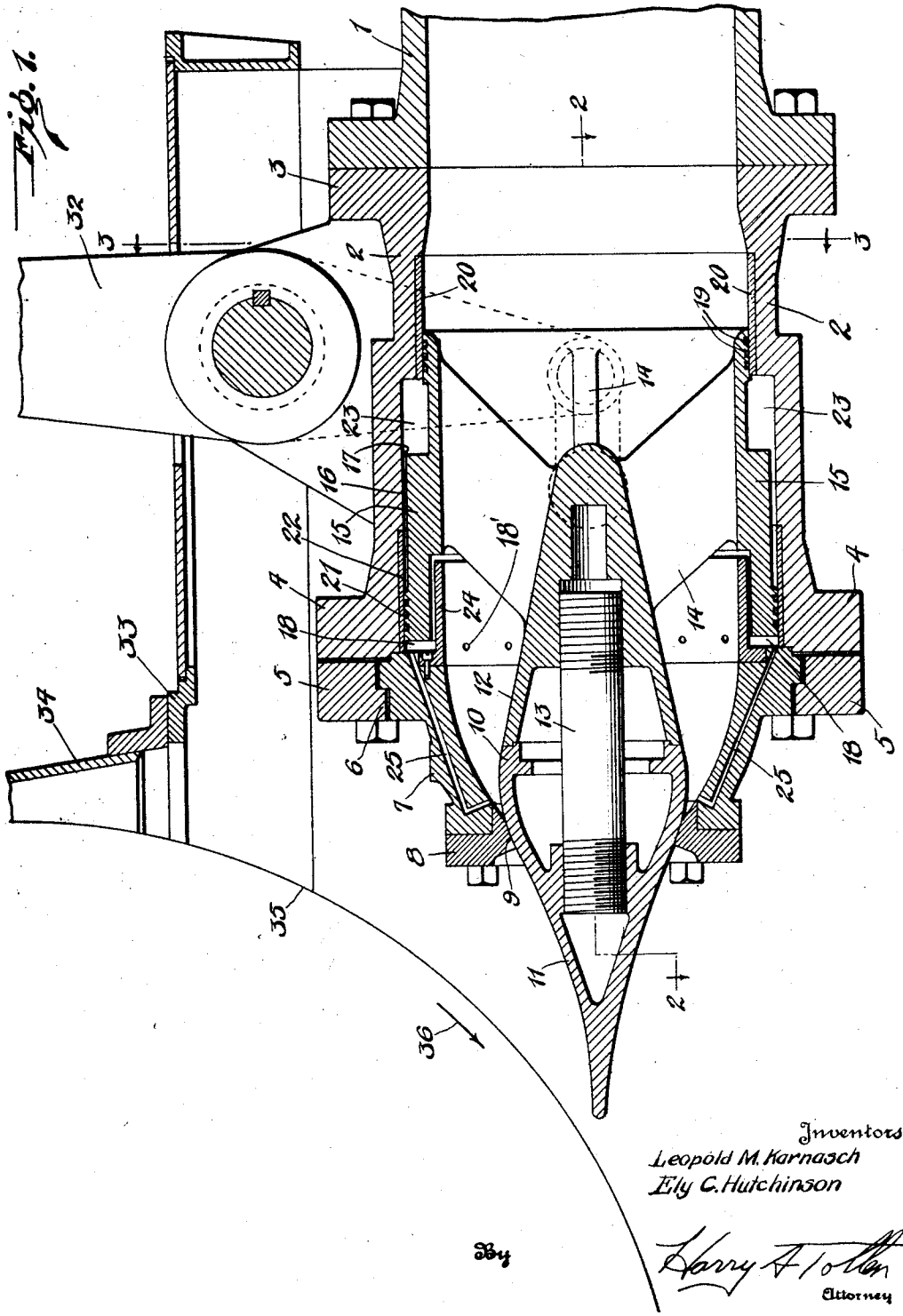
Nov. 6, 1928. 1,690,685

L. M. KARNASCH ET AL

NEEDLE NOZZLE CONSTRUCTION

Filed Aug. 16, 1926 6 Sheets-Sheet 1

Fig. 1.



Inventors
Leopold M. Karnasch
Ely C. Hutchinson

By

Attorney

Nov. 6, 1928. 1,690,685

L. M. KARNASCH ET AL

NEEDLE NOZZLE CONSTRUCTION

Filed Aug. 16, 1926 6 Sheets-Sheet 2

Fig. 2.

