Dec. 3, 1940. C. R. ALDEN 2,223,590

FLUID DISTRIBUTOR

Original Filed May 11, 1932 4 Sheets-Sheet 1

Fig. 1

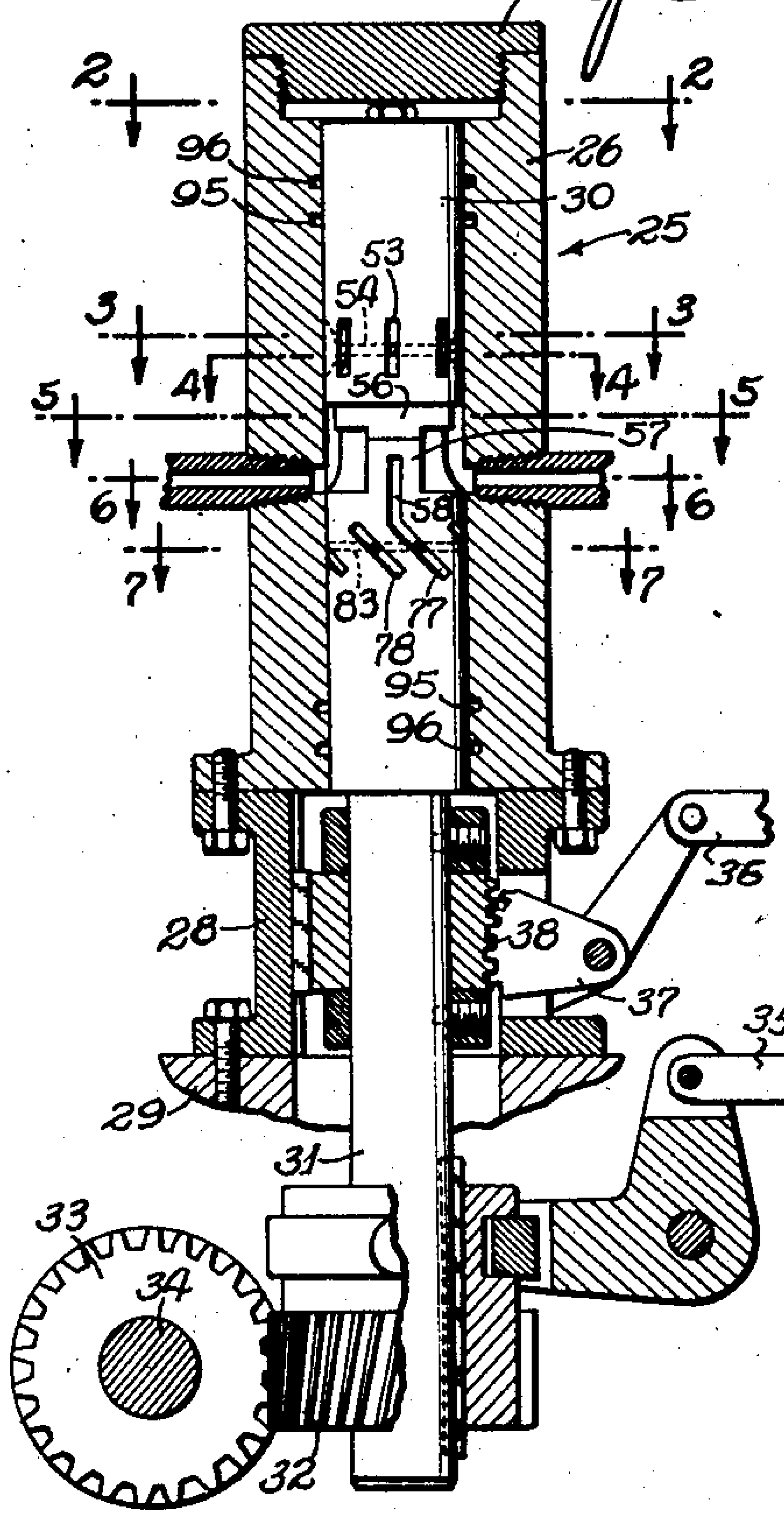


