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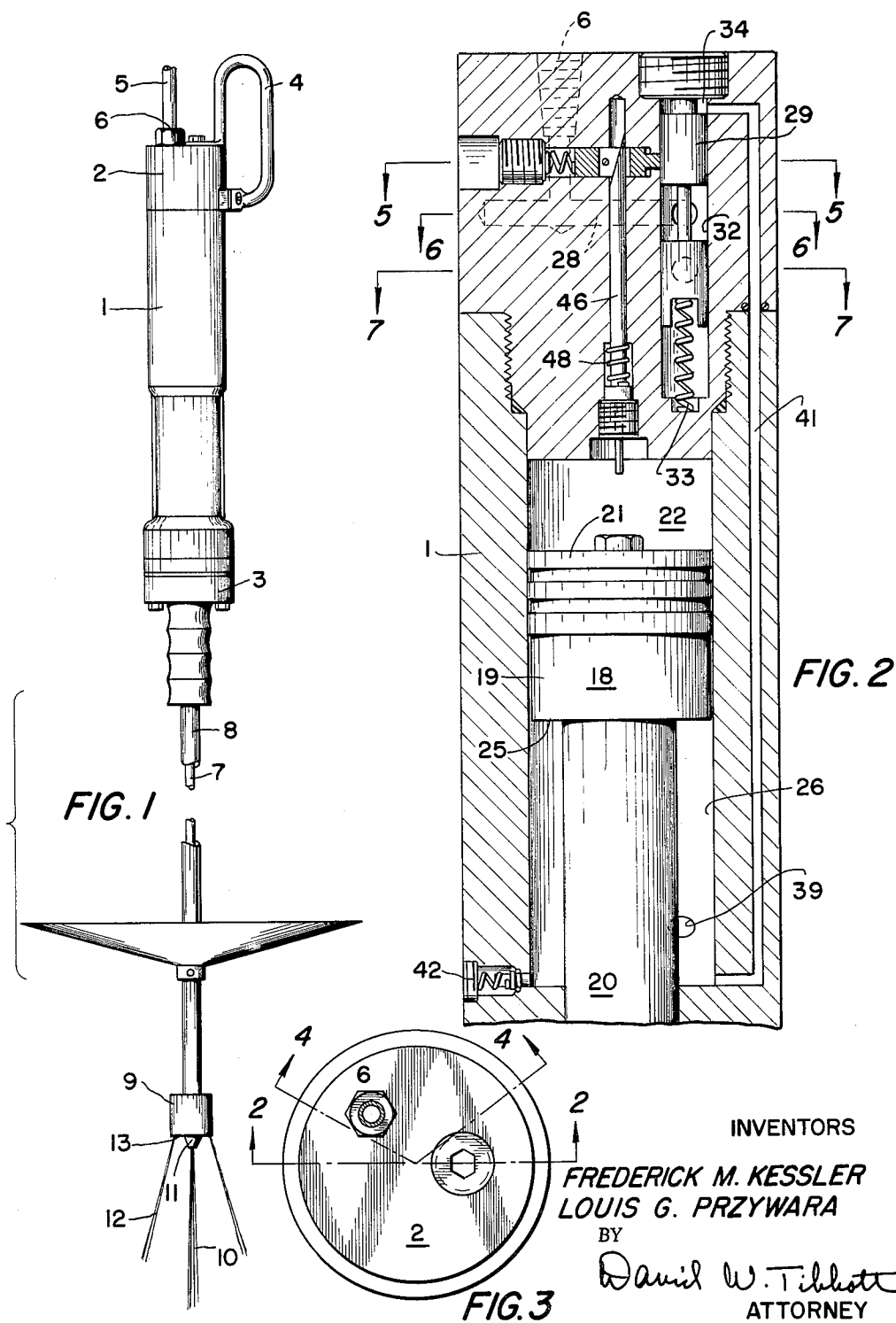
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3,207,442

