March 27, 1928.

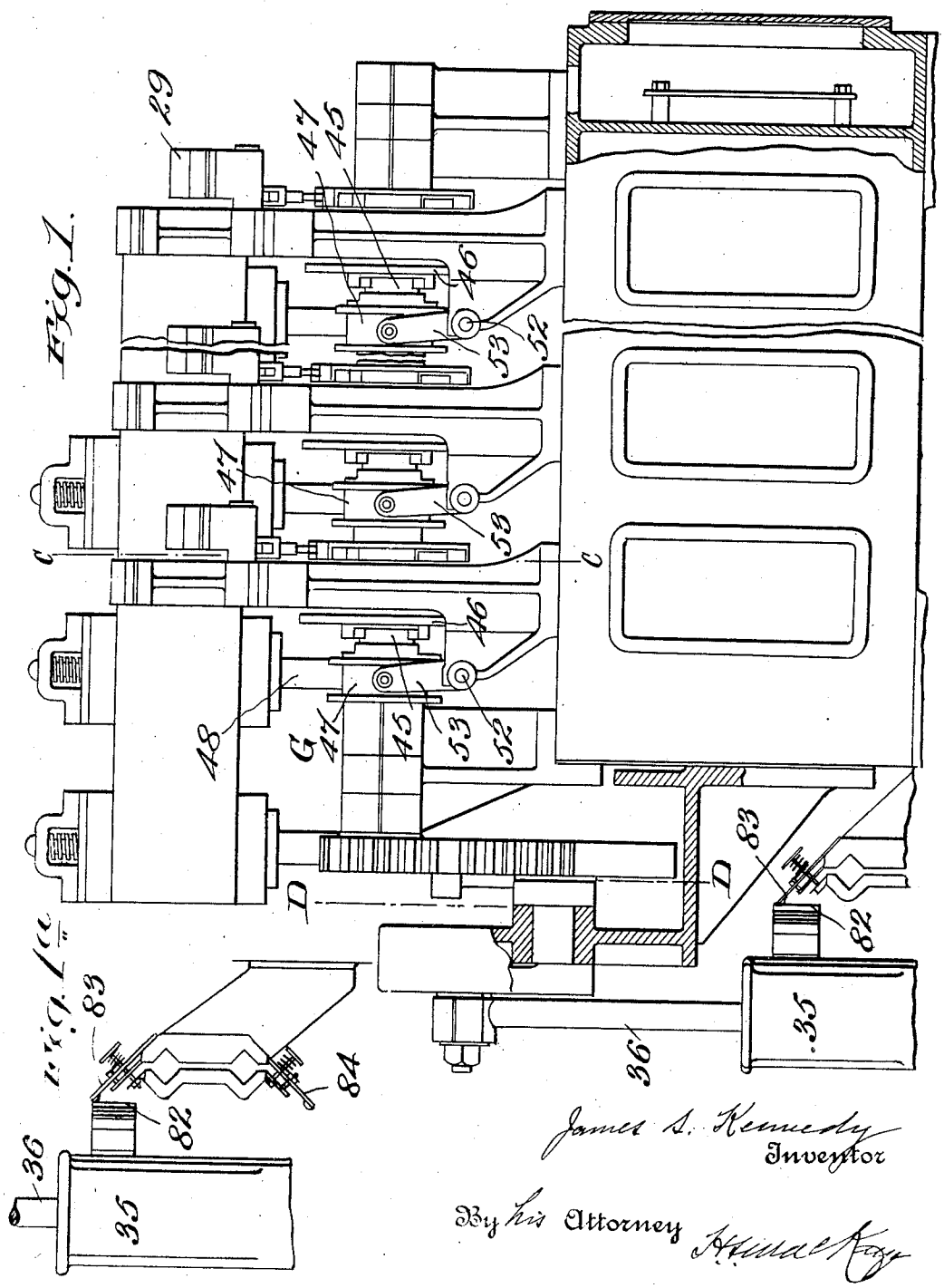
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J. S. KENNEDY

VALVE OPERATING MECHANISM

Filed Feb. 15, 1923

9 Sheets-Sheet 1



James S. Kennedy
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By his Attorney Thomas Kay

March 27, 1928.

