

[54] FLUID INJECTORS

[72] Inventor: Lawrence Edward Helyer, Ascot, England

[73] Assignee: J&T Engineers (Ascot) Limited

[22] Filed: Sept. 8, 1970

[21] Appl. No.: 70,226

[52] U.S. Cl. 239/126, 239/464, 239/533

[51] Int. Cl. B05b 9/00

[58] Field of Search 239/124, 125, 126, 533, 464

[56] References Cited

UNITED STATES PATENTS

2,677,417	5/1954	Logan et al.	239/126
2,345,402	3/1944	Lubbock et al.	239/125
2,579,829	12/1951	Joyce	239/125
2,743,137	4/1956	Wilson	239/125

Primary Examiner—M. Henson Wood, Jr.

Assistant Examiner—John J. Love

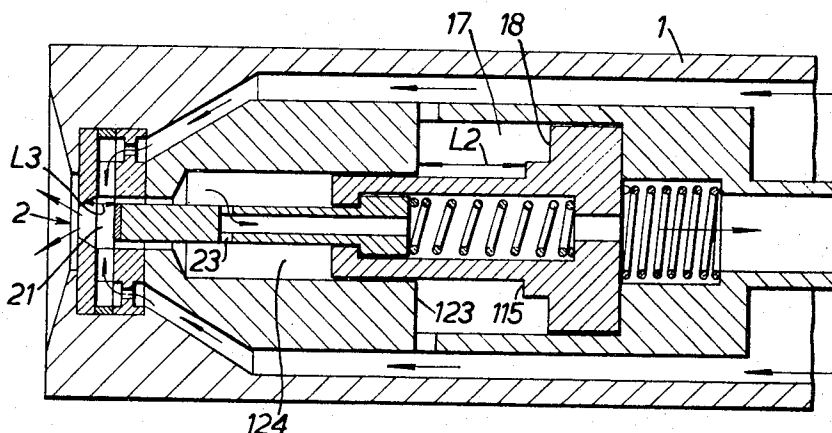
Attorney—Lawrence E. Laubscher and Laubscher & Sixby

[57]

ABSTRACT

The invention comprises a fluid injector including a discharge passage, and a tip sealing valve for controlling fluid discharge through said passage, said tip sealing valve being responsive to a fluid differential operative thereon in a non-discharge condition of the fluid injector to close said discharge passage, said tip sealing valve being responsive to another fluid differential operative thereon in a discharge condition of said fluid injector to permit fluid discharge through said discharge passage, said tip sealing valve comprising first and second relatively movable parts with a spring means interposed between said parts, said first part having a cross-sectional area effective to the pressure of fluid flowing in said fluid injector in the non-discharge condition thereof such that said first part will be seated in closure relationship with said discharge passage, and said second part being responsive to the pressure of said fluid in said fluid flow to compress said spring means against said seated first part, by which the force with which said first part is seated is a function of said fluid pressure effective cross-sectional area of said first part and the rating of said spring means.

16 Claims, 7 Drawing Figures



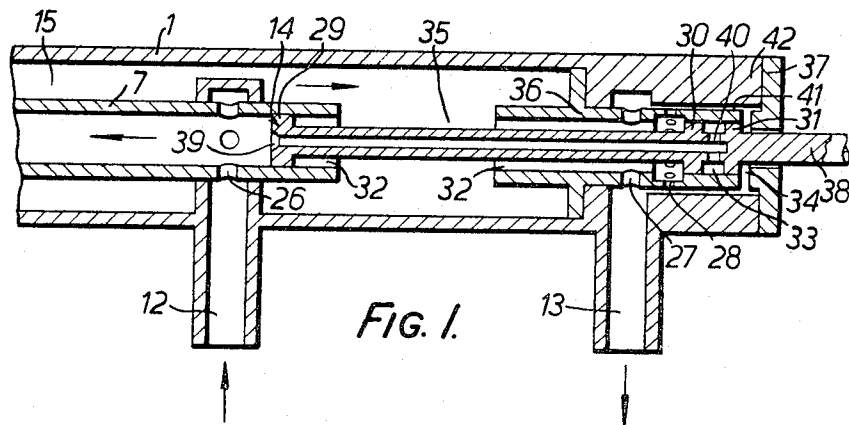


FIG. 1.

