

[54] **PRESSURE SENSITIVE FLUID INJECTOR
AND POGO STICK UTILIZING SAME**

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[56] **References Cited**

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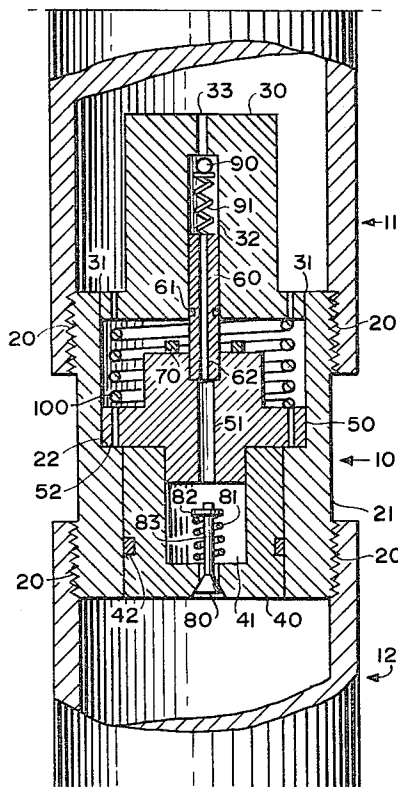
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ABSTRACT

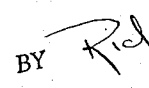
A fluid injector including a pressure sensitive piston through a hole in which is injected a predetermined quantity of fluid into an adjacent area, when a predetermined pressure is presented onto a face of the piston. The piston includes therein a cavity to contain the fluid to be injected and a valve in the hole for constraining the fluid within the cavity until the predetermined pressure is presented. As the pressure in the adjacent area increases, the fluid supply to the cavity of the piston is restricted, and the movement of the piston after the predetermined pressure is reached forces the fluid through the valve into the adjacent area.

Also presented is a pogo stick incorporating a combustion engine, the fuel to which is fed by the fluid injector of the invention.

4 Claims, 4 Drawing Figures



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PRESSURE SENSITIVE FLUID INJECTOR AND POGO STICK UTILIZING SAME

BACKGROUND OF THE INVENTION

1. Field Of The Invention

This invention relates to improvements in fluid injectors, and more particularly to fluid injectors of the type which inject fluid from a low pressure to a higher pressure. This invention also relates to improvements in pogo sticks, and particularly to improvements in pogo sticks incorporating a combustion engine therein.

2. Description Of The Prior Art

Pogo sticks have been widely enjoyed by both young and old, and are presently still of widespread popularity. In general, pogo sticks include a stick or shaft having two outstanding platform members near the bottom upon which the user may stand. Commonly, pogo sticks also have a telescoping shaft which is usually spring biased outwardly from the bottom so that when the user jumps upon the platform members of the stick, the telescoping shaft is pushed into the stick and the spring compressed. The spring then resiliently recoils to impart upward force upon the stick and the user to enable the user to continue to jump or hop upon the stick along a cycloid or other desired path.

It has been proposed by several inventors to incorporate into a pogo stick, engines of various types, to impart additional upward energy to the stick; in fact, the recoiling spring previously used is frequently omitted entirely in such engine-driven sticks. The engines proposed for such devices, however, have been complicated, requiring a large number of parts, and consequently require frequent maintenance and upkeep, and, in addition, are prohibitively expensive for general entertainment usage.

Of the pogo sticks heretofore advanced, two types are prevalent. One type employs a pressurized gas which is released into a chamber when the telescoping shaft is pushed into the stick. The gas therein, which is released into a chamber, forces the telescoping portion of the pogo stick outwardly thereby imparting upward energy to the user. The second type employs internal combustion engines of various design, all to date requiring appropriate means for igniting the fuel within a compression chamber, such as spark plugs and the like, and appropriate timing mechanisms, which, in themselves, are complicated and are not trouble-free.

One reason for the large number of parts required on pogo sticks heretofore proposed is the lack in the art of fuel injectors employable in instances in which it is desired to feed a fluid fuel into a compression chamber having higher internal pressure than the pressure of the fuel in the fuel tank or in the path through which the fuel may flow from the fuel tank to the compression chamber. Although such fuel injectors may be employable in many instances other than in pogo sticks, as below discussed, the invention of the fuel injector herein is believed to be one of the significant aspects and improvements of pogo sticks and other similar amusement devices.

