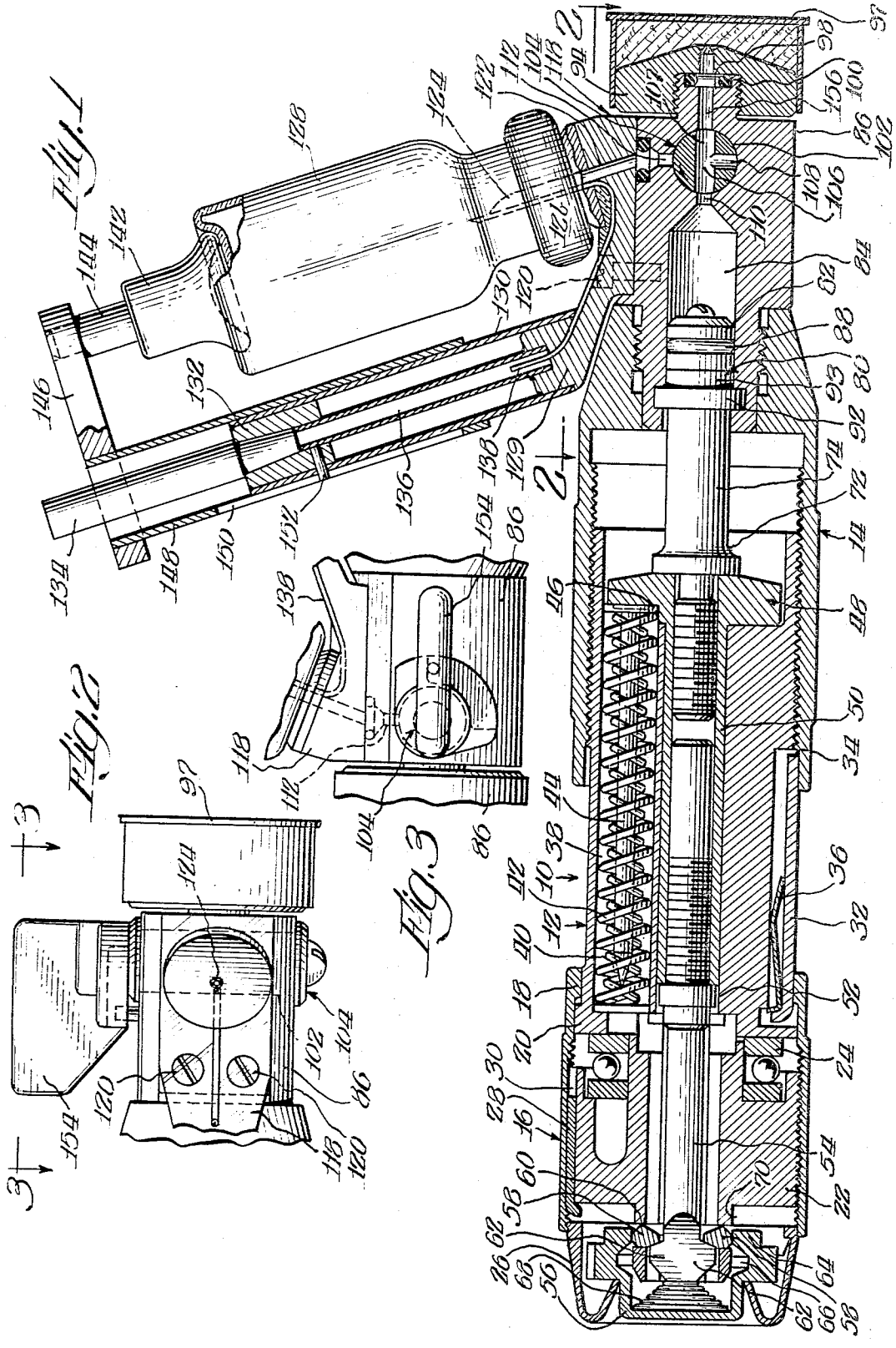
July 11, 1967 J. R. GORDON 3,330,276

HYPODERMIC JET INJECTOR