Fig. 2

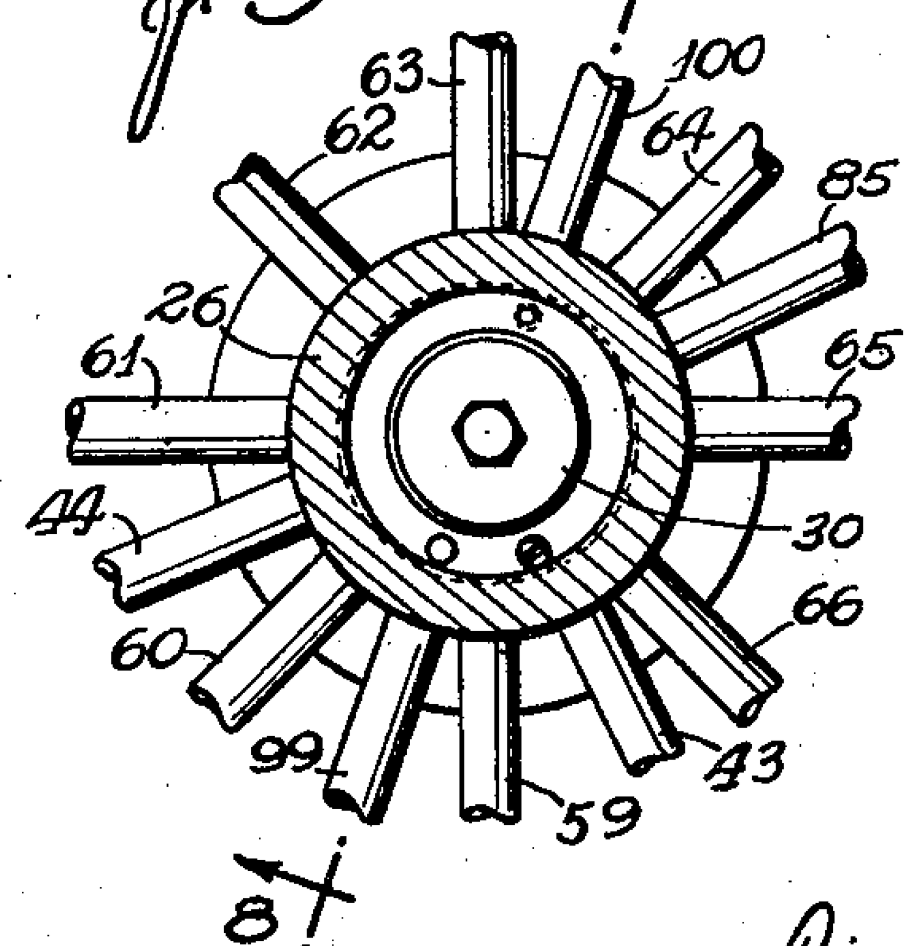


Fig. 3

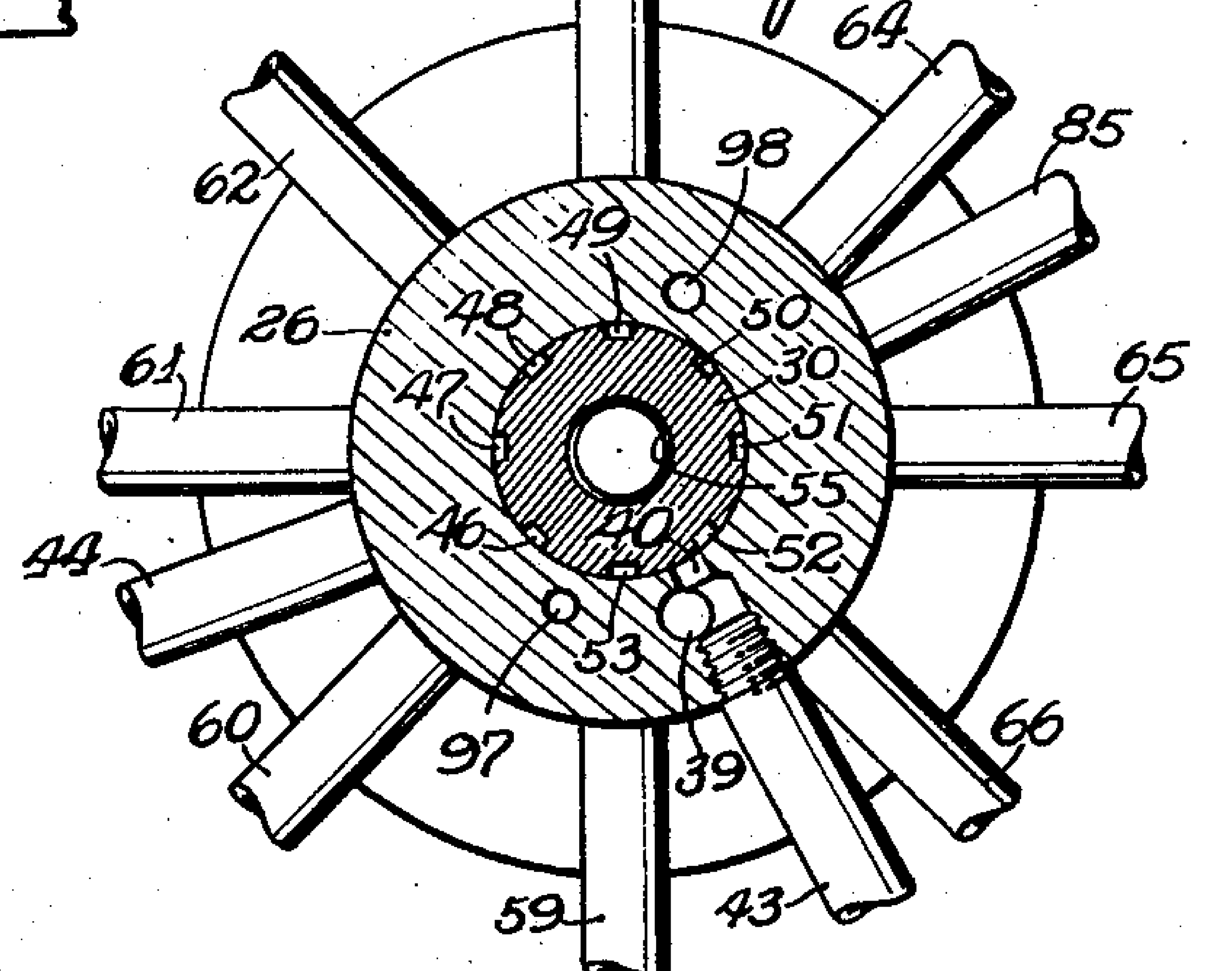
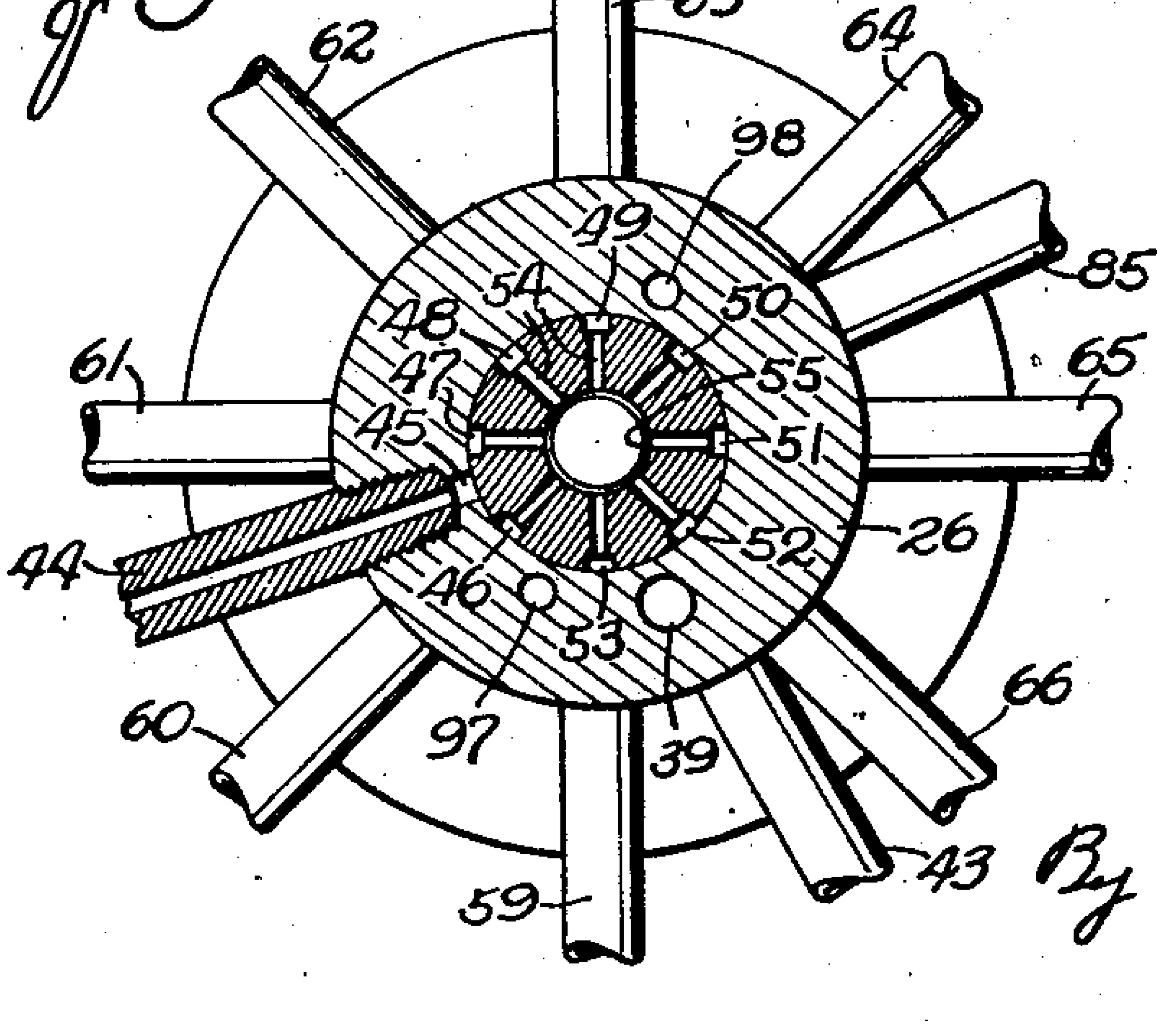