For example, there are numerous devices in which it is desirable to cause fuel or other fluid to be fed from a reservoir or fluid containing tank into a space having a higher pressure than that of the fluid reservoir, for instance, in ordinary internal combustion engines, pneumatic cylinders and other such applications having a pulsating pressure volume. To date, fluid injectors gen-

erally in use require many moving parts to inject the desired amount of fluid. Additionally, the fluid injectors heretofore advanced are mechanically sensitive rather than being pressure sensitive. For example, in an internal combustion engine application, frequently the fuel injectors are sensitive to a mechanical stimulus such as a camshaft or the like, rather than being responsive to the pressure of the chamber into which the fluid is to be injected.

Additionally, the fluid injectors heretofore proposed, without special atomizers or the like, usually inject the fluid in liquid form. This may be undesirable in certain applications; for example, wherein combustion is desired or wherein it is desired that the injected fluid be atomized into a mist or spray for use in the injected area. For instance, in internal combustion engines, it is often desirable that the injected fluid be in the form of a spray; especially this is true in diesel type engines, or engines in which spontaneous combustion occurs at the particular compression pressures and temperatures.

BRIEF DESCRIPTION OF THE INVENTION

In light of the above, it is, therefore, an object of the invention to provide a pogo stick which has few moving parts, and which incorporates an engine for imparting energy to the pogo stick and user.

It is another object of the invention to provide a pogo stick having a combustion engine incorporated therein.

It is a further object of the invention to provide a pogo stick incorporating a fuel injector which injects a fluid fuel from a lower pressure to a higher pressure.

It is still another object of the invention to provide a pogo stick which incorporates an internal combustion engine in which the combustion takes place spontaneously.

It is yet another object of the invention to provide a fluid injector which injects fuel from a reservoir at a first pressure to a volume at a higher pressure.

It is still yet another object of the invention to provide a fluid injector which is sensitive to and activated by a predetermined pressure.

It is yet a further object of the invention to provide a fluid injector which inherently atomizes the fluid injected into the pressurized volume.

These and other objects, features, and advantages will become apparent to those skilled in the art from the following detailed description when read in conjunction with the appended claims and accompanying drawing.

In accordance with one aspect of the invention, a fluid injector is presented including a mount having a cavity extending through it which carries a fluid control block having a channel therein adjacent the cavity at one end of the mount. A piston is included in the cavity at the other end of the mount, the piston being slidable therein toward and away from the control block, and having a portion of it extending into the channel within the control block. The piston additionally has a chamber therein which communicates with the channel of the control block through the portion which extends into the control block. A first valve is included within the channel of the control block, the valve being responsive to the position of the piston to control the fluid flow in the channel. A second valve is also provided within a hole in a wall of the piston to the chamber within the piston, the second valve being responsive to the pressure differential across the wall to enable

fluid to be injected therethrough when a particular predetermined pressure is presented across the wall of the piston. Finally, means are provided for biasing the piston away from the fluid control block.

Additionally, in accordance with another aspect of the invention, an improved pogo stick including a combustion engine incorporating the fuel injector of the invention is presented. The pogo stick includes a hollow handle in which fuel may be contained attached to a mount in which the fluid injector above described may be included. The telescoping rod may include a piston therein to define a combustion chamber at the other end of the mount to allow the fuel to be controlled and fed by the injector into the combustion chamber to spontaneously ignite therein to force the piston outwardly and to propel the pogo stick.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical section through the pressure sensitive fluid injector in a closed position.

FIG. 2 is a vertical section through the pressure sensitive fluid injector in an open position.

FIG. 3 is a graph of pressure as a function of volume for an internal combustion engine.

FIG. 4 is a vertical section through a pogo stick utilizing the pressure sensitive fluid injector of this invention.

DETAILED DESCRIPTION OF THE INVENTION

The structure and operation of the fluid injector of the preferred embodiment are illustrated in FIGS. 1 and 2. Although the fluid injector of the invention may be used in many applications, as discussed below, it is described with particular reference to its application in injecting a fluid disposed at one end of the injector into a chamber disposed at the other end and within which the pressure is variable. The injector is also particularly described with reference to a pogo stick. Specifically, as shown in FIGS. 1 and 2, the fluid injector 10 of the invention, illustrated partially in cross section, is disposed at one end thereof within a fluid tank or chamber 11 within which the contained fluid (not shown) is in contact with the injector 10. The other end of the fluid injector 10 is disposed within a pressure chamber 12, the pressure therewithin likewise contacting the opposite end of the injector 10.