Filed Oct. 7, 1963 2 Sheets-Sheet 1



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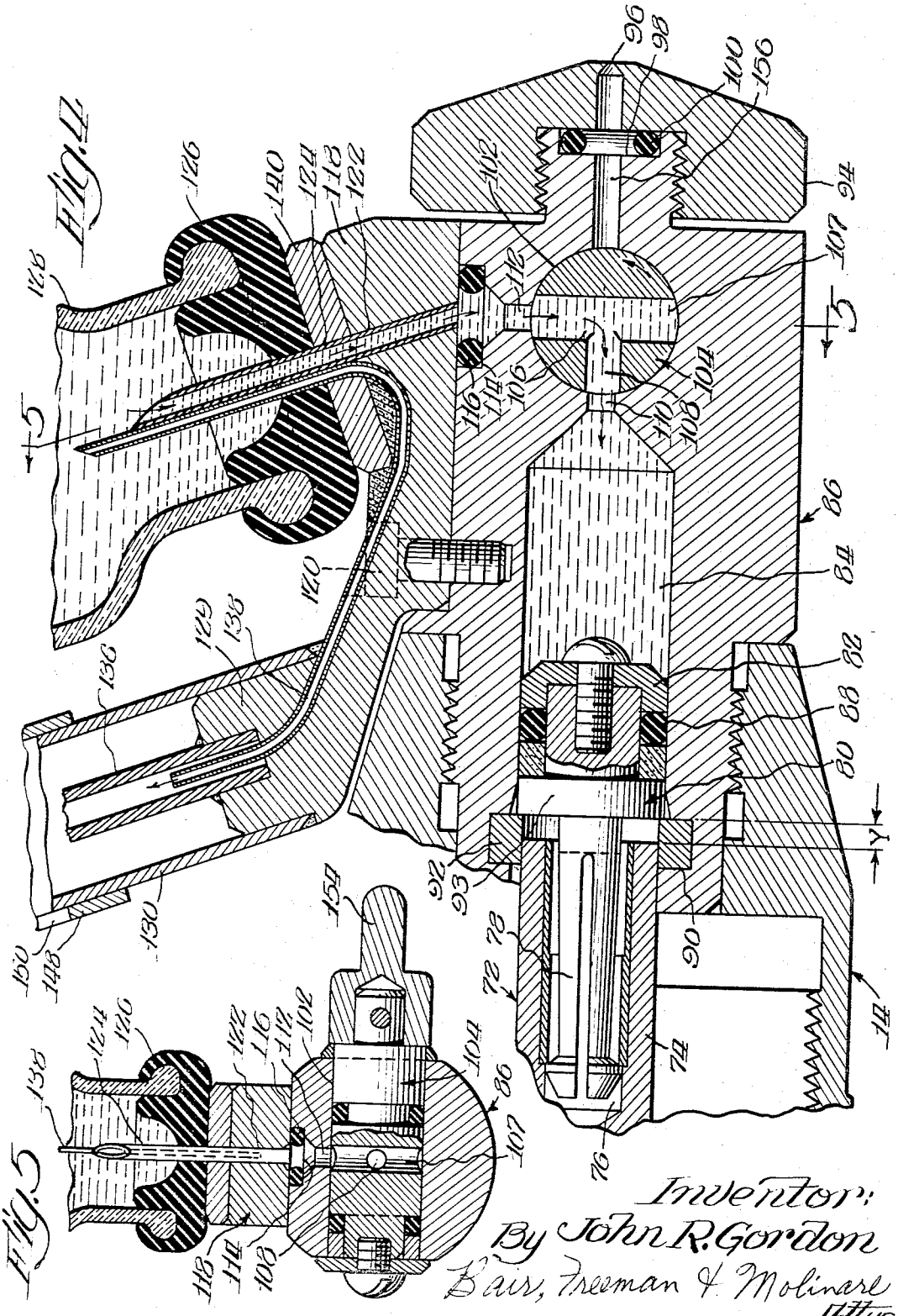