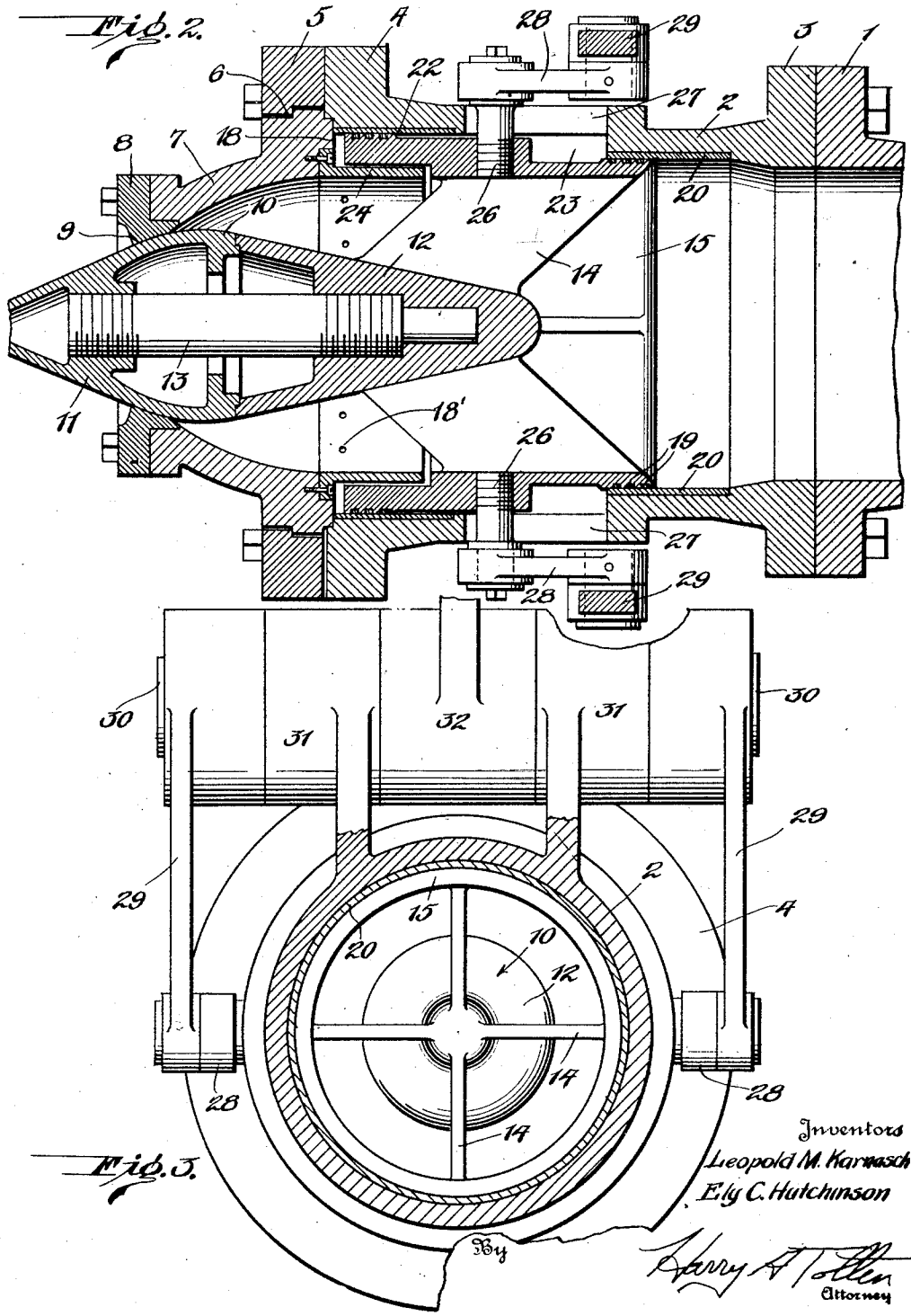


Fig. 3.

Inventors
Leopold M. Karnasch
Elg C. Hutchinson

By

Attorney

Nov. 6, 1928. 1,690,685

L. M. KARNASCH ET AL

NEEDLE NOZZLE CONSTRUCTION

Filed Aug. 16, 1926 6 Sheets-Sheet 3

Fig. 4.

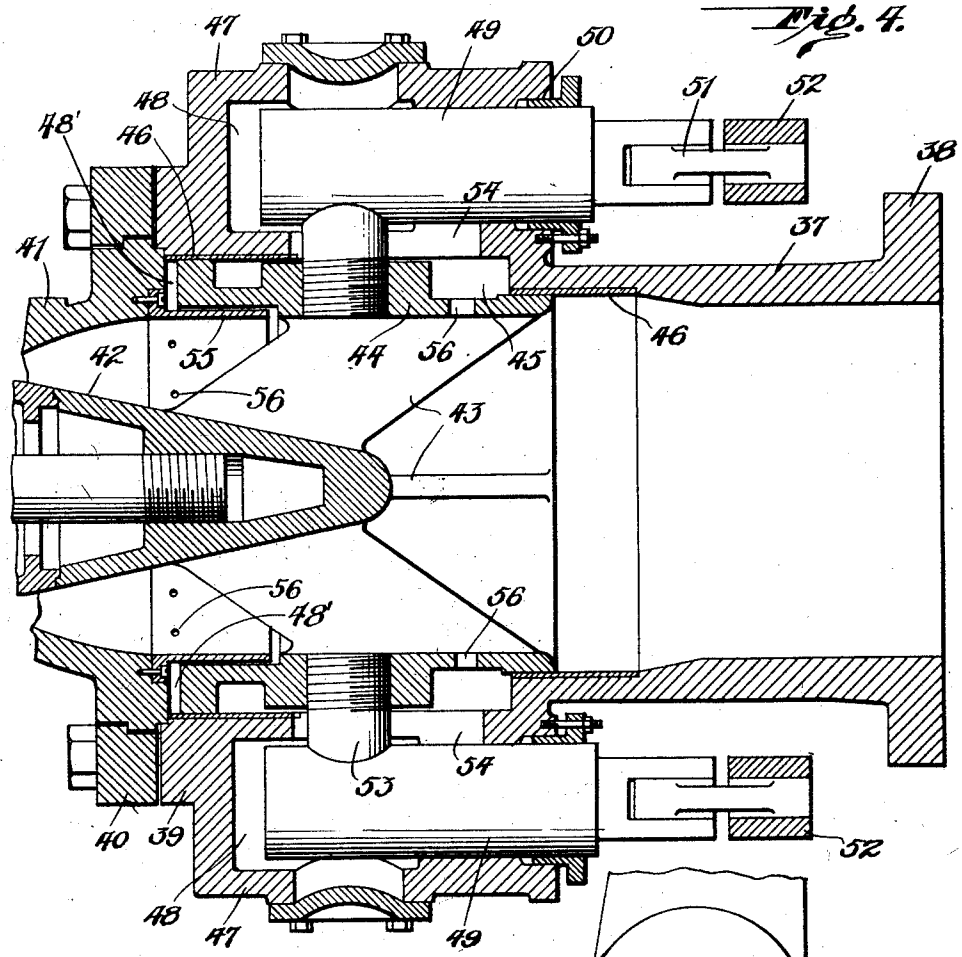
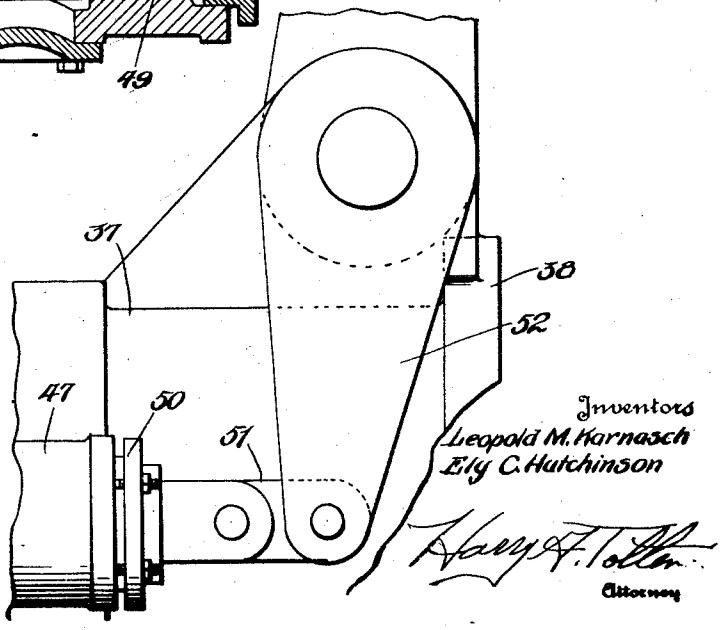


Fig. 5.



