8—8 of FIG. 7;

FIG. 9 is a bottom view of the fragment of the discharge head of FIG. 7 encompassed between the arrows 9—9 of FIG. 7;

FIG. 9A is a fragmentary side view of the discharge head of FIG. 9, just prior to its being turned to lock it in place in the inoculator;

FIG. 10 is a fragmentary plan view in section of the discharge head of the inoculator on the scale of FIG. 7 and taken along line 10—10 thereof;

FIG. 11 is a view on the scale of FIG. 7 of a modification of the discharge head of FIG. 7, said modification being designed for single inoculation operation, the modification being shown in its charging cycle;

FIG. 12 shows the modification of FIG. 11 installed in the inoculator of FIG. 1, in plan view and on the scale of FIG. 1;

FIG. 13 is a cross section to the modification of FIG. 12 taken along line 13 thereof and looking in the direction of the arrows at the end of said line;

FIG. 14 is a fragmentary view of the valves of FIG. 5 showing said valves in a different stage of operation from that shown in FIG. 5;

FIG. 15 shows a modification of the discharge head of FIG. 1; and

FIG. 16 shows another modification of the discharge head of FIG. 1.

Referring now to the drawings for a detailed description of the invention and particularly to FIG. 1, there is shown a housing 1 for the power mechanism of the inoculator. Said housing is mounted on a handle 2 of

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hollow construction designed to contain, if desired, a small bottle 28 (FIG. 3) of about 8.5 grams capacity of CO₂ gas. The discharge head is shown at 3 and includes a vial holder to be hereinafter described, and a vent tube 4 for the vial. Said discharge head 3 is removable from the housing 1 of the power cylinder by means to be hereinafter described in detail. A rotary valve 14 is provided in the discharge head 3 which closes the interior of the discharge head to outside air from the discharge end of the device when said device is not in use.

It is contemplated that rotary valve 14 will be operated automatically, and to this end it is provided with an exterior crank 138 to which is removably secured one end of a connecting rod 7. Said connecting rod 7 has a slot 8 in which is received the crank pin 138' of crank 138. The other end of connecting rod 7 is pivotally connected at 10 to a lever 9, the function of which will hereinafter be described. The purpose of the slot 8 is to make possible the rapid disconnection of pin 138 from connecting rod 7 when it is desired to remove the discharge head 3 from the inoculator.

Handle 2 is provided with a fitting 15, normally closed with a plug 11, which may be connected through a suitable flexible tube, shown in dot-dash line at 12, to a 50 pound tank 13 of compressed CO₂ as a source of gas under pressure for operating the inoculator.

The mechanism within housing 1 and handle 2 is shown more clearly in FIG. 3 to which reference is now made. It may be seen that handle 2 is secured to housing 1 by screws 26 and 30. The discharge head 3 is held in the gun in part by a breach block 25 and in part by a draw bolt 16 which is secured by a threaded connection 24 to a ram 34 forming part of the discharge head. The ram serves to create pressure upon the medicament in the discharge head 3 when said ram is moved to the left, as viewed in FIG. 3. Said movement to the left is produced by a piston 21 located in a bore 22 in housing 1, said bore being normally closed at its right hand end, is viewed in FIG. 3, by a plug 19 threadedly received in said bore and appropriately sealed with respect thereto.

Draw bolt 16 passes through a tube 18 which extends through an opening 18' centrally disposed in plug 19 and is appropriately sealed with respect to said plug. The left hand end of draw bolt 16 has a thread formed thereon which is received in a threaded opening 34' in the right hand end, as viewed in FIG. 3 of the ram 34.

Tube 18 abuts at its forward end upon the adjacent end of ram 34, and at its opposite end is spaced from the head 16' of the draw bolt 16, to form an annular space in which is received an inwardly extending flange 17' of a gauge ring 17 which is tubular in form and extends over tube 18 toward plug 19. It may be apparent that when the draw bolt 16 is screwed into threaded opening 34', head 16' advances toward ram 34 and compresses tube 18 and the flange 17' between head 16' and the end of ram 34, thereby securely uniting ram 34 with draw bolt 16.

As will be hereinafter described, ram 34 at times is separated from draw bolt 16 and under such conditions draw bolt 16 would be loose in tube 18 and capable of falling out of said tube. To prevent this inadvertent separation of draw bolt 16 from tube 18, a flat spring bushing 35 is provided around draw bolt 16 in an appropriately formed groove therefor, said flat spring bushing 35 being expansible against the inner surface of tube 18 to provide sufficient friction to hold said bolt 16 within tube 18.

Piston 21 is press-fitted or otherwise secured to tube 18 which passes through a central opening in said piston. Said piston 21 is adapted to abut at its radially inner end 21' against plug 19, and at its upper end to be slightly spaced therefrom, with the intermediate region of said piston separated from plug 19 to form a chamber 20 therebetween. Piston 21 is hollow and receives one end of a return spring 23 which abuts upon the inner wall

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of said piston, the outer end of said spring abutting upon the flange 36 of a bushing 36' into which tube 18 passes on the operative stroke of ram 34. Said spring 23 is preloaded when it is installed and is in the position as shown in FIG. 3, to insure a fast and positive return of piston 21 at all times.

It is contemplated that chamber 20 will be filled with a gas under pressure under the control of the operator to effect an inoculation. This gas, as stated previously, may come from a tank 13 through fitting 15 to an appropriate valve arrangement hereinafter to be described, or it may come from the small 8.5 gram CO₂ container 28. In the latter eventuality, container 28 is disposed inside hollow handle 2 and is held against a hollow piercing pin 27 threadedly mounted in the lower face of housing 1. An access door 178 is hingedly mounted on the side of handle 2 through pins 178' and provides an opening into handle 2 through which container 28 may be inserted thereinto. A lariat screw 29 is threadedly received in the bottom 29a of handle 2. A cup 179a is swiveled upon the upper end of lariat screw 29, as viewed in FIG. 3, and the inner edge 179 of said cup abuts upon the rounded lower end of the CO₂ container 28. Thus lariat screw 29 may be advanced into handle 2 against the container 28 to cause said container 28 to contact and be pierced by the piercing pin 27, thereby establishing communication between the interior of the container and the interior of the hollow pin 27. It may be noted that container 28 may always be kept in the position shown in FIG. 3 in readiness to perform its functions, even when the large tank 13 is being used, since means are provided, as hereinafter detailed, to automatically shut off the source of gas under pressure not then being used. Between piercing pin 27 and the cylinder bore 22 valving and trigger mechanism are provided to control the application of gas under pressure to the chamber 20 to move piston 21 and its associated ram 34 during the operative stroke of the inoculator. The valving and trigger mechanism are shown in FIG. 5 on an enlarged scale, and reference is now made thereto for a detailed description of said valving and trigger mechanism.

Housing 1 has a counterbore 39 formed therein from its right hand end, as viewed in FIG. 3, into which a plug 38 is threadedly received. Said plug has a wide peripheral groove 38' formed therein, which establishes with counterbore 39 a chamber 31 in communication, through a hole 31' in housing 1, with the interior of hollow piercing pin 27. Said chamber 31 is thus filled with CO₂ gas under full pressure from said container 28. Plug 38 is shorter than counterbore 39 and therefore establishes a second chamber 32 in said counterbore. Said second chamber 32 is in communication with the chamber 20 behind piston 21 in bore 22 through a cross bore 33 in housing 1. Communication is established between chamber 31 containing the gas under pressure and cross bore 33 through cross bores 33' in plug 38 which communicate with the hollow interior thereof formed by a counterbore 39' opening upon the left hand end of said plug 38. Chambers 31 and 32 are adapted to be closed with respect to one another by a disc valve 50 adapted to seat upon the open end of a flanged tube 60' fitted into counterbore 39' and abutting upon the slotted end of a sleeve 49' disposed in counterbore 39 and defining a portion of chamber 32. Axial thrust from plug 38 is transmitted to flanged tube 60 through an appropriate O ring seal and is then transmitted through the sleeve 49' to another appropriate O ring seal and the bottom of the counterbore 39. A spring 50' is compressed between the closed end of plug 38 and disc valve 50 to hold said disc valve 50 upon its seat when there is no pressure in chamber 31.