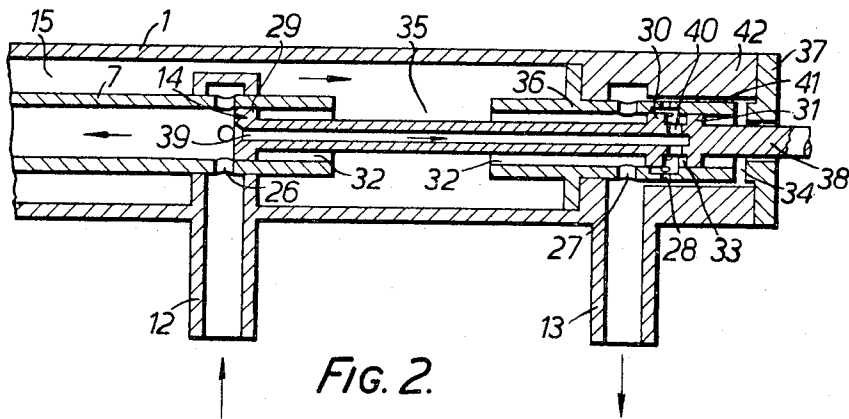


FIG. 2.

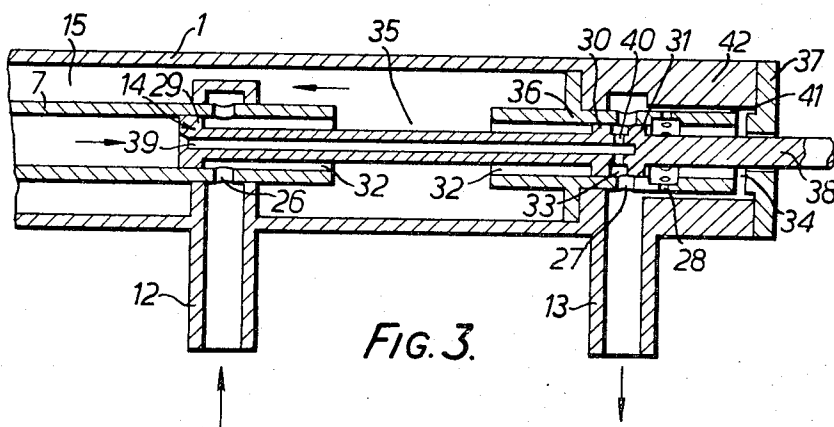


FIG. 3.

LAWRENCE E. HELYER
INVENTOR

BY
Lawrence E. Laubscher
ATTORNEY

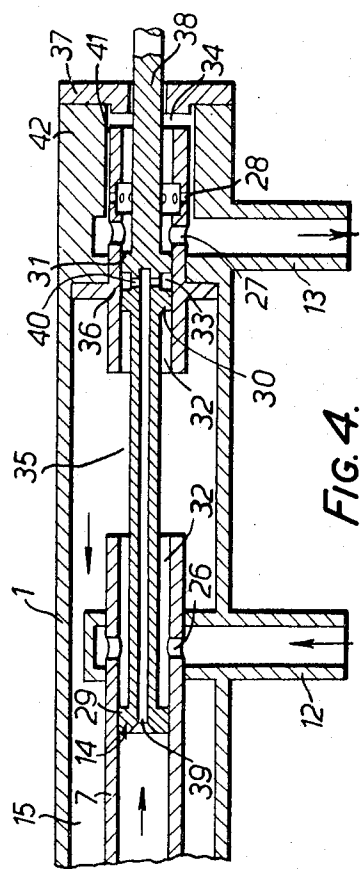


FIG. 4.