Fig. 4



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FLUID DISTRIBUTOR

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Fig. 5

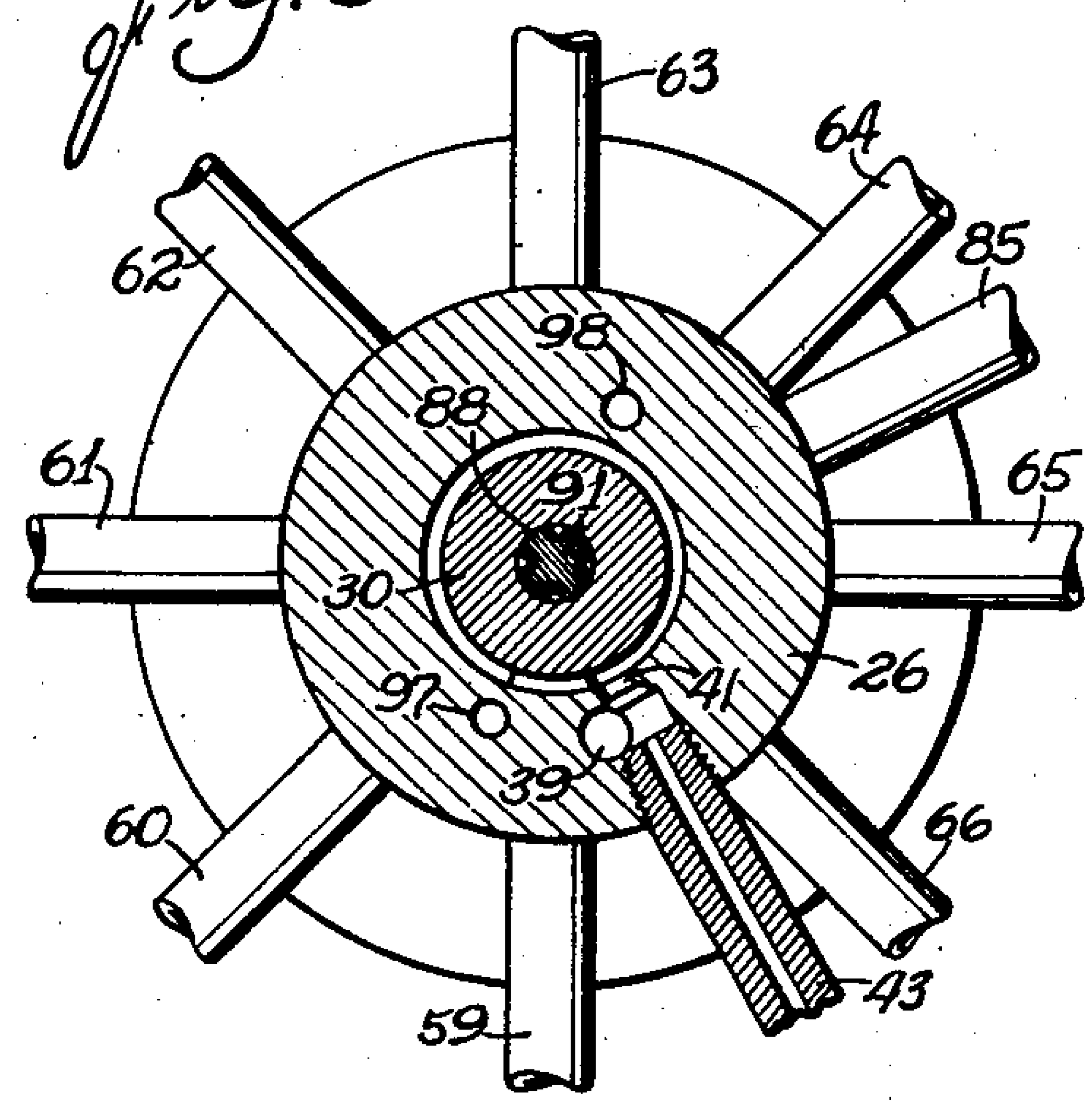


Fig. 6

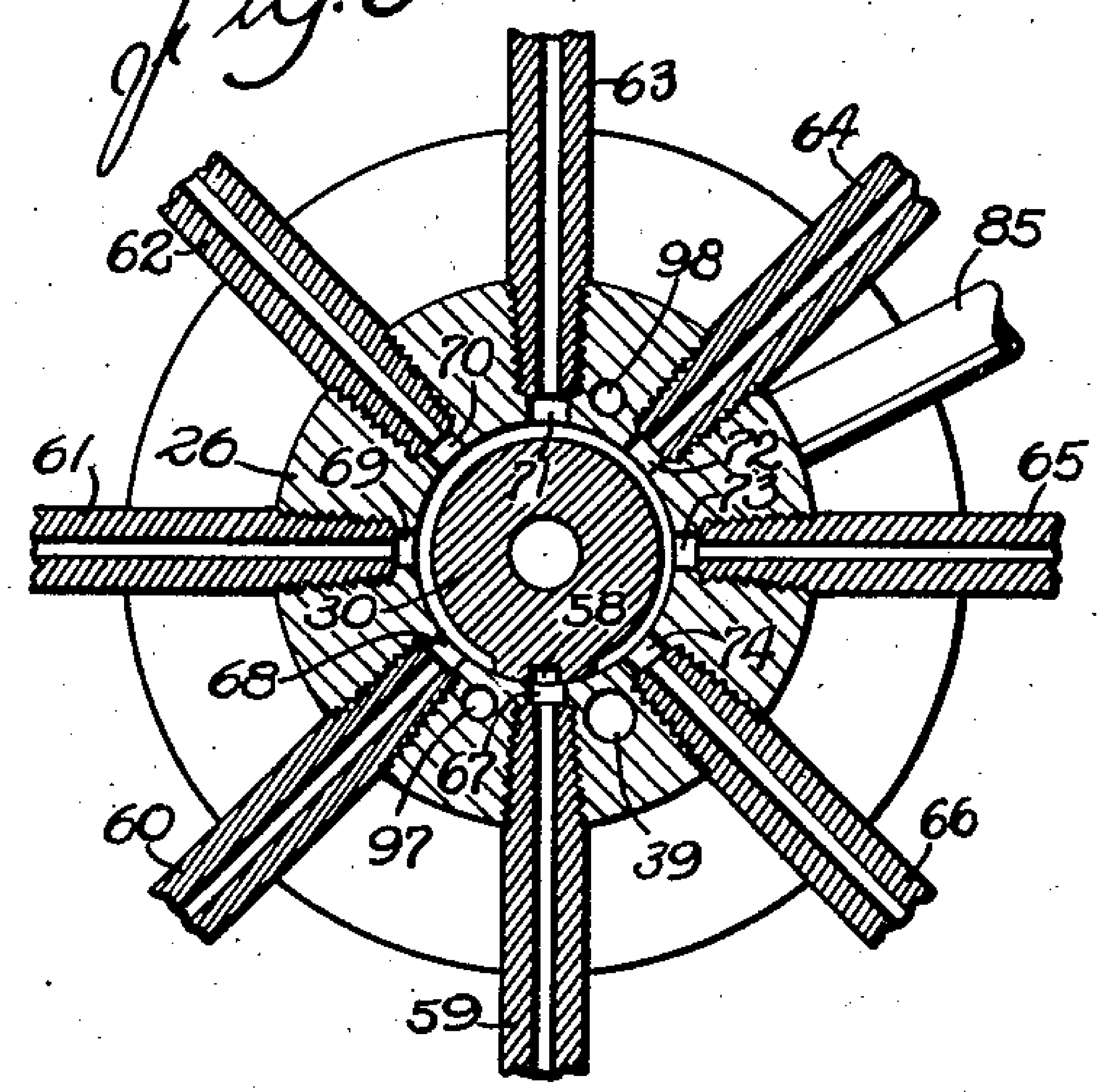


Fig. 8

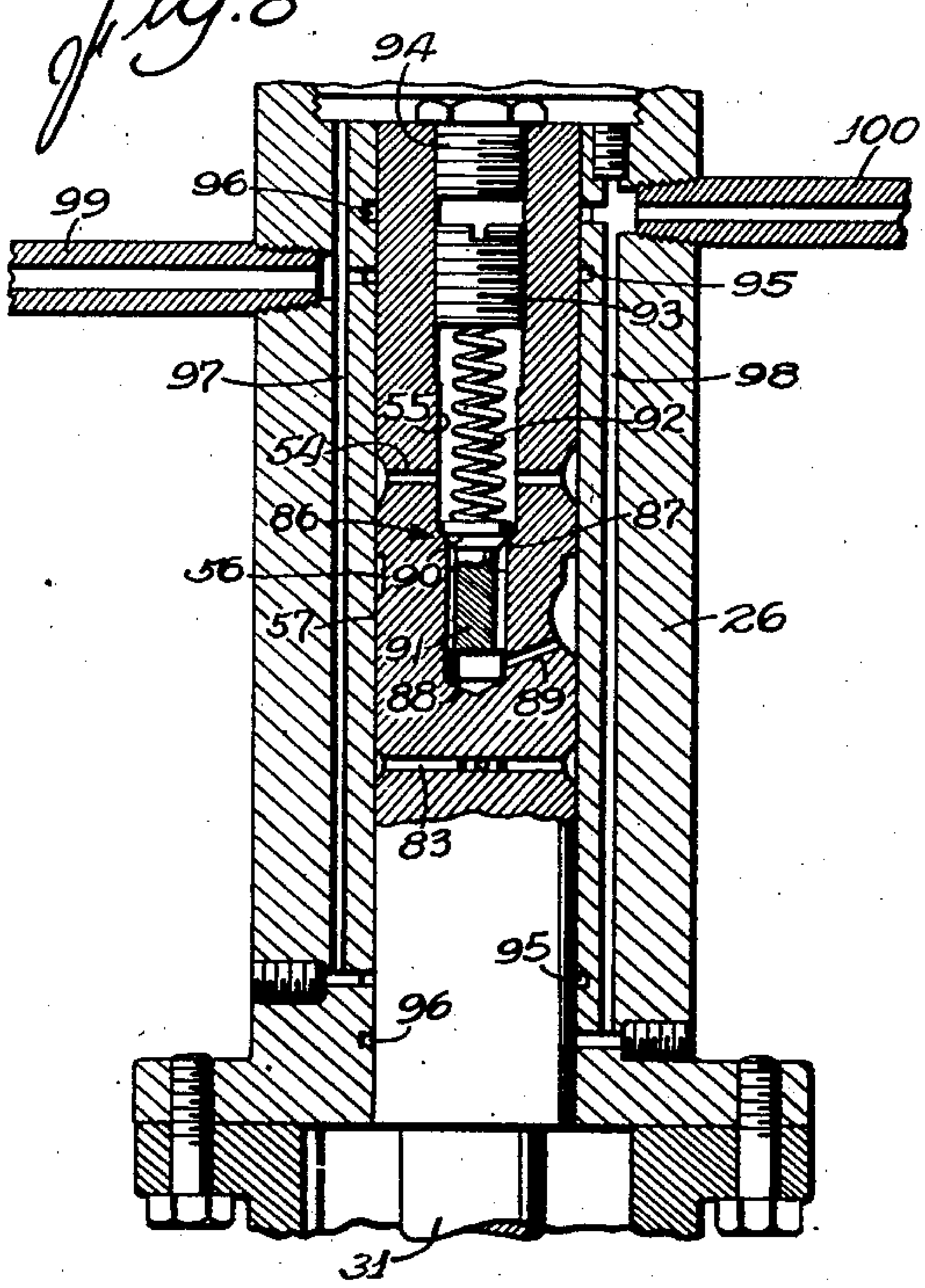
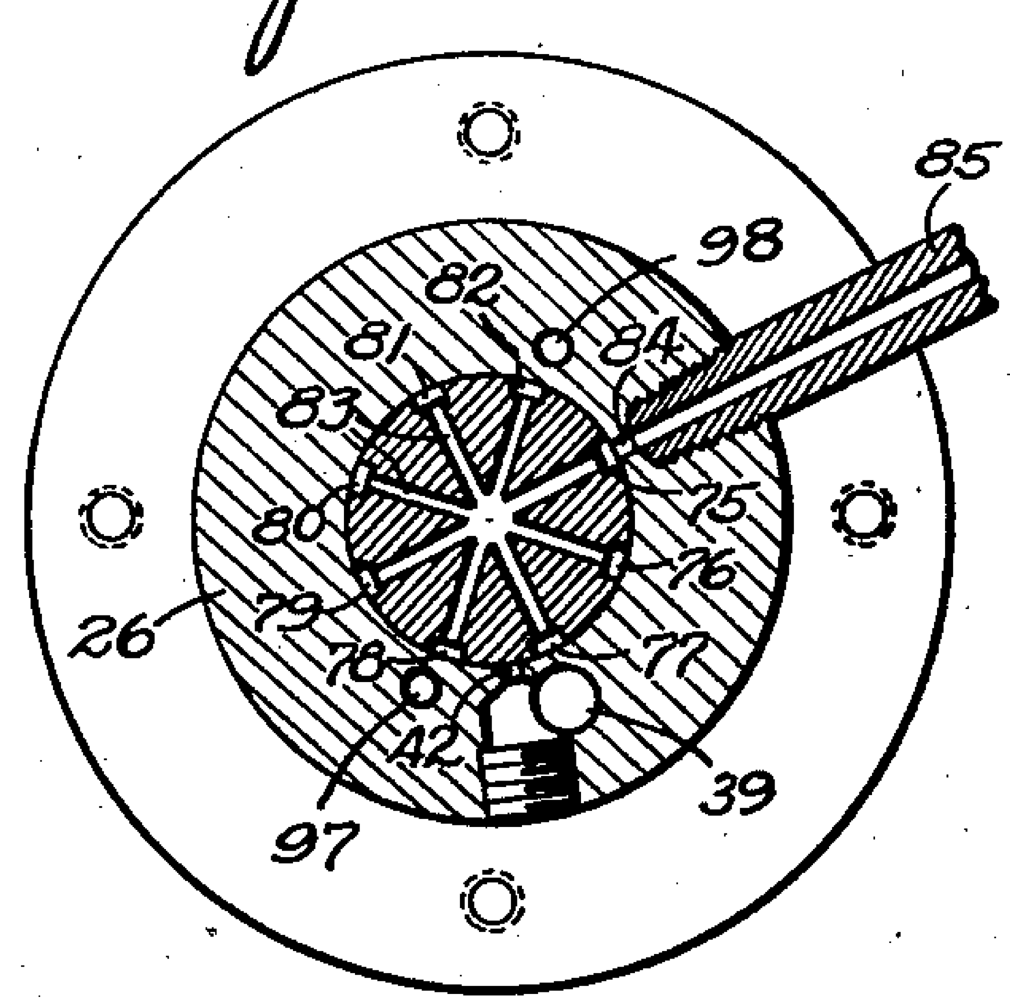