It may be apparent from the description thus far given that whether gas under pressure is admitted to cross bore 33 and chamber 20 behind piston 21, depends upon the opening and closing of disc valve 50. It is contemplated

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that said valve will be operated by a trigger mechanism which is located on the left side, as viewed in FIG. 3, of housing 1. Thus a counterbore 40 is formed in said housing in axial alignment with counterbore 39 and opening upon the left hand side of housing, as viewed in FIG. 3. Between said counterbores 39 and 40 there is formed a dividing wall 56 which has a central opening 56' formed therein to establish communication between counterbores 39 and 40. A parallel bore 53 of smaller diameter is formed in housing 1 above counterbore 40, as viewed in FIG. 5, and a cross bore 57 connects said bores 40 and 53. A plunger 41 is disposed in bore 40 and is loosely slidable therein. Said plunger 41 is hollow to receive one end of a compression spring 43. The other end of spring 43 abuts against the inner end of a hollow plug 42 which is threadedly received in a slightly larger threaded counterbore 42' opening upon the left hand end of housing 1. Said plug 42 is formed with a screw driver slot 43' through which the plug may be advanced into its counterbore to increase the compression of spring 43.

Plunger 41 has a shoulder screw 52 threaded thereinto and extending radially outwardly from said plunger through a slot 58 (FIGS. 1 and 6) in housing 1 to the exterior of said housing. Said plunger 41 also has formed therearound a peripheral groove 45 (FIGS. 3 and 5) which is in proximity to the cross bore 57. Extending from the right hand end of plunger 41, as viewed in FIG. 5, is a rod 49 which passes through sleeve 49' and is of smaller diameter than the interior of said sleeve to provide an annular space therebetween, said rod having a pin end 51' of reduced diameter, which extends through the flanged tube 60' with considerable clearance therebetween into proximity with the disc valve 50. Thus reciprocation of plunger 41 in its counterbore 40 causes the pin end 51' of rod 49 to reciprocate toward and away from disc valve 50, thereby providing a means for unseating said valve and opening flanged tube 60' to the fluid under pressure in counterbore 39'. This gas under pressure may then pass through tube 60', the slotted end of sleeve 49' into chamber 32 and thence through cross bore 33 into chamber 20 behind piston 21. Reciprocation of plunger 41 is effected by the mechanisms hereinafter to be described.

Within bore 53 is disposed a cam plunger 46. A spring 48 is compressed between the bottom of counterbore 53 and the interior of the hollow right hand end of plunger 46, as viewed in FIG. 5, to urge said plunger continuously toward the left. At the midportion of plunger 46 is formed a cone 47 which is substantially in axial alignment with cross bore 57. A lock ball 44 is disposed in cross bore 57, the diameter of the ball being greater than the thickness of the wall 59 separating bores 40 and 53. It may be apparent that when groove 45 on plunger 41 is aligned with cross bore 57, ball 44 will be pushed into said groove 45 by cone 47 on plunger 46 which, it may be remembered, is continuously urged to the left, as viewed in FIG. 5, by spring 48. The cone angle and the force of spring 48 are so chosen that the force of spring 43 and plunger 41 acting upon ball 44 to eject it from groove 45, is less than the force of the cone 47 and the spring 48 tending to push ball 44 into said groove 45. Thus spring 48 and cone 47 normally hold plunger 41, through ball 44 and groove 45, in the position shown in FIG. 5. In this position the reduced end 51' of rod 49 is out of contact with disc valve 50 and hence said disc valve remains seated upon the end of flanged tube 60' to prevent entry of gas under pressure into said tube 60'.

Within sleeve 49' is a U-cup seal 51 which is adapted to engage frictionally the exterior surface of rod 49 as the latter moves axially to the right, as shown in FIG. 5. An axial clearance 55 is provided between U-cup 51 and rod 49, an axial clearance 60 is provided between disc valve 50 and the end of the reduced portion 51' of rod 49, and a clearance 61 is provided between the end of plunger 41 and dividing wall 56. These clearances are respectively

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progressively larger so that upon axial movement of plunger 41 to the right, U-cup 51 will contact and seal the exterior of rod 49 first, then the pin 51' will contact disc valve 50 and finally, as shown in FIG. 5A, plunger 41 will contact dividing wall 56, disc valve 50 being held off its seat when plunger 41 contacts dividing wall 56. Thus, by axial reciprocation of plunger 46 to release ball 44 from its groove 45, plunger 41 may be permitted to move to the right to effect the unseating of the disc valve 50.

It is contemplated that plunger 46 will be operated by a trigger located to the left of housing 1, as shown in FIG. 3. To this end, plunger 46 extends outwardly to the left to provide a protruding end 63. Over the protruding end 63 is a U-shaped strap 5' which, as shown in FIGS. 1 and 2, is secured by suitable screw 5A to the front face of housing 1. Pivotaly mounted on said strap and in proximity to the protruding end 63 of plunger 46, is a trigger 5 which is formed with a cam 62 adapted to contact the said protruding end 63, but in the inoperative state of trigger 5 cam 62 is always slightly spaced from end 63. Trigger 5 is maintained in such spaced relation with respect to end 63 by a safety trigger 6 which is pivoted at 6' on housing 1 below and to the rear of trigger 5. Safety trigger 6 is provided with a forwardly extending finger 65 which normally contacts a face 64 on trigger 5. A leaf spring 6a is disposed within handle 2 and bears against a rear surface 6b on safety trigger 6. The spring pressure is such as to tend to rotate safety trigger 6 in a clockwise direction whereby to hold finger 65 in alignment with raised face 64 on trigger 5. When safety trigger 6 is squeezed, however, the finger 65 is rotated downwardly off the raised face 64 and thus frees trigger 5 for backward movement, that is, for counterclockwise movement as viewed in FIG. 3 to operate plunger 46.

Thus when the piston 21 is to be operated, the physician first squeezes safety trigger 6 to move finger 65 away from raised face 64 of trigger 5, and then he squeezes trigger 5 to cause cam surface 62 to bear against the protruding end 63 of the plunger 46. Continued squeezing of the trigger causes plunger 46 to move backwardly to align a smaller section of cone 47 with ball 44. At the smallest section of cone 47, ball 44 is entirely free of groove 45 in plunger 41, and the latter is then free to move backwardly under the influence of spring 43, first, to effect a seal around rod 49 and then to unseat disc valve 50. This, as previously described, opens cross bore 33 to the pressure in chamber 31. The pressure of the gas in cross bore 33 enters chamber 20, pushes piston 21 and the draw bolt 16 to the left as viewed in FIG. 2 against the action of return spring 20 until gauge ring 17 strikes the outer surface 68 on plug 19.

It may be apparent that the total travel of the piston and draw bolt 16 is determined by the axial length of the gauge ring 17, so that by interposing rings of different axial length between head 16' and a surface 68 on plug 19, the travel may be decreased or increased. Since the travel of the piston controls the travel of the ram 34, which is in immediate contact with the medicament, the quantity of medicament injected by the inoculator is thus controlled.

The exhaust gas is vented to the exterior of housing 1 around rod 49 and plunger 41, these elements being loose in their respective chambers or openings. During the application of pressure to piston 21, however, rod 49 is sealed by U-cup seal 51 and hence the admission of gas under pressure into chamber 20 behind piston 21 is effected without creating any sound. The patient, therefore, is not aware when an inoculation is made, except, possibly, for a dull thud which is produced by ram 41, as it strikes dividing wall 56. The gun may be removed from the patient while the piston 21 is in its operative or left hand position as viewed in FIG. 3, and then reset at a point remote from the patient, so that if he should hear the exhaust gas escaping from housing 1 during the resetting, it will not disturb him.