1,663,557

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VALVE OPERATING MECHANISM

Filed Feb. 15, 1923

9 Sheets-Sheet 2

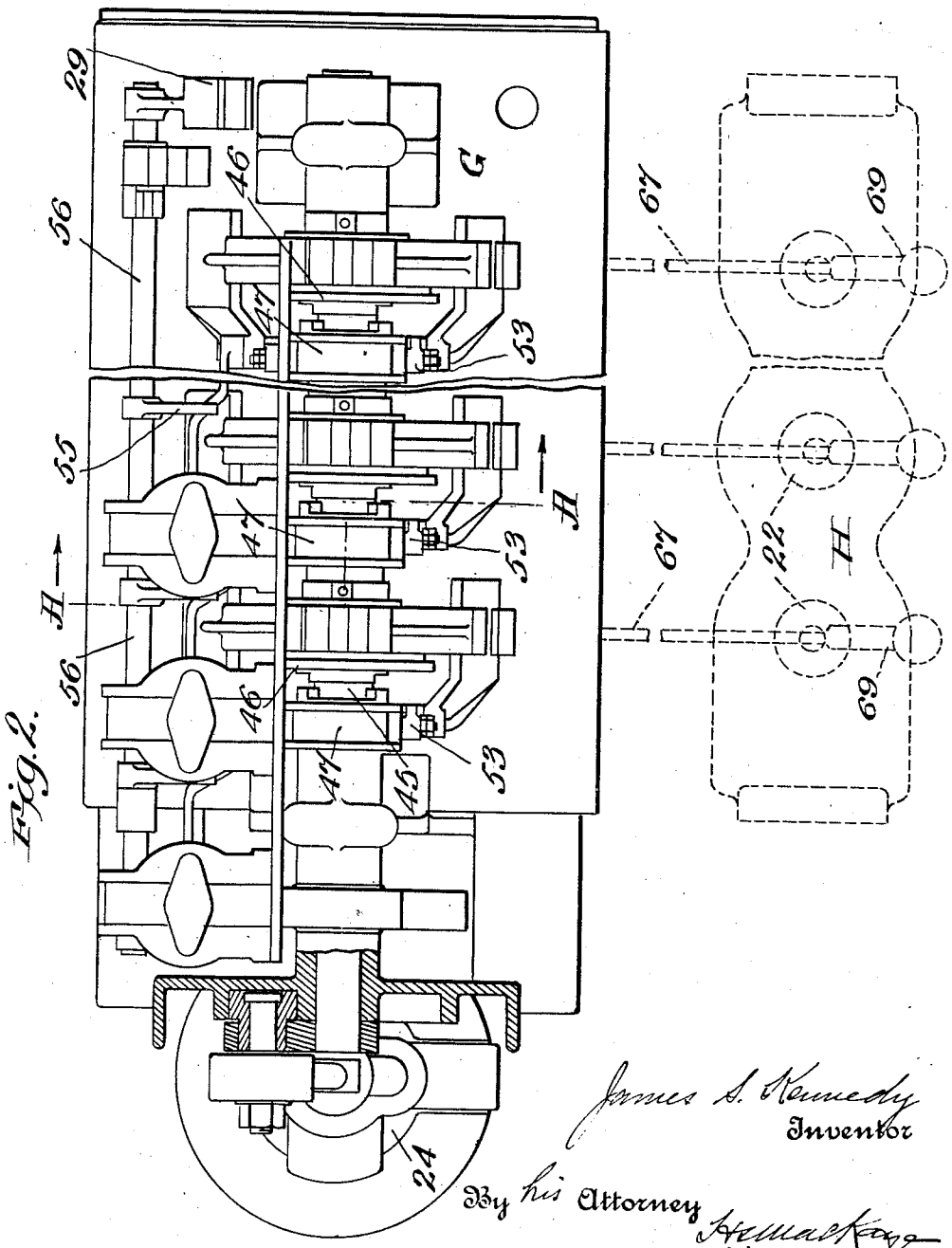


Fig. 2.

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VALVE OPERATING MECHANISM

Filed Feb. 15, 1923

9 Sheets-Sheet 3

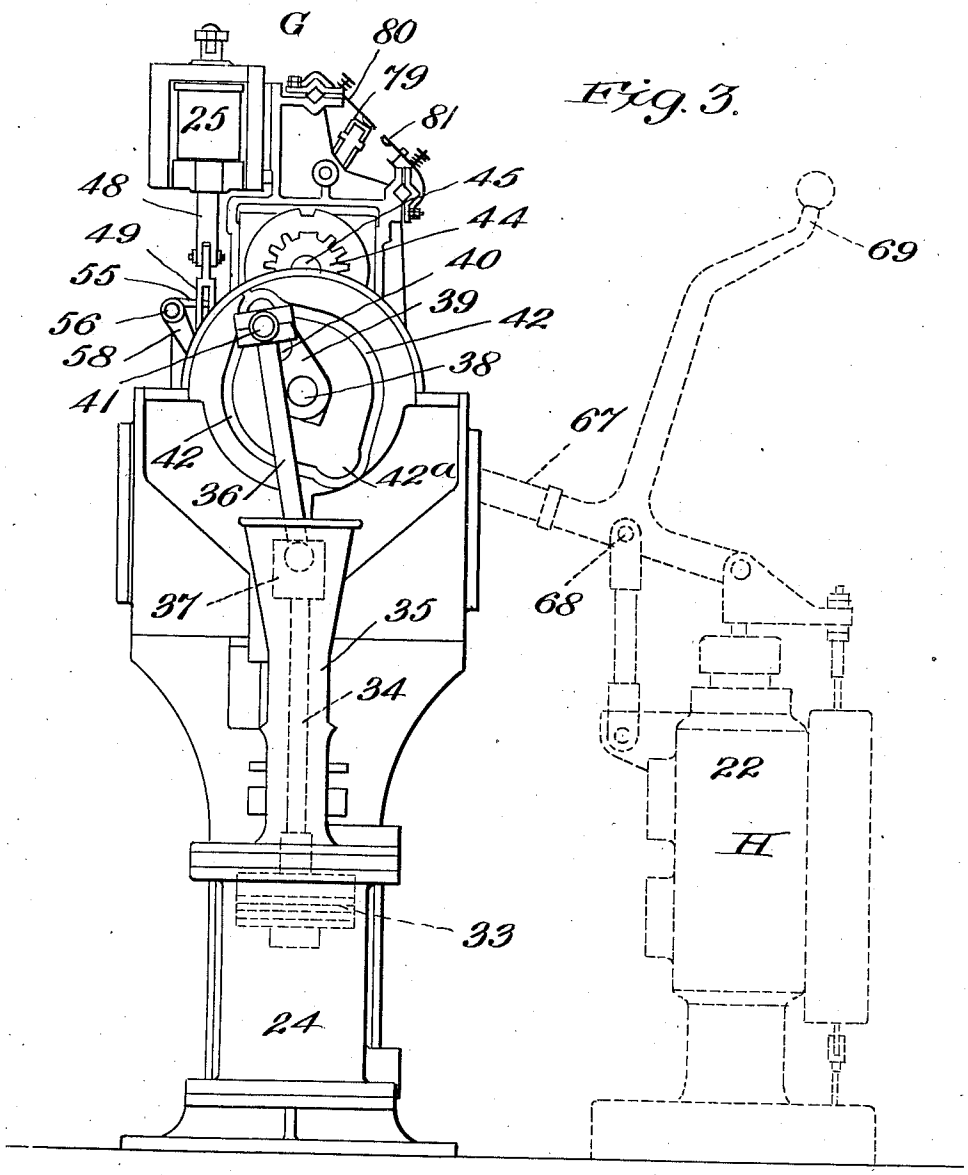


Fig. 3.

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VALVE OPERATING MECHANISM

Filed Feb. 15, 1923

9 Sheets-Sheet 4

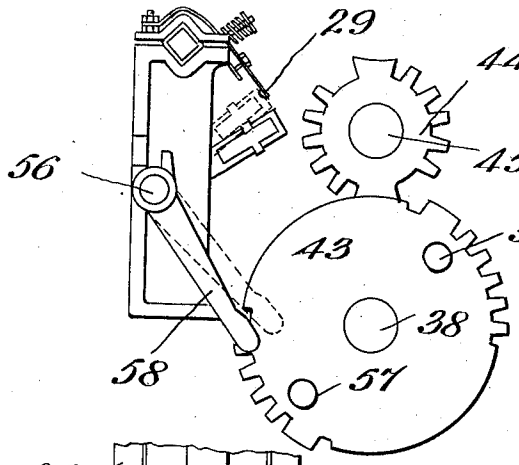


Fig. 4.

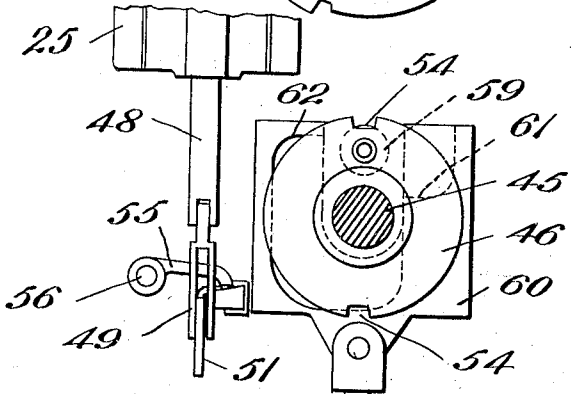
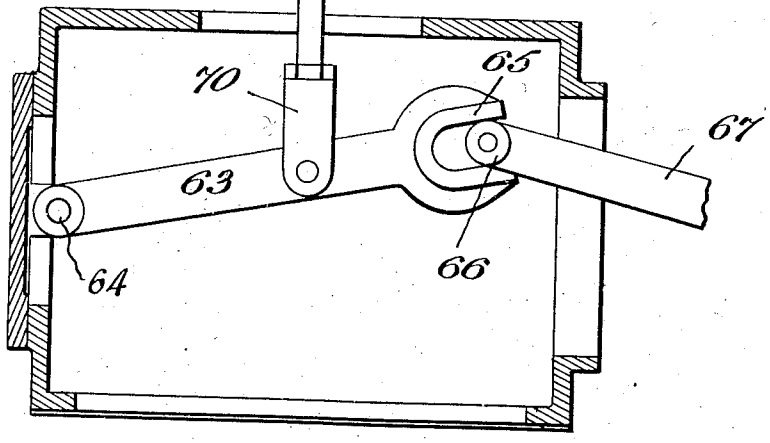


Fig. 5.



