

Dec. 17, 1940.

K. BLASIG

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FLUID RELAY MECHANISM

Filed Aug. 19, 1936

3 Sheets-Sheet 1

Fig. 1

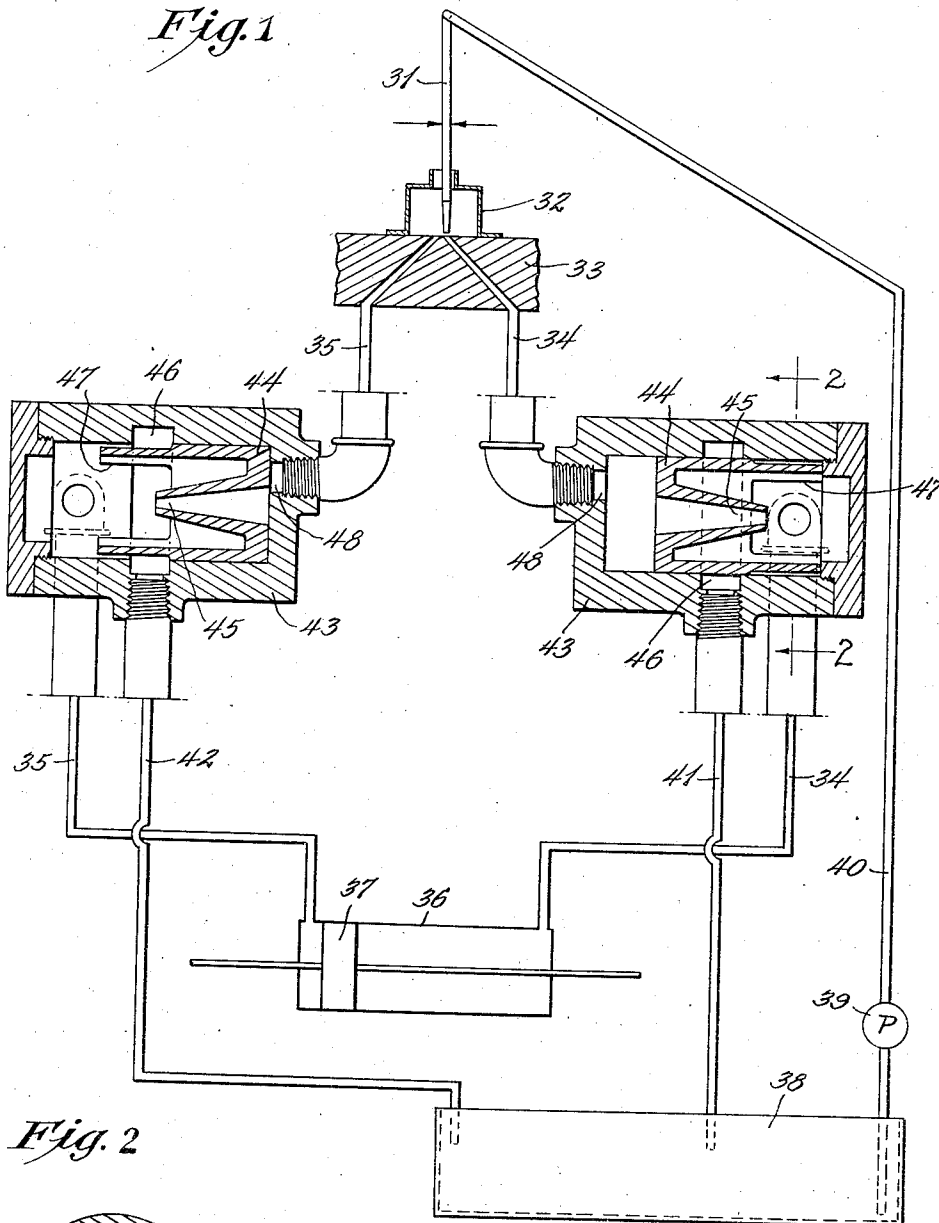
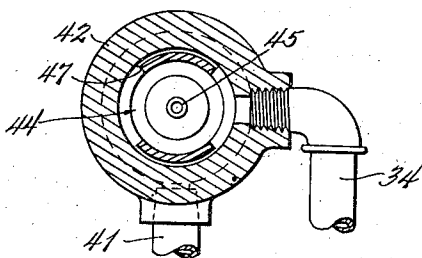