To reset the inoculator, it is necessary to move plunger 41 back against the action of its spring 43. It may be remembered that plunger 41 is accessible from the exterior of the housing 1 through shoulder screw 52 secured to the plunger and extending through an appropriate slot 58 in the housing to the exterior. The means for moving screw 52 in its slot 58 comprises reset lever 9 which is mounted for pivotal movement on a pin 9' passing through one of spaced ears 2' extending upwardly from handle 2 and embracing the lower portion of housing 1 therebetween, said pin 9' also passing through a recess 183' in housing 1 and into an appropriate opening therein. A torsion spring 183 anchored at one end in housing 1 and at its other end in lever 9, continuously urges said lever 9 in a clockwise direction, as viewed in FIG. 1. Said lever 9 has a surface 9a adapted to contact the shoulder on shoulder pin 52 when said lever is rotated in a counterclockwise direction, as viewed in FIG. 1.

Thus lever 9 is normally maintained in a position wherein it does not interfere with the operative movement of plunger 41, but when it is desired to vent the gas behind piston 21 and thereby to reset the inoculator, said lever 9 is pushed forwardly, that is, in a counterclockwise direction, as viewed in FIG. 1, by the physician, which action causes the lever to strike screw 52 and move said screw forward along with its plunger 41. This action first causes a seating of disc valve 50 to close chamber 32 to the gas under pressure, and then causes rod 49 to be withdrawn from the U-cup seal 51 and thus provide a passage for the gas in chamber 20 and cross bore 33 to escape to the atmosphere around plunger 41.

Since the inoculator of this invention is designed to work with gas under pressure supplied from a source of fixed quantity, such as containers 13 or 28, it is to be expected that the pressure of the gas will gradually decrease and will eventually reach a value at which an operative cycle of the gun cannot be completed. Under normal circumstances there is no indication given that a source is about to be exhausted so that a physician may commence to give an inoculation with the present inoculator, only to find that the pressure is not sufficient to complete an inoculating cycle. The medicament used in an incomplete inoculation is wasted and, in addition, the physician is unable to determine accurately just how much of the medicament has been injected. The giving of an incomplete inoculation by the apparatus of the present invention can be avoided with the aid of the mechanism shown in FIG. 4, to which reference is now made.

In FIG. 4 housing 1 is provided with a counterbore 82 which is essentially parallel to counterbore 40 in which plunger 41 is retained. A plunger 71 is disposed in counterbore 82 and extends through an opening 71' in a wall 71a forming the bottom of the counterbore 82. The left hand end of counterbore 82, as viewed in FIG. 4 is closed by a threaded plug 81 which serves as an abutment for a compression spring 80 bearing against an enlargement 80' on plunger 71. Said enlargement 80' has a peripheral groove 70 thereon in which is received one arm 69 of an indicator 83 pivoted at 86 on a boss 89 extending laterally from housing 1. Said indicator 83 sweeps over a scale scribed on boss 89 and graduated in pounds per square inch pressures from a maximum of 750 to a minimum of 400. It has been determined that when the pressure for operating piston 21 falls below 400 pounds per square inch (with a margin of safety of 50 pounds per square inch) a complete inoculation cannot be given, and hence the physician is instructed to cease operating the inoculator when the indicator falls to 400 and to obtain a fresh supply of CO₂ under pressure.

On the right hand side of wall 71a as shown in FIG. 4 is a stepped and threaded counterbore 89' into which fitting 15 is threaded. Said fitting has a counterbore at 90 which extends substantially midway of the ends of the fitting 15. At the bottom of counterbore 90 is formed an axially directed port 91 leading to a counterbore 87

which has internal threads 88 at the entrance end thereof. Within counterbore 87 is disposed the hollow plug end 74 of a tube 74a suitably connected to hose 12 leading to container 13. Said hollow plug end is retained in counterbore 87 by a lock nut 75. When, however, it is desired to operate from the small container 28 in the handle 2 and not from the large container 13, the hose 12 and the lock nut 75 are replaced by the previously described plug 10 which simply acts as a closure member to close off the otherwise open end of fitting 15.

Port 91 is normally closed by a disc valve 84 which is held against said port by a spring 85 compressed between said valve and a sleeve 85' interposed between the inner end of fitting 15 and wall 71a. Sleeve 85' is clamped against the bottom of counterbore 89' by fitting 15. A pin 77 is formed on sleeve 85' to assist in centering spring 85, and a hole 78 through pin 77 establishes communication between counterbore 90 and the interior 79 of sleeve 85'. Valve 84 may be unseated, however, by a reduced diameter pin 73 formed on the end of plug 74 and adapted to extend through port 91 when said plug 74 has been located in counterbore 87 by lock nut 75, that is, when said lock nut 75 abuts upon the end of fitting 15.

The interior of fitting 15 is also in communication with bore 53 through an appropriate clearance between the inner end of fitting 15 and the counterbore 89' and slots 76 formed in the end of said fitting 15 to create a passage from bore 53 around the inner end of fitting 15 and then through slots 76 to the interior thereof.

Thus the right hand end of plunger 71 is always exposed to gas under pressure, either from the container 28 through hole 53, or from the container 13 through interior passage 94 and side opening 93 in plug end 74, and this pressure acts upon plunger 71 in opposition to the pressure of spring 80. When sufficient gas pressure is present in counterbore 89 and in the interior 79 of sleeve 85' which is in communication with said counterbore, said pressure will overcome the force of spring 80 and move the plunger and its associated arm 69 to the left, as viewed in FIG. 4, thereby moving indicator 83 over its scale to the high pressure side thereof. As the gas pressure falls during the use of the inoculator, the physician merely observes the indicator 83, and stops using the inoculator when the pressure falls to 400 pounds per square inch, at which point a new source of gas under pressure must be substituted for the one that had become useless for further inoculations.

Inasmuch as the small container 28 may be connected through the hollow piercing pin 27 to the chamber 31 at the time tank 33 is to be connected to fitting 15, it is important, in order to prevent loss of pressure from container 28 during the coupling of hose 12 to fitting 15, that the counterbore 87 in fitting 15 be sealed with respect to the exterior of fitting 15 before pin 73 contacts and unseats valve 84. The length of counterbore 87 is therefore so chosen that an O ring seal 92 enters and seals the smooth (unthreaded) portion of counterbore 87 before pin 72 contacts valve 84. It is also contemplated that the lock nut 75 will be engaged with the threads 88 in the counterbore for at least two or three threads before valve 84 is unseated so that the pressure released by the unseating of the valve does not force the plug end 74 back out of counterbore 87.

Thus far the description has been concerned with the means for establishing and controlling movement of ram 34 into the discharge head 3. There now follows a description of the novel discharge head which is designed to be removable from the inoculator as a unit. The unit includes not only the nozzle and a support for a large bottle of inoculant, but also a reciprocating pump for charging the head, the pump remaining with the head when the latter is removed from the gun so that the head and its inoculant may be stored and instantly reused. The head is shown in detail in FIG. 7, to which reference is now made.

In FIG. 7, the discharge head 3 has a column 101 welded or otherwise firmly secured to it substantially at right angles to the general axis of said head. Column 101 terminates in an anchor ring 104 which is disposed at an angle of approximately 45° to the general axis of head 3. Two trunnions 145 (FIG. 1), spaced substantially 180° apart, extend outwardly from anchor ring 104 and extend through keyhole slots 148 in a U-shaped strap 146 adapted to pass around the bottom of a vial 108 containing the medicament to be injected. Said vial is clamped against a piercing head 103 by a suitable clamping thumb screw 147 disposed in the bottom of strap 146 and adapted to contact the bottom of vial 108.

Piercing head 103 has a nose 103' which is adapted to be inserted into the enlarged and inclined end 102 of a bore 111 extending through column 101. Said nose 103' is sealed with respect to end 102 of bore 111 by an O ring 102'.