Fig. 7



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FLUID DISTRIBUTOR

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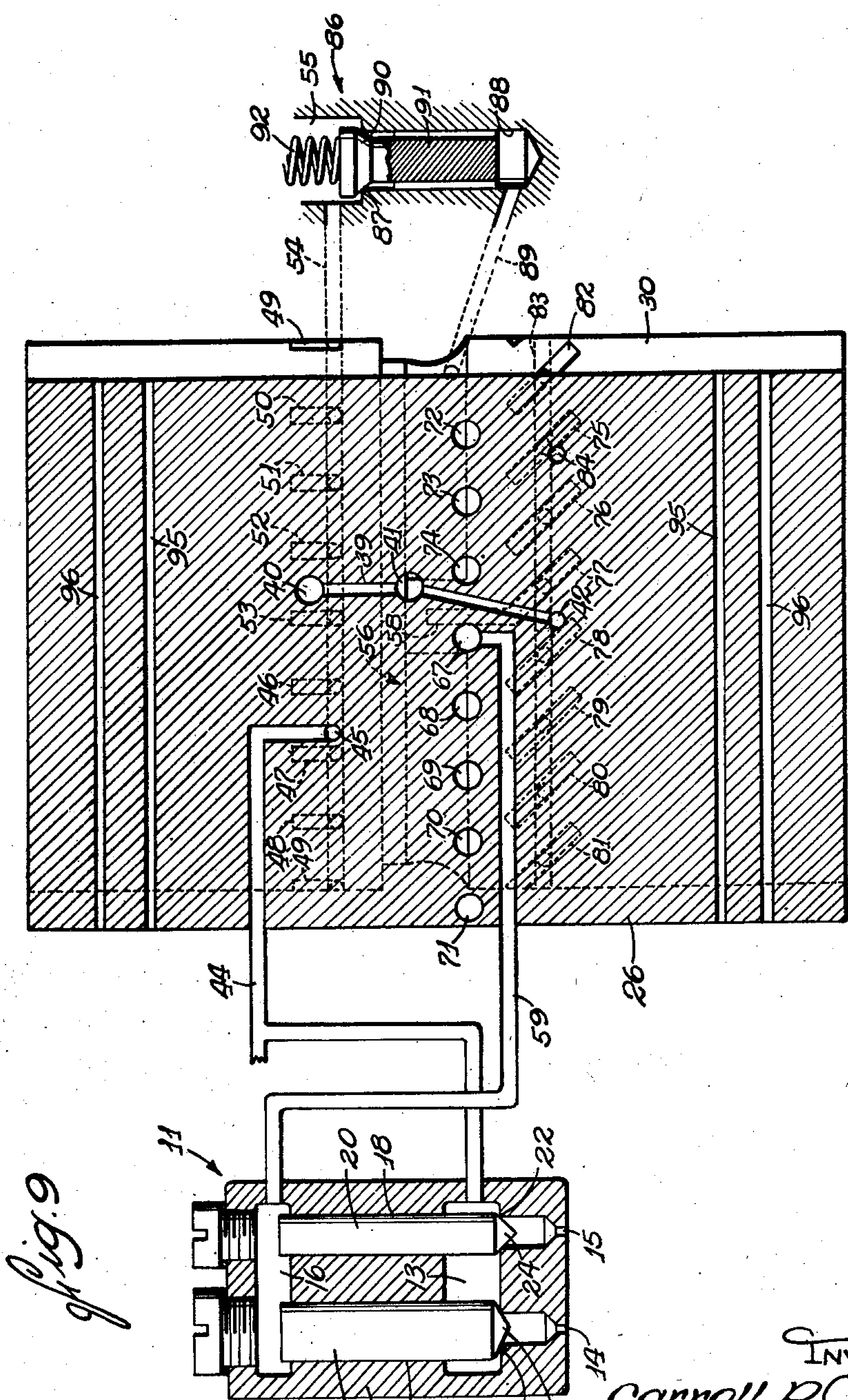

Fig. 9

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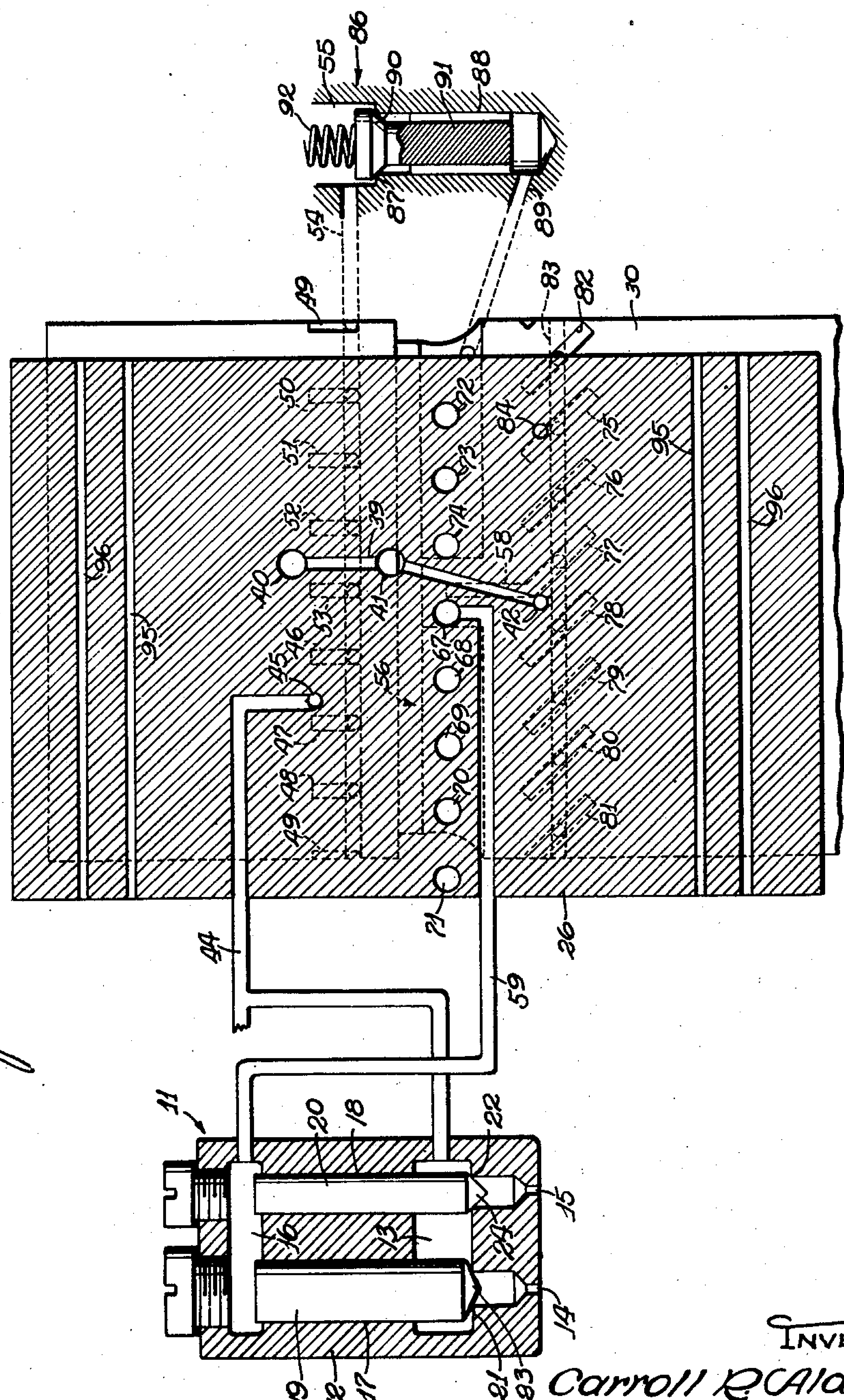