Fig. 2



Inventor
K. Blasig

A. D. Adams

Attorney

Dec. 17, 1940.

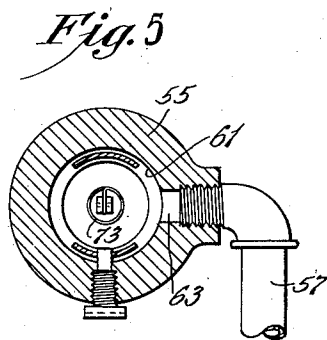
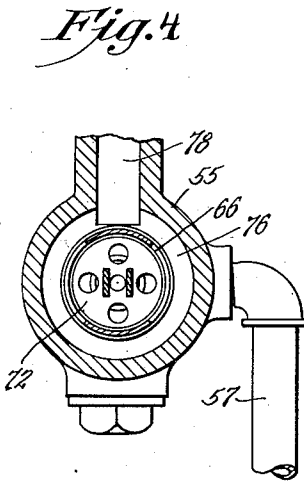
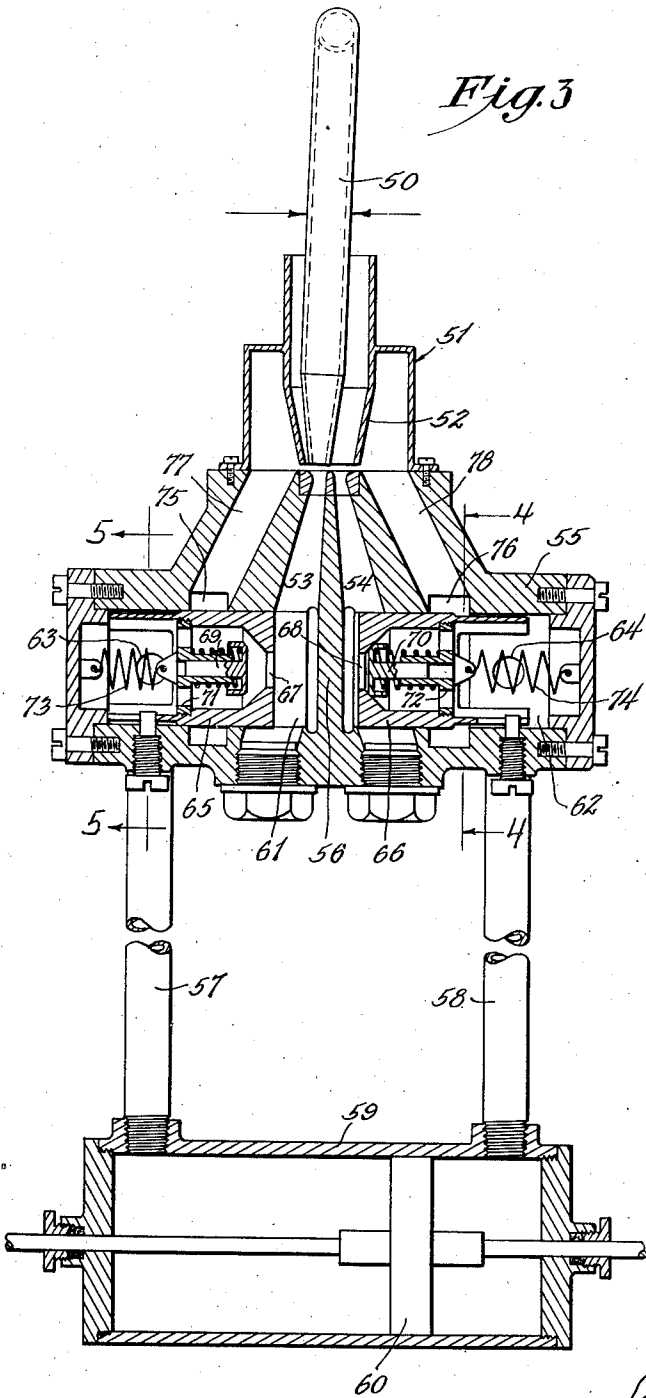
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3 Sheets-Sheet 2