Piercing head 103 is provided with two hollow needles one of which, 106, is short and is used for admitting the inoculant from the vial to bore 102, and the other, a longer one, 105, serves as a vent for the interior of the vial 108. To this end piercing needle 105 is retained in a blind hole 105' in piercing head 103 which communicates with the interior 110 of a vent tube 4 secured to the side of piercing head 103. A slot 144 is formed in anchor ring 104 to permit said tube 4 to pass therethrough. Tube 4 is preferably made long to extend above the highest level of inoculant in vial 108 and thus to prevent any dripping of the medicament or inoculant out of said tube in the event that back pressure is developed in the vial due to temperature changes, etc.

The vial 108 is a standard vial in which drugs and inoculants are sold and is capped or sealed by the drug manufacturer. The cap generally comprises a rubber stopper such as is shown at 107 which, in turn, is encased with a metal cup-shaped cover 109 rolled under the rim of the vial 108 to form a permanent seal. Said metal cover is usually provided with a disc which is readily removable to expose the center of the rubber stopper. Thus, after such disc is removed and it is desired to attach the vial 108 to the piercing head 103, piercing needle 106 is aligned with the center of the stopper and this automatically locates the longer needle 105 with respect to the stopper. Said needle 105 is then pushed through the stopper 107 just inside the inner edge of the remnant of metal cap 109, and needle 105 is made to continue through the stopper with the shorter needle 106 joining in passing through stopper 107, until both needles 105 and 106 have passed through stopper 107 and the cap 109 abuts upon piercing head 103. It is understood, of course, that the piercing head is applied to the vial while the vial is upright on a table and the piercing head is removed from the inoculator discharge head 3, so that downward pressure may be applied to the piercing head to assist in forcing needles 105 and 106 through the rubber stopper 107. With vial 108 assembled with respect to the piercing head 103 and its vent tube 4, the entire assembly is then inverted and assembled with respect to ring 104 by inserting nose 103' into the enlarged end 108 of bore 111. Strap 146 is swung around the vial into alignment with the axis of the vial, and thumb screw 147 is turned to secure vial 108 to anchor ring 104.

The discharge head 3 has a bore 100 centrally disposed therein. Said bore 100 has a counterbore 113 and a second counterbore 113a. It is contemplated that ram 34 will push a piston into the bore 100 and will thereby push the inoculant which occupies the bore out of said bore through an appropriate discharge orifice. Such piston must, of course, be sealed with respect to both the ram 34 and the bore 100. Because of the requirement of absolute cleanliness for all parts of the discharge head which contact the medicament, the seals

are made of polytetrafluoroethylene which is relatively inelastic. The piston must therefore be made up of separable parts which when brought together form a groove into which an O ring seal made of polytetrafluoroethylene may be placed. Thus the piston used in bore 100 is comprised of parts 118 and 121, part 118 supporting on its stepped inner diameter an O ring seal 119. Said part 118 encircles a reduced diameter end 148a of sufficient length to pass through piston part 118 and then beyond into a threaded opening 121' in piston part 121. A suitable cotter pin or lock wire 123 bent to go into an appropriate cross slot 122 cut in the end of piston part 121 serves to lock said piston part against rotation on threaded reduced diameter end 148a. In addition to providing a space for lock wire 123, slot 122 performs the additional function of providing a port or portion of a passage extending from a chamber 149, formed by bore 100 and piston part 121, through the centers of piston parts 121 and 118 to the counterbore 113. The latter portion of the passage to counterbore 113 is completed through polytetrafluoroethylene O ring 119 on the interior of piston part 118, over a conical surface 141 on the inner end of reduced diameter end 148a of ram 34, which with O ring 119 forms a space or port 140, and then radially outwardly between O ring 119 and the left hand end of ram 34 into an opening 143 formed between the end of ram 34 and piston part 118 by slots 142 cut in the right hand end, as viewed in FIG. 7 of said piston part 118.

It may be observed that in the retracted position of the ram 34 shown in FIG. 7 there is direct communication from an angle bore 112, passing through discharge head 3 and column 101 into communication with bore 111 therein, to the interior of chamber 149. In such retracted position of ram 34, piston part 118, which is axially reciprocable relative to ram 34, is in its left hand position, as viewed in FIG. 7, to make available the space between itself and the ram for the passage of medicament from bore 111 into chamber 149 on the return stroke of ram 34. The return stroke is, in fact, the suction stroke of a pump formed by the piston parts 118 and 121, and ram 34. On the pressure or operative stroke of said pump, piston part 118 moves to the right, as viewed in FIG. 7, to cause O ring 119 to bear against conical surface 141 in sealing relation therewith, thereby preventing return of the medicament in chamber 149 to bore 111. The discharge end of chamber 149, through which the medicament is forced on the pressure stroke of the pump, is a very small hole 124 in bottom wall 150 of bore 100 leading outwardly from chamber 149 and adapted to be closed by rotary valve 14.

The left hand end of discharge head 3, as viewed in FIG. 7, and particularly that portion beyond wall 150, has formed therein a transversely disposed bore 136, in which the reduced diameter end 125 of rotary valve 14 is located, and an enlarged continuation of small hole 124 which is threaded at 131 to receive a threaded nozzle 130. The reduced diameter end 125 of rotary valve 14 has a small diametral hole 151 thereacross which is substantially in alignment with the very small hole 124 in wall 150. Adjacent end 125 of valve 14 is a washer 126 of polytetrafluoroethylene, the opening in which is adapted to be aligned with hole 151 in valve 14, said washer 126 serving as the seal for a hardened insert 127 press-fitted or otherwise retained in an appropriate opening in nozzle 130. Insert 127 has a passage 128 there-through in alignment with the opening in washer 126 at one end, and at its other end said passage 128 is progressively smaller in diameter to form the orifice 129 through which the medicament is ejected by the pump in bore 100.

Rotary valve 14, as shown in FIG. 10, extends through a boss 137 formed in the side of discharge head 3, said boss having an enlarged threaded opening 133 extending thereinto in axial alignment with transverse bore 136.

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The outer end of valve 14 is enlarged and is separated from the reduced diameter end 125 thereof by a radially extending flange 134 on one side of which is a polytetrafluoroethylene O ring 135 and on the other side of which is a bushing 132 which is threaded into bore 133 and serves to hold valve 14 in place in discharge head 3 as well as to provide the necessary pressure between flange 134, O ring 135 and the bottom of bore 133 to effect a seal therebetween. As described hereinabove, valve 14 is provided with a crank 138 on the exterior end thereof by which said valve may be oscillated between open and closed position. FIG. 7 shows valve 14 in its open position, and FIG. 14 shows the valve 14 in its closed position.

Bore 136 is a reamed opening produced conventionally and the reduced diameter end 125 of valve 14 is also produced in a conventional manner using conventional tolerances. Thus the end 125 fits relatively loosely in bore 136 instead of being lapped together as is the normal practice, to make the joint between them leakproof. Instead of relying upon the joint between end 125 and bore 136 for a seal in the present design, the seal is provided by the polytetrafluoroethylene washer 126 which although relatively inelastic, is nevertheless possessed of a limited resilience and hence is clamped against the face of end 125 by the insert 127. Washer 126 is therefore deformed sufficiently to cause it to conform to the contour of end 125 as shown at 152 to make a perfect seal inexpensively. Since polytetrafluoroethylene has a very low coefficient of friction, valve 14 can be oscillated against the pressure of the washer with low torque. It may also be noted that washer 126 is not required to effect a seal against high pressures of the medicament but instead is intended to be effective only during the suction stroke of the pump formed on the end of ram 34 where it seals only atmospheric pressure.

It may be recalled that one of the objects of the invention is to provide a removable discharge head, the removal of which can be effected by a simple quarter turn of the head in the housing for the inoculator. Referring now to FIGS. 7, 8 and 9, it may be observed that discharge head 3 has on the right hand end thereof, as viewed in FIGS. 3, 7 and 9, a section of reduced diameter 139, and that the extreme right hand end of said head 3 is provided with radially extending ears 117 and 117'. These ears, as shown in FIGS. 2 and 3, are adapted to pass axially through appropriate grooves 154 and 155 in the left hand end of breech block 25, as viewed in FIG. 3, and into a peripheral groove 117b in which said head may be rotated one-quarter turn to lock it therein. Said ears 117 and 117' constitute in effect a bayonet joint between head 3 and breech block 25. It is necessary, of course, to provide a stop for the turning movement of head 3, and to this end an axially disposed pin 156 is provided in breech block 25, said pin extending axially into peripheral groove 117b and being located at the point at which head 3 is oriented to present crank 138 in the intended manner to connecting rod 7 and to cause column 101 to be disposed in a position which is generally coplanar with handle 2.