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1,663,557

VALVE OPERATING MECHANISM

Filed Feb. 15, 1923

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Fig. 6.

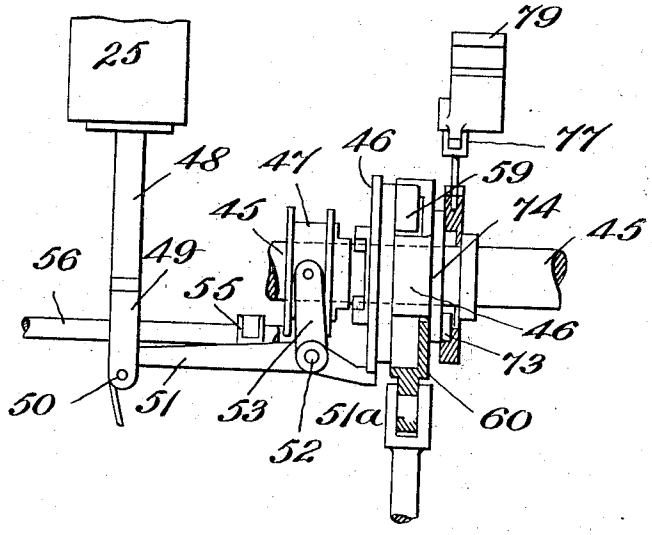
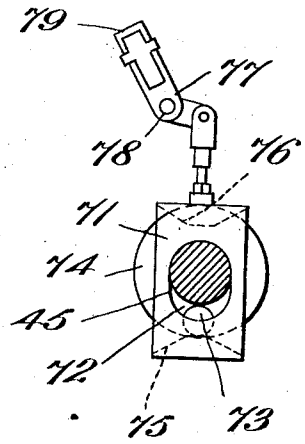


Fig. 7.



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By his Attorney Randall Kay

March 27, 1928.

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VALVE OPERATING MECHANISM

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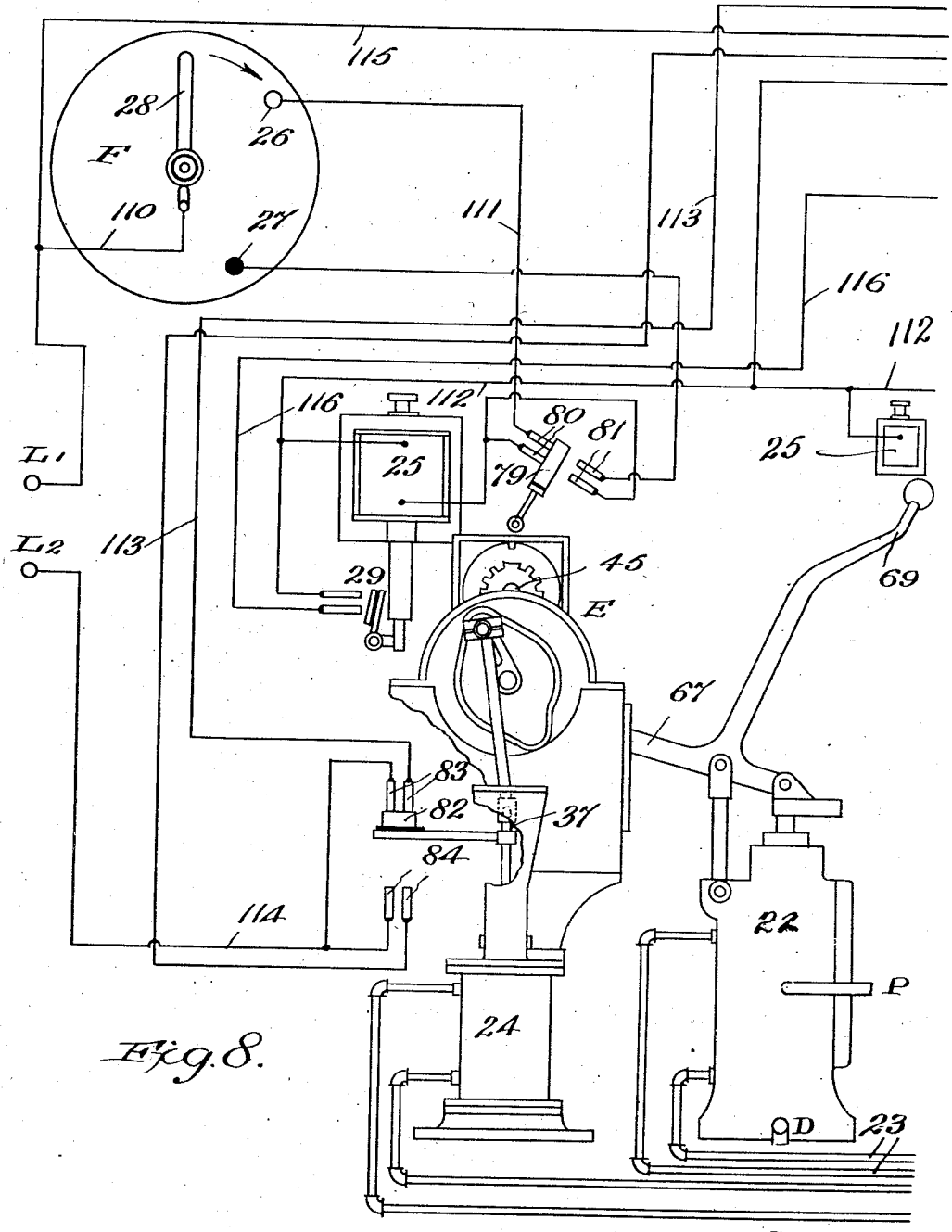


Fig. 8.