HIGH PRESSURE FLUID GUN

Filed Dec. 18, 1963

5 Sheets-Sheet 1



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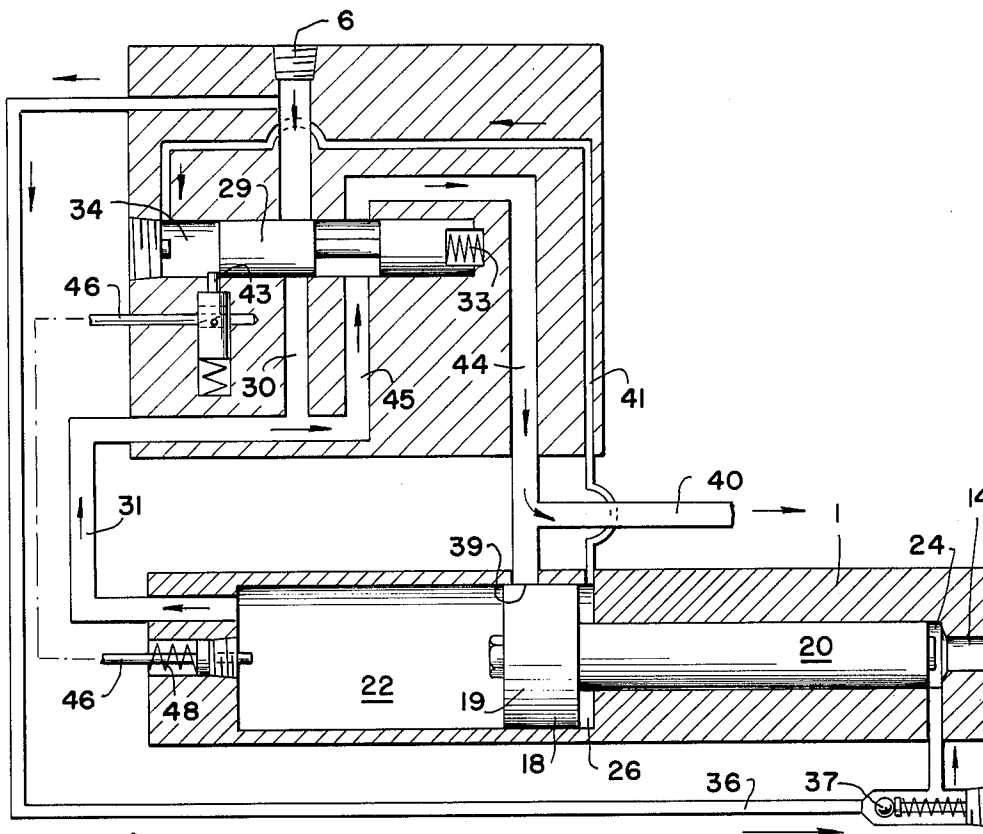