It may be noted that said groove 117b is actually open at its inner end, that is, at the right hand end thereof, as viewed in FIG. 3, so that said groove does not provide any limit stop for axial movement of discharge head 3 into housing 1. This stop is provided, however, by the flange 36 of the bushing 36', which is contacted by the face 157 (FIG. 9) of the ears 117 and 117'. It is desirable that once the head is turned and in place against pin 156, it be held there by suitable friction means to avoid an inadvertent turning of the head in the housing 1. This friction is provided by making the space between flange 36 and the outer end of groove 117b less than the axial dimension of an ear 117, and by making the leading edge of an ear 117, 117' narrower than the trailing edge so that said ear when turned will be wedged

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into the said groove against the action of spring 23. Thus, as shown in FIGS. 9 and 9A, the ear 117 is provided with a cam surface 158 which creates a narrow leading face 158' capable of entering easily into the space between flange 36 and the face 117c of groove 117b, and that as the ear is turned into groove 117b the progressively wider ear then causes the flanged bushing 36' to be moved to the right, as viewed in FIG. 9A, against the action of spring 23, so that when the ear 117' comes to rest against pin 156, the pressure of spring 23 holds ear 117' against the breech block 25 with sufficient friction to resist inadvertent turning of the head 3 relative to housing 1. The actual displacement of flange 36 from head 25 is shown in FIG. 3 at 37.

To make head 3 a truly separable unit from housing 1, it is necessary that ram 34 remain with said head at all times, particularly when the head contains an inoculant which is to be put aside until it is again needed. To this end, counterbore 113 is sealed at its right hand end, as viewed in FIG. 7, by an O ring seal 114 retained in a second counterbore 113a between metal washers 116 and 116a. A snap ring 115 holds washer 116 in counterbore 113a. Since piston part 118 has a greater outer diameter than the inner diameter of the rings 116a and 116, and since piston parts 118 and 121 are axially held on ram 34, said ram is effectively locked in head 3.

It is of course more economical, when giving single inoculation, to dispense with the vial 108 and column 101, which are normally used for mass inoculations, and to use a head which will accept just a single dose at a time. Such a substitute head is more simple in construction since it dispenses with the pump valves shown in FIG. 7.

In FIG. 11, a single-inoculation discharge head is shown at 174, and it is shown in that stage of its operation in which it is being filled from a vial 159 which is substantially identical to vial 108 and therefore is sealed in substantially the same manner. A special piercing head 161, however, is provided, said head having a hollow piercing needle 160 extending from one face thereof, and having a threaded recess 163 in its opposite end. A polytetrafluoroethylene sealing washer 162 is disposed in a recess around the inner end of needle 160.

The discharge head 174 has a bore 175 therein into which is fitted a plunger 170 sealed with respect to said bore 175 by an O ring 169. The end of head 174 opposite plunger 170 is of reduced diameter, and at the inner end of said reduced diameter end is formed a small hole 177, adjacent to which is disposed a sealing washer 166 made of polytetrafluoroethylene. Said washer 166 is concentrically disposed with respect to hole 177 and is clamped against the portion of head 174 adjacent thereto by an insert 165 of tubular form, the latter in turn having a shoulder at its outer end against which is pressed an internally threaded cap 164 which engage external threads 167 on the reduced diameter end of head 174. It is apparent that as cap 164 is advanced upon the reduced diameter end, it will force tubular insert 165 against seal 166 and effectively seal the opening 177 against loss of medicament except through the interior of said insert. At the lower end of head 174, as viewed in FIG. 11, are formed ears 171 which are identical in size and shape to the ears 117 and 117' of the head 3, so that said head 174 may be inserted into housing 1 interchangeably with head 3.

As in the case of insert 127, the internal diameter of tubular insert 165 is progressively reduced toward the outer end of said insert to form a small orifice 176 through which the inoculant is ejected. Insert 165 and cap 164 together may be considered to comprise the nozzle for the single-inoculation head 174.

Plunger 170 terminates at its lower end, as viewed in FIG. 11, in a portion of reduced diameter 172 which is of substantially the same diameter as ram 34 of head 3 (FIG. 14). Since head 174 is to be used for single

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inoculations which may vary in quantity of inoculant used, the exterior surface of plunger 170 is graduated as at 173 in FIG. 11, the graduations using the radial end surface 171' as a point of reference. The graduations are preferably in fractions of a cubic centimeter, the maximum dosage being approximately one cubic centimeter and the minimum practical dosage being one-tenth of a cubic centimeter.

Cap 164 has external threads adapted to cooperate with the threads 163 in the recess in piercing head 161, so that when it is desired to fill the head 174 with medicament, cap 164 is simply screwed into head 161 until the nozzle, that is, the end of the insert 165 contacts sealing washer 162 with sufficient pressure to effect a seal. Plunger 170 is then pulled out beyond the one cubic centimeter mark on the graduations 173 by holding the threaded end 172 in one hand, head 174 in the other, and pulling the two apart. Next, needle 160 is pushed through the stopper 107 of vial 159 and plunger 170 is forced into bore 175 as far as it can go. This pumps all of the air from the chamber 176' formed by plunger 170 and bore 175 into vial 159 and creates a pressure within said vial. Plunger 170 is then slowly pulled out of bore 175, past the one cubic centimeter mark on graduation 173, the vial during this maneuver being held in an inverted position to insure the flow of medicament and not air into bore 175. This operation is repeated several times to make certain that all air has been removed from bore 175. At the final filling stroke, plunger 170 is pulled outwardly relative to bore 175, slightly past the mark on the graduations 173 indicating the dose intended, and finally brought back to the exact dose. Cap 164 is then unscrewed from the piercing head 161 and head 174 is inserted into the gun in the same manner as described with reference to discharge head 3 to produce the assembly shown in FIG. 12 except that draw bolt 16 and the gauge ring 17 are omitted as unnecessary. The medicament in the head 174 is discharged by manipulating the trigger mechanism of the inoculator in precisely the same manner as is done with respect to the discharge head 3.

Although the function of the various parts of the devices hereinabove described have been given so that the operation of the two forms of inoculator illustrated may be deduced therefrom, for a better understanding of this invention a step-by-step description of the operation of the devices will now be detailed.

Adverting first to the form shown in FIGS. 1 to 10, and assuming that the head 3 is assembled with respect to housing 1 and ram 34 is secured to draw bolt 16, the first operation is to push down release lever 9, that is, to rotate it in a counterclockwise direction as viewed in FIG. 1, thereby making certain that the trigger 5 and the safety trigger 6 are reset. Next, door 178 is swung about hinge pins 178' to gain access to the interior of handle 2. Lariat screw 29 is backed off and a CO₂ container 28 is placed in handle 2 with the bottom 179 thereof received in swiveled cup 179a and the upper end thereof in a notch 180 in the handle, the purpose of which is to locate said upper end of container 28 correctly with respect to the piercing needle 27. Lariat screw 29 is advanced into the handle to push the container 28 against the piercing needle 27. It is preferred that the lariat screw be turned until the needle contacts the sealed upper end of container 28 and then is turned two complete turns further to make certain that the needle has pierced the container. The gas under pressure in container 28 immediately passes through the piercing needle 27 to chamber 31 and is held there, since valve 50 is in closed position. Access door 178 is closed and the inoculator is now ready to effect an inoculation.