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HYPODERMIC JET INJECTOR

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This invention relates to a manually operated hypodermic jet injector capable of administering successive injections of a liquid medicament through the epidermis. In some respects, this invention is similar to the multi-dose injector of Alfred W. Kath set forth in U.S. patent application Ser. No. 271,205, and in other respects it is similar to the single dose injector of Anthony Venditty, set forth in U.S. Patent No. 2,762,370.

Although the advantages of using hypodermic jet injectors rather than hypodermic needles are well-known, utilization by potential users, as by diabetics or pediatricians, is reduced due to relatively high costs of the medicament in ampule form or of the instrument itself. As a specific example, most diabetics continue to use hypodermic needles for administering insulin to themselves because of such high costs. In the case of a single-dose jet injector, similar to that set forth in U.S. Patent No. 2,762,370, ampules are used; although the instrument itself is relatively inexpensive, the required insulin dosage in ampule form costs approximately six times more than the cost of administering the insulin by a hypodermic needle. Also, in the case of a multi-dose jet injector, similar to that set forth in U.S. patent application Ser. No. 271,205, although the medicament is stored in a bottle in liquid form and not in ampule form, the cost of the instrument itself is quite high.

Furthermore, in the case of the multi-dose injectors, where the medicament is stored in the relatively inexpensive liquid form, the use of insulin presents a problem since in presently used long-acting insulin, such as Lente, PZI, and NPH, the insulin is mixed with a protein to provide a suspension, rather than a solution. In such suspensions, particles settle out of the suspension and are likely to cause clogging of the channels through which the insulin passes; also, there is a problem of the formation of crystals, which also cause clogging of the channels. Therefore, particularly in the case of insulin, it is highly important that the channels conducting insulin from the storage bottle or container to the medicament discharge chamber be constructed in such a manner that clogging thereof is substantially avoided.

It is therefore an important object of this invention to provide a hypodermic jet injector capable of storing a quantity of liquid medicament in bulk form while providing an injector of relatively inexpensive construction.

It is another object of this invention to provide a hypodermic jet injector which is mechanically loaded and operated for each injection and which is also capable of applying successive injections of medicament without separate loading of medicament for each injection.

It is also an object of this invention to provide a multi-dose jet injector particularly adapted for administering insulin.

It is still another object of this invention to provide a jet injector particularly adapted for the injection of insulin, wherein a quantity of insulin is stored in a bottle, and the channel from the bottle to the medicament discharge chamber is substantially straight, of minimum length and of substantially uniform cross-section, to thereby substantially reduce the possibility of clogging of the channel by particles settling out of the insulin suspension.

It is an additional object of this invention to provide a multi-dose jet injector particularly convenient to manipulate either by a person administering medicament to oneself or to another.

Further purposes and objects of this invention will appear as the specification proceeds.

A particular embodiment of the present invention is illustrated in the accompanying drawings wherein:

FIGURE 1 is a side elevational view of my hypodermic jet injector;

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

FIGURE 3 is a view taken along the line 3—3 of FIGURE 2;

FIGURE 4 is an enlarged, partially sectioned view of the discharge end of the hypodermic jet injector of FIGURE 1; and

FIGURE 5 is a sectional view, on a reduced scale, taken along the line 5—5 of FIGURE 4.

Referring to the drawings, my hypodermic jet injector, generally indicated by the numeral **10**, has the general appearance of an elongated body which includes a mechanism housing **12** that is enclosed at the forward end by a front sleeve **14**, which is threadably connected thereto. At the opposite or rear end of the housing **12**, a winding sleeve **16** is rotatably connected to the mechanism housing **12**. The sleeve **16** includes an inturned flange **18**, which cooperates with the annular ridge **20** of the housing **12** in order to prevent longitudinal movement between the housing **12** and the sleeve **16**.