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VALVE OPERATING MECHANISM

Filed Feb. 15, 1923

9 Sheets-Sheet 7

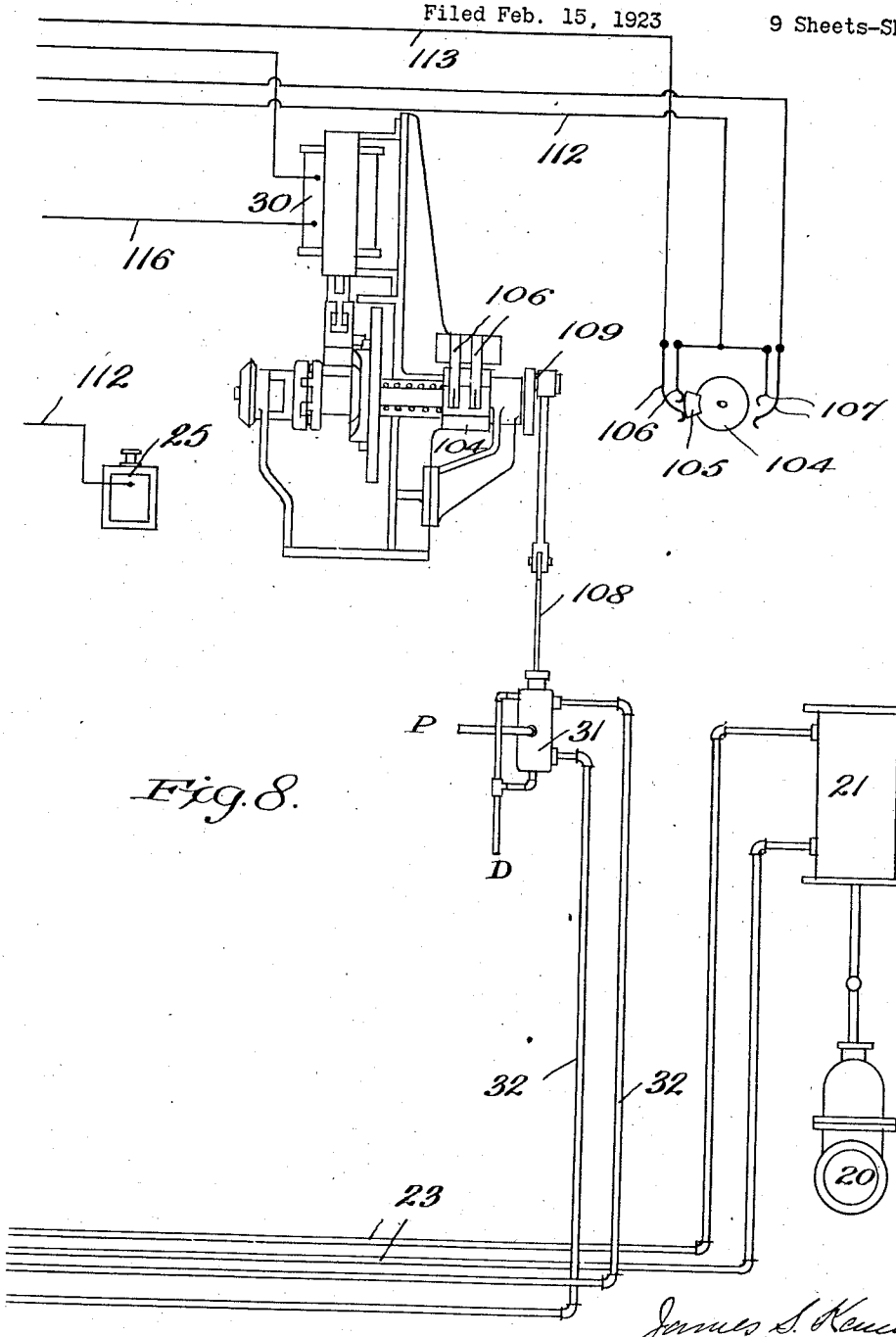


Fig. 8.

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By his Attorney Russell C. Knox

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VALVE OPERATING MECHANISM

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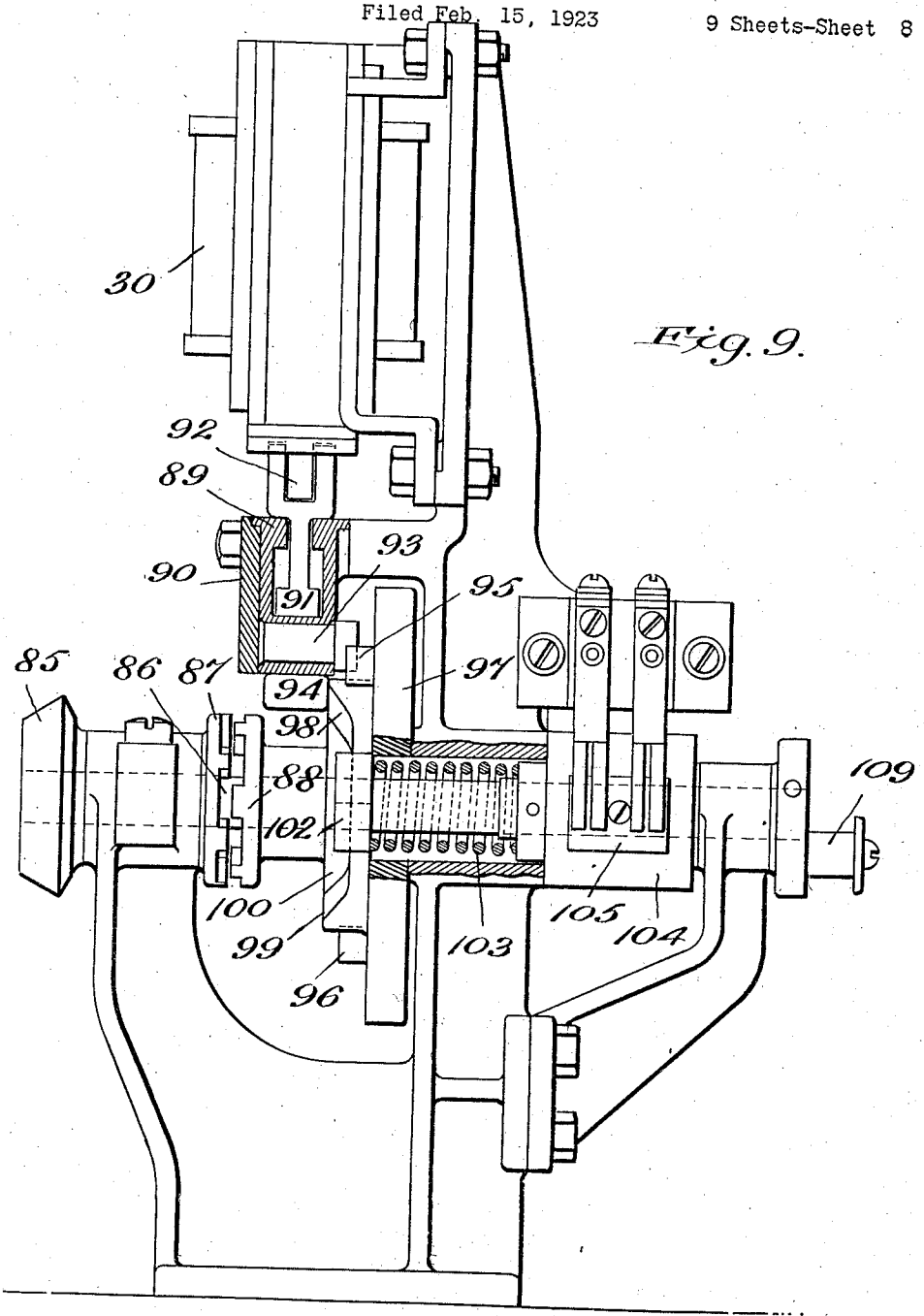


Fig. 9.