Next, the discharge head 3 is prepared for filling with an inoculant. This is best accomplished when the head 3 is removed from the housing 1. Thus, draw bolt 16 is removed from the housing 1 and head 3 is turned one-

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quarter turn and also pulled out of housing 1. Draw bolt 16 is then screwed back into opening 34' on ram 34. Using the draw bolt 16 as a handle, ram 34 is pushed in and out a few times to make certain that all parts of the head move freely. Next, vial 108 is mounted on the piercing head 103, and then clamped in place on anchor ring 104 by means of strap 146 and thumb screw 147. Following this, ram 34 is pushed completely into the head 3, and valve 14 is turned by hand to close the hole 124 in the bottom of the bore 100. With hole 124 closed, ram 34 is slowly withdrawn from the head, which causes the cone 141 to back away from the O ring seal 119 and, at the same time, pulls the piston parts 118 and 121 away from ram 34. This results in the opening of the space between O ring 119 and cone 141, that is, it creates port 140, so that as the ram 34 continues to move to the right, as viewed in FIG. 7, for example, it creates a vacuum in chamber 149. The medicament in vial 108, being at atmospheric pressure, then begins to flow out of the vial through the hollow needle 106, bore 111, angle bore 112, counterbore 113, opening 143, port 140, around the interior of piston part 118, through the slots 122 and into chamber 149. Simultaneously, air enters vial 108 through tube 4, blind hole 105' and hollow needle 105, to replace the medicament that has flowed out of the vial. Any residual air that remains in the passage 127' adjacent orifice 129 may be purged by opening valve 14 and moving ram 34 into the head until the medicament begins to flow through said orifice. Draw bolt 16 is then removed and the discharge head is assembled with respect to the gun. This is accomplished most conveniently by holding the gun in one hand and the discharge head in the other and then inserting the ram 34, which extends outwardly in its fully charged position, into bore 18' as shown in FIG. 3, the ears 117 and 117' being aligned with grooves 154 and 155 and passed therealong until face 115 contacts the face of flange 36 on bushing 36'. At this point discharge head 3 is turned counterclockwise until it stops against stop pin 156.

Next, a gauge ring 17 of proper axial length for the dosage to be injected is selected and placed over the tube 18 which, at this point, extends to the right of housing 1, as viewed in FIG. 3. Draw bolt 16 is inserted into gauge ring 17 and into the tube 18 and advanced along threaded opening 34' until tube 18 and the gauge ring are securely clamped against ram 34. This, of course, also unites ram 34 with piston 21. Lastly, connecting rod 7 is swung downwardly to cause crank pin 138' to be received in slot 8 in the connecting rod, and the inoculator is then ready for use.

The inoculation is effected very simply by first squeezing safety trigger 6, then placing orifice 129 against the patient's skin firmly and pulling trigger 5. This simple sequence of operations, as seen in FIGS. 3 and 5, causes cam 62 on trigger 5 to push against end 63 of cam plunger 46 and thus moves cone 47 to the right, as viewed in FIG. 3, away from lock ball 44. Said ball 44 is cammed out of groove 45 in plunger 41 and into groove 66 formed immediately adjacent the small end of cone 47. This frees plunger 41, which is forced by compression spring 43 to move instantly to the right, as viewed in FIG. 5, to seal the annular opening or port 55 around the end 51' of rod 49, and to open disc valve 50. Gas under pressure then is released from chamber 31 and passes to chamber 32, thence through cross bore 33 into chamber 20, to force piston 21 to the left, as viewed in FIGS. 3 and 5, under a pressure of between 400 and 750 pounds per square inch. The effective area of piston part 118 (FIG. 7) which is in direct contact with the medicament to be injected is one-tenth that of piston 21 and hence the medicament in chamber 149 is forced into the flesh of the patient at a pressure of ten times the pressure of the gas in chamber 31. Assuming the latter to be 750 pounds per square inch, the pressure exerted by piston part 118 upon the medicament in chamber 149 is 7500 pounds per square inch.

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Immediately prior to the application of pressure to the medicament in chamber 149, of course, a slight relative axial movement took place between ram 34 and piston part 118 as hereinabove described, such that ram 34 and particularly the cone 141 thereon contacted and compressed O ring seal 119 against piston part 118 to close the passage therebetween and to prevent passage of the medicament from chamber 149 through the piston parts 118 and 121 back around ram 34 into counterbore 113.

A number of inoculations can be made successively, so long as the chamber 149 in discharge head 3 contains inoculant. Thus, the next inoculation is made by first pushing release lever 9 down, that is, in a counterclockwise direction, as viewed in FIG. 1, which brings its surface 9a into contact with shoulder screw 52 secured to and extending from plunger 41. Continued rotation of lever 9 in the same direction moves plunger 41 to the left, as viewed in FIG. 5, to cock the gun, that is, to cause ball 44 to be cammed by cone 47 into groove 45 of plunger 41.

Simultaneously with the counterclockwise rotation of lever 9, as viewed in FIG. 1, connecting rod 7 was caused to move to the left to turn crank 138 in a clockwise direction and thereby rotate valve 14 to its closed position. Inasmuch as ball 44 does not drop into its groove 45 until the last portion of the movement of lever 9 in its resetting direction, U-cup seal 51 remains on rod 49 in sealing position until after valve 14 is closed, so that the chamber 20 behind piston 21 is not vented until said valve 14 is closed. The venting of chamber 20 reduces the pressure therein to atmospheric, thereupon releasing spring 23 and allowing said spring to move piston 21 to the right together with ram 34 and piston parts 118 and 121. During the pressure stroke of ram 34 the annular space around said ram increases in volume so that a certain amount of medicament is drawn into bore 100 as ram 34 enters said bore. On the return stroke of ram 34, brought about by the return of piston 21 by its spring 23, with valve 14 closed, chamber 149 will be filled with medicament from vial 108, as previously described. Lever 9 will, of course, be returned to the position shown in FIG. 1 by the torsion spring 183, and with the return of lever 9 to its original position, connecting rod 7 will oscillate crank 138 in the opposite direction to rotate valve 14 to its open position. The inoculator is now ready for the next inoculation to be brought about by the successive release of triggers 6 and 5 as previously described.

A further modification of the discharge head 3 is shown in FIG. 15. In this modification the rotary valve 14 is dispensed with and a pressure differential operated valve is used in its place. Thus a discharge head 184 is provided, which has a chamber 185 therein of substantially the same size as that of chamber 149 of discharge head 3. Said discharge head 184 is provided with a column 101' which is substantially identical to column 101 of FIG. 7 and with radially extending ears 117a which are identical to ears 117 and 117' so that said discharge head 184 may be interchangeable with discharge head 3.

Discharge head 184 terminates in a small axially directed extension 187 in which a blind hole 186 is formed opening on the inside of chamber 185. A small cross bore 197 connects blind hole 186 with an unsymmetrical V-groove 196 formed in the exterior of extension 187. An O ring 189 is snapped into groove 196, but the cross section of said O ring 189 is such that when said O ring is so snapped into the groove, it does not ride upon the bottom of said groove, but only contacts one side of said groove so that an annular space is formed between the inner surface of the O ring and the bottom of the groove.

The outer surface of discharge head 184 in proximity to extension 187 is threaded externally with a thread 190 to receive a clamp nut 191. Within clamp nut 191 is a spacer 195 which has a central opening therein 195a and which carries a tubular insert 194, the outer end of which is of reduced diameter to provide an orifice internally, and

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a shoulder externally which bears against the bottom of the counterbore 200 in clamp nut 191. Thus insert 194 extends through clamp nut 191 and is received in a similar counterbore 193a in spacer 195. A seal washer 193 provides a seal between spacer 195 and insert 194, and a sealing washer 192 provides a seal between spacer 195 and the end of discharge head 184. Spacer 195 is formed with a cavity 201 to receive extension 187, said cavity being of sufficient diameter to clear O ring 189.

When clamp nut 191 is tightened on thread 190, it clamps insert 194 against spacer 195 through the seal washer 193 and it clamps spacer 195 against the end of head 184 through sealing washer 192.