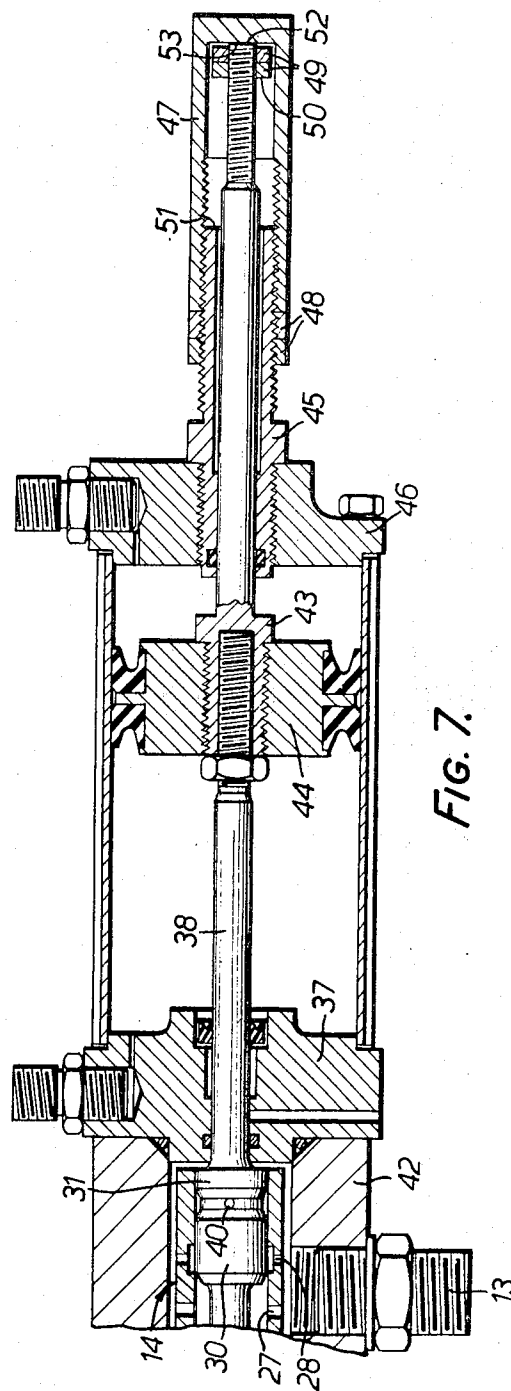


FIG. 7.

LAWRENCE E. HELYER
INVENTOR

BY
Lawrence E. Lautscher
ATTORNEY

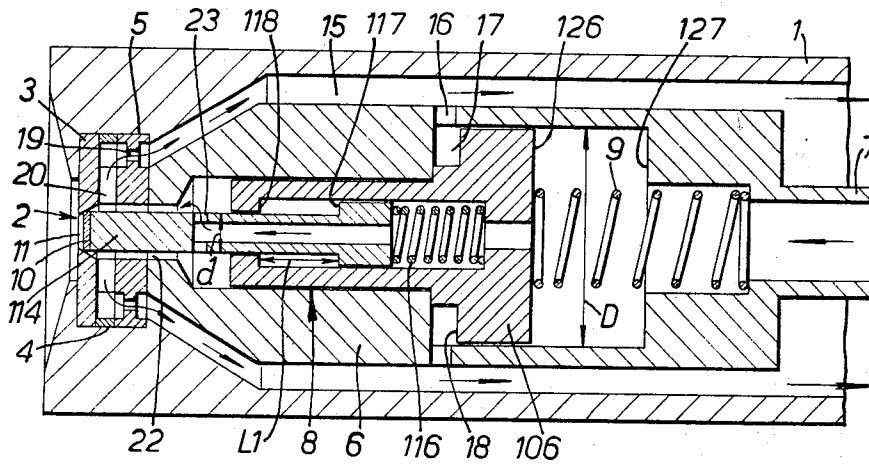


FIG. 5.

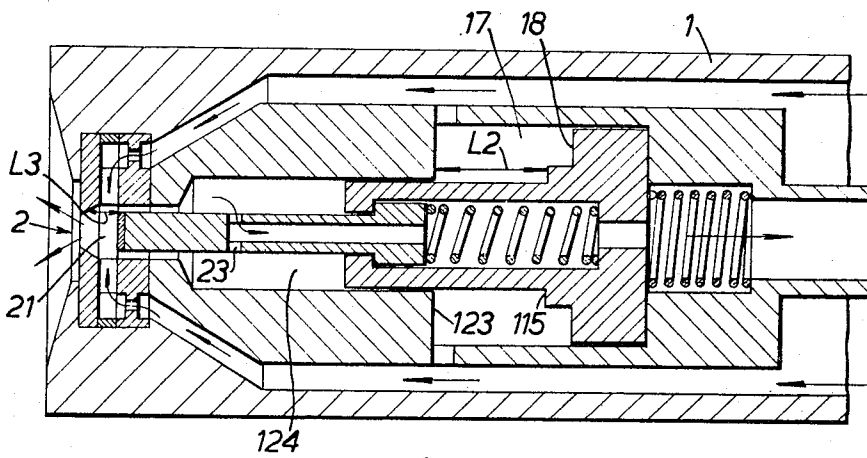


FIG. 6.

