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PNEUMATIC RELAY

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Fig. 1

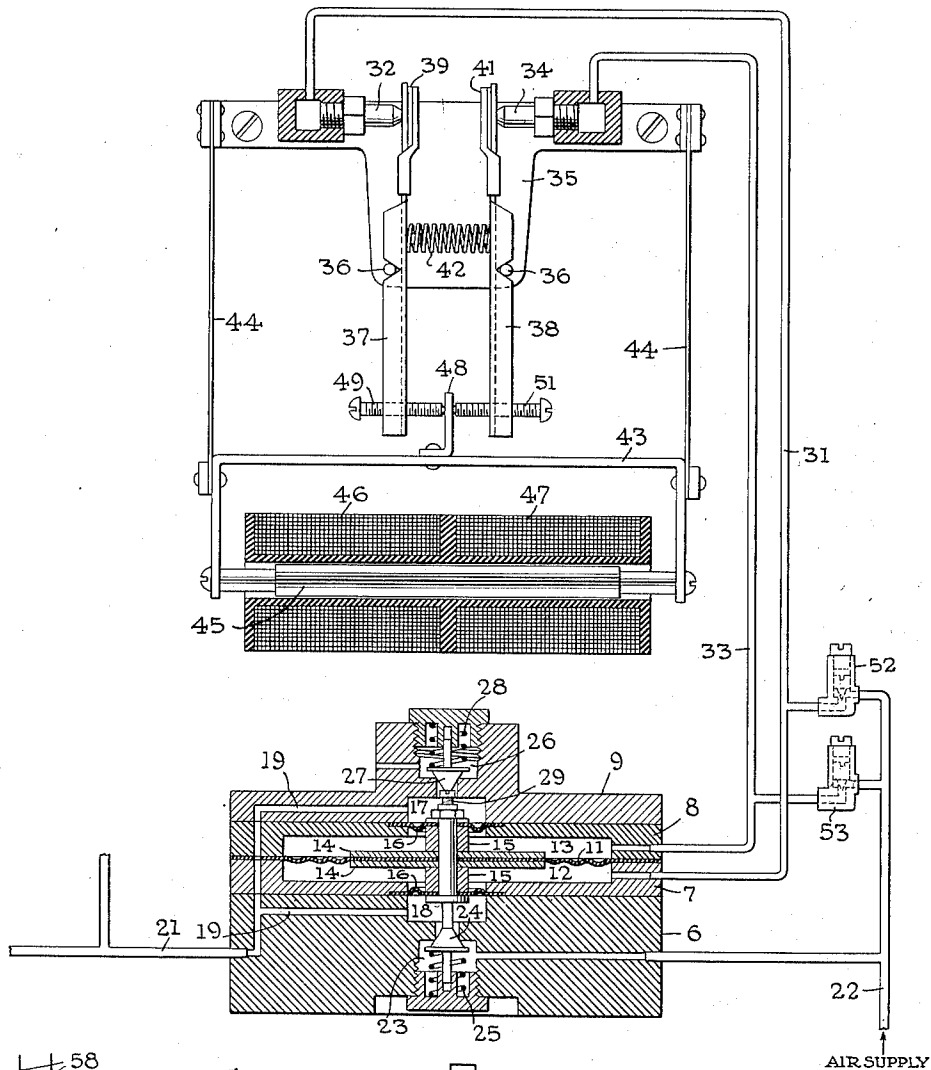
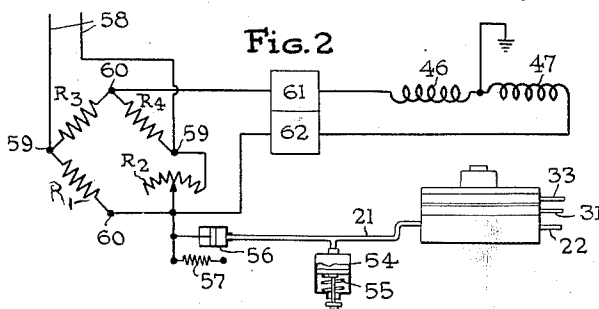


Fig. 2



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PNEUMATIC RELAY

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3 Claims. (Cl. 137—85)

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This invention relates to electrically controlled pneumatic relays, and is intended for, but not limited to, use in automatic control systems for temperature, humidity and other atmospheric conditions.

In the control art, a type of system having many practical advantages comprises a sensing element which is an A. C. Wheatstone bridge or similar network and a related pneumatic motor element which exercises control. The variable to be controlled affects the resistance of an arm of the bridge, and thus produces an output voltage whose phase is a function of the direction of change of said variable. An electronic amplifier constructed in two sections and arranged to function as a phase discriminator, is actuated by said output voltage, and controls the relative energization of two coils. The control is such that as the output to one coil increases, that to the other is either zero, or decreasing and vice versa.

The present invention relates to the relay valve, actuated by the coils in question to translate the electric output into an appropriately varying pneumatic pressure, which actuates the motor element exercising control.