When head 184 is assembled in housing 1 and pressure is built up in chamber 185 by ram 34, the medicament passes from opening 184 into cross bore 197 where it expands O ring 189 to allow said medicament to flow out around the O ring into cavity 201 and thence into insert 194. On the suction stroke of ram 34, however, a vacuum is created in chamber 185 which draws O ring 189 inwardly into its groove 196 to seal cross bore 197 from the atmosphere and to allow the medicament to be drawn into chamber 185, as previously described with reference to FIG. 7 when valve 14 thereof is closed.

The modification of the discharge head shown in FIG. 16 as designed adapts the inoculator of this invention for use with prepared ampules of medicament known as Metapules. One such Metapule is shown at 202 and is comprised of a thin, rupturable sac of about one cubic centimeter in volume. It is retained in a discharge head 203 formed with a through bore 204, a first counterbore 205 and a second counterbore 206, the second counterbore being sufficiently large to contain said Metapule 202.

Head 203 is closed at one end by a cap 207 which is secured to head 203 by threads 208 and has a small orifice 209 through which the contents of the Metapule are ejected from the head. The discharging force is transmitted to Metapule 202 from tube 18 of FIG. 3 by a ram 210 which is retained in through bore 204 and is of the same outside diameter as ram 34 of FIG. 1. Said ram 210 has an enlarged end 211 disposed in first counterbore 205 which serves to hold ram 210 against movement thereof out of head 203 to the right as viewed in FIG. 16.

The diameter of head 203 is identical to that of head 3 of FIG. 3, and said head 203 is provided at its end with radially extending ears 212, 213 which are identical ears 117a on head 3, so that said head 203 is interchangeable in housing 1 with head 3. The length of ram 210 extending beyond the end of head 203 is the same as the length of ram 34 of FIG. 3 extending beyond the end of head 3 so that said ram 210 extends into and is operated by tube 18 in the same manner as ram 34 to effect an inoculation. However, since the Metapule 202 provides a single inoculation and head 203 does not have a pump for drawing a new charge of inoculant into head 203, it is unnecessary that ram 210 be secured to draw bolt 16. Head 203 may be reused by unscrewing cap 207, removing all remnants of the previous ampule, sterilizing head 203, cap 207 and ram 210, and then inserting a new Metapule into said head and replacing cap 207.

It may be noted that the same housing and the power unit retained therein may be used with the four different heads shown in FIGS. 7, 11, 15 and 16, each of which heads is interchangeable with the other heads. It may be noted further that each head is a complete unit with its ram, whether or not the ram is equipped to function as a pump, and that the ram is removable from the power unit with the head to remain therewith until the head is again to be used. Thus it is possible to remove any one of the aforesaid four heads, with or without a charge of medicament therein ready for use, and to store said head away from the power unit for as

long as the medicament therein can be safely stored. If a physician has a succession of patients to inoculate each of which requires a different medicament, he may have a number of heads of the same kind each charged with a different medicament, but only one power unit, and by removing one head with the aid of the quick-disconnect ears 117, 117' and substituting for it the charged head having the desired medicament, he can continue his inoculations almost without interruption. There is no need to disassemble a head, remove the undesired medicament, sterilize the head, and reassemble and charge the head with the next medicament.

The power unit is similarly flexible in that it can be used with a small 8.5 cc. container compressed gas so as to be portable, or it can be connected to a large container of compressed gas for a long series of inoculations, the latter being done without removing or in any way taking cognizance of a partly used 8.5 cc. container which may simultaneously be connected into the unit.

The safety features incorporated into the power unit include not only means for preventing an inadvertent operation of a trigger to release a charge of medicament, but also an indicator to warn the physician that the pressure of his supply of gas is approaching the value at which an incomplete inoculation will be made with its attendant uncertainty as to the amount injected and the wastage of the amount remaining to be injected.

It is understood that the foregoing description is merely illustrative of preferred embodiments of this invention and that the scope of this invention is not to be limited thereto but to be determined by the appended claims.

This application is a continuation of my prior application for United States Letters Patent, Serial No. 200,411, for Universal Inoculator, filed June 6, 1962.

I claim:

1. A jet-type inoculator comprising a power unit and a medicament ejecting discharge head adapted to be operated by the power unit, said discharge head comprising a container for medicament, apertured means on the container through which the medicament is ejected, a ram in the container, cooperating means on the ram and container preventing withdrawal of the ram from the container, quick-release means on the discharge head and power unit releasably securing the discharge head to the power unit, reciprocable means in the power unit adapted to engage the ram to urge the ram into the container to pressurize medicament therein, and means for energizing the reciprocable means.

2. A jet-type inoculator as described in claim 1, said head comprising further a source of medicament exterior to the container, means rigidly fixing said source on the head, said container having a medicament passage therinto, said rigidly fixing means having a passage connecting the source with the medicament passage into the container, a piston in the container secured to the ram movement therewith, pressure differential operated valve means movable with the piston and other valve means on the container for alternately creating subatmospheric and above-atmospheric pressure in the container as the ram and the piston secured thereto reciprocate in the container, whereby to pump medicament into the container from said source and out of the container through said apertured means.

3. A jet-type inoculator as described in claim 2, said container having a wall adjacent the apertured means, a nose on the wall extending toward said apertured means, a V-groove in the nose, said wall having an opening therein from the interior of the container terminating in the bottom of the V-groove, and said other valve means on the container comprising an endless ring of deformable material in said V-groove normally contacting the sides of said groove to seal the terminus of said opening and expansible away from said sides of said groove under pressure from pressurized medicament in

the container to permit ejection of medicament from said container.

4. A jet-type inoculator as described in claim 1, said releasable means comprising a breech block secured to the power unit, said breech block having an axially extending internal groove and a circumferentially extending recess intersecting the internal groove, said container having a radially outwardly extending ear adapted to pass through said internal groove and into said circumferentially extending recess, and means frictionally holding said ear in said recess.

5. An injector type inoculator comprising an apertured body, a tubular container for inoculant and means for supporting the container from the body, said supporting means comprising a breech block secured in the aperture in the body, said block having an opening therethrough to receive said container, a radially outwardly extending ear on the container, said block having an axially disposed groove defining a portion of said opening through which said ear is adapted to pass and a recess at its inner end into which said ear is adapted to be turned, a spring retainer in the body partially closing said recess, and a spring bearing continuously against said retainer to urge said retainer toward said block, said ear when received in said recess extending beyond the inner end of said block and contacting said spring retainer, whereby said ear and container are frictionally held by the spring retainer against turning in the block.

6. An injector as described in claim 5, said ear having an entering end which is smaller axially than the axial dimension of said recess whereby to facilitate turning said ear into said recess.

7. A discharge head for an injector-type inoculator, said head comprising a cylindrical container having a bore therinto from one end thereof, a nozzle extending from the other end thereof, a passage connecting the bore with the nozzle, a manually operable valve in the passage adapted to open and close said passage, an apertured cap threadedly secured to said other end and adapted to hold the nozzle in place on the container, a ram in the bore and adapted to be reciprocated therein, a radially outwardly extending column secured to the exterior of the container near the said one end thereof, an anchor ring secured to the end of the column, a piercing head frictionally secured to the column, said piercing head having a first hollow piercing needle and a second hollow piercing needle, said second hollow piercing needle being longer than the first hollow piercing needle, a tube secured to the piercing head and communicating with the second hollow piercing needle, there being a passageway from the first hollow piercing needle through the piercing head, the column and the container to the bore in the container, a vial of medicament pierced by said first and second needles and secured thereby to the piercing head, whereby medicament from said vial may flow through said first hollow piercing needle and connecting passageways to the bore while air may flow from said tube through said second hollow piercing needle into said vial, and means on the said one end of the container and of the ram for releasably securing the container and ram to an injector-type inoculator.

