

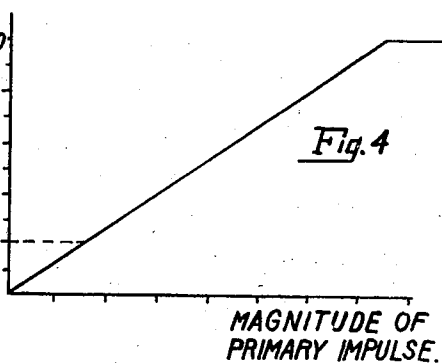
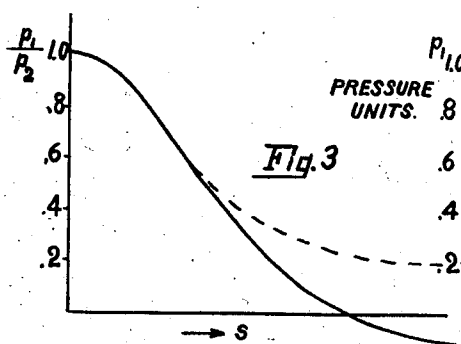
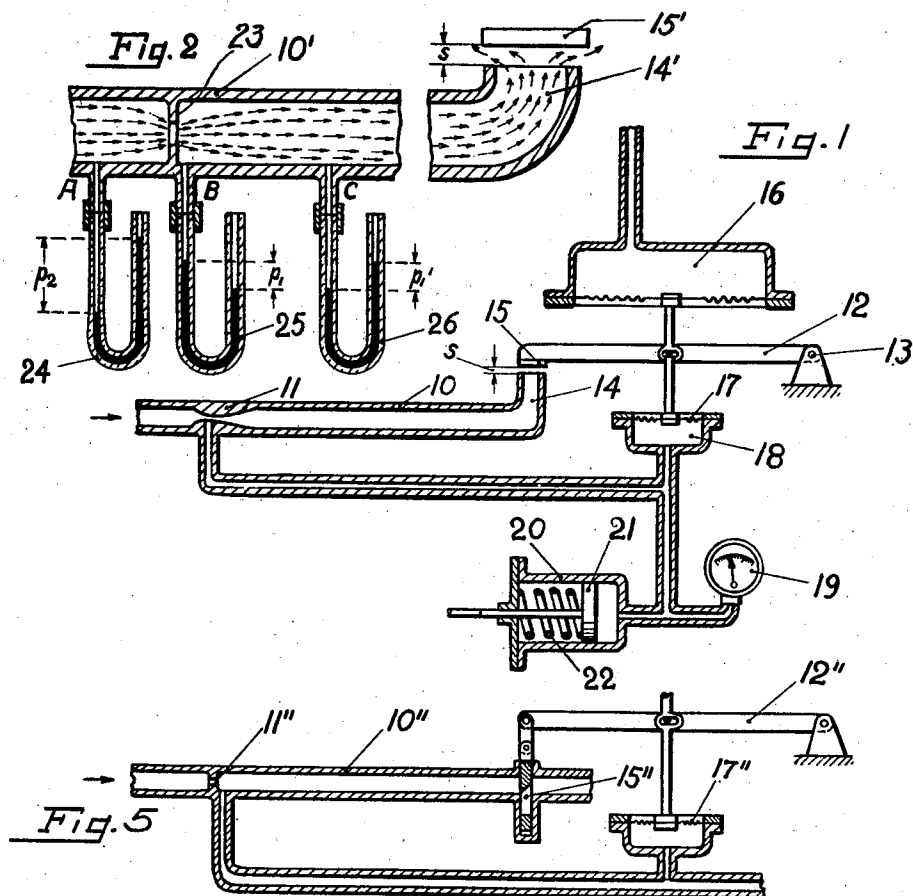
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RELAY

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RELAY

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This invention relates to relays, more particularly to relays of the pressure fluid type.

Relays are used to convert primary impulses, such as forces, or positions, into secondary impulses of different magnitude to be used for various purposes, such as operating measuring instruments, control apparatus, or the like.

To insure a constant and correct relation between the primary controlling impulses and the secondary impulses created by the relay the latter may also be applied to act on the relay in addition, or opposition, to the controlling impulses, e. g., in such a way as to partly or entirely counterbalance the primary impulses.

As far as I am aware, it has heretofore been the practice to derive such additional influences from a positive pressure set up in a section of a conduit adjoining a constriction through which a pressure fluid flows controlled by the said relay. The pressure set up in the said section constitutes also the secondary impulse, used further for measuring and controlling purposes.

It is an object of this invention to provide an improved relay of simple construction having a high sensitivity responding to and creating impulses of a wider difference in magnitude than heretofore.