For convenience, the fluid container 11 and the pressure chamber 12 may be threadably engaged with threads 20 to the supporting body 21 of the injector 10, the injector and its associated chambers being preferably of cylindrical shape as shown, well suited to such threaded fittings. However, in instances in which other shapes may be desired, other type joining structures may be employed, the primary desired characteristic being that the particular joining structure employed does not allow gas or fluid to leak therethrough.

The injector 10, within the supporting casing 21, includes two main assemblies. The first assembly is a fluid control block 30 interfacing the fluid within the container 11 and which is rigidly fastened to the support casing 21 by welding, soldering, or otherwise at the junction 31 therebetween. Since there is no motion between the control block 30 and the support 21, it may be cast as a single structure, if desired. Within the block 30 is a channel 32 of first diameter extending a portion of the way therethrough. Joining the channel 32 and communicating therewith is a channel 33 of smaller or

reduced diameter which extends to the top of the block 30 to allow fluid communication to be established between the fluid container 11 and the interior of channel 32.

The second main assembly of the injector 10 includes a secondary piston which may, for ease of fabrication, include three interconnected members, as shown. The first member 40, of cylindrical shape, has formed there-within a chamber 41 to receive and temporarily store the fluid to be injected. The member 40 is slideably disposed within the support casing 21, a ring or gasket 42 being provided to maintain isolation from one end of the member 40 to the other.

Affixed to the member 40 is the second member 50 having a channel 51 therethrough to communicate with the chamber 41 within member 40. The third member 60 of the secondary piston is an elongated rod of diameter approximately equal to that of the chamber 32 in the fluid control block 30, and which is slidably disposed therein at one end and rigidly affixed at the other end to the second member 50. A fluid isolating gasket 61 is provided to maintain the isolation along the length of the rod 60. Formed coaxially within the rod 60 is another channel 62 communicating with the channel 51 in the block 50, and the chamber 32 within the fluid block 30. Thus, fluid communication is established between the fluid container 11 and the chamber 41 via the channels 33 and 32 in block 30, the channel 62 in rod 60, and the channel 51 in the block 50.

The secondary piston is constrained within the supporting body 21 by shoulders 22 which engage a lip 52 of the second member 50 at one end of its travel. The secondary piston, it can be seen, is therefore free to travel coaxially upwards and downwards, with the rod 60 penetrating and withdrawing from the channel 32 as the first member 40 travels up and down within the support 21.

To cushion the secondary piston upon impact with the bottom of fluid control block 30, the cushion ring 70 is provided. The cushion ring 70 may be of rubber, sponge, or other resilient material, and may be mounted on top of the secondary piston, as shown, or alternatively, may be affixed to the bottom of the fluid control block 30. The particular height of the cushion ring 70 may be of importance in the operation of the fluid injector, as described below in detail.

To constrain the fluid within the injector and the fluid container 11 until the injection pressure is reached within the chamber 12 a valve 80 is provided. The valve 80 seats within a hole 43 within the first member 40 between the storage chamber 41 and the compression chamber 12. The valve 80 is normally biased upwardly to a closed position, as shown in FIG. 1, by a spring 81, or other such biasing means, which may be retained in position and attached with respect to valve 80 by a ring or washer 82 attached to the shaft 83 of the valve 80.

To control the fluid flow into the chamber 41, a ball 90 and a spring 91 are provided above rod 60 within channel 32. The spring 91 is of sufficient length to allow the ball 90 to be freely carried below the inlet hole 33 when the secondary piston is in the lower position, shoulders 22 engaging lip 52, as shown in FIG. 1, thereby allowing the fluid within container 11 to flow through the channels 33, 32, 62, 51, and into the chamber 41. Thus, in the normal quiescent state illustrated

in FIG. 1, the fluid is free to communicate with chamber 41 from container 11.

Normally biasing the secondary piston to the downward position with respect to the fluid control block 30 is a spring 100. The particular spring constants of spring 100 and 81 may be of importance in controlling the fluid injection, as described below with respect to the operation of the fluid injector.