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1,663,557

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VALVE OPERATING MECHANISM

Filed Feb. 15, 1923

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Fig. 10.

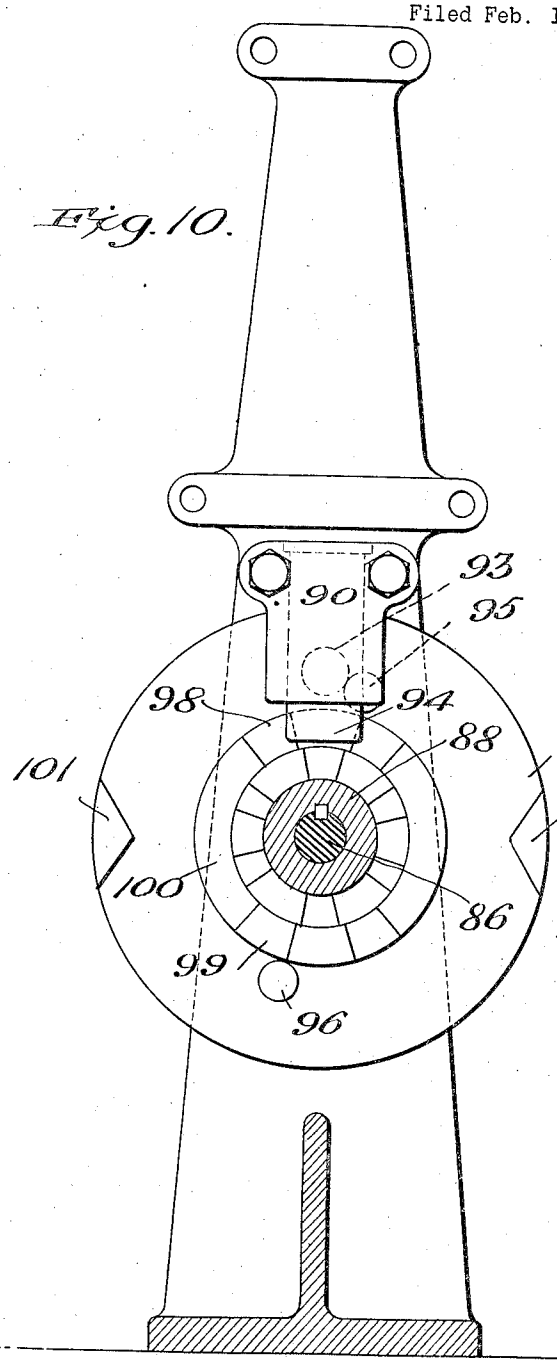
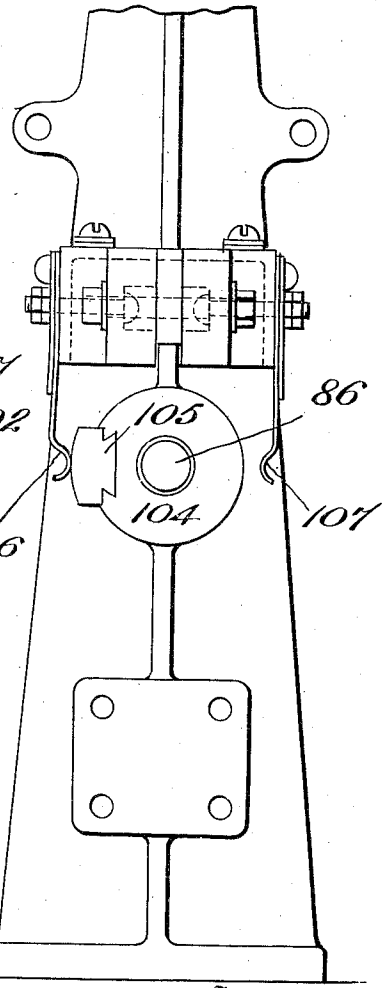


Fig. 11.



Inventor
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Patented Mar. 27, 1928.

1,663,557

UNITED STATES PATENT OFFICE.

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VALVE-OPERATING MECHANISM.

Application filed February 15, 1923. Serial No. 619,258.

The present invention relates to a new and useful apparatus of a compact and reliable design adapted to either automatic or manual control of a group or system of valves or equivalent devices from a central point located at any desired distance from the agencies to be controlled.

While it is to be understood that the novel apparatus in question is capable of advantageous use in connection with a great variety of controllable valves or the like for all sorts of purposes, it is especially useful in connection with the control of valves governing the operation of hydraulic engines, and more particularly where said engines are used to actuate the valves directly controlling the operation of gas generator sets.

In my United States Patent No. 1,498,174 there is described an automatic system of interlocked controls for gas generator sets in which the operations of the various agencies are primarily governed by a central timer or main controller by whose timed revolution the necessary repeated orderly cycles of operation of the set are assured with certainty. The present invention is particularly well fitted for use in a system of this kind, and will, therefore, be so described hereinafter; it being understood that this particular embodiment of the invention is shown by way of example, and that the scope of the invention is not limited to this adaptation.

In gas generator sets, most of the parts which have to be moved are so heavy that it has become customary to actuate them by hydraulic engines (cylinders and pistons). These engines are controlled by suitable valves which cause the hydraulic pressure to act upon one side or the other of each hydraulic piston, according as the main valve to be actuated by each engine is to be opened or closed. In practice, for instance, the lifting of the actuating piston opens the main valve, while such valve is closed by the forcing down of the piston.

The valves which thus determine the direction of movement of the hydraulic engines may be called the "control" valves, and these are generally placed together in a group or series which may be called the "control nest." All of the operations of a gas generator set may be suitably governed and carried out by one or more operators who actuate the control valves in proper order by hand. It has been found highly advantageous, however, to operate these control valves by automatic means governed from a suitable central timer or main controller; for instance, as described in my pending patent application aforementioned. The apparatus forming the subject matter hereof is intended for this purpose (among others) and will be so described.

In automatic systems of the character mentioned, however, means for manual operation of the control valves are always retained, as it would, of course, become necessary to resort to them in case of any failure of operation of the automatic apparatus. It is one of the principal novel advantages of the present invention that it permits of instant use of the manual operators of the control valves without disconnecting said valves from the automatic apparatus, and without resorting to preliminary preparation of any kind.

Another prominent advantage of this apparatus is that, while the starting of each automatic valve operation is electrically governed, the motive force used is hydraulic, and the disengagement or release terminating each operation is mechanically accomplished. The flexibility of electric operation is thus secured in governing the apparatus, while its motivation is accomplished by reliable and positive hydraulic mechanism.