Inventor
K. Blasig

A. D. Adams

Attorney

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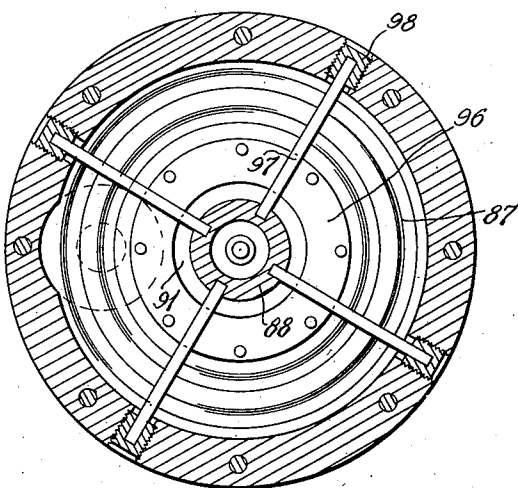
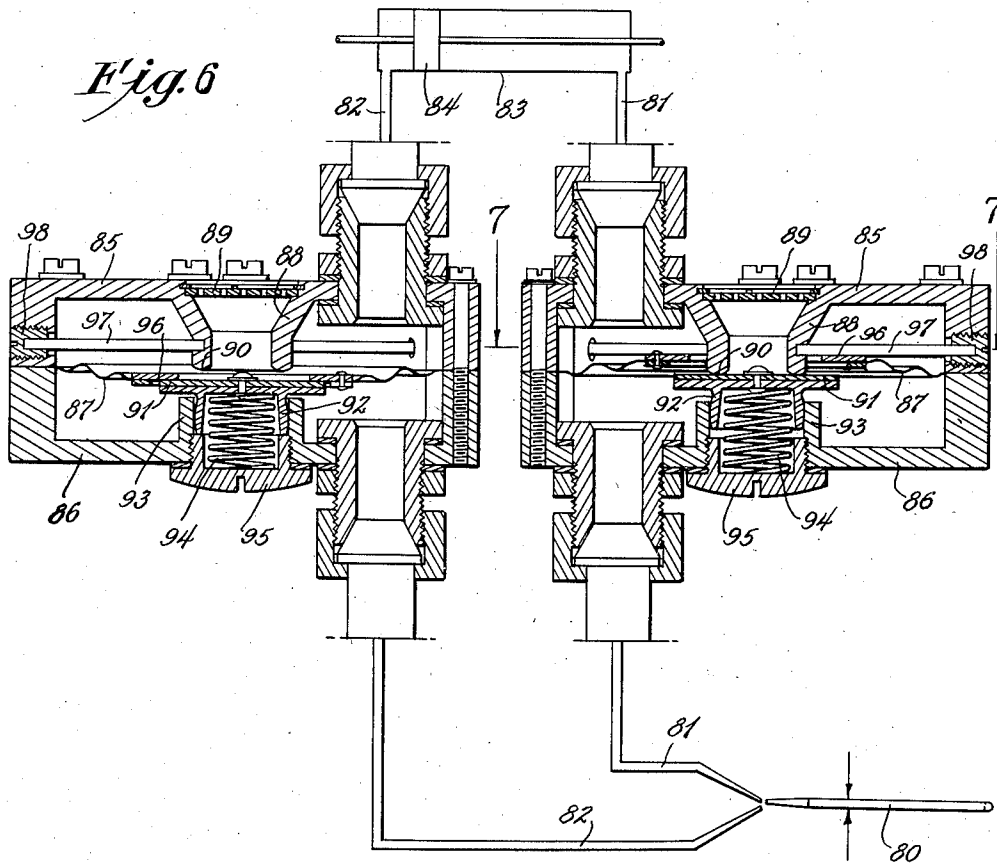
K. BLASIG