A latch housing **22**, which also serves as a bearing support for thrust bearing **24**, is threaded into the rear end of the winding sleeve **16**. The thrust bearing **24** is interposed between the latch housing **22** and the mechanism housing **12** in order to permit relative rotation between the parts. A release button cap **26** is securely fastened to the winding sleeve **16** by means of a conventional non-reversible, bayonet type connection. The cap **26**, the winding sleeve **16**, and the latch housing **22** are all rotatable together, the sleeve **16** being locked to the housing **22** by means of a key **28** which fits into the slot **30** provided in the housing **22** and the sleeve **16**.

The mechanism housing **12** is locked to the forward sleeve **14** in order to prevent rotation therebetween by means of a latch **32**, which is adapted to fit into a series of longitudinal slots **34** provided in the inner surface of the sleeve **14**. A spring **36** biases the latch **32** outwardly. The mechanism housing **12** includes a series of blind, axially extending openings **38** which are spaced circumferentially in the housing **12**. Although single springs may be inserted into the openings **38**, the springs are preferably used in pairs, the internal springs **40** being of a smaller diameter and of opposite helix to the external springs **42**. Pins **44** are located concentrically of the springs **40** and **42** and extend through the openings **38** in order to prevent the buckling of the springs **40** and **42** within the openings **38**. The forward ends of the springs seat in recesses **46** provided in the nut **48**, the recesses **46** being concentric with the openings **38**.

The nut **48** includes a sleeve-like extension **50**, which projects rearwardly in the bore **52** of the housing **12**; the extension **50** is prevented from rotational movement within the mechanism housing **12** by suitable means, as a key (not shown). The extension **50** is internally threaded and is adapted to threadably receive the lifting screw **54**. Thus, upon rotation of the screw **54**, the nut **48** is pulled rearwardly to thereby compress the springs **40** and **42** and load the injector **10**.

A latch mechanism is provided for locking the lifting screw **54** against axial movement until such time as the springs **40** and **42** are released for injecting the medicament. Latch wedges **58** project through the openings **60** provided in the latch housing **22** and are adapted to en-

gage the fins **62** at the rear end of the lifting screw **54**. The release button **56** includes an inwardly turned flange **64** which is adapted to bear against the outer ends of the latch wedges **58**, to normally prevent them from retracting into the groove **66** of the latch housing **22**. The release button **56**, upon depression, causes the side walls to move forwardly into the groove **70** of the latch housing **22** against the compression of the spring **68**, whereupon the groove **66** in the side wall of the button **56** becomes aligned with the openings **60** in the latch housing **22**. Due to the slope on the bottom of the wedges **58**, they move outwardly into the groove **66**, to thereby release the lifting screw **54**.

The internal threads at the upper end of the nut **48** threadably receive a ram **72** having an extended forward portion **74**; the forward portion **74** is provided with a bore **76** which is adapted to slidably receive the split shank **78** of the plunger **80**. The plunger head **82** is slidable within the medicament chamber **84** of the valve housing member **86**. In order to prevent a back-flow of medicament, an O-ring **88** is provided on the plunger head **82** for sealing against the inner surfaces of the chamber **84**. Also, a groove **90** is provided in the valve housing **86** in order to receive a stop ring **92** which is adapted to abut the flange **93** on the plunger **80** for preventing further rearward travel of the plunger **80** while permitting further rearward movement of the ram **72**.

The valve housing member **86** is an elongated body and is adapted to threadably engage the forward end of the forward sleeve **14** and, at its opposite end, receives the discharge nose **94**, which includes a medicament discharge orifice **96**. The discharge nose is protectively covered by a cap **97**. The forward end of the member **86** includes a recess **98** which is adapted to receive a gasket or O-ring **100** for providing a pressure tight seal between the discharge nose **94** and the member **86**.