Inventors
Leopold M. Karnasch
Ely C. Hutchinson

Harry F. Tolles
Attorney

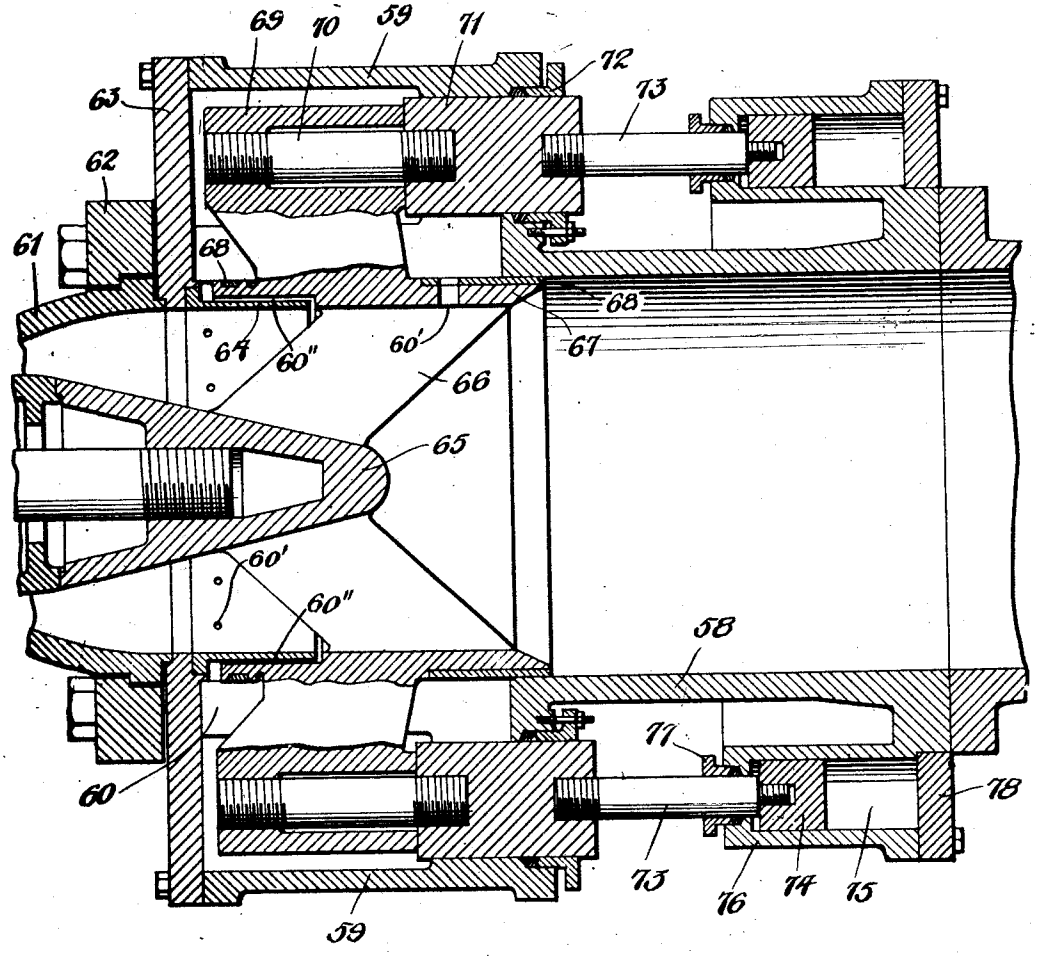
Nov. 6, 1928. 1,690,685

L. M. KARNASCH ET AL

NEEDLE NOZZLE CONSTRUCTION

Filed Aug. 16, 1926 6 Sheets-Sheet 4

Fig. 6.



Inventors
Leopold M. Karnasch
Ely C. Hutchinson

By Harry A. Toulmin
Attorney

Nov. 6, 1928. 1,690,685

L. M. KARNASCH ET AL

NEEDLE NOZZLE CONSTRUCTION

Filed Aug. 16, 1926 6 Sheets-Sheet 5

Fig. 7.