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FLUID RELAY MECHANISM

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3 Sheets-Sheet 3



Inventor
K. Blasig

A. D. Adams

Attorney

UNITED STATES PATENT OFFICE

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FLUID RELAY MECHANISM

Kurt Blasig, Berlin-Steglitz, Germany, assignor
to Askania-Werke A. G., a company of Ger-
many

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10 Claims. (Cl. 121—38)

This invention relates to fluid pressure operated relay mechanism of the type in which a pressure differential is created by admitting fluid under pressure to one or the other of two conduits connected to operate a control device or motor, such as a cylinder having a control piston therein, a double acting valve, or the like. Among other objects, the invention aims to provide novel means to relieve the pressure in which ever conduit happens to constitute the return line from the controlling device or motor to the source of the pressure fluid, the main idea being greatly to increase the efficiency and sensitivity of relays, such as the well known "Askania" jet pipe regulators.

Other aims and advantages of the invention will appear in the specification, when considered in connection with the accompanying drawings, wherein:

Fig. 1 is a sectional view of two relief valves in a hydraulic relay, conventional parts of the apparatus being shown diagrammatically;

Fig. 2 is a sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is a central sectional view of another embodiment of the invention;

Figs. 4 and 5 are sectional views taken on the lines 4—4 and 5—5, respectively, of Fig. 3;

Fig. 6 is a sectional view of another embodiment of the invention showing relief valves best adapted to be used in systems operating by low pressure fluid or air; and

Fig. 7 is a sectional view taken on the line 7—7 of Fig. 6.

In all relay mechanism of the type set forth, a pressure differential is created on opposite sides of a double acting piston or diaphragm as soon as the mechanism is moved out of its neutral position and the fluid flows to one side of the cylinder or diaphragm while it exhausts or returns from the other side. The direction of movement depends on the deflection of the relay mechanism from its neutral position. In devices of this kind, the operating medium returns in the line of lower pressure through the relay mechanism. This has many disadvantages because the reaction of the returning fluid affects the relay mechanism by creating unbalancing forces acting on the mechanism. A further disadvantage of devices of this kind is that the fluid is throttled in the return line and thereby creates a resistance which decreases the efficiency of the operation because energy has to be supplied to create forces which are necessary to force the operating medium back through the return open-

ing. This force changes with the second power of the control speed or the corresponding quantity of operating medium and it is impossible to obtain the power from the controlling device, such as a piston or diaphragm, which would otherwise be available, if such a restriction could be avoided. In other words, the efficiency of the mechanism is decreased because of this additional energy loss.

Some attempts have been made to avoid or decrease the energy losses in relays of the fluid jet type. For example, the two conduits having adjacent orifices were arranged in a plane substantially at right angles to the plane of movement of the jet pipe, inclined to each other, so that the oil returning through either orifice would not strike the jet pipe nozzle. Moreover, the distance of the nozzle from the distributor block or orifices has been increased to remove the end of the nozzle from the path of the returning fluid so that the fluid does not react on the jet pipe. However, such changes, although they increased the sensitivity of the relay mechanism by decreasing the reacting forces, have not decreased the energy losses nor increased the efficiency of the apparatus. This invention, therefore, provides means to avoid the disadvantages of energy losses incident to returning the operating medium. The main idea is to provide an additional opening or by-pass for the return flow of the fluid and automatic valve means to by-pass the fluid there-through whenever the flow is reversed or the pressure decreases in one conduit below the pressure in the other. The arrangement is such that, in addition to reducing the reaction on the controlling relay, the throttling effect of the small orifice on the returning fluid is eliminated.