Stability of the system is secured by the use of a "rebalancer" whose action is related to said varying pneumatic pressure (i. e., the pressure in the controlling motor). Such a rebalancer may, within the range of equivalents offered by the prior art, either actually rebalance the bridge (the more usual arrangement) or neutralize the output caused by unbalance.

Both schemes are disclosed in an application of I. I. Davies, Serial No. 649,246 filed February 21, 1946, now Patent Number 2,523,198, dated September 19, 1950, which is owned by applicant's assignee.

The advantage offered by systems of the type described is that they combine the sensitive sensing action of the Wheatstone bridge with the smooth graduated control offered by the pneumatic leak-port.

The distinctive thing about the relay is that the controlling diaphragm is in a balanced condition when the sensing system is in balance, regardless of the controlled or branch line pressure. This pressure may at such time have any value within the controlling range of the relay.

The invention will be described in detail by reference to the accompanying drawing, in which:

Fig. 1 is a view part in section and part in elevation, showing the improved relay.

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Fig. 2 is a simplified diagram of a typical null balance bridge system in which the relay may be incorporated.

The valve portion of the relay is enclosed in a housing made up of a base 6, two diaphragm chamber portions 7 and 8 and a cap 9. These are connected tightly by bolts or like means, not illustrated.

Clamped between parts 7 and 8 is the margin of a combined diaphragm and gasket 11 so that the central diaphragm portion is exposed over equal areas on its opposite faces to pressures in chambers 12 and 13. The center of the diaphragm is stiffened by a hub assembly made up of center plates 14 and hub members 15. Small diaphragms 16 of equal area are clamped at their centers between the hub members 15 and end washers, the whole assembly being clamped by a center bolt as clearly shown in the drawing.

The margins of diaphragms 16 are clamped and act as gaskets respectively between member 8 and cap 9 (to separate chamber 13 from exhaust chamber 17) and between base 6 and member 7 (to separate chamber 12 from inlet chamber 18). Thus the diaphragms 16 serve as packless joints. The chambers 17 and 18 are connected by passages 19 with the branch line 21. This, as will be further explained, leads to the motor which performs the regulatory function and also to the rebalancing motor. The pressures in chambers 17 and 18 are always equal and since diaphragms 16 are of equal areas the relay valve is indifferent to pressure in the branch line 21.

The main air supply line 22, which may for example be maintained at 15 pounds gauge pressure, leads to chamber 23 in base 6. An inlet poppet valve 24 controls flow from chamber 23 to chamber 18, and closes in the direction of flow. It is biased in a closing direction by a spring 25 as well as by supply pressure. The valve 24 has a pilot which is engaged by the hub assembly upon downward motion of the diaphragm 11 from its mid-position.

In the cap 9 is an exhaust valve chamber 26, vented to atmosphere. In this chamber is a poppet-type exhaust valve 27 which controls flow from chamber 17 and opens in the direction of outflow. The valve is loaded by spring 28 heavily enough to remain closed under the full pressure in supply line 22, acting on the area of the valve. The valve is so arranged as to be forced open by the hub assembly when the

diaphragm 11 moves upward from its mid-position.

Thus the diaphragm has a mid-position in which both valves 24 and 27 are closed. The valves are opened selectively by motion of the diaphragm in one or the other direction. To permit adjustment of clearance a thrust screw 29 is threaded into the hub assembly and is the member which actually engages exhaust valve 27.

A line 31 connects chamber 12 with leak port 32 and a line 33 connects chamber 13 with a leak port 34. The leak ports 32 and 34 are directed toward one another and are mounted on a fixed support 35. Supported at mid-length in fulcrum 36, carried by support 35, are levers 37 and 38, which carry at their upper ends lids or valves 39, 41 arranged to open and close respective leak ports 32, 34. The levers are biased to close their lids upon the leak ports by a coil compression spring 42 which reacts between the levers.

An inverted U-shaped yoke 43 is suspended from support 35 by parallel flexible suspender strips 44. The yoke carries a cylindrical iron core 45 which serves as the axially movable core of two solenoids 46 and 47.

A lug 48 in yoke 43 extends between the lower ends of levers 37, 38 and actuates them selectively to open the related leak ports 32 and 34 to extents dependent on the displacement of core 45 from its mid-position. For adjustment purposes, thrust screws 49 and 51 are threaded into the levers 37 and 38 and engage the lug 48.

Air is supplied from line 22 to line 31 through the adjustable throttle valve 52 and to line 33 through the adjustable throttle valve 53. These valves are each adjusted to a flow capacity less than the wide open flow capacity of the related leak ports 32, 34, so that variable throttling of the leak ports will vary pressures in respective chambers 13 and 12 from a pressure slightly above atmospheric to the full supply pressure in line 22.

Line 21 leads to a single acting pressure motor 54 which has a return spring 55. Motor 54 is the motor which exercises control. For example, if the control is thermostatic, motor 54 would control means for supplying or withdrawing heat. Line 21 also leads to a small pressure motor 56 which has a biasing spring 57 and adjusts the bridge rebalancer.