In operation, starting at the normal quiescent state, fluid is permitted to enter the fluid injector, essentially filling chambers 41 and channels 51, 62, 32 and 33. As the pressure within the compression chamber 12 increases, such as may be caused, for example, by the upward movement of a piston 110 (see FIG. 2) within the compression chamber 12, the secondary piston moves upward to the position illustrated in FIG. 2, thereby compressing spring 100 and raising spring 91 to seal ball 90 in the channel 33 to stop the fluid flow to the interior to injector 10. At some point after the ball 90 seats, but before the secondary piston reaches the end of its travel, at which cushion ring 70 contacts block 30, the fluid within the injector is subjected to a compressive pressure due to the pressure within compression chamber 12 caused by the piston 110. Then, at a predetermined compression chamber pressure, the pressure required to overcome the bias of the spring 81 will be exceeded forcing the valve 80 to open and expelling the fluid contained within chamber 41 into the compression chamber 12. The precise amount of fluid expelled will be determined and controlled by the amount of fluid displaced by the length of upward travel of the secondary piston after the initial stopping point, the volume contained within channel 32 above the rod 60, the diameter of channel 62, the height of the ring 70, and the bias of spring 81 defining the initial stopping point. At this point it should be noted that the bias imparted on the valve 80 by the spring 81 holding it normally closed should be chosen to exert a force at least equalling that exerted by the pressure of the compression chamber on the first member 40 at the initial stopping point of the secondary piston, to insure that the valve 80 remains closed to prevent the fluid from being forced prematurely into the compression chamber.

Because of the particular design of the valve 80 in its seat 43, and because the fluid is injected just as the bias pressure of the spring 81 against the valve 80 is overcome, the fluid injected into the compression chamber 12 may be atomized during the injection process. This may be particularly desirable in many applications, such as in the operation of an internal combustion engine or the like. On the other hand, by utilizing a spring of relatively weak bias, the valve 80 may be made to open early in the pressure cycle and will allow the fluid to be injected in the flowing form.

Since the fluid within container 11 may leak or seep into the volume separating the secondary piston and the fluid distributing block, a plurality of holes 120 and 121 may be provided to allow the fluid to pass freely thereinto so that the secondary piston will not be obstructed by the presence of the fluid. Consequently, with the holes so disposed, the fluid will normally exist in that separating volume. These holes give rise to an additional control on the operation of the secondary piston in that by appropriate sizing and spacing of the holes, a dashpot or damping effect may be achieved to slow down the movement of the secondary piston or to

add an additional control to determine the pressure required within the compression chamber 12 to raise the secondary piston to inject fluid after or during the period which valve 80 is open, as shown in FIG. 2.

It can be seen that the entire operation of the fluid injector is a function only of the pressure within the chamber 12, the actuating pressure being determined by the particular biases of springs 81 and 100, the amount of fluid being controlled by the height of the ring 70 and bias of spring 100, and the speed being determined also by the bias of spring 100 and by the dashpot effect of holes 120 and 121. Thus, no external mechanical linkages of any kind are required to operate or cause the fluid to be injected.

The fluid injector may have particularly advantageous use in internal combustion engines in injecting a cooling fluid such as water or a mixture of water and alcohol into the compression chamber at a precise predetermined pressure, for example, the pressure existent in the compression chamber at the instant of combustion. As shown in FIG. 3, the ordinary pressure volume curve 150 for an internal combustion engine has a sharp spike 151 which exists at the instant of combustion. By employing the fluid injector of the invention to inject a cooling fluid at the instant of combustion, the spike can be flattened with a resultant decrease of pressure at a higher volume as the piston completes the combustion stroke, the curve following the dotted line 152. Thus, it can be seen that the difference in the area within the respective curves represents the increased energy obtained by such injection. Thus, in terms of efficiency, the pressure-volume spike may be efficiently eliminated with the fluid injector of the invention. The fluid injector of the invention may be incorporated into an internal combustion engine in a second hole, the first being for the spark plug, or, with minor modifications, might be employed into the body of a spark plug, itself.