FIG. 10

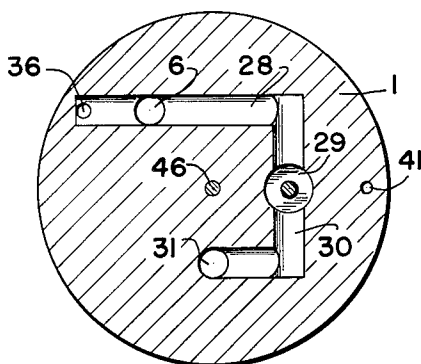


FIG. 6

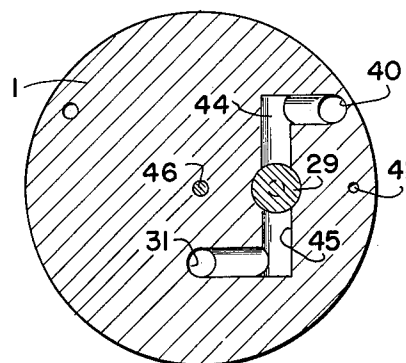


FIG. 7

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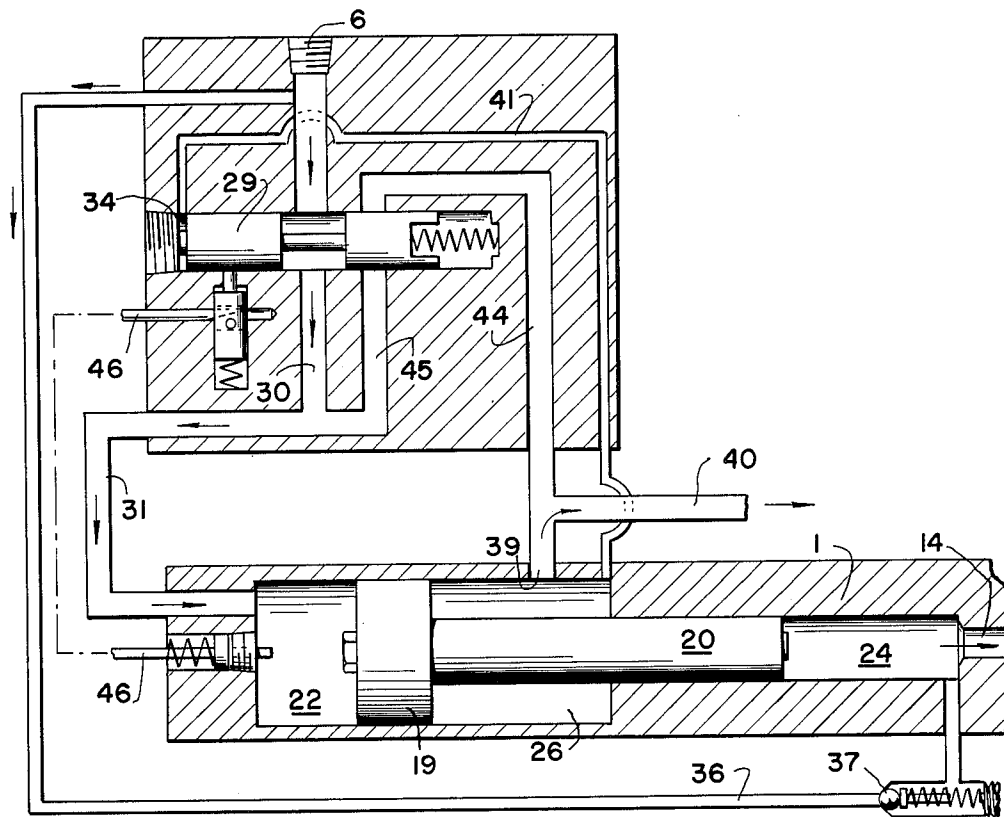


FIG. 9

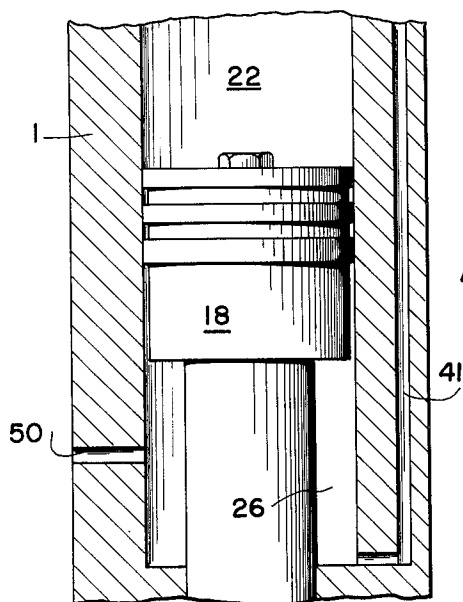


FIG. 11

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HIGH PRESSURE FLUID GUN

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This invention relates to a gun adapted to shoot a stream or jet of fluid under very high pressures. This type of gun can be used for a variety of purposes, for example, cleaning scale and corrosion from metal surfaces.

This type of gun may eject fluid streams under pressures running as high as 50,000 p.s.i. Generally, flexible hoses cannot handle such high pressures. As a result, in the past, this type of gun has been connected to a fluid compressor or pump by a rigid pipeline which limited the mobility and portability of the gun.

The principal object of this invention is to provide a high pressure fluid gun which can be connected to a compressor or pump by a flexible hose, thus allowing the gun to be moved around readily within a limited area.