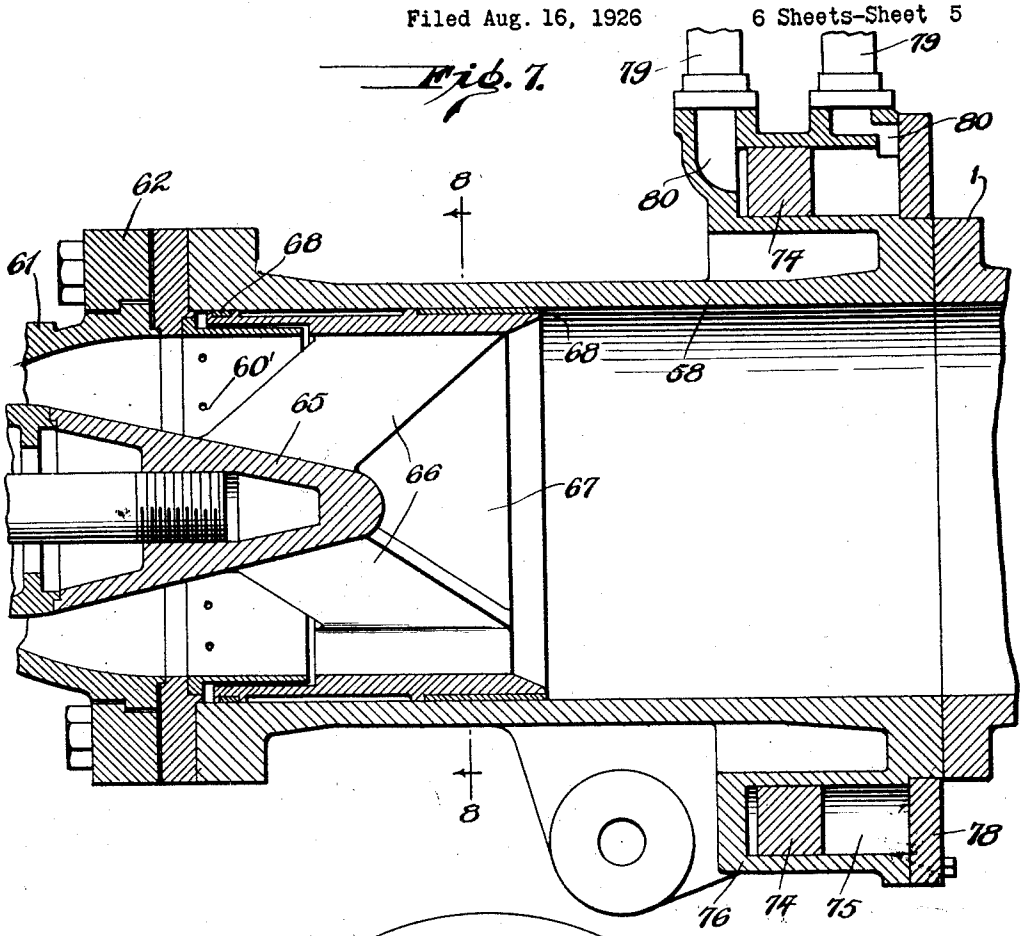
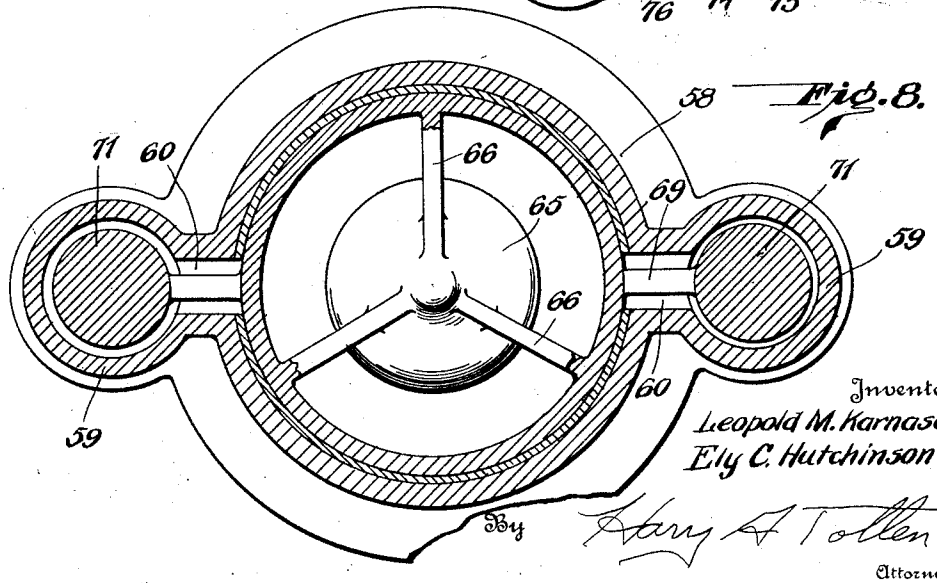


Fig. 8.