As illustrated most clearly in FIGURES 4 and 5 the member **86** includes a tranverse aperture **102** which is adapted to rotatably receive a cylindrical valve member **104**. Centrally of the valve member **104**, there is provided a T-shaped opening **106** having a main channel **107** and a branch channel **108**. The channel **108** is alignable with the bore **110** which is forward of the medicament chamber **84**. The main channel **107**, in one position, is adapted to be aligned with the inlet **112** in the upper end of the member **86**, and in a 90° rotated position is alignable with both the bore **110** and the front port **156** in the housing **86** and is adapted to permit the flow of medicament from the medicament chamber **84** to the discharge orifice **96**. A counter-bore **114** is provided above the inlet **112** for receiving an O-ring **116** in order to provide a seal between the member **86** and the bottle support member **118**. The inlet **112** and the connecting counter-bore **114** form a cavity which interconnects the main channel **107** and channel defined in the needle **124** in a minimum straight line distance to further facilitate flow and prevent clogging and crystallization of the medicament.

As shown most clearly in FIGURE 5, the top side of the valve housing **86** includes a flattened upper surface for carrying the support member **118**. The support **118** is secured to the flattened surface by means of screws **120** or other suitable fasteners. The bottle support member **118** includes an opening **122** which is adapted to support the straight hollow needle **124**. The needle **124** is inserted into the cap **126** of the medicament bottle **128**. In this regard, it is important to note that the hollow needle **124** provides a straight channel having a substantially uniform cross-section for the flow of medicament from the bottle **128** directly to the valve member **104**, which communicates with the medicament chamber **84**. Thus, the possibility of clogging or blocking the channel with crystals or particles, which drop out of suspension, is substantially eliminated since bends, turns, and restrictions, wherein clogging is likely to occur, are avoided. Also, the channel from the bottle **128** to the valve **104** is of minimum length and this also contributes to the substantial elimination of the clogging of flow channels.

Of further importance, the bottle **128** is tipped rearwardly from its vertical axis in order that it does not interfere with the injecting operation, while at the same time is sufficiently forward so that it does not interfere with the winding or loading operation of the injector.

The bottle support member includes a rearwardly extending air filter support portion **129**. A tubular member **130** is secured to the filter support portion **129** and interiorly carries a hollow plug **132**. The plug **132**, at its upper end, carries an air filter member **134**. The lower end of the hollow plug **132** supports an air tube **136** which is located concentrically of the tube **130** and is received within an opening provided in the rear portion **129**. A vent tube **138** is directed into the air tube **136** from the medicament bottle **128**; the vent tube is located adjacent to the hollow needle **124** and opens into the bottle **128**. Thus, as medicament is released, it is replaced by filtered air.

A resilient support pad **140** is interposed between the bottle support member **118** and the cap **126** of the bottle **128**; furthermore, at the upper end of the bottle **128**, a resilient support member **142** is carried on a shaft **144** which is mounted on an arm **146**. The arm **146** in turn is fixed to the tube **148** which is slidably positioned around the tube **130**. The tube **148** includes an elongated longitudinal slot **150** which is adapted to engage a rivet **150**, which is secured to the hollow plug member **132** to thereby avoid rotation of the arm **146**, while permitting axial movement thereof. Thus, by axial adjustment of the tube **148**, the support member **148** may be positioned firmly against the bottom of the bottle **128**, whereby the bottle is securely maintained in position between the resilient supports **140** and **142**.

In the operation of the injector **10**, assuming that medicament has just been discharged, the valve member **104** is rotated from the position of FIGURE 1 to the position of FIGURE 4, so that there is communication from the bottle **128** to the medicament chamber **84**. The valve member **104** is rotated by an exterior handle **154** which is secured to it. The winding sleeve **16** is turned in a counterclockwise direction in order to move the lifting screw **54** rearwardly. As the end of the screw **54** contacts and compresses the spring **68**, the release button **56** moves rearwardly and the wedges **58** are forced out of the groove **66**. The wedges **58** then move underneath the fins **62** of the lifting screw **54** in order to latch the screw **54**. At this time, the spring **68** snaps the release button **56** to the loading position.