To ensure a ready comprehension of the utility of the relay reference will be made to Fig. 2.

In this figure (which is a simplified diagram) the A. C. leads 58 lead to the input terminals 59 of an A. C. bridge in which R_1 is a resistance sensitive to the controlled variable, R_2 is the rebalancing resistance adjustable by rebalancing motor 56 and R_3 , R_4 are the remaining arms of the bridge.

The output terminals 60 are connected through the two halves 61, 62 of an electronic amplifying phase discriminator to the windings 46 and 47, respectively.

When the A. C. bridge is in balance the windings 47 and 46 are in balance. They may act equally on core 45 in opposite directions, or both may be inert, depending on the functional characteristics of 61, 62 with which the present invention is not concerned.

If the bridge goes out of balance because of a change of (say) temperature, the energization of one of the coils 46 or 47 rises while the other falls (or remains zero). Thus, core 45 moves in one direction or the other, opening a

selected one of the leak ports 32 or 34 while the other remains closed. The effect is to lower pressure in chamber 12 or chamber 13 while the other chamber remains under supply pressure.

The secondary effects are to open the supply valve 24 or exhaust valve 27 and so change the pressure in line 21, whereupon the changed pressure causes motor 54 to move and so exercise control. After a slight time interval the changed pressure on line 21 operates rebalancing motor 56 and so tends to restore the bridge to balance. When the bridge returns to balance, so does the relay, but at a different branch line pressure.

In this way a single relay valve, which is indifferent to pressure in the branch line, is controlled by two leak ports which open selectively. Since the chambers 12 and 13 are both under supply pressure when the relay is in inactive condition, adequate forces to actuate the valves are instantly available.

In the interest of simple illustration, many unessential details of construction have been omitted from the drawing. Hence the illustrated embodiment is exemplary only.

In the above description the coils 46, 47 may be deenergized in the null balanced condition of the bridge, and may be selectively energized as the bridge goes out of balance in one direction or the other. According to another known arrangement the two coils could be equally and oppositely energized to about half intensity when the bridge is in balance, unbalance according to direction intensifying the energization of a selected one and diminishing that of the other. Novelty is not claimed for either arrangement.

It is also possible to have both leak ports wide open in the null or balanced condition of the system. This would require an obvious reversal of the mechanical connection between yoke 43 and the lids and a corresponding reversal of the action of spring 42. It is workable but not considered as desirable as the illustrated arrangement.

What is claimed is:

1. In a regulatory system of the type including means comprising a movable core and related electric circuits for shifting said core in response to unbalance of said circuits in a direction corresponding to the direction of said unbalance, the combination of a double-acting expansible chamber motor; two leak port mechanisms each controlling pressure in a corresponding working space of said motor and each comprising a supply restriction, a vent restriction and means for varying one of said restrictions, said mechanisms being selectively actuated to vary the pressure in the corresponding working space by motion of said core in opposite directions and constructed and arranged so that when in a predetermined position corresponding to the position of said core when said circuits are balanced equal pressures are established in said working spaces; biasing means serving to urge said motor to mid-position when said pressures are equal; and inlet and exhaust valve means controlling a regulatory pressure and operatively so connected with said motor that inlet and exhaust are closed in said mid-position and are open selectively upon motion of the motor in opposite directions.

2. The combination of a housing enclosing a diaphragm chamber; a diaphragm subdividing said chamber; two leak port mechanisms arranged respectively to control pressures acting in said chambers on opposite sides of said diaphragm and each leak port mechanism comprising a supply restriction, a vent restriction and

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means for varying one of said restrictions; inlet and exhaust valve means selectively operable upon motion of said diaphragm in opposite directions from an intermediate position assumed when opposing pressures on the diaphragm are equal, said valve means controlling a regulatory pressure; and means comprising two electric circuits and a movable core affected by said circuits for shifting, according to its direction of motion, the restriction-varying means of a selected leak port mechanism from a closed position in response to unbalance of said circuits in opposite directions, said restriction-varying means of said leak port mechanisms, when closed, serving to establish equal pressures on the two sides of the diaphragm.

3. The combination of a housing enclosing a diaphragm chamber; a diaphragm subdividing said chamber; two leak port mechanisms arranged respectively to control the pressure effective in said chambers on opposite sides of said diaphragm, each leak port mechanism comprising a supply restriction, a vent restriction and means for varying said vent restriction and

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biased to close said vent restriction; inlet and exhaust valve means selectively operable upon motion of said diaphragm in opposite directions from the position assumed when said pressures are equal and adapted to control a regulatory pressure; and means comprising a movable core and related electric circuits for actuating the restriction-varying means of respective leak port mechanisms selectively in response to unbalance of said circuits and according to the direction of such unbalance.

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REFERENCES CITED

The following references are of record in the file of this patent:

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Number	Name	Date
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