Another advantage of the invention is found in the fact that the various automatic clutches whereby the common motive force is directed in due order and sequence to the various control valve operators are all connected, locked and unlocked while stationary. This, of course, insures certainty of operation and perfection of engagement, while decreasing wear and tear and noise.

This apparatus is so constructed that while any one valve is being moved there cannot occur any accidental movement of any other valve due to premature closure of circuit in any part of the automatic system. Furthermore the electrical operation is rendered entirely independent of manual operation, so that the two cannot interfere with each other.

Another advantage possessed by the pre-

ferred embodiment of this invention is that the apparatus can be readily applied, as a complete separable and independent machine, to control valve groups already in operation. This is made possible by constructing the machine in the form of a series of similar units, side by side, capable of being placed nearer together or further apart to suit the grouping of the control valves to be operated.

In the accompanying drawings, Figure 1, 1a, is an elevation of enough of the valve operator proper to disclose the construction of the whole, Figure 2 is a plan view of the same, showing its relation to the control nest which it operates, Figure 3 is an end elevation of what is shown in Figure 1, Figure 4 is a vertical sectional view of the line D—D on Figure 1 showing the intermittent gear drive and clutch release, Figure 5 is a similar view on the line A—A on Figure 2, Figure 6 is a view partly in elevation and partly in section of certain details hereinafter described, Figure 7 is a similar view on the line C—C on Figure 1, Figure 8 (on two sheets) is a general diagrammatic view of the entire system, showing the electrical and hydraulic connections, Figure 9 is a side elevation partly in vertical section of the clutch unit for operating the pilot valve, Figure 10 is a front elevation of the same with a portion broken away, and Figure 11 is a rear elevation of the same.

Before beginning a detailed description of the construction of this apparatus it will be well to convey a general idea of the plan of operation, whereby the utility of the various elementary operations will be made more readily intelligible. This general idea may be had by a preliminary reference to Figure 8 of the drawings, which figure will be returned to later in describing the details of the electric circuits, etc.

One of the main valves of a gas generator set is diagrammatically shown at 20, operated by an up or down movement imparted by the main hydraulic engine 21. This engine is controlled by the four-way plunger valve 22, with which it is connected by the pipes 23. For each of the main valves and engines 20, 21, there is a corresponding four-way "control" valve 22, and these last are arranged side by side in a "control nest" hereinafter described.

The control valve operator proper, indicated generally at E in Figure 8 is composed of a row of similar control valve operating units, all driven at proper times by the common hydraulic engine 24. For any given movement of this engine only one control valve 22 is actuated, the proper valve being selected in each instance by a control valve solenoid 25. There is one solenoid 25 for each valve 22, and each solenoid causes engagement of a corresponding clutch which brings the appropriate valve 22 into operative relation with the common motor mechanism driven by the engine 24.

At F is indicated in diagram the central timing switch described in my patent application aforesaid, showing one valve-opening contact 26 and one valve closed contact 27. This is shown merely as a type of any central electric control, whether automatic or manual. The contact finger 28 is moved clockwise at a predetermined rate, preferably in an intermittent manner. There is one contact 26 and a contact 27 for each control valve solenoid 25.

When any one solenoid 25 is energized it accomplishes two things, namely—it closes the pilot valve switch 29 and it operates its corresponding clutch to prepare its appropriate control valve to be moved. Closing the switch 29 energizes the pilot valve solenoid 30 which causes engagement of a clutch whereby the pilot valve 31 is operated. The pilot valve is suitably connected by piping 32 with the common control valve hydraulic engine 24, and the mechanism driven by this last at once operates through the clutch which was caused to engage by the solenoid 25, to move the proper control valve 22. This last then operates to set in motion the corresponding main valve engine 21, as before described.

The detailed operations incidental to the general plan just described will appear fully in connection with the following description of Figures 1 to 7 and 9 to 11.

In Figure 2, the row of control valve operator units, actuated selectively by power furnished by the common hydraulic engine 24, is indicated in plan at G; and the parallel row of control valves in the control nest is shown in plan at H. The group G is shown in side elevation in Figure 1, the group H being removed. In Figure 3 the group G is shown in end elevation in full lines, the same view of the group H being there shown in dotted lines.

Describing first the common power mechanism for the various operator units, the piston 33 of the engine 24 travels all the way up or all the way down in response to each successive operation of the pilot valve 31. The piston rod 34, sliding in the guide 35 impels the pitman 36, which is pivoted to the crosshead 37, and thereby causes a 180 degree revolution of the shaft 38.

In order to avoid all danger of stopping on a dead center, this movement is preferably accomplished by the following mechanism. There is fixed on the end of the shaft 38 a crank arm 39 having a slot 40 in which plays a pin 41 on the end of the pitman 36. This pin passes through the slot 40 and slides along a curved wall 42, best shown in Figure 3. Starting from the position shown in Figure 3, and assuming downward movement of

the piston 33, the first movement of the pin will be along the slot 40. Having reached the bottom of this slot, the pin will begin to revolve the shaft 38 anti-clockwise, and, toward the end of the stroke, the pin will move outward in the slot 40 until it contacts with the sloping wall 42. Thereafter, and until the end of the stroke, the wall 42 will exert a cam action on the pin, guiding it well past the dead center to the recess 42a, where it will remain until the next or upward stroke begins. The next stroke will accomplish another half revolution of the shaft 38 in the same manner, except that the guiding cam action will be accomplished by the upper part of the wall 42.

Referring to Figure 4, the shaft 38 carries and drives a mutilated gear 43 whose convex smooth portions fit the concave portions of a smaller mutilated gear 44, fixed upon the common operating shaft 45. This shaft extends from end to end of the group of units G. This engagement of the gears 43 and 44 insures locked stationary condition of the latter at all times except when the teeth of the two gears engage. From the arrangement of the teeth shown in Figure 4, it will be seen that, during a large portion of the movement of the gear 43, the shaft 45 will not move; but that it will be given a relatively quick half turn during the period of engagement of the teeth on the two gears. As the gear 43 moves anti-clockwise it will drive the gear 44 clockwise. The two separate sets of teeth on both gears operate alternately as the piston 33 moves alternately up and down.

In Figures 5, 6 and 7 are shown the details of construction of each operating unit. Each unit comprises a clutch member 46 which is loosely centered on the common shaft 45 and a reciprocating opposed clutch member 47, keyed slidably on the shaft so as to revolve with it. Each unit comprises a solenoid 25 from whose movable core depends a rod 48 carrying a fork 49, having a pin 50 over which extends the hooked end of the clutch-throwing lever 51. This lever is fulcrumed at 52 and carries a fork 53 cooperating in a well known manner with the grooved clutch member 47 to throw the same into and out of engagement with the opposed clutch member 46. A locking extension piece 51^a is fixed to the shaft 52 in the vertical plane of the main shaft 45, and its end engages one or the other of two slots 54 placed 180 degrees apart in the periphery of the clutch member 46 (see Figure 5). This engagement locks the member 46 when the clutch is disengaged, but, when the hooked end of the lever 51 is lifted by the solenoid to engage the clutch, the extension 51^a leaves its notch 54 and unlocks the member 46, permitting its rotation.