The simplest embodiment of this invention involves the provision in two pressure conduits of a by-pass which is designed to open automatically and relieve the pressure in the conduit carrying the lowest pressure or acting as the return line. In case a pressure differential is created between both conduits, the pressure is relieved entirely in the line which would normally carry the lower pressure. Under these circumstances, the full pressure in the high pressure line can be used to operate the controlling motor. In some instances, it is desirable to employ independent valves in the pressure conduits which permit flow of the pressure fluid in one direction but which relieve the pressure when the fluid flows in the opposite direction by opening an outlet until the pressures on both sides have adjusted themselves to maintain a certain position of the controlling

motor or mechanism with a predetermined pressure difference. Also, the relief valves may be so designed as to maintain a certain pressure in the line of lower pressure above the exhaust pressure.

In Fig. 1 there is shown an illustrative embodiment of the invention wherein separate valves are arranged in the conduits. In this case, the jet pipe 31 extends into an oil catcher 32 on a distributor block 33 from which pressure conduits 34 and 35 lead to a cylinder 36 having a control piston 37. Oil or other liquid is supplied to the jet pipe 31 from a reservoir 38 by means of a pump 39 through a conduit 40.

In each of the pressure conduits, there is shown a piston-type valve which controls the exhaust or discharging oil through by-pass conduits 41 and 42 leading to the reservoir 38. Each valve includes a suitable casing 43 having a hollow piston 44 which is conveniently made cup-shaped and has a centrally arranged nozzle 45 pointing toward the open end of the piston and leading to the operating cylinder 36. The piston valves 44 serve to open and close ports or annular grooves 46 in the casings which communicate with the exhaust conduits 41 or 42. The right hand valve in Fig. 1 is shown as being in position to close the by-pass 46 and permits the oil to pass freely through the nozzle 45 into the conduit 34 leading to the right hand end of the cylinder 36. The outer ends of the pistons are shown as being slightly reduced in diameter and have cut-away slots or notches 47 to permit the oil to flow freely into and out of the respective conduits 34 and 35. The piston valve at the left hand side of Fig. 1 is shown as being open to permit the returning oil from the cylinder 36 to pass through the conduit 35 into the valve casing and out through the by-pass conduit 42, it being noted that the valve uncovers the port or annular channel 46 in this position. Incidentally, the inner end walls of the valve casings are shown as having ports 48 communicating with the conduits 34 and 35. In this instance, the inner end of the left hand valve partially covers the port 48 to which the conduit 35 is connected and thus permits some of the returning oil to pass through the end of the nozzle and up through the conduit 35 to the oil catcher so as to keep the oil catcher and the conduit filled at all times.

In such systems, it is desirable to maintain an oil level in the oil catcher 32 notwithstanding the fact that the pressure is relieved in which-ever conduit happens to constitute the return line. The idea is to keep the lower end of the jet pipe submerged and prevent air from entering the conduits when liquid, such as oil, is used as the operating fluid. A slight excess of oil may be introduced through the jet pipe to cause the oil catcher to overflow. The openings 45 and 48 permit a slight pressure in the return line sufficient to keep the oil catcher full of oil. It will be understood that such relay devices are arranged within a housing (not shown) so that the overflowing and/or by-passed oil or fluid will return into a reservoir.