The winding sleeve **16** is then rotated in a clockwise direction in order to turn the screw **54** in the sleeve **50** and to thereby move the nut **48** rearwardly and compress the springs **40** and **42**. As the nut **48** moves rearwardly, the ram **72** and plunger **80** also move rearwardly, the movement of the plunger **80** being stopped by the ring **92**. As the plunger **80** moves rearwardly, medicament flows from the bottle **126**, through the straight channel **124** and the valve **104**, and finally into the chamber **84**; the flow of medicament is unobstructed by deposits in the channel **124**. When the desired amount of loading is attained, as in the position of FIGURE 1, the winding is stopped and the valve **104** is rotated to the position of FIGURE 1 whereby the main channel is aligned with the medicament chamber **84** and the front port **156** in the valve housing **86**. The injector **10** is then ready to inject the medicament. Upon pressing the button **56**, the lifting screw **54** is moved forwardly, thereby moving the wedges **58** into the groove **66**; this releases the lifting screw **54** as well as the nut **48**, the ram **72** and the plunger **80**. Also, the rearwardly tipped position of the bottle **126** contributes to ease of loading and also to ease of injecting since it is out of the way during both operations.

As shown most clearly in FIGURE 4, upon release of the lifting screw **54**, the ram **72** moves forwardly a

short distance Y before there is actual movement of the plunger **80**. The free movement of the ram **72** in this distance provides a high impact force in order to provide an initial high pressure sufficient to penetrate the epidermis and provide an opening through which the medicament may pass. Upon moving the distance Y, the impact force is dissipated, reducing the pressure at which the medicament is discharged through the epidermis.

It is clear from the foregoing that all of the objects have been accomplished. The injector **10** is of relatively inexpensive and simple construction and is particularly adaptable for use by diabetics who require periodic and frequent injections of insulin. The injector **10** combines advantages of a single-dose injector with advantages of a multi-dose injector since the relatively inexpensive construction of a single-dose injector is adapted for injections directly from a medicament bottle rather than from ampules. Furthermore, a straight and relatively short flow channel of substantially uniform cross-section is provided for the flow of medicament from the bottle to the valve member, thereby substantially avoiding clogging of the flow channel. This is particularly important in the case of insulin, which tends to precipitate solids which cause blocking of small openings. Also, the position of the medicament bottle is such that interference with the loading and injecting operations is substantially avoided.

While in the foregoing there has been provided a detailed description of a particular embodiment of the present invention, it is to be understood that all equivalents obvious to those having skill in the art are to be included within the scope of the invention as claimed.

What I claim and desire to secure by Letters Patent is:

1. A hypodermic jet injector comprising an injector body with a medicament discharge orifice at one end, a chamber for medicament in the body spaced from said orifice, a medicament container having a pierceable cap secured to said body, a valve in said body between said

chamber and discharge orifice for selectively directing medicament from the container to the chamber or communicating the chamber with said orifice and power means communicating with the chamber for selectively propelling medicament from the chamber through said orifice; said injector body having a flattened surface thereon above the valve, elongated bore means in said body perpendicular to said flattened surface communicating with said valve, a counter-bore at the outer end of said bore means, compressible seal means in said counterbore, a container-support having flat face means clamped against said flattened surface and said seal means, a straight tubular member carried by said container-support with one end of the tubular member opening directly into said bore means and the other end of the tubular member extending outwardly of the container-support, and a resilient pad on said container-support surrounding said tubular member as it emerges from said container-support, the capped end of said container being pierced by said tubular member and resting against said resilient pad.

2. A device as in claim **1** wherein the container-support is shaped to incline the resilient pad to face in a direction away from the end of the injector body at which the discharge orifice is located.

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