Inasmuch as a pressure, or impulse, derived in the conventional way has a definite and positive value which is greater than zero, as will be hereinafter explained in detail, the range of the relay is limited to primary impulses having a definite and positive minimum value. Primary impulses of a lesser magnitude will not operate the relay.

According to this invention, the disadvantages of the conventional type of relay are overcome by deriving the secondary impulse-pressure at a point of the conduit within the suction range of a constriction, whereby even negative, i. e., suction pressure values will be attained.

Objects and advantages of this invention will appear from a consideration of the description which follows with the accompanying drawing showing embodiments of the invention for illustrative purposes. It is to be understood that this description is not to be taken in a limiting sense, the scope of the invention being defined in the appended claims.

Referring to the drawing:

Fig. 1 is a diagrammatic illustration, partly in section, of a relay mechanism;

Fig. 2 is a diagrammatic illustration of the pressure conditions existing at a constriction;

Figs. 3 and 4 are diagrams to illustrate the operation of the invention; and

Fig. 5 is a modified form of relay of Fig. 1 shown partly in section.

Pressure fluid from a source (not shown) is flowing through a conduit 10 having a constriction therein, shown as being a Venturi tube 11. The flow of pressure fluid through the conduit 10 is controlled by a relay shown as having a control-impulse receiving member, lever 12, pivotally mounted at 13 and controlling the discharge of fluid from a port 14 by means of a baffle plate 15. The opening of the discharge port is a function of the space "S" between the baffle plate and the port opening.

The position of the control member of the relay, the lever 12, is controlled by a primary impulse, such as a pressure acting within the diaphragm chamber 16.

In opposition to the control impulse there is shown to act upon the relay a secondary pressure-impulse taken at the throat of the Venturi tube and acting on a second diaphragm 17 within a diaphragm chamber 18. The size of this diaphragm determines the ratio between the primary impulses acting on the relay and the secondary impulses set up by the fluid at the throat of the Venturi tube. The smaller the diaphragm 17 the greater will have to be the pressure acting on the same to counterbalance the primary impulse.

The secondary pressure impulse may be read at a gage 19 and be further used to operate a control device (not shown) by means of a servomotor 20. The servo-motor is shown as having a piston 21 movable by the pressure acting on one side against the action of a spring 22.

For explanation of the operation of the invention, reference may first be had to Fig. 2, illustrating the pressure conditions in the neighborhood of a constriction in a conduit.

A conduit 10' having a constriction in the form of an orifice plate 23 therein is tapped at points A, B and C and the pressure existing at these points measured by gages 24, 25 and 26. The pressure in front of the orifice plate is indicated by gage 24 as being of positive magnitude p_2 . At a point C, behind the orifice plate a pressure p_1 may vary between an upper limit p_2 , when the port 14' of the conduit is completely closed by the baffle plate 15', and a lower limit determined by the flow resistance of the conduit and the reaction of the baffle plate on the discharging fluid. It was found by experiments that the lower pres-

sure limit is at about one-fifth of the pressure value p_2 .

As diagrammatically indicated by the arrows, the fluid is constricted to a narrow path when passing through the orifice plate, forming a so-called "vena contracta." Characteristic of the conditions existing at a "vena contracta" is an increase in velocity of the fluid and a corresponding decrease in pressure. As indicated by the gage 25 connected at a point B within the range of the "vena contracta" the pressure p , existing at that point, may attain a negative or suction-value. The pressure range at B is therefore considerably greater than at C and may vary from the positive value p_2 to a negative value p_1 , depending on the relative size of the orifice.

It has heretofore been the practice to connect the diaphragm chamber 18 to a point C of the conduit 10'. The characteristics of the relay of the known type are illustrated by the dotted curves in Figs. 3 and 4.

In Fig. 3 the ratio of the pressures upstream and downstream of the constriction is plotted against the stroke s of the baffle plate. It is seen that for a closed discharge port, corresponding $s=0$ the pressure ratio will be 1.0. When the port is opened the ratio will gradually decrease according to the dotted line and approach the value .2. It appears therefrom that even if there is no controlling impulse acting on the relay there will be a force exerted by the diaphragm 17, tending to maintain the port 14 open and resisting a change of this condition. Controlling impulses of a lesser magnitude than the force of the diaphragm 17 will therefore have no effect on the relay and not be converted into secondary impulses. The dotted line in Fig. 4 will illustrate the foregoing.

In Fig. 4 the secondary impulses expressed in terms of pressure p_1 , are plotted against primary controlling impulses. It appears that at a controlling impulse of zero or small magnitude there will always be a secondary impulse of the magnitude of .2 pressure unit, thereby rendering the relay nonresponsive to small control forces.

According to this invention the secondary impulses are taken at a point "B" within the "vena contracta" or suction-range of the constriction, as shown in Fig. 1.