Other important objects of this invention are: to provide a high pressure fluid gun which also ejects a low pressure fluid spray adjacent its high pressure jet for cleaning a surface of debris loosened by the high pressure jet; to provide a high pressure fluid gun of relatively simple construction which incorporates a self-contained pressure booster; to provide a pressure booster containing a reciprocating piston and a single valve limited to the admission and exhaust of pressure fluid from a single pressure area of the piston; and to provide a simple, easily operated, and reliable pressure booster.

The invention is illustrated in the accompanying drawings wherein:

FIG. 1 is an elevational and broken view of a high pressure fluid gun embodying the invention;

FIG. 2 is an axial section of the rear portion of the gun taken along the line 2—2 of FIG. 3;

FIG. 3 is an end view of the rear end of the gun of FIG. 1;

FIGS. 4A and 4B are sectional views of the rear portion and the front portion, respectively, of the gun taken along the line 4—4 in FIG. 3;

FIG. 5 is a section of FIG. 2 taken along the line 5—5 in FIG. 2;

FIG. 6 is a section of FIG. 2 taken along the line 6—6 in FIG. 2;

FIG. 7 is a section of FIG. 2 taken along the line 7—7 in FIG. 2;

FIG. 8 is a diagrammatic view of the gun illustrating its operation and showing the booster piston at the start of its forward stroke;

FIG. 9 is similar to FIG. 8 and shows the booster piston in the middle of its forward stroke;

FIG. 10 is similar to FIGS. 8 and 9 and shows the booster piston at the beginning of its return stroke; and

FIG. 11 is a fragmentary section of the gun illustrating a second embodiment.

The fluid jet gun shown in FIG. 1 includes a hollow body or casing 1, a backhead 2 attached to the rear end of the casing 1, and a front head 3 attached to its front end. A handle 4 is mounted on the backhead 2, and a hose 5 is connected to a fluid inlet 6 contained in the backhead 2. The front head 3 carries an inner pipe 7 and an outer pipe 8 concentrically surrounding the inner pipe 7. Both pipes 7 and 8 extend forward to a nozzle 9 adapted to eject a high pressure stream or jet 10 of fluid from a central orifice 11 and a low pressure fluid

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spray 12 from outer orifices 13 surrounding the central orifice 11. The passage 14 enclosed within the inner pipe 7 communicates with the central orifice 11 and the annular passage 15 located between the inner and outer pipes 7 and 8 communicates with the outer orifices 13.

The hollow casing 1 contains a reciprocating piston 18 which includes a relatively large diameter head 19 and a smaller diameter nose 20. The rear face 21 of the piston head 19 slides in a first piston chamber 22 and the front face 23 of the nose 20 slides in a second piston chamber 24. The front face 25 of the piston head 19 slides in a third piston chamber 26. Low pressure fluid is admitted into the first piston chamber 22 to drive the piston 18 forward and apply a much higher pressure to the fluid in the second piston chamber 24. The higher pressure in the second piston chamber 24 is the result of the differential areas of the rear piston face 21 and the front piston nose face 23. For example, the low pressure fluid may be under a pressure of 10,000 p.s.i. and the high pressure fluid may be under a pressure of 20,000 p.s.i. Preferably, the fluid is a liquid.

The piston 18 is driven forward by the admission of low pressure fluid from the inlet 6 to the first piston chamber 22. This operation is schematically shown in FIGS. 8 and 9. Low pressure fluid flows from the inlet 6 through the passage 28 to a slide valve 29. With the slide valve 29 located at the rear end of its travel, as shown in FIGS. 8 and 9, it allows fluid to flow from the low pressure passage 28 into the intake passage 30 and the common passage 31 opening into the first piston chamber 22.

The slide valve 29 slides in a corresponding bore 32 formed in the casing 1 and is movable between a pair of alternate positions, a rear position shown in FIGS. 8 and 9 and a front position shown in FIG. 10. A spring 33 is arranged in the valve bore 32 to bias the slide valve 29 to its rear position. It is moved to its forward position by the introduction of pressure into the valve chamber 34 located at the rear of the valve 29. The manner in which pressure is introduced into the valve chamber 34 will be explained later.