In Fig. 3, there is shown an embodiment wherein the relief valves are combined with the distributor block for the jet pipe in the form of a single unit. This arrangement is especially advantageous in jet pipe relays using oil because it provides means whereby some of the oil may easily be by-passed from the valve into the oil catcher to keep the jet pipe submerged. In this

instance, the jet pipe 50 extends into an oil catcher 51 and its lower end is surrounded by a frusto-conical tube 52. It discharges through orifices into passages 53 and 54 formed in the body of the distributor block 55 on opposite sides of a central partition 56. The passages 53 and 54 are adapted to be controlled by the relief valves and communicate with conduits 57 and 58 leading to the opposite ends of the control cylinder 59 having the control piston 60. Herein, the casing 55 has cylindrical openings 61 and 62 extending into opposite ends thereof and communicating at their inner ends with the passages 53 and 54, respectively, and near their outer ends with the conduits 57 and 58, respectively, through lateral openings 63 and 64. Hollow piston valves 65, 66 are shown as being inserted in the cylinders and they have openings 67 and 68 at their inner ends adapted to be closed by small spring urged valves 69 and 70 conveniently mounted in spiders 71 and 72. These valves are biased to move outwardly by tension springs 73 and 74. When they are in their normal position, the spring urged valves 69 and 70 close the ports 67 and 68. Also, in these positions, the piston valves 65 and 66 cover annular ports 75 and 76 which communicate with by-pass conduits 77 and 78 respectively, both leading to the oil catcher 51 outside of the annular baffle or shell 52. The arrangement is such that the returning oil current or eddies cannot affect the movement of the jet pipe.

In the example shown, the oil is being discharged from the jet pipe into the passage 53 and pressure has opened the valve 69 so that the oil can flow through the port 67; thence through the spider 71 and through the slotted outer end of the piston into the port or opening 63 leading to the conduit 57 to move the control piston 60 to the right. The returning oil on the other side of the piston passes upwardly through the conduit 58 into the right hand cylinder through opening 64. The pressure of this returning oil is sufficient to overcome the tension of spring 74 and move the piston valve 66 to the left, as shown, so as to uncover the annular port 76 and permit the oil to pass through the by-pass passage 78 into the oil catcher. From the oil catcher, the excess oil overflows and falls to a reservoir (not shown), as hereinbefore explained. When the flow of the oil is reversed, the positions of the valves will be reversed and the operation will be otherwise the same.

In Fig. 6, there is shown an embodiment of the invention especially adapted for use in relay systems operating on low pressure fluid, such as air, and in the case of controls wherein a certain pressure must be maintained in the line of lower pressure. In this instance, a jet pipe 80 discharges into conduits 81 and 82 leading to the cylinder 83 having the control piston 84. The valves in this instance are designed to relieve only partially the pressure on the return side of the controlling pistons. It is only necessary to describe one of the valves in this case, because both of them are shown as being identical. Herein, each valve has a casing composed of sections 85 and 86 bolted together and carrying a diaphragm 87 clamped between them. The upper section 85 of the casing has an integral pressure relief conduit or outlet 88 leading to the central portion of the casing providing a relief opening shown as being covered by a perforated plate or screen 89. The inner end of this conduit terminates in a valve seat 90 which is adapted

to be closed by a valve 91 having an extension 92 guided in an upstanding sleeve 93 integral with the lower section 85 of the casing. This valve is held normally closed by means of a coil spring 94 in a screw cap 95. The disk 91 is shown as being larger than the valve seat 90 and provides another valve seat which cooperates with an annular valve plate 95 secured to and held normally seated by the diaphragm, but it is adapted to be opened by the flow of fluid or the jet pipe pressure exerted in one direction on the diaphragm. The right hand valve 96 in Fig. 8 is shown as being open so that the operating fluid flows into the right hand end of the control cylinder. The pressure on the left side of the piston 82 is relieved until it balances the pressure of spring 94 plus the pressure in the conduit 82 on the jet pipe side of the diaphragm. Thus, a pressure is maintained in the lower pressure line. To limit the opening movement of the diaphragm valve, there is shown a series of radial arms or stop bars 97 projecting into openings in the outlet conduit 88 and mounted at their outer ends in screw plugs 98. However, any other suitable stop members may be employed.