Inventors
Leopold M. Karnasch
Elly C. Hutchinson

By Harry A. Tollen

Attorney

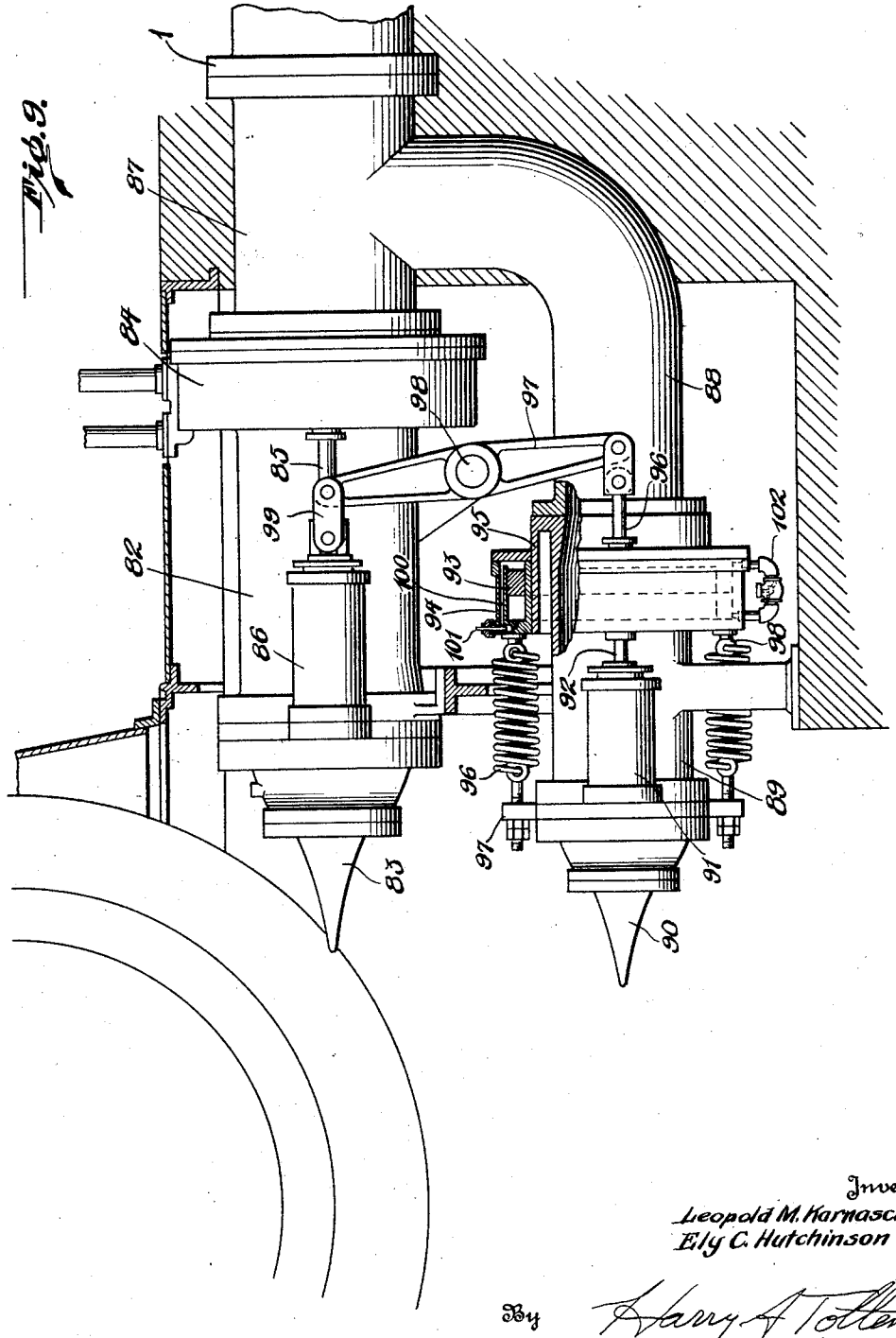
Nov. 6, 1928. 1,690,685

L. M. KARNASCH ET AL

NEEDLE NOZZLE CONSTRUCTION

Filed Aug. 16, 1926 6 Sheets-Sheet 6

Fig. 9.



Inventors
Leopold M. Karnasch
Ely C. Hutchinson

By Harry A. Toulmin

Attorney

Patented Nov. 6, 1928. 1,690,685

UNITED STATES PATENT OFFICE.

LEOPOLD M. KARNASCH, OF SAN FRANCISCO, AND ELY C. HUTCHINSON, OF OAKLAND, CALIFORNIA, ASSIGNORS TO THE PELTON WATER WHEEL CO., OF SAN FRANCISCO, CALIFORNIA, A CORPORATION OF CALIFORNIA.

NEEDLE-NOZZLE CONSTRUCTION.

Application filed August 16, 1926. Serial No. 129,638.

This invention relates to improvements in hydraulic control apparatus and particularly to the construction of the needle nozzle and the needle and associated elements.

In the prior art it has been customary to construct the needle nozzle of sinuous form, with reverse curves, or of T-shaped construction in order to accommodate the structure for supporting and operating the needle so that the supporting and operating elements could be suitably extended through the nozzle body to the exterior thereof for connection with suitable control apparatus. It has been found that a considerable number of disadvantages occur in a construction of this character which for the most part reside in the result which the construction produces on the water pouring through the nozzle body and discharged onto the water wheel. These constructions do not permit of an even uniform flow of water from the point of inlet to the point of discharge, on the contrary they require that the water which frequently passes through at extremely high velocity must bend to conform with the nozzle form in addition to passing the obstruction offered by the needle supporting stem. The water is then required to change its direction and send it in a direction parallel with the needle before discharging through the annular form between the nozzle body and the needle in the open position of the needle, and it has been found that the discharge plainly showed the results of the discrepancies created inside the nozzle body of the types above mentioned by the lack of symmetry, the unbalanced flow conditions, the variations in direction of flow of the water, the variation of velocity, resulting in creating turbulences in the water. The sinuous and elbow forms of nozzles may also aid in the generation of a spirally wearing movement in the water as it advances to the point of the nozzle and discharge which frequently causes the discharging stream to break badly after leaving the nozzle and resulting in a decrease in efficiency of operation of the unit with which it forms a part. There are numerous other objections to which these forms of nozzle bodies are subject, from a consideration of the principles governing hydraulics.

It is the object of the present invention to produce a new type of nozzle body and needle construction together with the construction of the operating means therefor, in which the nozzle body is built on a straight-line principle for the purpose of eliminating the disadvantages of the types of construction above set forth.

In providing the improved form of construction of this invention numerous additional features have been added including a special method of supporting and guiding the needle in its operation in the nozzle body, together with the provision of means for balancing the operation of the needle in accordance with the variation of flow or the velocity of the discharge in the nozzle in order to permit of the operation of the needle in any desired manner by suitable operating means requiring a minimum amount of power for operating purposes.

The invention comprehends numerous objects and advantages in the construction of a straight line needle nozzle with a special needle construction and method of mounting and guiding the same in the body, with the provision of suitable guide means and operating means in conjunction therewith, which are all more particularly pointed out in the following detailed description and in the claims directed to the preferred construction of the apparatus, it being understood, however, that various other forms of the nozzle construction defining straight line principles are readily conceivable which are considered to form a part of the present invention within the scope of the same as herein set forth.

In the drawings forming part of this application:

Figure 1 is a vertical longitudinal section through a needle nozzle construction made in accordance with this invention in which the needle is provided with a suitable link construction operated from a rocker shaft from suitable control apparatus.

Figure 2 is a horizontal sectional view through the nozzle body construction taken substantially on the line 2—2 of Fig. 1.

Figure 3 is a vertical transverse sectional view taken substantially on line 3—3 of Fig. 1, through the nozzle body and showing the construction of the rocker arm assembly and mounting therefor.

Figure 4 is a horizontal sectional view through a nozzle body construction similar

to that shown in Fig. 1, but having a slightly different form of counter balance structure and motion transmitting mechanism operated by the control apparatus.

Figure 5 is a detailed side elevation of the link and rocker arm structure for the nozzle body construction shown in Fig. 4.

Figure 6 is a horizontal sectional view similar to Fig. 2 and in which the operating mechanism for the needle is adapted for direct servomotor control.

Figure 7 is a vertical longitudinal section through a construction as shown in Fig. 6 illustrating particularly a servomotor construction for controlling and operating the needle.

Figure 8 is a vertical transverse sectional view taken on line 8—8 of Fig. 7.

Figure 9 is a side elevation of a straight line nozzle construction in accordance with this invention provided with a servomotor control and showing connections with an auxiliary relief nozzle of new design embodying straight line features.

Referring to the drawings, particularly Figs. 1, 2 and 3, 1 indicates the discharge or down stream end of a penstock or water supply pipe to which is fitted the nozzle body 2 through a suitable bolted flange connection as indicated at 3. The down stream end of the nozzle body 2 is formed with an annular flange 4 to which is secured the ring member 5 having an inwardly extending annular shoulder 6 engaging with the flange on the nozzle tip 7 for securing the nozzle tip in assembled relation on the nozzle body 2. This nozzle tip is provided with a removable seat member 8 formed with the needle seat at 9.