Because of the particular nature of the fluid injector, it may conveniently be incorporated into a combustion-powered pogo stick, such as that illustrated in FIG. 4. In FIG. 4, the injector 10 may interconnect a tank 11 which may contain a fuel such as kerosene, gasoline, or the like and a compression chamber 12. The tank may be formed of a piece of pipe 130 and may have a cap 131 removably enclosing it. The compression chamber 12 may likewise be formed of a piece of pipe 132 enclosed at the bottom end by a cap 133 onto which the foot members 134 may be formed. Contained within the compression cylinder 132 is a piston 140 forming, with piston rings 141, an essentially gastight fit across its length. The cylinder 140 is mounted upon a shaft 142 which is terminated in a semicircular resilient contact member 143, of rubber, sponge, or the like. Thus, the cylinder and shaft are free to telescope into and out of chamber 132. To allow air to enter the compression chamber 132 and the exhaust to exit from the chamber, a vent port 144 is provided through a wall of the chamber 132 near a bottom portion thereof.

In operation, the piston 140 is manually moved to the bottom of the compression chamber 132, as illustrated in FIG. 4. The user then jumps onto the pogo stick and foot members 134, thereby rapidly moving the piston 140 up into the compression chamber 132. At a point at which the pressure within the compression chamber 132 equals the bias pressure of the valve spring of the fluid injector 10, as above described with respect to

FIGS. 1 and 2, the fuel from tank 11 is injected into the compression chamber. Because of the relatively high compression pressure achieved, combustion spontaneously occurs thereby forcing the piston 140 down and imparting upward force to the pogo stick and the user. At the bottom of the stroke, the exhaust gas from within the compression chamber 132 exits through the port 144. The process is continued with the piston 140 reciprocating by alternative downward motion of the user onto the stick and the upward motion imparted by the combustion within the chamber 132.

The various parts of the pogo stick may be made from metal such as steel or the like and fuel tank 11 also may be made of high impact plastic or such material.

In the pogo stick application described, the fuel from fuel tank 11 is gravity fed into the fluid injector 10. It will be appreciated, however, in other applications it may be desirable to feed into the fluid injector 10 the fluid under pressure; for example, by tubes, pipes or the like, depending, of course, upon the particular operating conditions encountered.

It can be seen, therefore, that with inclusion of the fluid injector of the invention, in a pogo stick as described, a lightweight, reliable, and efficiently-operated unit may be obtained, in contradistinction to the pogo sticks of the prior art in which many complicated parts and ignition timing devices and the like were required.

Other appropriate uses for the fluid injector may include the devices in which oil or other lubricating substance is desired to be injected at a predetermined pressure; for example, in air line lubrication devices such as pneumatic air cylinders and the like. Also, the injector may be used in chemical processes in liquid gas mixing. It will be appreciated that the invention may be used additionally to inject one fluid into another, the only condition for operation being that the area into which the injected fluid flows exhibits pulsating or varying pressure to activate the injector.

Although the invention has been described and illustrated with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and scope of the invention as hereinafter claimed.

What is claimed is:

1. A fluid injector, comprising: a mount having a

cavity therethrough;

a fluid control block having a channel therein including a portion of reduced diameter, said block covered by said mount adjacent to the cavity at one end of said mount;

a piston in the cavity at the other end of said mount slidable therein toward and away from said control block, a portion of said piston extending into the channel within said control block;

said piston having a chamber therein communicating with the channel of said control block through said portion extending thereinto;

a first valve within the channel of said control block responsive to the position of said piston, said valve comprising a spring disposed in the channel, said spring being of relaxed length slightly less than the length of the channel from said reduced diameter to said portion of said piston extending thereinto when said piston is away from said block, and a ball carried by said spring toward said reduced diameter, whereby when said piston is moved toward said block, said spring is compressed and said ball is moved into said reduced diameter to restrict fluid flow therethrough;

a second valve disposed within a hole within a wall of said piston to the chamber therewithin, responsive to the pressure differential across the wall; and means for biasing said piston away from said fluid control block.

2. The injector of claim 1 wherein said second valve comprises: a shaft portion extending the hole in the wall of said piston, an enlarged portion on said shaft on a side of the wall of said piston away from the chamber therein, movable into the hole in the wall of said piston to restrict the fluid flow therethrough, and a spring acting upon said shaft and said piston to normally urge said enlarged portion of said shaft into the hole in the wall of the piston to restrict fluid flow therethrough.

3. The injector of claim 2 wherein said means for biasing said piston away from said fluid control block is a spring between said piston and said fluid control block.

4. The injector of claim 3 wherein said spring acting upon said shaft and said piston has a spring constant to urge said enlarged portion of said shaft into the hole in the wall in said piston with a force of at least equal to the force exerted upon said piston by the pressure at which injection is desired.

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