The low pressure fluid at the inlet 6 also flows forwardly through the long passage 36 to a check valve 37, as shown in FIGS. 8 and 9. When the pressure in the second piston chamber 24 is below the pressure in the long passage 36, the check valve 37 opens and allows fluid to flow from the passage 36 into the second piston chamber 24. However, the check valve 37 closes the long passage 36 when the pressure in the second piston chamber rises above the pressure of the fluid in the passage 36. This occurs when the piston 18 is driven forward, as shown in FIGS. 8 and 9.

The second piston chamber 24 opens into the inner pipe 7, extending forward from the front head 3, so that fluid in the second piston chamber is free to flow through the inner passage 14 in the pipe 7 and be discharged from the central orifice 11 in the nozzle 9. When the piston 18 is driven forward, the fluid in the second piston chamber 24 is trapped therein by the check valve 37 and, as a result, is placed under a substantially higher pressure relative to the pressure of the low pressure fluid at the inlet 6. This is caused by the differential areas 21 and 23 of the piston 18 in the first and second piston chambers 22 and 24, as previously explained. FIG. 9 illustrates the piston 18 as it is moved part way forward during its forward stroke. This is the working stroke of the piston 18.

As the piston 18 moves forward, the front face 25 of the piston head 19 drives fluid from the third piston chamber 26 through the port 39 and into a longitudinal passage 40. The passage 40 extends forward in the casing 1 and is connected to the outer annular passage 15

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formed between the inner and outer pipes 7 and 8 at the front end of the gun, as shown in FIG. 4B. As a result, during the forward stroke of the piston 18, the low pressure fluid in the third piston chamber 26 is delivered from the outer orifices 13 in the nozzle 9 in the form of a low pressure fluid spray 12 surrounding the high pressure fluid jet 10 delivered from the central orifice 11.

Eventually, the piston 18 moves forward sufficiently to close and seal the port 39. Thereafter, further forward movement of the piston traps fluid in the third piston chamber 26 and attempts to compress it. The forward end of the third piston chamber 26 is connected by a small conduit 41 to the valve chamber 34 located at the rear end of the slide valve 29. As a result, when fluid is trapped in the front end of the third piston chamber 26, the rise in pressure is transmitted to the valve chamber 34 and drives the slide valve 29 forward to the position shown in FIG. 10. A spring-pressed relief valve 42 is mounted in the front end of the third piston chamber 26, as shown in FIG. 2, to release the pressure in the chamber 26 when it exceeds the pressure necessary to operate the slide valve 29. The relief valve 42 protects the gun against being damaged by the pressure in the chamber 26 rising too high.

When the slide valve 29 moves to its forward position, a spring-pressed detent 43 moves into position to lock it, thus preventing it from returning to its rear position. In the forward position of the slide valve 29, the first piston chamber 22 is isolated from the inlet 6 and connected to an exhaust passage 44. The slide valve 29 interconnects the common passage 31 by a branch passage 45 leading to the exhaust passage 44. The exhaust passage 44 is connected to the long passage 40 which opens through the outer orifice 13 in the nozzle 9. As soon as the first piston chamber 22 is connected to the exhaust passage 44, the pressure in that chamber drops and the low pressure fluid in the second piston chamber 24 drives the piston rearwardly. As a result, when the piston 18 moves rearwardly, as shown in FIG. 10, fluid in the first piston chamber 22 flows through the common passage 31 and the branch passage 45, past the slide valve 29, through the exhaust passage 44 and the long passage 40 and is discharged in the form of a fluid spray 12 from the outer orifices 13 in the nozzle 9.

When the piston 18 reaches the end of its rearward travel, it pushes a rod 46 rearwardly. The rear end of the rod 46 is provided with a cam surface 47 arranged to retract the spring detent 43 when the rod is moved rearward. When the slide valve 29 is released, its spring 33 returns to its rearward position, as shown in FIG. 8. The rod 46 is normally biased forwardly by a spring 48.