Fig. 10

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UNITED STATES PATENT OFFICE

2,223,590

FLUID DISTRIBUTOR

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Original application May 11, 1932, Serial No. 610,612, now Patent No. 2,145,640, dated January 31, 1939. Divided and this application December 10, 1937, Serial No. 179,070

10 Claims. (Cl. 251—107)

The present application is a division of my copending application Serial No. 610,612, filed May 11, 1932 (Patent No. 2,145,640, granted Jan. 31, 1939), and relates to a new and improved fluid distributor especially adapted for use in fuel injection systems.

One of the objects of the invention is to provide a novel distributor which is operable to effect pressure fluctuations in timed sequence in a plurality of control ports, and to periodically charge a feed port with fluid under pressure once for the pressure fluctuation in each control port.

Another object is to provide a new and improved fluid distributor adjustable to vary the extent and duration of said pressure fluctuations.

A further object is to provide a novel fluid distributor adjustable to charge the feed port with a relatively high pressure when said pressure fluctuations are of substantial duration, and with a relatively low pressure when said fluctuations are of short duration.

Another object is to provide a new and improved rotary fluid distributor comprising a casing having a high pressure port, a low pressure port and a plurality of peripherally spaced control ports, and a rotor in said casing having means for normally connecting said control ports to said high pressure port and having a recess movable successively across said control ports and alternately into communication with said high and low pressure ports once for and in overlapping relation with the communication of said recess with each control port.

Further objects and advantages will become apparent as the description proceeds.

In the accompanying drawings, Fig. 1 is an enlarged axial sectional view of a rotary distributor embodying the features of my invention.

Figs. 2 to 7 are transverse sectional views of the distributor taken respectively along lines 2—2 to 7—7 of Fig. 1.

Fig. 8 is an axial sectional view of the distributor taken along line 8—8 of Fig. 2.

Fig. 9 is a fragmentary diagrammatic view of the distributor showing a development of the distributor casing in cross hatched outline superimposed on a development of the rotor partially in dotted outline, with the rotor adjusted axially for full open throttle operation.

Fig. 10 is a view similar to Fig. 9 but with the rotor adjusted axially for idling throttle operation.

The distributor may be adapted generally to various uses, but is particularly suited for and hence described in connection with a plurality of hydraulically operable fluid discharge valves, one of which is illustrated at 11 in Figs. 9 and 10.

The distributor may be employed to control various types of hydraulically operable valves, but for purposes of illustration the valve 11 is shown as of the multiple orifice type for which the distributor is especially adapted. In its preferred form, the valve 11 has a casing 12 which is formed in one end with a feed chamber 13 discharging through two parallel orifices 14 and 15, and which is formed in the other end with a control chamber 16. The chambers 13 and 16 are connected by two parallel bores 17 and 18, respectively, in alinement with the orifices 14 and 15. Two plungers 19 and 20 are reciprocal respectively in the bores 17 and 18 and are exposed at opposite ends respectively in the chambers 13 and 16. Suitable valve seats 21 and 22 are formed in the casing 12 respectively at the inlets of the orifices 14 and 15, and are adapted for engagement respectively by valve members 23 and 24 on the ends of the plungers 19 and 20 in the feed chamber 13. When the orifices 14 and 15 are closed, the valve seats 21 and 22 reduce the effective end pressure areas of the associated plungers 19 and 20, and when the orifices are open, the opposite ends of each plunger are equal in effective pressure area. The valve seats 21 and 22 are unequal in size so that the effective differential between the pressure areas of the plunger 19 is greater than that of the plunger 20.

It will be evident that when equal pressures exist in the chambers 13 and 16, the orifices 14 and 15, if closed, will remain closed due to the differential areas of the plungers 19 and 20. Upon reducing the pressure in the chamber 16 to a predetermined point, at which the seating force on the plunger 19 is less than the lifting force, the pressure in the chamber 13 will lift the valve member 23 to open the orifice 14. At this point, the orifice 15 will remain closed, due to the smaller differential area of the plunger 20. Upon reducing the pressure in the chamber 16 still further to a second predetermined point, the pressure in the chamber 13 will lift the valve member 24 to open the orifice 15. It will thus be seen that upon suitable gradual relative pressure variations in the chambers 13 and 16, the orifices 14 and 15 will be opened in sequence. Upon subsequent reduction of pressure in the chamber 13, the pressure in the chamber 16 will actuate the plungers 19 and 20 to close the orifices 14 and 15 and thereby reestablish the initial conditions.

The distributor indicated generally at 25 constitutes means for controlling the pressures in the feed and control chambers 13 and 16 to effect operation of the various valves 11 in timed sequence, and in the operation of each valve to effect sequential opening of the orifices 14 and 15. In its preferred form, the distributor comprises a cylindrical casing 26 which is closed at one end by a removable screw plug 27 and which is mounted at the other end on a housing 28 adapted to be rigidly secured to a suitable support 29. A rotor 30 is slidably and rotatably mounted in the casing 26, and has an extension shaft 31 projecting therefrom through the housing 28 for operative connection to a suitable drive, such as an engine crank shaft (not shown). In the present instance, the drive connection comprises a spiral gear 32 axially splined to the shaft 31 and meshing with a second spiral gear 33 on a shaft 34.

The angular phase relation between the rotor 30 and the drive shaft 34 is subject to adjustment through shifting of the gear 32 relative to the gear 33 longitudinally of the shaft 31. An actuator 35 is operatively connected to the gear 32, and thus affords means for effecting the desired phase setting.