LAURENCE E. HELYER

INVENTOR

BY

Lawrence E. Laubscher

ATTORNEY

FLUID INJECTORS

According to the invention there is provided a fluid injector including a discharge passage, and a tip sealing valve for controlling fluid discharge through said passage, said tip sealing valve being responsive to a fluid differential operative thereon in a non-discharge condition of the fluid injector to close said discharge passage, said tip sealing valve being responsive to another fluid differential operative thereon in a discharge condition of said fluid injector to permit fluid discharge through said discharge passage, said tip sealing valve comprising first and second relatively movable parts with a spring means interposed between said parts, said first part having a cross-sectional area effective to the pressure of fluid flowing in said fluid injector in the non-discharge condition thereof such that said first part will be seated in closure relationship with said discharge passage, and said second part being responsive to the pressure of said fluid in said fluid flow to compress said spring means against said seated first part, by which the force with which said first part is seated is a function of said fluid pressure effective cross-sectional area of said first part and the rating of said spring means.

In order that the invention will be well understood there will now be described one embodiment thereof, given by way of example only, reference being had to the accompanying drawings, in which:

FIG. 1 is a schematic sectional side elevation the change-over valve end of a fluid injector when shutdown;

FIG. 2 is a similar view of the same injector when shut down, which shows the introduction of additional fluid circulating within the injector;

FIG. 3 is a similar view of the same injector when operative to discharge fluid;

FIG. 4 is a similar detailed view showing the injector in the discharge condition, but with the change-over valve thereof in a different position, so as to regulate the quantity of discharge fluid;

FIG. 5 is a detailed section to a larger scale showing the forward end of the injector of the preceding Figures when the injector is in the shut-down condition as shown in FIGS. 1 and 2;

FIG. 6 is a detailed section to a larger scale showing the forward end of said injector when in the discharge condition as shown in FIGS. 3 and 4, and

FIG. 7 is a detailed section to a larger scale showing in constructional form the rear end of the same injector coupled to a means for adjusting the position of the change-over valve.

The fluid injector is primarily intended for incorporation in an oil fuel burner suitable for use in an oil fired boiler. Such burners are arranged in the furnace walls of the boiler for firing the boiler's fuel. Oil fuel is used as the prime fuel for firing burners, or as a secondary fuel for igniting coal when that is the primary fuel. The boiler would generate steam, and have land, marine or other industrial applications.

The fluid injector includes a multi-part barrel 1 supporting at its forward end an atomizer assembly 2. The barrel would be suitably mounted in the wall of the boiler with its forward end inset from the boiler interior. The atomizer assembly 2 comprises an orifice plate 3, a swirl plate 4 and a distributor plate 5.

The distributor plate abuts a cylindrical body 6 which is secured at its rear end to a multi-part central tube 7. A tip sealing valve assembly 8 is slidably mounted within the body 6 and is biased forwardly by a spring 9. When there is no fluid supply to the injector, the bias of the spring 9 is sufficient to urge the valve tip 10 into a discharge orifice 11 in the orifice plate 3 and so close that orifice. Normally, fluid is continuously supplied to the injector, and the position of the tip sealing valve assembly 8 is controlled by the differential as between the supply and return pressure of that fluid, as will appear.

The barrel 1 includes fixed oil fuel inlet and return pipes 12 and 13 respectively. Those pipes would be coupled into a suitable oil fuel delivery and return circuit, the details of which may be conventional and form no part of the present in-

vention. A change-over valve 14 is axially slidable within the central tube 7 and a control sleeve 36, and is movable between positions in which to effect oil flows within the injector as indicated by the arrows in the various Figures.