Operation

Prior to using the gun, the inlet 6 is connected by the hose 5 to a suitable source of low pressure fluid say 10,000 p.s.i. The operator holds the gun by the handle 4 with the nozzle 9 located adjacent to and pointed at the surface which the operator intends to treat with the fluid jet 10. Thereafter, the operator opens a valve 5 to admit the low pressure fluid to the inlet 6.

Assume at the moment of initially feeding fluid to the inlet 6, the piston 18 is located in the position shown in FIG. 8. The low pressure fluid flows from the inlet 6 through the long passage 36 and the check valve 37 into the second piston chamber 24 until that chamber is full. Simultaneously, the fluid also flows from the inlet 6 through the low pressure passage 28 and the slide valve 29. From the valve 29, the fluid flows through the intake passage 30 and the common passage 31 and into the first piston chamber 22. As it fills the first piston chamber 22, the fluid drives the piston 18 forward and raises the pressure in the second piston chamber 24, because of the differential areas between the rear piston face 21 and the front face 23 of the piston nose 20.

As the pressure increases in the second piston chamber

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24, the check valve 37 closes to prevent fluid in the chamber 24 from backing into the long passage 36. As a result of the increased pressure in the second piston chamber 24, say 20,000 p.s.i., the fluid in the chamber 24 is forced out the inner passage 14 in the inner pipe 7 and shot from the central orifice 11 in the nozzle 9 as a high pressure jet 10. The jet 10 can be used for various purposes, for example, cutting scale from a metal surface.

As the piston 18 moves forward, fluid in the third piston chamber 26 is driven out the port 39 and into the longitudinal passage 40. From the passage 40, the fluid is driven through the annular passage 15, formed between the inner and outer pipes 7 and 8, and sprayed from the outer orifices 13 in the nozzle 9 as a low pressure fluid spray 12 surrounding the high pressure jet 10. The port 39, the passages 40 and 15 and the outer orifices 13 are large enough to prevent the fluid pressure in the third piston chamber 26 from rising a substantial amount as the fluid is driven from it. The fluid spray 12 surrounding the high pressure jet 10 acts as a washing fluid to wash debris from the surfaces as the jet 10 loosens the debris.

Eventually, the piston 18 nears the end of its forward stroke and passes the port 39. Once the port 39 is closed, the remaining fluid in the third piston chamber 26 is trapped and its pressure rises rapidly. This rapid pressure rise is transmitted through the small conduit 41 to the rear valve chamber 34 wherein it pushes the slide valve 29 forward until the detent 43 latches it in its forward position. This position is shown in FIG. 10.

As soon as the slide valve 29 moves forward, it isolates the first piston chamber 22 from the inlet 6 and connects it with the exhaust passage 44. Thus, fluid can flow from the first piston chamber 22 through the common passage 31, the branch passage 45, the slide valve 29 and into the exhaust passage 44. From there, it flows into the longitudinal passage 40, through the annular passage 15 at the front of the gun and out of the outer orifices 13 in the nozzle 9, in the form of a spray 12.

Simultaneously, some of the fluid in the exhaust passage 44 enters the third piston chamber 26 as that chamber increases in volume during the rearward stroke of the piston 18.

The piston 18 is driven rearwardly by the low pressure fluid in the second piston chamber 24 which is in communication with the inlet 6 through the check valve 37 and the long passage 36. This rearward movement of the piston 18 begins as soon as the slide valve 29 is moved to its forward position and the pressure in the first piston chamber 22 begins decreasing.

Eventually, the piston 18 reaches the end of its return stroke and pushes the rod 46 rearward to release the detent 43 and unlatch the slide valve 29 whereby the valve 29 returns to its rearward position, as shown in FIG. 8. At this point, fluid from the inlet 6 again enters the first piston chamber 22 and the piston 18 begins its forward stroke. From then on the operation of the gun is repeated in the same manner as previously described. In other words, the piston 18 alternately moves forward and rearward periodically with the high pressure jet 10 occurring only on the forward stroke of the piston 18. However, during the reverse stroke of the piston 18, the low pressure fluid flowing into the second piston chamber flows out the central orifice 11 of the nozzle 9.