The first operation of the solenoid 25 is to unlock the clutch member 46 and throw the clutch member 47 into engagement by lifting the outer end of the lever 51. This lever lifts the arm 55 which extends across 51 and is fixed on the shaft 56, which extends all the way along and behind the units G. This shaft is thus revolved closing the pilot valve switch 29, located at the right of the group G in Figures 1 and 2.

Closing this switch 29 acts in a manner hereinafter described to operate the pilot valve, which sets the hydraulic engine 24 in motion, lifting or depressing the piston 33 as the case may be, and revolving the shafts 38 and 45 through 180 degrees. Engagement of the clutch members 46 and 47 is thus accomplished electrically, while they are both stationary, but their disengagement is mechanically accomplished as follows.

Shortly before completion of the stroke of the hydraulic piston 33, one of the pins 57, placed 180 degrees apart on the gear 43, strikes the lever 58 fixed on the end of the shaft 56. This opens the pilot valve switch 29 and, at the same time, the finger 55 fixed to the shaft 56 presses down the lever 51 and restores the parts to the position shown in Figure 6. Previous to this the solenoid 25 has been de-energized, as will be made clear hereinafter, so that the fork 49 and pin 50 have fallen into the position shown in Figure 6, leaving downward movement of the hooked end of the lever 51 unimpeded.

The half turn of the common shaft 45 is thus accomplished while the clutch members are engaged, and disengagement takes place during idle movement of the gear 43, and therefore while the shaft 45 is stationary. During the movement of the shaft 45, operation of the particular control valve 22 selected takes place by the following means.

On the back of the clutch member 46 is fixed a roller 59 which moves in a circle with the clutch member, close to the transmission plate 60 mounted for vertical reciprocating movement. Starting, for instance, from the position shown in Figure 5, the roller, moving clockwise, soon strikes the shoulder 61 on the member 60 and pushes it down, until the roller finally leaves said shoulder and comes to rest in a position 180 degrees from that shown in Figure 5. On the next clockwise movement of 59, it strikes the shoulder 62 on the opposite side of the transmission member 60, and, when the half turn of 59 is completed, the parts are restored to the position shown in Figure 5. It is thus shown that successive half turns of the clutch member 46 and roller 59 cause alternate up and down movements of the member 60.

Directly beneath each member 60, an operating lever 63 is located, being pivoted at 64 and having jaws 65 at its outer end which embrace a pin 66 on the swinging lever 67 of the corresponding control valve. Each

lever 67 is fulcrumed at 68, and is pivotally connected with the operating plunger of the corresponding valve 22. A handle 69 on the lever 67 furnishes the means for manual operation. Each lever 63 is operatively connected, by a pivotally secured connecting bar 70, with its corresponding transmission plate 60. The up and down movements of the member 60 thus act to swing the corresponding lever 67 and operate its control valve 22.

Inspection of Figure 5 will show that, when not in operation, the roller 59 is free of both shoulders 61 and 62, and entirely disconnected from the transmission plate 60. Thus manual operation of any valve is made possible without stopping to disconnect the automatic operator, since the member 60 can move freely up and down with the movements of the lever 67.

In Figures 6 and 7 are shown the means for operating the "unit preparing switch" described hereinafter. Back of the transmission member 60 in each unit is a flat plate 71, having a slot 72 embracng the operating shaft 45. Up and down movement is imparted to this plate 71 by a roller 73 on the disc 74 fixed to the clutch member 46. This roller impinges, near the end of each half turn movement of 46, against the sloping surfaces 75, 76, shown in dotted lines in Figure 7, thus pushing the plate 71 up or down.

This movement of the plate 71 swings the two armed lever 77 (which is pivoted at 78) so that its insulated metal tip 79 makes alternate contact with spring terminals 80 and 81 (see Figures 3 and 3). One of the results of this action is to break the energizing circuit through the solenoid 25 of the particular unit in operation, as heretofore mentioned.

In addition to the unit preparing switches just described, one of which is furnished in connection with each operating unit, a common operator-preparing switch is provided. This is directly operated by the movable member of the hydraulic operator 24 and comprises an insulated metallic contact 82 carried by the crosshead 37 and adapted to connect the pair of electric contact terminals 83 when raised (as in Figure 3) or to connect the terminals 84 when depressed (see also Figure 8). The function of this switch will appear hereinafter.

The operation of the pilot valve initiated, as already described, by closure of the switch 29, is carried out by the mechanism shown in Figures 9, 10, and 11. The motive force for this purpose is furnished by any convenient source of power, and preferably by a constantly running gear not shown meshing with the bevel gear 85 sleeved loosely on a shaft 86 extending from end to end of the pilot valve operator. On the opposite end of the sleeve which carries the gear 85 is the driving member 87 of a positive clutch. Normally the shaft 86 is stationary, but it may be revolved 180 degrees at a time by bringing the driven clutch member 88 into engagement with the driving member 87. The member 88 is keyed on the shaft 86 and can be made to slide to the right or left in Figure 9.

As has already been explained, the pilot valve solenoid 30 is energized by closing the switch 29. Directly beneath the solenoid 30 there is provided a slide 89 which can be lifted in the guideway 90 by means of the extension 91 pivotally attached at 92 to the core of the solenoid 30.

The slide 89 carries a horizontal pin 93 and a vertically placed roller 94 under the slide. The pin 93 stands normally in the path of movement of the two pins 95 and 96 placed 180 degrees apart on the front face of the circular flange 97 fixed to the back of the clutch member 88. The roller 94 rests normally against the flat top of one or the other of the raised portions 98, 99, placed 180 degrees apart on the front face of the cam plate 100, also forming a part of the movable or driven clutch member 88. Diametrically opposed projections 101 and 102 project forward from the front of the disc or flange 97, being located ninety degrees from the cams 98 and 99. These projections have inclined faces which are adapted to slip over the pin 93, when raised, as the clutch revolves, pushing the pin down and insuring the descent of the slide 89.

When the slide 89 is lifted by the solenoid 30, the roller 94 is lifted away from in front of the cam portion 98 or 99, and the pin 93 is lifted out of the path of movement of the pins 95 and 96. This permits the spring 103 to press the clutch member 88 into engagement with the member 87, causing 88 to revolve, and with it the shaft 86.

Mounted on the shaft 86 is the insulated drum 104 carrying the metal piece 105 which normally makes contact with the terminals 106 or 107 in alternation. As will be seen by inspection of Figure 8, the first result of revolving the shaft 86 and drum 104 is to break the circuit of the solenoid 30. This allows the slide 89 to drop so as to bring the roller 94 into position to receive the thrust of one of the cam surfaces 98 or 99. Should the slide 89 stick for any reason, it would be drawn down by one of the projections 101 or 102 before the cam 98 or 99 reached the roller 94. The revolution of the shaft 86 continues until the raised cam portion 98 or 99 comes under the roller 94, which causes the clutch member 88 to move to the right in Figure 9 and disengages it from the member 87. The shaft 86 is thus brought to rest just as the pin 95 or 96 comes against the pin 93 thus locking the shaft against further movement.