The needle is indicated generally at 10 and is formed of a pair of sections 11 and 12 respectively secured in assembled relation by a suitable pin 13. The section 11 forms the needle point and is of suitable curved form and provided with a portion adjacent the central part of the needle adapted for seating cooperation with the seat 9 in the seating member 8 in order to close the discharge end of the needle body and prevent a flow of fluid therethrough. The section 12 of the needle is of a substantially cone shape having the pointed end directed toward the upstream end of the nozzle body with which is formed a plurality of webs 14 having a substantial dimension in the axial plane of the nozzle body and of a relatively thin cross section. These webs 14 are suitably formed with the needle-supporting guide sleeve 15, which in turn is formed at the down stream end with a large diameter at 16 operating within the enlarged bore 17 of the nozzle body 2. The down stream end of this bore as indicated at 18 forms one part of the hereafter termed counter balance chamber. The upstream end of the guide sleeve 15 is of reduced diameter with respect to the size of the portion 16 and is provided with a plurality of packing rings 19 of annular form seating in suitable grooves in the periphery of the upstream end of said guide and supporting sleeve 15 and having bearing contacts with the renewable bearing sleeve 20 suitably mounted on the interior of the bore of the nozzle body. The downstream end of the supporting and guide sleeve 15 is also provided with a plurality of packing rings 21 of annular form seating in annular grooves formed in the guide sleeve 15 which have bearing engagement with the renewable bearing sleeve 22 inserted in the downstream end of the enlarged portion 17 of the nozzle body.

These packing rings 19 and 21 operate to prevent substantial leakage past the end of the supporting and guide sleeve 15 into the chamber surrounding said supporting and guide sleeve indicated by the numeral 23 and also prevents leakage of the pressure from the counter balance chamber past the guide sleeve which would impair the efficiency of operation and counter-balancing of the needle structure. A renewable liner 24 of annular form having a diameter matching that of the upstream end of the discharge passage in the nozzle tip 7 at the point where it is suitably secured in a recess portion of the upstream end of said nozzle tip and serves to form the inner annular wall of the counter balance chamber 18 and extends within an annular recess in the down stream end of the supporting guide sleeve 15 for the needle. This nozzle tip 7 is formed with bores as indicated at 25 which communicate at the downstream end of said nozzle tip with the discharge passage therethrough adjacent to the valve seat member, while the opposite ends of the bores 25 communicate with the counter balance chamber 18 in order to permit the fluid pressure within the nozzle tip to communicate with the counter balance chamber and provide the counter balancing operation in a manner which will be presently set forth.

Communicating also with the counter balance chamber 18 is a series of holes 18′ which pass through the sleeve 24 to permit the rapid displacement of the fluid in chamber 18 when the needle 10 is moved by the governor at such a rate that the holes 25 and annular clearance surrounding the ring 24 would be inadequate to handle the volumetric changes in chamber 18 without creating undesirable resistance.

The structure shown in Figs. 1 to 3 is provided with suitable operating means which includes the pins 26 as clearly shown in Figure 2 of the drawings extending laterally through the slots 27 formed in the side walls of the nozzle body 2 and with which are suitably connected the links 28 pivotally connected to the operating levers 29 mounted on the ends of the rock shafts 30 which in turn are rotatable in the bearings 31 on the nozzle

body 2 as clearly illustrated in Figure 3, while the main operating lever 32 connected with suitable control apparatus well known in the art, serves to transmit the motion from this control apparatus (not shown) to the rocker shaft 30, to the operating lever 29, and thereby produce the desired operation of the needle 10.

The bed of the water wheel housing is indicated at 33, the water wheel housing proper is indicated at 34. The water wheel runner is adapted to operate within a circumference indicated by the circle 35 and normally operatable in the direction of the arrow 36 as shown in Figure 1. The relation of the needle and nozzle structure with the water wheel is best illustrated in Figure 1.

The operation of the needle from this construction it will be seen is axially through the nozzle body 2 which is provided with an axial discharge passage in order that the line of discharge of fluid under pressure from the downstream end of the pen stock 1 will be in a stream line and therefore the turbulences created in the water under high pressure and at substantially high velocity being discharged through this construction will not be found as in the construction of the types above mentioned so that the stream of water discharged through this straight line nozzle structure will produce the most efficient results for the amount of pressure used. It should be readily apparent that the velocity of the fluid flowing through this body will substantially affect the operation of the needle 12 and that the conditions will vary with the position of the needle with respect to its seat. In the position as shown in Figure 1 in which the nozzle is closed against the discharge of the fluid, the needle will be held firmly against the seat by the pressure in the nozzle body and this operation will be counter balanced through the pressure entering the counter balance chamber 18 through the bore 25 and the annular clearance space surrounding the renewable liner 24, also the holes 18', so that should it be desired to move the needle to an open position substantially little force will be required in view of the balance of pressure on the point of the needle. Any leakage past the packing rings 19 and 21 into the chamber 23 is immediately drawn off in any suitable manner in order that this leakage will in no way interfere with the operation of the counter balance chamber 18. If the needle moves toward the open position the condition of balancing will change due to the velocity of the water flowing outwardly past the needle and through the nozzle tip 7 and impinging on the curved point of the section 11 of the needle assembly. The velocity of the water discharging through the nozzle tip will also change the conditions of pressure in the counter balance chamber in view of the position of the outlet bore 25 communicating with said chamber so that instead of the pressure entering the chamber 18 the flow of fluid being discharged through the nozzle tip will have a tendency to create a suction or ejector effect, and also to lower the pressure by virtue of the increased velocity as the water approaches the point of final discharge according to the well known law $H=\frac{V_2}{2_g}$ in accordance with the position of the needle after it leaves the seat 9. The construction of the parts are so designed that the variation in the hydraulic pressure of various parts of the nozzle body and the nozzle tip together with that acting on the needle and the changes in the velocity of the fluid passing through the nozzle body will always affect between the needle body and the counter balance chamber 18 substantially a balance of the forces through distribution thereof in opposite direction for equalizing purposes, as a result of which the main operating lever requires a lesser force for the purpose of operation to move the needle into closed or open position or any intermediate position therebetween. Should the needle be in any position permitting discharge of the fluid it is to be understood that the same counter balancing effect is maintained and that the operation of the main operating lever 32 may be obtained with minimum resistance for the purpose of moving the needle 10 into closed position as shown in Figure 1.