As has been explained, the jet pipe pressure admitted through conduit 81 has moved the control piston 84 to the left; while the return fluid passes downwardly through the conduit 82 and the valve on the left hand side. The returning fluid on the left hand diaphragm 87 exerts pressure on the disk valve 91 through the intermediary of the annular valve plate 95, thereby holding the valve 96 closed and overcoming the compression of the spring 94 to open the disk valve and permit the fluid to escape through the relief conduit 88. This not only prevents any of the returning air or other fluid from passing back through the conduit 82 to the jet pipe 80 and interfering with its movement, but also permits a predetermined pressure to be maintained in the line of lower pressure.

From the foregoing description, it will be readily understood that relay mechanism embodying this invention is very efficient and sensitive. The valve means in the pressure conduits always serves to relieve the pressure in the return conduit so that the maximum amount of power delivered is available for operating the control motor. When such valves are used in conjunction with hydraulic fluid jet relays of the "Askania" type, the nozzles of the jet pipes may be placed at a minimum distance from the openings or orifices in the distributor blocks so as to discharge almost directly into said orifices. This is made possible because eddy currents produced by returning oil are eliminated. Moreover, it is no longer necessary that the conduits in the distributor blocks shall lie in a plane at right angles to the plane of movement of the jet pipe. They may be arranged in the same plane and this simplifies the manufacture of the distributor blocks. Furthermore, pneumatic relays operating at low pressures are made very sensitive to changes in pressure.

Although the illustrated relay systems are shown as employing jet pipes, it will be understood that the invention is applicable to many other forms of fluid pressure relays or control devices, such as those employing ordinary four-way valves.

Obviously, the present invention is not restricted to the particular embodiment thereof herein shown and described. Moreover, it is

not indispensable that all the features of the invention be used conjointly, since they may be employed advantageously in various combinations and subcombinations.

What is claimed is:

1. A pressure fluid jet pipe relay system comprising, in combination, a movable jet pipe adapted to be moved in response to a controlling impulse and having a discharge nozzle for the fluid; a pair of conduits having inlet orifices at one end closely adjacent to said jet pipe nozzle to receive the pressure fluid; a servo-motor connected to the other end of said conduits adapted to be operated by the pressure fluid delivered through said orifices; an exhaust opening for the pressure fluid in each of said conduits; and an automatic valve in each conduit operative by the fluid flow to the servo-motor to close the exhaust opening and also operative by return flow of fluid from the servo-motor to open the exhaust opening and thereby permit at least a major portion of the fluid to escape directly through the exhaust opening.

2. In a hydraulic jet-pipe relay of the character described, an oil catcher into which the jet-pipe projects; a distributor block having conduits into which the jet-pipe is adapted to discharge fluid to operate a control device; a valve housing associated with the distributor block and having by-pass conduits leading from said fluid conduits to said oil catcher; valves in said housing responsive to the direction of the fluid for closing said by-pass conduits upon a flowing of fluid from the relay and for opening said by-pass conduits upon a return of fluid to said relay; and a check valve arranged to prevent a return of fluid through said distributor conduits.

3. In a hydraulic jet pipe relay of the character described, an oil catcher into which the jet pipe projects; a distributor block having conduits into which the jet pipe is adapted to discharge to operate a control device; a valve housing associated with said distributor block and having by-pass conduits leading from said fluid conduits to said oil catcher; hollow piston valves in said valve housing for opening and closing said by-pass conduits and having ports therein permitting the passage of fluid therethrough to operate the control device; and spring urged valve members normally closing said ports, said piston valves being operable by the pressure differential of the fluid admitted and the fluid returned through the respective conduits to close the by-pass conduit to the oil catcher to admitted fluid and to open the by-pass conduit to returning fluid.