Any suitable means, such as an automatic governor (not shown) or a manual throttle actuator 36, may be provided for adjusting the rotor 30 axially. In the present instance, the actuator 36 is operatively connected to a gear sector 37 pivoted on the housing 28 and meshing therein with a rack 38 rigid with the shaft 31.

Opening in longitudinally spaced relation to the interior of the casing 26, and interconnected by a passage 39 formed therein, are three high pressure fluid inlet ports 40, 41 and 42. A high pressure supply line or conduit 43 is connected to the casing 26 in the transverse plane (see Fig. 5) of the intermediate port 41, and is in communication therewith and with the passage 39.

The common branched feed conduit 44, leading to the various valves 11, is connected at its inlet end to the casing 26, and communicates with the interior thereof through a port 45. The ports 40 and 45 are located in transverse planes (see Figs. 3 and 4) closely spaced longitudinally of the casing 26. Formed in the exterior of the rotor 30 are eight uniformly peripherally spaced and narrow elongated feed slots or grooves 46 to 53, one slot for each valve 11. The slots are parallel to the rotor axis; extend longitudinally through the transverse plane of the feed port 45 in all positions of axial adjustment of the rotor 30; are adapted to extend through the transverse plane of the port 40 for the purpose of periodically connecting the two ports to charge the feed conduit 44; and are connected respectively through radial passages 54 to an axial chamber 55 formed in the free end of the rotor, and hence constantly in intercommunication.

Preferably, the ports 40 and 45 are spaced peripherally of the casing 26, so that the periodic connection of the feed conduit 44 with the high pressure conduit 43 is established through successive sets of two of the slots, the associated passages 54 and the chamber 55.

Formed in the exterior of the rotor 30 is an uninterrupted peripheral high pressure belt defined by a groove 56 (see Figs. 1 and 5) in constant communication with the intermediate port 41 for all positions of axial adjustment. A cutoff land 57 extends longitudinally of the rotor 30 into one end and almost across the high pressure belt 56. Formed in the side of the rotor 30 and extending longitudinally thereof is a narrow elongated low pressure slot or groove 58. One end of the slot 58 extends centrally into the land 57.

Eight control conduits 59 to 66 for the respective valves 11 are suitably connected to the casing 26, and open respectively through eight uniformly peripherally spaced control ports 67 to 74 in a single transverse plane (see Fig. 6) to the interior thereof in registration longitudinally of the rotor with the high pressure belt 56 and the slot 58 for all positions of axial adjustment of the rotor. Hence, the slot 58 is movable successively across the ports 67 to 74 in timed relation to the charging of the common feed conduit 44 to effect the timed sequential pressure reductions in the control conduits 59 to 66. The land at each side of the slot 58 is sufficient in width to prevent the control ports from connecting it to the high pressure belt 56.

The low pressure slot 58 is an extension of one of eight uniformly peripherally spaced and narrow elongated slots or grooves 75 to 82 formed in the exterior of the rotor 30 in a single transverse plane (see Figs. 1 and 7), and constantly in intercommunication through intersecting radial connecting passages 83. Connected to the casing 26 and opening thereto through a port 84 in the same plane as the high pressure port 42 (see Fig. 7) is a low pressure fluid conduit 85. The two ports are adapted to communicate alternately and successively with the slots 75 to 82 in all axial positions of the rotor 30 so that each time the port 84 is over one of the slots 75 to 82, the slot 58 will be connected to the low pressure conduit 85, and at alternate times the slot 58 is connected to the high pressure conduit 43.

To vary the duration of pressure reduction in the control conduits 59 to 66, and hence the period of injection, the slots 75 to 82 are inclined to the rotor axis so that axial shifting of the rotor 30 is effective to adjust the phase relation of the period of communication of the slots with the low pressure port 84 to the period of communication of the slot 58 with each of the control ports 67 to 74.

The operation is illustrated in Figs. 9 and 10. In Fig. 9, with the rotor 30 adjusted for full throttle opening and rotated into position about to effect operation of the illustrated multiple nozzle valve 11, the high pressure port 40 has left the feed slot 53, and the feed port 45 has left the slot 47, so that the common feed conduit 44 has been charged and cut off preparatory for nozzle valve opening. The maximum fluid pressure is therefore impressed in the feed chamber 13, but the valve members 23 and 24 because of the differential seating area ratios of the plungers 19 and 20 remain seated.

The control port 67 has left the high pressure belt 56 and is about to communicate with the low pressure slot 58 preparatory for a reduction of the seating pressure in the control conduit 59 and the chamber 16. Since the rotor 30 is adjusted for maximum throttle opening, the slot 58 is connected to the low pressure substantially concurrently with communication with the port 67 so as to effect a seating pressure reduction of maximum duration for maximum discharge. Thus, just as the port 67 is about to communicate with the slot 58, the low pressure port 84 is about to communicate with the slot 75 and the high pressure port 42 is about to leave the slot 78.

Progressive reduction of the seating pressure causes the valve members 23 and 24 to lift in predetermined sequence. Upon further rotation of the rotor 30, the port 84 will leave the slot 75 to interrupt the low pressure connection, and the high pressure port 42 will come into communication with the slot 77 to charge the slot 58 with high pressure so as to restore the seating pressure in the chamber 16, thereby seating the valve members 23 and 24.

In Fig. 10, with the rotor 30 adjusted for idling throttle operation, and occupying the same rotary position as in Fig. 9, the angular phase relation of the ports 40, 45 and 67 to the slots 52, 46 and 58 is unaltered. However, the slot 58 upon communication with the port 67 has already been connected for a substantial time to the low pressure, and hence the low pressure port 84 will in a short time leave the slot 75 so that the period of pressure reduction is of short duration. Thus, the period of pressure reduction is adjusted by varying the degree to which the communication of the slot 58 with the control port 67 overlaps the period of connection of the slot with the low pressure port 84. In the variation of the duration of pressure reduction, the starting point of pressure reduction is fixed while the cut-off is variable. It will be evident that if the rotor 30 is adjusted axially into a position wherein the port 84 will have moved out of communication with the low pressure source before the port 67 is brought into communication with the slot 58, a closed throttle condition will exist and the valve 11 will not open. It will be understood that at certain small throttle openings, the period of control pressure reduction may be so short that only the valve member 23 will lift.

One of the features of the invention resides in reducing the maximum charging pressure in the feed conduit 44 for idling operation, so as to insure quick and positive seating of the nozzle valves and accurate metering of the small amounts of fluid discharged. To this end, the feed slots 46 to 53 are movable out of the range of the high pressure port 40 upon axial adjustment of the rotor 30 for small throttle openings (see Fig. 10) so as to prevent charging of the feed port 45 directly from the high pressure source, and means is provided for charging the feed port indirectly from the source past a pressure reducing valve 86 (see Figs. 8, 9 and 10).