For some purposes the construction shown in Figures 1 to 3 is not desirable in view of the fact that where the water contains considerable grit and other foreign matter, it will have a tendency to lodge in the packings 19 and 21 and quickly cut these packings and the wearing sleeves 20 and 22 away that this particular type of structure is not practical for such application.

The construction shown in Figures 4 and 5 has therefore been provided which is designed for use in such cases in order to provide a construction having the same practical advantages as that shown in Figure 1 but having additional wearing qualities to offset the destructive action of grit and other foreign matter in the water.

The nozzle body as indicated at 37 has the annular flange 38 on the upstream end adapted for attachment to the pen stock and is formed with the annular flange 39 on the downstream end for receiving the ring 40 adapted to suitably secure the nozzle tip 41 thereto as heretofore described in connection with the structure shown in Figure 1. The needle structure indicated at 42 is the same as that shown in Figures 1 to 3 including the web structure 43 connecting the needle body proper with the annular guide and supporting sleeve 44. This supporting and guide sleeve 44 for the needle is operatable within the enlarged chamber 45 of the

nozzle body and has the opposite ends thereof provided with bearing contacts on annular wear receiving liners 46 of annular form as clearly illustrated in Figure 4. In this construction the nozzle body 37 is formed at opposite sides with the housing extensions 47 formed to provide counter balance chambers 48 which receive the plungers 49 extending rearwardly through stuffing boxes 50 of suitable form as used in the art, with the rear ends projecting into the atmosphere and receiving the link connections 51 carried by the operating levers 52. These plungers 49 have suitable pin connections 53 with the supporting and guide sleeve 44 and needle 42 which extend through the slotted opening 54 providing communication between the chamber 45 and the counter balance chamber 48. A renewable liner 55 is secured to the upstream end of the nozzle 41 and provides a chamber in which the lower end or downstream end of the guide sleeve 44 operates. This guide sleeve 44 is formed with a plurality of openings 56 to provide communication between the fluid discharge passage through the nozzle body 37 and the counter balance chamber 48, and also into the annular chamber 48′, a portion of the fluid also entering past the wear liners 46 and the fluid finally passing into the counter balance chamber through the passages 54.

With this construction as shown in Figures 4 and 5 it will be apparent that the pressure is adapted to enter the counter balance chambers 48 and provide the counter balancing operation in a manner similar to that shown and described in connection with Figure 1, and in which the balancing operation is secured between the needle 42 and the nozzle 41 so that the proper balancing operation is obtained in all positions of the needle by a construction which may be readily operated with little power applied to the operating lever 52. In addition, it will be seen that the construction of the parts reduces the disadvantages which would be inherent in the construction shown in Figs. 1 to 3 resulting from the wearing of the parts and the packings 19 and 21 so that considerable wearing can be experienced in the construction without affecting the balancing operation or the efficient guiding operation of the needle.

In Figures 6, 7 and 8, a construction substantially similar to that shown in Figures 1 to 4 is illustrated and which instead of providing a link and rocker shaft, operating structure utilizes a servomoter operated by fluid pressure, which may be mounted in any convenient position and controlled in any manner well known in the art for the purpose.

In the construction shown in these last mentioned figures, the straight line nozzle body is indicated as 58 having the downstream end thereof provided at opposite sides with housings 59 as shown in Figure 6 provided with communications through passages 60, 60′ and 60″ into the body. The nozzle tip 61 is mounted on the downstream end of the nozzle body by the ring 62 in the manner described in connection with Figure 1, which secures the end plate members 63 disposed between the nozzle body and the ring 62 in position as shown in Figures 6 and 7 and which is adapted to form a closure for the downstream end of the chambers formed within the housing 59. The renewable liner 64 in this construction is attached to the plate member 63 instead of to the nozzle tip as in the constructions heretofore described. The needle is indicated at 65 which is connected through the web 66 to the supporting and guide sleeve 67 of the spider type construction above described having renewable wear receiving collars 68 removably replaced on the opposite ends thereof and provided with suitable bearings cooperating with the inside of the bore of the nozzle body 58.

At diametrically opposite points as shown in Figure 6 the guide sleeve 67 for the needle is formed with projecting head 69 provided with threaded bores to receive the pins 70 which attach the head 69 to the plungers 71 slidably mounted in the housing 59 and having suitable packed joints by the packing 72 to prevent leakage. These plungers 71 are suitably connected by the rods 73 with the servomotor piston 74 which is of annular form as illustrated in Figures 6 and 7 and mounted for sliding movement within the annular servomotor cylinder 75 formed within the annular projecting body 76 which may be cast integral with the flange on the upstream end of the nozzle body 58. Suitable stuffing boxes 77 serve to pack the rods 73 to prevent leakage of oil from the servomotor which receives the covered plate 78 at the opposite end and suitably removably secured thereto for the purpose of permitting the assembly of the parts. With particular reference to Figure 7, two oil conveying pipes 79 are connected with the servomotor cylinder 75 and have the passages 80 communicating with the ends thereof at opposite sides of the piston 74 so that through the provision of suitable fluid actuating control means the servomotor piston 74 may be reciprocated within the cylinder 75 in order to move the needle valve 65 into closed or open position or any intermediate position.

This provides a direct governor or actuator method of moving the needle through the direct motion of the annular piston 74 instead of through the use of a series of links and levers as indicated in the structure shown in Figures 1 and 4.

It will be seen that all of the constructions thus far described embody a nozzle construction in which the flow of fluid through the

nozzle body is in a straight line from the pen stock to the downstream end at which point the fluid is discharged through the nozzle tip secured to the body. With this straight line body construction which permits of the direct discharge of the fluid under pressure without distortion thereof in any manner, it has been found that the efficiency of operation of a device of this character is materially increased and that the resistance offered to the flow of fluid by the web connections between the needle body proper and the supporting and guide sleeve therefor, does not detrimentally affect the flow of the fluid or the character of the discharge from the nozzle. These constructions, therefore, have been found to eliminate substantially all of the disadvantageous features of the old types of nozzle body structures as heretofore set forth and to provide a balanced needle supporting structure through the use of hydraulic pressure in the nozzle body itself to produce the balancing operation in order that the power of the operating means for the needle is not required to offset the pressure of the discharging fluid through the body.