In the position of the valve 14 shown in FIG. 1, the oil is supplied through the central tube 7, and passes via the atomizer assembly 2 to return through an annular duct 15 defined between the barrel 1 and the cylindrical body 6 and central tube 7. Such oil flow effects a differential pressure operating to close the valve tip 10 against the discharge orifice 11. Thus, no oil will be discharged from the injector. Even so, during that time there is a continuous circulation of oil within the injector. The quantity of fluid which circulates within the injector can be regulated, as will be later described.

In the position of the valve 14 shown in FIG. 3, the reverse oil flow occurs through the injector. In this case, the differential pressure acting on the valve assembly 8 retracts the tip 10 thereof, against the bias of the spring 9, to open the discharge orifice. Oil will, accordingly, be discharged through that orifice. A proportion of the oil supplied to the injector will not be discharged but will return through the central tube 7. That proportion, and hence the quantity of oil which is discharged, can be regulated, as will be later described.

Describing now the forward end of the injector (shown in FIGS. 5 and 6) in more detail, ports 16 in the wall of the cylindrical body 6 provide communication as between the duct 15 and a chamber 17 located forwardly of a shoulder 18 on a tip sealing valve body 106. Distributor apertures 19 are provided in the distributor plate 5 and swirl passages 20 in the swirl plate. A swirl chamber 21 is located radially inwardly of that plate and between it and the discharge orifice 11. A central passage 22 lies behind the swirl chamber, and passages 23 are provided in the tip sealing valve pintle 114. The tip sealing valve body 106 (together to form the tip valve assembly 8), and is biased forwardly by a spring 116. A shoulder 117 on the tip sealing valve pintle 114 engages with a shoulder 118 on the tip sealing valve body, so retaining the pintle 114 within the body 116 when the tip sealing valve assembly 8 is in the open position shown in FIG. 6. The tip sealing valve assembly 8 is slidably mounted within the body 6 and is biased forwardly by a spring 9. When there is no fluid supply to the injector, the bias of the spring 9 is sufficient to urge the valve tip 10 into the discharge orifice 11 in the orifice plate 3, and so close that orifice.

Thus, when the fluid flow is as shown in FIG. 5, owing to velocity head losses there will be a pressure drop across the passage 23 and across the swirl passages 20 and the distributor apertures 19. The incoming fluid operative on the tip sealing body 106 and the tip sealing valve pintle 114 is, as a consequence, at a higher pressure than the outgoing fluid flowing through the duct 15 and thus operative on the body 106 within the chamber 17.

That fluid pressure differential, in conjunction with the relative areas of the tip valve body 106 exposed to the fluid, is effective to firmly close the tip valve pintle 114 with its tip 10 in the orifice 11 to prevent discharge therethrough.

The tip valve body 106, under the influence of this fluid pressure differential, is caused to move forwardly after the sealing valve pintle tip 10 engages with the orifice 11 until the shoulder 115 of the tip valve body 106 engages with the land 123 of the chamber 17, thus compressing the spring 116 by the length L1 determined by the difference of the distance L2 and L3.

The force acting on the tip 10 of the tip sealing pintle 114 to maintain the tip 10 in the orifice 11 is determined by the greater fluid pressure acting on the area defined by diameter d and the external pressure acting on the same area, together with the force required to compress the spring 116 by the distance L1. Thus by selection of suitable values of d and suitable spring rates for the spring 116, any desired force can be generated to hold the tip of the tip valve pintle against the orifice for a given value of fluid pressure acting on the area defined by d .

The control of this force enables the material of the tip 10 of the tip valve pintle 114 to be selected from a range of materials, metallic and non metallic, so that no fluid can discharge from the orifice when the tip valve is closed as in FIG. 5, even when the surface of the orifice is worn or otherwise irregular.

Furthermore, the forces on the tip valve pintle and consequently on the orifice plate 3, being controlled in the manner described, ensure that at the instant of change from the open to closed position of the valve, no excessive force is generated between the tip 10 and the orifice 11 due to this change in the direction of the fluid flow. This allows materials to be used for the orifice plate 3 which may be brittle in nature and would fracture if subject to impact or shock loads.