It will thus be seen that a momentary action of the solenoid 30 is produced, after which the solenoid is quickly de-energized by breaking its circuit at the switch 104. Movement of the shaft 86 is thus initiated electrically, and is continued until a half turn of the shaft has been accomplished, at which time the shaft is automatically brought to rest by mechanical disengagement of clutch members.

This half turn of the shaft 86 actuates the plunger rod 108 of the pilot valve 31, by means of the off-set pin 109 at the rear end of the shaft 86. One half turn produces a complete upward movement of the valve plunger and the next half turn produces a complete downward movement thereof. As before explained these alternate movements of the pilot valve produce corresponding movements of the hydraulic engine 24.

It will now be possible to return to the diagram, Figure 8, to explain in detail the operation of the entire device. This explanation will have reference to a single unit, a single control valve and a single main valve with its actuating hydraulic engine; but it will be understood that it applies to each and all of the units with their corresponding operated elements, and that separate circuit closing contacts are provided at proper points along the travel of the movable member of the central timer switch F for the respective units. Of course any kind of switches can be used at the central control, either automatic or manual.

Assuming that the main valve 20 is closed, the central timer finger 28 moves forward clockwise until it touches the contact terminal 26. Circuit is at once established as follows:—From the main terminal L^1 by wire 110, finger 28, terminal 26, wire 111, terminals 80 and contact 79, solenoid 25, wire 112, terminals 106 and contact 105, wire 113, terminals 83 and contact 82, and wire 114 to main terminal L^2.

The solenoid 25, causes engagement of the control valve operating clutch members 46 and 47 and closes the switch 29. This establishes a circuit through the pilot valve solenoid 30 in multiple arc with the circuit traced above, as follows:—From main terminal L^1, by wire 115, solenoid 30, wire 116, switch 29, wire 112, terminals 106 and contact 105, wire 113, terminals 83 and contact 82, and wire 114 to main terminal L^2.

The pilot valve is thus operated, the circuits of both solenoids 25 and 30 being broken almost at once by movement of the contact 105 away from the terminals 106. Operation of the pilot valve starts the piston 33 in the hydraulic engine 24, and a further break in the solenoid circuits is caused by movement of the contact 82 away from the terminals 83.

At the same time the half turn imparted by the engine 24 to the operator shaft 45 actuates the proper control valve 22, whereby the desired movement in the main hydraulic engine 21 is produced. Accompanying this operation, the contact 79 is swung over to connect the terminals 81 in preparation for reversal of movement of the control valve thus breaking the circuit of the solenoid 25 at yet another point.

At the end of the half turn movement of the shaft 45 which moves the control valve, the switch 29 is opened, the contact 82 bridges the terminals 84 preparatory to reverse movement of the engine 24, and the contact 105 bridges the terminals 107 preparatory to reverse movement of the pilot valve. These last named switches may, therefore be named respectively the general operator preparing switch and the pilot preparing switch.

When the next operator unit is to be actuated, it is accomplished by an upward movement of the pilot valve plunger causing an upward movement of the operating piston 33. The movement of the common operating shaft 45 is as before, however, in a clockwise direction. The circuits established at the central timing switch and by closure of the pilot switch 29 will be as before, save that the current passing through the solenoids 25 and 30 passes through the terminals 84 and 107, instead of through 83 and 106.

The switch actuated directly by movement of the crosshead 37 acts to break the general circuit through all the solenoids 25 (all connected on the wire 112) immediately after the hydraulic engine begins to move, either up or down. Hence, if the piston 33 should be arrested accidentally after starting, no other unit clutch in the general control valve operator could be operated from the central timing switch, and the pilot valve could not be improperly operated.

Whenever any operator unit acts to open a control valve it throws the switch contact 79 from the terminals 80 to terminals 81. This disconnects the opening contact 26 at the central timing switch, and that particular unit cannot be again operated except through its closing contact 27, which is connected with one of the terminals 81. This switch may therefore be termed the unit preparing switch, since, after each operation of its particular unit, it prepares the circuit which must be closed for the next operation. It will be noted that each unit preparing switch is operated solely by the electrically controlled automatic operation and is never disturbed by any manual operation of a control valve.

It will be seen from the above description that the subject matter of this invention is an electrohydraulic mechanism for selective operation of a distinct group of instrumen-

talities of any kind from a central point. While control valves are the specific instrumentalities which have been described as operated, it is to be understood that the invention is not limited to these. In the claims hereof the expression "control valves" is intended to include any instrumentality capable of selective operation by the apparatus claimed.

This invention is capable of embodiment in a great variety of structures, and it is not limited to the details herein shown and described.

What is claimed is—

1. In combination with a group of control valves, mechanism for positively operating the same in two directions and operative connections between said valves and said mechanism adapted to permit manual operation of any valve unimpeded by said mechanism.

2. Apparatus for operating control valves comprising driving mechanism, transmission members, capable of operative connection with such valves for positively moving them in two directions, said members when idle being adapted to move independently of their driving mechanism, whereby manual operation of the valves may be had without disturbing their normal connection with the operating apparatus.

3. Apparatus for operating control valves comprising a transmission plate adapted to reciprocate in its own plane and connected with a control valve, a rotatable operating shaft, and means driven by said shaft for engaging said plate to impart positive operative reciprocating movement thereto in two directions.

4. Apparatus as in claim 3 wherein a pin adapted to move around the operating shaft engages a shoulder on the transmission plate during a portion of a half revolution and then moves clear of engagement with said plate.

5. Apparatus as in claim 3 comprising a pin adapted to move around the operating shaft and a transmission plate normally disconnected from said pin and having a shoulder on each side of the shaft, said shoulders being adapted to be alternately engaged by said pin on the occurrence of successive half turns of the shaft.

6. In apparatus for operating control valves, a series of units side by side each adapted to operation of a single control valve, in combination with a common operating shaft and means adapted for use during operation of the valve controller for bringing each unit selectively into operation with said shaft.

7. Apparatus as in claim 6 comprising an operative lever actuated by each unit, each lever being furnished with open jaws at its movable extremity adapted to engage the movable member of a control valve.

8. Apparatus of the character described, comprising a row of automatic control valve units side by side, a common operating shaft for said units, selective means for bringing each of said units separately into operative relation with said shaft, said last named means comprising a hydraulic engine adapted to impart successive half turns to the operating shaft between periods of rest.

9. In apparatus of a character described, a straight row of automatic control valve units side by side and a common operating shaft extending along said row, in combination with means for bringing each of said units separately into operative relation with said shaft for movement in two directions, said means comprising a clutch, electromagnetic means for actuating the same and an electric circuit for energizing said actuating means.

In testimony whereof I have hereto set my hand on this 9th day of February 1923.

JAMES S. KENNEDY.