The features of straight line needle nozzle construction as above described are applicable to water wheel installations where auxiliary relief valves or means are used for protecting the pen stocks against excessive water hammer during periods of speed regulation on the governor by direct motion or through a link and countershaft mechanism to operate the power needle and vary the supply of the power water to the wheel. For the purpose of illustrating the application of this principle to such constructions reference is particularly made to Figure 9 in which the power nozzle is illustrated at 82 having the controlling needle 83 constructed in any one of the manners heretofore described in connection with Figures 1 to 8 inclusive. In the structure illustrated a servomotor control is provided at 84 of the type illustrated in Figures 6, 7 and 8 having a rod connection 85 with suitable mechanism in the housing 86 for transmitting motion to the needle 83 in order that upon the operation of the servomotor piston the needle 83 may be controlled for regulating fluid discharge through the nozzle in a desired manner. The pen stock 87 is formed with a branch 88 on which is mounted the auxiliary nozzle 89 in which the nozzle body is constructed on the straight line principle in accordance with any of the types of construction heretofore described and shown in Figures 1 to 8 inclusive. The auxiliary needle is indicated as 90 which is controlled by suitable mechanism connected therewith and operatable in the housing 91 with which the rod 92 is associated and forms a part and which is connected to the annular piston 93 in the oil cylinder 94 which is slidably mounted on the nozzle body by means of the annular flange 95 formed thereon as illustrated in Figure 9.

Suitable coil springs 96 are anchored at the forward end of the nozzle construction as indicated at 97 and at the opposite ends are connected to the cylinder 94 as illustrated at 98 and normally operate to retain the cylinder 94 at the down stream end of its stroke of movement on the flange 95.

A rod connection 96 from the piston 93 has a link connection with the lever 97 pivoted at 98 on an extension formed on the power nozzle body 82, the said pivot being provided in the lever 97. The other end of the lever is provided with a link connection 99 with the rod assembly 85 in order that the lever 97 is directly operatable by the operation of the needle 83 and associated connected mechanism which provides a control for the auxiliary needle 90. A by-pass conduit 100 is formed in the cylinder structure 94 to permit oil therein to flow from the upstream side of the piston to the down stream side thereof under the control of a suitable form of needle valve 101 which may be adjusted to control the flow in a desired manner. In order to permit the quick closing of the needle valve 90 upon a quick opening of the main power needle 83 the cylinder 94 is provided with a check control by-pass 102 to permit the ready flow of fluid from the downstream side of the piston 93 to the upstream side thereof.

During the regulation of the main power nozzle and needle 83 through the operation of the servomotor 84 it will be understood that should the needle 83 be suddenly moved from the full open to the full closed position that the auxiliary relief nozzle will immediately open to its full extent through the operation of the lever 97 to prevent water hammer or other difficulties arising from the sudden checking of the flow of fluid under pressure. After opening to the full position the release of nozzle 89 would have the needle 90 thereof moved gradually to the closed position by the operation of the springs 96 controlled by the flow of fluid through the by-pass 100. Should this main power needle 83 after a sudden closing movement be then again suddenly opened to the full position, the by-pass 102 will permit the fluid on the downstream side of the piston 93 to return quickly to the upstream side thereof in order that the needle 90 may move to the closed position in the auxiliary nozzle and the position of the piston 93 in the cylinder 94 will not interfere with the full opening movement of the needle 83. In this way the proper co-operation between the operation of the needle 83 and the needle 90 of the auxiliary relief nozzle are obtained through this construction of the cylinder 94 having the fluid actuating piston 93 therein all operating as a dash-pot on the flange 95 of the nozzle body.

What is claimed is:

1. Hydraulic control apparatus, comprising a nozzle body, a needle operatable in said body for controlling discharge therefrom, operating means connected with said needle extending laterally through said body operatable from the side thereof, and means co-operating with said needle and said body for distributing the pressure therein for balancing said needle in whole or in part at all positions of operation.

2. Hydraulic control apparatus, comprising a nozzle body, a needle operatable axially in said body, to control discharge of fluid therethrough, balancing means for said needle to balance the pressure created by the fluid flowing past the needle in the operation of the nozzle, and operating means at the side of the body in the lateral plane of said needle connected thereto and adapted to move said needle axially in the body in controlling discharge through said body.

3. Hydraulic control apparatus, comprising a straight line discharge nozzle body, a needle axially movable in said body for controlling fluid flow therethrough, an annular guide sleeve attached to said needle and slidable in said body, said guide sleeve having means co-operating with said body adapted to equalize fluid pressure for balancing the operation of said needle, and operating means attached to said guide sleeve and operatable at the side of said nozzle body for controlling and operating said needle.

4. Hydraulic control apparatus, comprising a nozzle body, a needle axially movable in said body to control discharge therethrough, an annular sleeve member attached to said needle and slidable in a chamber formed in said body for guiding said needle in the operation thereof, pressure chambers at the opposite ends of said sleeve, means for admitting and controlling pressure in said chambers, operatable to balance the operation of said sleeve in said body, and operating means attached to said sleeve adapted for operating said valve to control flow and discharge from said body.

5. Hydraulic control apparatus, comprising a straight line discharge nozzle body, a nozzle tip secured on said body, a needle axially movable in said body for controlling discharge therethrough in co-operation with said tip, annular supporting means slidable in said body for said needle operatable to support and guide said needle in operation, means formed between the body and the supporting means for the needle operatable to provide a counter balance for said needle, and operating means at the side of said body connected to the needle supporting means and manually controllable for governing the flow of fluid through said body.

6. Hydraulic control apparatus, comprising a straight line discharge nozzle body, a nozzle tip secured on said nozzle body, a needle axially movable in said body for controlling discharge therethrough in cooperation with said tip, annular supporting means slidable in said body for said needle, webs extending inwardly from said supporting means and connecting with the needle for concentrically supporting the same therein, a fluid actuated piston associated with the needle, a cylinder carried by the nozzle body and within which the piston operates, and means for admitting fluid to either side of the piston to operate the same.

In testimony whereof we have signed our names to this specification.

LEOPOLD M. KARNASCH.
ELY C. HUTCHINSON.