When the fluid flow within the injector is reversed, as shown in FIG. 6, then there will be a pressure drop across the atomizer assembly 2 as described before but in the opposite direction, so that the fluid pressure in the chambers 17 and 124 are sufficiently greater than the pressure in the center tube 7 acting on the area of the valve defined by diameter D to urge the tip valve assembly 8 away from the orifice plate 3 and so open the orifice therein to permit discharge therethrough. The movement of the tip valve body 106 is constrained by a land 126 meeting a land 127, and that of the tip valve pintle by the shoulder 117 engaging the shoulder 118. Thus, the movement of the tip 10 is determined relative to the orifice plate 3 and is made to be in register with or inset from the rearward surface of the swirl chamber 21 as desired.

As mentioned, the reversal of fluid flow within the injector is controlled by the change-over valve 14.

The position of that valve 14 in relation to ports 27, 28, also controls the relative proportions of fluid discharge through the discharge orifice 11, and fluid spill return flow through the central tube 7 when the tip valve assembly 8 is open, and of fluid continuously circulated within the injector when the tip valve assembly 8 is closed.

The valve 14 comprises a spool having a land 29 in sliding engagement with the central tube 7, and lands 30, 31 in sliding engagement with the control sleeve 36. The lands 29, 30, 31, define therebetween chambers 32, 33. The chamber 32 is maintained in communication with the duct 15 by a chamber 35 provided between the control sleeve 36 and the central tube 7. Another chamber 34 is defined between the land 31 and a closure member 37 serving to close the rear end of the injector and make a liquid seal with a plunger 38 of the valve 14. That plunger would be operatively manually or be connected to any suitable power means such as an electrical solenoid or air cylinder so as to be reciprocally movable under selective control. The ports 27, 28 are provided in the wall of the control sleeve 36, and ports 26 are provided in the wall of the central tube 7.

When the change-over valve 14 is in the position shown in FIG. 1, the land 29 is positioned behind the ports 26 having direct communication with the fluid supply pipe 12 so that fluid will flow from that pipe via the ports 26 and into the central tube 7 to pass therealong towards the atomizer assembly 2. A return path from the duct 15 to the return pipe 13 is provided by way of the aperture 35 and the ports 27, such that the fluid will return from the duct 15 via the chamber 35 into the chamber 32 and pass therefrom via the ports 27 into the return pipe 13.

With the injector maintained in the shut-off condition as shown in FIGS. 2 and 5, additional circulating flow may be introduced by connecting a central passage 39 in the valve 14 via the chamber 33 to the ports 28 so that the fluid will pass therefrom into the return pipe 13. Care must be taken to ensure that the fluid flow returning from the duct 15 into the return pipe 13 is not reduced, when the valve 14 is moved inwardly to introduce additional circulation within the injector.

To effect a discharge condition, the change-over valve 14 is moved inwardly to the position shown in FIG. 3 in which the land 29 lies forwardly of the supply pipe 12 and the ports 26 to interrupt communication between those ports 26 and the forward region of the central tube 7. Instead, the ports 26 communicate with the chamber 32 with the result that flow will

occur into that chamber 32 and exit therefrom via the chamber 35 into the duct 15. Return from the atomizer assembly 2 takes place via the central tube 7 to the land 29, and then through the central passage 39 in the valve 14 and ports 40 therefrom into the chamber 33, to exit via the ports 27 into the directly registering return pipe 13.

With the injector in the discharge condition the fluid spill return flow into the return pipe 13 can be regulated to obtain a corresponding variation in the discharge flow. A lesser fluid spill return flow and hence a greater discharge flow is obtained by moving the change-over valve 14 inwardly, so that the land 31 is caused to interfere with the fluid spill return flow from the chamber 33 via the port 27 into the return pipe 13. This fluid spill return flow can be shut off entirely by continuing to move the change-over valve 14 inwardly until it is in the position shown in FIG. 4. At this position the discharge flow will be a maximum for a particular size of discharge orifice 11, and a particular supply pressure.

Care must be taken to ensure that the tip sealing valve assembly 8 can move to the discharge position shown in FIG. 6, before the fluid spill return flow is shut off entirely. Otherwise a hydraulic lock will be caused in the central tube 7, which will render the tip sealing valve inoperative.

The distribution of fluid flow as between discharge and return for a particular size of atomizer is also determined by the diameter *a* of the central passage 22 and the size and number of passages 23 in the tip sealing valve assembly 8.

There is an annular gap 41 between the rear end of the control sleeve and the associated end 42 of the barrel. In the absence of that gap, there would tend to be a hydraulic lock when the change-over valve is retracted caused by fluid being trapped in the chamber 34. With the annular gap, such fluid will be displaced from the chamber and into the return pipe 13.