In the preferred form, the valve 86 is interposed between the chamber 55 and the high pressure belt 56. The chamber 55 opens past a valve seat 87 to a reduced axial bore extension 88 communicating through a passage 89 with the pressure belt 56. A valve member 90 having a longitudinally fluted guide stem 91 slidably disposed in the bore 88 is normally urged against the seat 87 by a coiled compression spring 92 in the chamber 55. The spring 92 is seated against an adjusting screw plug 93 threaded into the chamber 55. The outer end of the chamber 55 is suitably closed by a removable screw plug 94. It will be evident that the pressure reduction effected by the valve 86 on the fuel in passing from the belt 56 to the chamber 55 is subject to adjustment by adjusting the pressure of the spring 92.

The distributor 25 is constructed to prevent fluid from leaking past the ends of the rotor 30 out of the casing 26, and to lubricate and balance the rotor so as to insure ease of rotation. Thus, two spaced annular labyrinth grooves 95 and 96 are formed in each end of the casing 26 about the rotor 30. The inner grooves 95 and the outer grooves 96 are connected respectively by longitudinal passages 97 and 98 formed in the wall of the casing 26 (see Fig. 8). A drain conduit 99 is connected to the casing 26 in communication with the passage 97. It will be evident that fluid under pressure tending to leak outwardly along the rotor 30 will be caught by the grooves 95 and withdrawn through the conduit 99. A viscous fluid under pressure, such, for example, as lubricating oil, is supplied to the outer grooves 96 through a conduit 100 connected to the casing 26 in communication with the passage 98, and tends to leak inwardly along the rotor 30 to the grooves 95 so as to insure the prevention of leakage of fluid outwardly past the grooves 95, and to lubricate and balance the rotor.

I claim as my invention:

1. A fluid distributor comprising, in combination, a casing having a control port, a high pressure port and a low pressure port, and a rotor slidably and rotatably mounted in said casing, said rotor having a longitudinal slot and an inclined slot in intercommunication and being operable to connect said control port alternately with said high pressure port and said longitudinal slot, and periodically to connect said inclined slot to said low pressure port concurrently with said connection between said longitudinal slot and said control port over a predetermined period, axial adjustment of said rotor being effective to adjust the duration of said period.

2. A fluid distributor comprising, in combination, a casing having a feed port and a plurality of control ports, and means for charging said control ports with fluid under pressure and successively effecting pressure fluctuations in said control ports, and for periodically charging said feed port with fluid under pressure once for each cycle of pressure fluctuations in each control port.

3. A fluid distributor comprising, in combination, a casing having a high pressure port, a low pressure port and a plurality of peripherally spaced control ports, and a rotor in said casing for successively connecting said control ports alternately to said high and low pressure ports.

4. A fluid distributor comprising, in combination, a casing having a high pressure port, a low pressure port and a plurality of peripherally spaced control ports, and an axially adjustable rotor in said casing, said rotor comprising a peripheral belt in communication with said high pressure port and normally open to said control ports, a land projecting into said belt and formed with a longitudinal groove movable successively across said control ports, and a plurality of peripherally spaced longitudinally inclined grooves corresponding in number and spacing to said control ports and being in communication with said longitudinal groove and in intercommunication, said inclined grooves being movable successively into alternate communication with said high and low pressure ports.

5. A fluid distributor comprising, in combination, a casing having a high pressure port, a low pressure port and a plurality of peripherally spaced control ports, and an axially adjustable rotor in said casing, said rotor comprising a peripheral belt in communication with said high pressure port and normally open to said control ports, a land projecting into said belt and formed with a longitudinal groove parallel to the rotor axis and movable successively into communication for predetermined periods with said control ports, and a plurality of generally longitudinal grooves inclined to said axis and corresponding in num-

ber and peripheral spacing to said control ports and being in intercommunication and in communication with said first mentioned groove, said inclined grooves being periodically movable into communication with said low pressure port for a predetermined period once during each of said first mentioned periods, axial adjustment of said rotor serving to vary the phase relation of said first and last mentioned periods.

6. A fluid distributor comprising, in combination, a casing having a high pressure port, a low pressure port and a plurality of peripherally spaced control ports, and an axially adjustable rotor in said casing, said rotor comprising a peripheral belt in communication with said high pressure port and normally open to said control ports, a land projecting into said belt and formed with a longitudinal groove parallel to the rotor axis and movable successively into communication for predetermined periods with said control ports, and a plurality of generally longitudinal grooves inclined to said axis and corresponding in number and peripheral spacing to said control ports and being in intercommunication and in communication with said first mentioned groove, said inclined grooves being periodically movable into communication with said low pressure port for a predetermined period once during each of said first mentioned periods, and at all other times into communication with said high pressure port.

7. A rotary distributor comprising, in combination, a casing having an outlet port and a fluid pressure inlet port peripherally spaced from said outlet port, a rotor in said casing and formed with a plurality of uniformly peripherally spaced intercommunicating grooves parallel to the rotor axis, said grooves being rotatably movable successively into direct communication with said outlet port and simultaneously rotatably movable in a different phase relation successively into direct communication with said inlet port.

8. A rotary distributor comprising, in combination, a casing having an outlet port and a fluid pressure inlet port peripherally spaced from said outlet port, an axially adjustable rotor in said casing and formed with a plurality of uniformly peripherally spaced intercommunicating grooves parallel to the rotor axis, said grooves being rotatably movable successively into direct communication with said outlet port in all axial positions of said rotor and being adjustable by said rotor into and out of position for simultaneous rotatable movement in a different phase relation successively into direct communication with said inlet port, and means for directing fluid under pressure at all times to said grooves.

9. A rotary distributor comprising, in combination, a casing having a feed port, three longitudinally spaced high pressure inlet ports, a plurality of uniformly peripherally spaced control ports and a low pressure inlet port, an axially adjustable rotor in said casing and formed with a peripheral high pressure belt always open to one of said high pressure ports and located in the plane of said control ports, a land on said rotor projecting into said belt through the plane of said control ports, a plurality of longitudinally inclined peripherally spaced intercommunicating control grooves in said rotor corresponding in number and spacing to said control ports and movable successively into communication with the second of said high pressure ports for predetermined spaced periods and over alternate periods into communication with said low pressure port, a longitudinal control groove connected to said first mentioned grooves and opening in said land for movement successively across said control ports for periods variably overlapping said first mentioned periods, the phase of overlap being adjustable by axial adjustment of said rotor, and a plurality of peripherally spaced feed grooves in and parallel to the axis of said rotor corresponding in number and spacing to said control ports and movable successively into communication with said feed port each time in advance of communication between said longitudinal groove and an associated control port, and being adjustable by axial adjustment of said rotor into and out of position for movement successively into communication with the third of said high pressure ports each time simultaneously with communication of an associated feed groove with said feed port, and means including a pressure reducing means for supplying pressure fluid from said belt to said feed grooves.

10. A fluid distributor comprising, in combination, a casing having a feed port and two spaced pressure inlet ports, and a rotor slidably and rotatably mounted in said casing, said rotor having a high pressure space always in communication with one of said pressure ports, two peripherally spaced longitudinal slots in the range of said feed port for all axial positions and movable longitudinally into and out of the range of the other of said pressure ports, said slots when in the range of said other pressure port being adapted respectively to communicate simultaneously with said feed port and said other pressure port once for each revolution of said rotor, and means for constantly supplying fluid from said high pressure space to said slots under a relatively reduced pressure.

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