4. In a pressure fluid relay having two fluid conduits through which pressure fluid is adapted to be delivered to and returned from a control device, combination pressure relief and check valves in each of said conduits, said valves having relief ports opening to the atmosphere, and each of said valves including a first valve member controlling a relief port, a second check valve member for sealing the conduit to return flow to the relay, and means responsive to the direction of flow and arranged to operate said first and second valve members to open the check valve and close the relief port upon a flow of fluid from the relay and close the check valve member and open the relief port upon a flow of fluid to the relay.

5. In a pressure fluid relay having two fluid conduits through either of which pressure fluid is adapted to be delivered to a control device

while fluid is returned through the other, pressure relief valves in each of said conduits having outlets or relief openings to the atmosphere, and each comprising associated valve members, one of the valve members contacting and closing the relief opening and the other valve member moving relatively to the first-mentioned valve member and thereby forming a passage means therebetween to permit fluid to flow to one control device, and one valve member sealing itself against the other and both being then operated as a unit by the fluid flowing from the control device to open the relief opening and relieve the pressure in the fluid conduit carrying the returning fluid.

6. In a pressure fluid relay having two fluid conduits through either of which pressure fluid is adapted to be delivered to a control device while fluid is returned through the other, relief valves connected to each of said conduits, each comprising a casing having a by-pass conduit leading to the atmosphere; a spring-urged, disk-shaped first valve member normally closing said by-pass conduit; an annular second valve member surrounding the by-pass conduit and normally seated on said first valve member; an annular diaphragm secured within said casing and carrying said second valve member, said diaphragm being arranged to move the second valve member to its open position by lifting it from the first when pressure fluid flows towards the control device during which movement the first valve member remains closed, and arranged upon a return of fluid from the control device to move the second valve member into the closed position by sealing it against the first and moving the latter into the open position thereby.

7. The combination with a pressure fluid relay having two fluid conduits through either of which fluid pressure is adapted to be delivered to a control device while fluid is returned through the other, pressure relief valves in said conduits each comprising a casing having a relief opening; a valve member within the casing normally closing said relief opening; a second valve member associated with and normally sealed against the first valve member but adapted to be opened by pressure fluid flowing through the valve casing toward the control device, while the first

valve member remains closed, both of said valve members being arranged to be operated as a unit to open said relief opening by the pressure fluid returning from the control device.

8. In a hydraulic jet pipe relay of the character described, an oil catcher into which the jet pipe projects and is adapted to be submerged; conduits having spaced orifices into which the jet pipe is adapted to discharge and connected to operate a control device; and by-pass valve means operable by the pressure of the returning fluid and connected between said conduits and said oil catcher to relieve part of the pressure fluid in the conduit through which the oil returns, said valve means thereby permitting some of the returning oil to be delivered to the oil catcher to keep it filled.

9. In a jet-pipe relay the combination with a movable jet-pipe, of an oil catcher into which said jet-pipe projects; a distributor block having reception orifices into which the jet-pipe is adapted to discharge pressure fluid to operate a control device, and conduits communicating with said orifices; means responsive to the direction of flow in said conduits and connected to control an additional outlet port for withdrawing upon a return of pressure fluid to the relay part of the returning fluid, whereby a low resistance passage is provided for the returning fluid while part of the fluid is permitted to flow through said orifice to maintain the oil catcher filled.

10. In a pressure fluid relay having controlled ports and conduits through which pressure fluid is adapted to be delivered to and returned from a control device a pressure relief valve in each conduit comprising a valve casing having inlet and outlet openings and an exhaust port; a movable piston therein for controlling the exhaust port, said piston having an orifice through which pressure fluid is permitted to pass and being in the form of a conical nozzle thereby offering a greater flow resistance in one direction than in the other, the exhaust port being positioned relatively to the piston so that upon flow in one direction and a corresponding movement of the piston to one end the port is opened, while upon flow in the other direction it is closed.

KURT BLASIG.