An external adjustment mechanism permits independent regulation of both the quantities of discharged fluid when the tip sealing valve assembly is open, and fluid continuously circulated within the injector when the tip sealing valve assembly is closed. The mechanism is so arranged that either adjustment can be made without interfering with the other setting.

From FIG. 7 it can be seen that an adjustment spindle 43 is in rigid connection with the plunger 38 of the change-over valve 14 at a power operative drive sleeve 44. The spindle 43 slides in an adjustment sleeve 45 which is part of the power operator support frame 46. The spindle 43 is enclosed by a barrel 47 which is screwed in engagement with the sleeve 45. The barrel 47 abuts adjustment nuts 48 which are also in screwed engagement with the sleeve 45. Adjustment nuts 49 are in screwed engagement with the spindle 43 and form a land 50 which abuts a land 51 formed on the end of the sleeve 45. A land 52 is formed on the end of the spindle 43, and a land 53 is formed inside the barrel 47.

To adjust the circulating fluid within the fluid injector, as in FIG. 2, the nuts 48 are screwed inwardly so that the barrel 47 which abuts them can be moved in. Thus, the travel of the spindle 43 is restricted because the land 52 abuts the land 53, causing the valve 14 to move inwardly.

The fluid spill return flow is regulated, as shown in FIGS. 3 and 4, by the nuts 49 which abut the land 51, and they can be unscrewed allowing the spindle 43 a controlled inward movement.

An oil burner incorporating the fluid injector as described would also have an air register to provide the combustion air, a flame stabilizer to maintain the flame at the point where the fuel is injected, valves to regulate the shut off the air and fuel supplies, and an ignitor to initiate combustion.

The described fluid injector is advantageous in that during shut-off, fluid is continuously circulated through it to cool the injector and obviate the need for the injector to be retracted away from the interior of the boiler. Again, because of that continuous circulation, fuel cracking and blockage in the injector are obviated and there is no necessity for cleaning between discharge operations. The tip sealing and change-

over valves are self-contained units, which permits their easy removal for service or replacing; the ingress of dust into the valve system is prevented because the change-over valve is enclosed in the center tube as an integral part of the injector. The fuel flow for a particular pressure can be maintained at constant volume when the injector is operated by presetting the circulating flow when the injector is in the shut-off condition; this feature is of importance in automatic boiler control since it permits taking off and putting on burners without disturbing the total fuel flow. By providing for a regulated degree of fluid spill return flow during discharge, a wider range of operation is obtained without reducing the quality of fuel atomization. The construction of the injector also allows the use of second fluids to further increase the range of operation, for a single atomizer. The components of the injector are so sized that the injector may be housed in standard carrier tubes.

I claim:

1. In a fluid injector apparatus including housing means (1) containing a discharge passage (11), and tip sealing valve means (8) for controlling the discharge of fluid through said passage, said tip sealing valve means being responsive to a first fluid differential established thereon when said fluid injector apparatus is in a non-discharge condition to close said discharge passage, said tip sealing valve means being responsive to a second fluid differential established thereon when said fluid injector apparatus is in a discharge condition to permit fluid discharge through said discharge passage; said tip sealing valve means comprising

first and second relatively movable parts (114, 106) arranged in said housing adjacent said discharge passage, said first part (114) being slidably movable within said second part (106); and

spring means (116) interposed between said parts for biasing said first part outwardly relative to said second part toward said discharge passage; said first part having a cross-sectional area effective to the pressure of the fluid flowing in said fluid injector apparatus when in the non-discharge condition such that said first part is seated in closure relationship with said discharge passage;

said second part being responsive to said fluid pressure to compress said spring means against said seated first part, thereby causing the seating force of said first part to be a function of said fluid pressure effective cross-sectional area of said first part and the rating of said spring means.

2. A fluid injector according to claim 1, wherein said first and second parts are responsive to the pressure of fluid flowing in said fluid injector in said non-discharge condition thereof to be both urged towards said discharge passage with said first part seating in closure relationship therewith prior to the movement of said second part being arrested so that said second part will act to compress said spring means against said seated first part by which to apply a closure force thereagainst determined, for a given fluid pressure effectively applied to said second part, by the rating of said spring means.