Second embodiment

This embodiment is shown in FIG. 11. In this embodiment the low pressure fluid at the inlet 6 is prevented from entering the third piston chamber 26, by eliminating the port 39, and the relief valve 42 is replaced by a port 50 communicating with the atmosphere. Instead of the low pressure fluid at the inlet 6 from flowing into the third piston chamber 26 and being utilized for moving the slide valve 29 forward, air enters the chamber 26 through the port 50 and is utilized for operating the slide valve 29. Otherwise, this embodiment is same as the first embodiment.

Although two embodiments are illustrated and described in detail, it will be understood that the invention is not limited simply to these embodiments, but contemplates other embodiments and variations which utilize the concepts and teachings of this invention.

Having described our invention, we claim:

1. A high pressure fluid jet gun comprising:

- (a) a casing forming first and second axially aligned piston chambers; 5
- (b) a jet nozzle on the front of said casing adapted to shoot a stream of fluid therefrom; 10
- (c) a fluid inlet in said casing adapted to receive fluid at a relatively low pressure from a suitable source; 15
- (d) a piston reciprocally mounted in said piston chambers and having a pair of fluid pressure areas, the first of said pressure areas being of a relatively larger area and sliding in the first piston chamber and the second being of a relatively smaller area and sliding in the second piston chamber; 15
- (e) a first conduit interconnecting the second piston chamber with said nozzle; 20
- (f) a second conduit connecting said fluid inlet with the second piston chamber, said second conduit containing a check valve allowing fluid to flow from said inlet to said second chamber but preventing a reverse flow of fluid; 25
- (g) a second nozzle located adjacent said first nozzle; and
- (h) valve means operative in a first position to connect said first piston chamber with said inlet to force the piston in a pressure boosting direction to compress the fluid in the second chamber and force it out the nozzle, said valve means being also operative in a second position to isolate said first piston chamber from said inlet and to connect said first chamber to said second nozzle during the movement of the piston in the other or piston return direction wherein the fluid in said first chamber is pumped out said second nozzle during the movement of said piston in the piston return direction. 40

2. A high pressure fluid jet gun comprising:

- (a) a casing forming first and second axially aligned piston chambers; 45
- (b) a jet nozzle on the front end of said casing adapted to shoot a stream of fluid therefrom;
- (c) a fluid inlet in said casing adapted to receive fluid at a relatively low pressure from a suitable source;

- (d) a piston reciprocally mounted in said piston chambers and having a pair of fluid pressure areas, the first of said pressure areas being of a relatively larger area and sliding in the first piston chamber and the second being of a relatively smaller area and sliding in the second piston chamber;
 - (e) a first conduit interconnecting the second piston chamber with said nozzle;
 - (f) a second conduit connecting said fluid inlet with the second piston chamber, said second conduit containing a check valve allowing fluid to flow from said inlet to said second chamber but preventing a reverse flow of fluid;
 - (g) valve means operative in a first position to connect said first piston chamber with said inlet to force the piston in a pressure boosting direction to compress the fluid in the second chamber and force it out the nozzle, said valve means being also operative in a second position to isolate said first piston chamber from said inlet and to connect said first chamber to an exhaust vent during the movement of the piston in the other or piston return direction;
 - (h) the said casing including a third axially aligned piston chamber; and
 - (i) said piston including a third pressure area sliding in said third chamber and arranged to force fluid from said third chamber during the movement of the piston in said piston boosting direction.
3. The fluid jet gun of claim 2 wherein:
- (a) said valve means is arranged to admit fluid from said inlet to said third chamber during the movement of said piston in the piston return direction.
4. The fluid jet gun of claim 3 wherein:
- (a) said third chamber is connected to said valve means in a manner to move it to said second position at the end of the movement of the piston in the pressure boosting direction.
5. The fluid jet gun of claim 4 including: means operative in response to the arrival of said piston at the end of its movement in the piston return direction, to move said valve means to its first position.

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EVERETT W. KIRBY, *Primary Examiner.*