8. A discharge head as described in claim 7, said ram fitting loosely the bore in the container to provide space around the ram for passage of medicament therearound, a two-part piston secured to the end of the ram, said first and second parts of said piston being axially spaced from one another and having passageways there-through in communication with one another and with the space around said ram, means supporting the piston part adjacent the ram for relative axial movement therewith, means interposed between the ram and piston part adjacent thereto to effect a seal therebetween and prevent flow of medicament through said adjacent piston part, means in the bore between the passageway connecting the bore to the column and the said one end

of the bore sealing the ram in the bore, and means for sealing said adjacent piston part in said bore, whereby medicament is drawn into said bore around the ram and through said piston parts when the ram is retracted from said bore and said medicament is pressurized in said bore by said adjacent piston when the ram is pushed into said bore.

9. An injector type inoculator comprising a body, a tubular container for medicament adapted to be secured at one end to said body, a discharge orifice at the other end of said container, a vial of medicament, means remote from said discharge orifice and adjacent said one end of said container for supporting said vial from said container for movement therewith, said vial-supporting means and said container having aligned openings establishing communication from the interior of the container to the interior of the vial, a ram in the container adapted to be reciprocated therein and forming with said other end a medicament chamber, valve means interposed between the interior of the container and the discharge orifice for closing the orifice to the interior of the container, and pressure-differential operated valve means on the ram and adapted on movement of the ram toward said orifice to close the chamber to the opening in the container in communication with the interior of the vial and on movement of the ram away from said orifice to open said chamber to the said opening in the container, and means on the body and extending to the first-mentioned valve means for opening and closing the first-mentioned valve means.

10. An injector type inoculator as described in claim 9, said means on the body and extending to the first-mentioned valve means comprising a lever on the body, a crank on the first-mentioned valve disposed exteriorly of the container, and a connecting rod connecting the lever to the said crank, said connecting rod being pivoted to said lever and having a disconnectible pivotal connection with said crank.

11. An injector type inoculator as described in claim 9, said body including power means for reciprocating said ram, a reciprocable control element for controlling operation of said power means, a lever exterior to the body and adapted to contact the control element to move said control element, a crank on the first-mentioned valve disposed exteriorly of the container, and a connecting rod connecting the lever to the crank whereby to move said control element and said valve in unison.

12. An injector-type inoculator comprising a body, means on the body defining a medicament chamber and a discharge orifice for the medicament, means in the body for pressurizing said chamber to effect an ejection of the medicament therefrom, manually operable trigger means on the body for controlling the application of said pressurizing means to said chamber, and a manually operable safety trigger on the body, said safety trigger having a latch movable therewith, and means on the first-mentioned trigger means adapted to be directly contacted and held against movement in a pressure-applying direction of said trigger by said latch, whereby to prevent movement of said first-mentioned trigger means in a pressure-applying direction, unless said safety trigger and the latch movable therewith have been moved out of contact with said holding means on said first-mentioned trigger.

13. An injector-type inoculator comprising a body, means on the body defining a medicament chamber and a discharge orifice for the medicament, fluid-operated means in the body for pressurizing said chamber to effect an ejection of the medicament from said chamber, a source of fluid under pressure, an inlet passage in the body for fluid under pressure, an inlet valve in the inlet passage to open and close said passage, an inlet chamber in the body in fluid communication with said inlet valve, a passage connecting said inlet chamber with said fluid-operated means in the body for pressurizing said cham-

ber, an outlet passage in fluid communication with said inlet chamber, an outlet valve in said outlet passage, a unitary valve operator for said inlet and outlet valves and constructed to close one of said valves before the other is opened, resilient means normally urging said operator to close said outlet valve and open said inlet valve, latch means on the body for holding said valve operator in a position to open said outlet valve and close said inlet valve, and manually operable means for releasing said last means to operate said fluid-operated means to effect a pressurization of medicament in said medicament chamber.

14. An injector-type inoculator as described in claim 13, said latch means comprising a cam plunger in the body adjacent said valve operator, a ball interlock in the body between the valve operator and cam plunger, said valve operator having a peripheral groove to receive a portion of said ball, said ball being adapted to be cammed into and released from said groove by axial movement of said cam plunger in opposite directions, resilient means normally urging said cam plunger in a direction to cam said ball in said peripheral groove, and trigger means on the body for moving said cam plunger in a direction to release said ball from said groove.

15. An injector-type inoculator as described in claim 14, and manually operable latch means for rendering said trigger means inoperable.

16. An injector-type inoculator comprising a body, a container for medicament on the body, said container having a discharge opening at one end thereof and a ram in the other end to pressurize the medicament in the container to effect an ejection of the medicament through said discharge opening, a piston connected to the ram, resilient means for moving the ram away from the discharge opening, fluid under pressure adapted to act upon said piston to move the piston and ram toward the discharge opening to pressurize said medicament, a source of fluid under pressure, a valve for controlling flow of fluid under pressure to said piston, and movable to within a fully open or fully closed position, a valve operator, resilient means constantly urging said valve operator to move said valve to its fully opened position, latch means for holding said valve operator in a position corresponding to fully closed position of said valve, and manually operable means for releasing said latch means to cause said resilient means to move the valve operator and valve from fully closed position of the valve to fully opened position thereof.

17. An injector type inoculator as described in claim 16, manually operable means for moving said valve operator back to latch, said operator in its position corresponding to fully closed position, a vent valve in the body adapted to vent the fluid acting upon said piston, and means on the valve operator adapted to operate the vent valve to vent said fluid when said valve operator is moved back as aforesaid.

18. An injector-type inoculator as described in claim 16, manually operable means for moving said valve operator back to latch said operator in its position corresponding to fully closed position of the fluid pressure valve, a vent valve in the body adapted to vent the fluid acting upon said piston, and means on the valve operator adapted to operate the vent valve to vent said fluid when the valve operator is moved back as aforesaid, said operator first permitting closure of the fluid pressure valve and then operating the vent valve to vent said fluid.

19. An injector-type inoculator comprising a body having an opening therethrough, a container for medicament disposed in one end of said body opening, said container having a discharge opening in its outer end and a ram in its inner end to pressurize the medicament in the container to effect an ejection of the medicament through said orifice, the quantity of medicament ejected being a function of the degree of movement of the ram toward the discharge opening, an apertured fitting closing the

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other end of the body opening, a piston in the body opening, a draw bolt having a threaded connection at one end with the ram, said bolt extending through the apertured fitting, a head on the opposite end of the bolt, a sleeve on the bolt and extending through said apertured fitting, a gauge ring interposed between the end of the sleeve and the head on the bolt, said gauge ring extending radially outwardly beyond the sleeve, and said sleeve, gauge ring and draw bolt being secured to said ram by advancing the bolt into the ram along the threaded connection therewith, a piston secured to said sleeve in said body for movement with said sleeve and ram, said body having a cylindrical chamber for said piston, and resilient means in the body and acting upon said piston to urge said piston in a direction to pull said sleeve and connected ram away from said discharge orifice.

20. An injector-type inoculator comprising a body, a container for medicament, said body having an opening therethrough and said container being received in one end of said body opening and extending outwardly from said body, said container having a discharge opening at one end thereof and a ram in the other end to pressurize the medicament in the container to effect an ejection of the medicament through said orifice, the quantity of medicament ejected being a function of the degree of movement of the ram toward the discharge opening, an apertured fitting closing the other end of said body opening, a draw bolt secured at one end to the ram and extending through the apertured fitting, a radially extending abutment on the end of the draw bolt extending through said apertured fitting, a gauge ring of predetermined axial length on the draw bolt adjacent said abutment and adapted to engage

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the fitting upon movement of the bolt and ram in a medicament-ejecting direction to limit movement of said ram and thereby limit the quantity of medicament ejected.

21. An ejector type inoculator comprising an inoculant-holding assembly having a barrel and a plunger in the barrel; a body having an opening thereinto to receive the assembly, interlocking means on the assembly and body for removably holding the assembly in the body, means providing an opening into said barrel, said plunger being manually manipulatable relative to said barrel for filling said barrel with a predetermined quantity of inoculant from a vial through said opening, and manually controlled power means in said body for moving said plunger into said barrel.

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