3. A fluid injector according to claim 2, wherein said second part is responsive to the pressure of fluid flowing in said fluid injector in said discharge condition thereof to be urged away from said discharge passage and to carry with it during such motion said first part by which to effect opening of said discharge passage.

4. A fluid injector according to claim 2, including a first fluid flow path to one side of said tip sealing valve, a second fluid flow path to the other side of said tip sealing valve, and passage means through said tip sealing valve interconnecting said two flow paths, said tip sealing valve being responsive to a fluid differential as between said two flow paths to close said discharge passage, when fluid flow occurs through said first to said second fluid flow path, and to permit fluid discharge through said discharge passage, when fluid flow occurs through said second to said first fluid flow path.

5. A fluid injector according to claim 4, wherein said passage means is defined in said first part and is dimensioned

to effect a pressure drop in fluid flowing from one said fluid flow path to the other.

6. A fluid injector according to claim 5, wherein said first part has first and second sections interconnected by a shoulder and of smaller and larger cross-sectional areas respectively, said second section being slidably located in a chamber provided within said second part with said first section extending outwardly of said chamber towards said discharge passage, said second section defining said chamber on its opposite sides into first and second regions, said first region being located on the shoulder side of said second section and being in communication with said second fluid flow path, said second region forming part of said first fluid flow path, a second passage means being provided in said first part and extending axially therein from said second chamber region to said first mentioned passage means which extend generally radially in said first section and communicate said second passage means with said second fluid flow passage, whereby said effective cross-sectional area of said first part is said first section thereof.

7. A fluid injector according to claim 6, wherein said second part has a radially intumed end defining one end of said chamber and effective to co-act with said shoulder to withdraw said first part from its seated position when said injector changes from its non-discharge to its discharge condition.

8. A fluid injector according to claim 7, wherein said spring means is positioned in said chamber with one end abutting the end face of said second section of said first part and its other end abutting the opposite end of said chamber.

9. A fluid injector according to claim 4, including further passage means in said second fluid flow path and so dimensioned as to effect a pressure drop thereacross in fluid flowing through said second path.

10. A fluid injector according to claim 9, including juxtaposed orifice, swirl and distributor plates, said discharge passage being in said orifice plate, and said further passage means comprising swirl passages in said swirl plate and distributor apertures in said distributor plate.

11. A fluid injector according to claim 9, wherein said tip sealing valve is slidably mounted within an annular body defining therein, on one side of said valve, said first fluid flow path, and on the opposite side of said valve, a part of said second fluid flow path, said second path being otherwise defined externally of said body and being interconnected with said second part path by said further passage means.

12. A fluid injector according to claim 11, wherein said second part has first and second sections interconnected by a shoulder and of smaller and larger cross-sectional area respectively, a chamber being defined to one side of said shoulder, that chamber being interconnected with said second fluid flow path defined externally of said body to expose said shoulder to the pressure of fluid in said second flow path, and wherein, when fluid flow occurs from said first to said second fluid flow path, the fluid pressure acting on the larger, first section which is exposed to said first flow path produces a fluid force on said first part greater than that produced thereon by fluid pressure acting on said second part shoulder in conjunction with fluid pressure acting on the smaller, second section exposed to said part of said second flow path and vice versa when fluid flow occurs from said second to said first fluid flow path.

13. A fluid injector according to claim 12, wherein said larger, second section of said second part is axially movable within defined limits within said body and attains its forward position in the non-discharge condition of said injector prior to said spring means bottoming.

14. A fluid injector according to claim 10 wherein said swirl passages provide communication between the two parts of said second fluid flow path when said first part is seated to provide a fluid flow path through said injector at that time to enable fluid to circulate through said injector.

15. A fluid injector according to claim 1, including further spring means effective to urge said second part towards said

7

8

discharge passage to cause said first part to close said discharge passage when there is no fluid supply to said injector.

16. A fluid injector according to claim 1, including a change-over valve selectively movable into one position in 5

which to condition the injector for fluid discharge and into another position in which the injector is conditioned for non-discharge but conditioned to accept a continuous circulation of fluid through itself when in said non-discharge condition.

* * * * *

10

15

20

25

30

35

40

45

50

55

60

65

70

75