Turning again to Fig. 3, it is easily understood that the pressure

$$\frac{p_1}{p_2}$$

will become zero, and even attain negative values when the pressure p , becomes a suction pressure as indicated by the solid curve. Correspondingly, the influence of the diaphragm 17 on the control member will be zero and the secondary impulse zero when the control impulse is zero. This condition is illustrated by the solid curve in Fig. 4 extending to the zero point.

The operation of the relay shown in Fig. 1 will now be easily understood. Assuming a control impulse acting on the control member suddenly becomes zero. The pressure acting on the diaphragm 17 will at this instant tend to open the port 14 thereby increasing the flow through conduit 10. The increasing flow reduces the pressure existing within the range of the "vena contracta" to the exact zero value, so that no force will be exerted by the diaphragm 17. If, for some reason, the primary impulse should decrease so rapidly, that the control member of the relay overshoots the zero position, the flow through the conduit

10 will be increased to cause a negative pressure to act on the diaphragm 17, thereby operating the relay to throttle the flow until the zero position is obtained.

It is also apparent that if an upwardly directed impulse is applied to the relay lever an equal and oppositely directed force will be exerted by the diaphragm 17 and the gage 19 will indicate suction pressure.

A modified form of the relay is shown in Fig. 10. The conduit 10'' is provided with a nonvariable constriction shown as being an orifice plate 11'' and a variable constriction, or throttle, shown as being a gate-valve 15''. The secondary pressure impulse is taken at a point within the "vena contracta" or suction range of the orifice plate 11'' to act in the same way on a diaphragm 17'' as hereinbefore explained. The device for exerting primary impulses on the lever 12'' is not shown.

Obviously, the present invention is not restricted to the particular embodiments thereof herein shown and described. Other types of flow resisting means may be employed than herein shown and described. The constant resistance offered by a long conduit may be utilized, for instance, as is well known in the art, or other changes may be made without departing from the scope of the invention. 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 sub-combinations.

What is claimed is:

1. Pressure fluid relay comprising, in combination, a conduit having a discharge port; a constriction in said conduit; a member responsive to an outside control impulse and arranged to vary the discharge from said port for varying the pressure within the suction range of said constriction in response to said outside control impulse; and means responsive to a pressure taken at the suction range of said constriction and connected to act on said member in opposition to the controlling impulse.

2. Pressure fluid relay comprising, in combination, a conduit; a fixed constriction in said conduit; a variable constriction downstream of said fixed constriction; means responsive to an outside primary impulse for adjusting said variable constriction; and a secondary impulse pressure conduit connected to said first named conduit within the suction range of said fixed constriction, whereby the secondary impulse pressure becomes a function of the primary impulse, ranging from suction pressure values upwards.

3. Pressure fluid relay comprising, in combination, a conduit; a fixed constriction in said conduit; a discharge port downstream of said fixed constriction; means responsive to an outside primary impulse for adjusting said discharge port; and a secondary impulse pressure conduit connected to said first named conduit within the suction range of said fixed constriction, whereby the secondary impulse pressure becomes a function of the primary impulse, ranging from suction pressure values upwards.

4. Pressure fluid relay comprising, in combination, a conduit; a fixed and a variable constriction therein; means responsive to an outside primary impulse for adjusting said variable constriction; and a secondary impulse pressure conduit connected to said first named conduit within the suction range of the constriction arranged upstream relatively to the second con-

striction, whereby the secondary impulse pressure becomes a function of the primary impulse, ranging from suction pressure values upwards.

5 5. Pressure fluid relay comprising, in combination, a conduit; a constriction in said conduit; a variable throttle in said conduit downstream of said constriction; means responsive to an outside primary impulse for adjusting said throttle; and
10 a secondary impulse pressure conduit connected to the said first named conduit within the suction range of said constriction, whereby the impulse pressure becomes a function of the primary impulse.

15 6. Pressure fluid relay comprising, in combination, a conduit having a discharge port; a constriction in said conduit; a movable baffle plate arranged to control the discharge of pressure fluid through said port, means responsive to an outside impulse and connected to move said
20 baffle plate for varying the pressure within the suction range of said constriction in response to said outside impulse; and means responsive to a pressure taken at the suction range of said constriction and connected to act on said baffle plate.

25 7. Pressure fluid relay comprising, in combination, a conduit; a Venturi tube in said conduit; a discharge throttle in said conduit; means responsive to an outside control impulse and connected to adjust said throttle for varying the
30 pressure within the suction range of said Venturi

tube in response to said control impulse; and a diaphragm acted upon by a pressure taken at the throat of said Venturi tube and connected to act in opposition to said impulse means.

8. Pressure fluid relay comprising, in combination, a conduit, an orifice plate in said conduit; a discharge throttle in said conduit; means responsive to an outside control impulse and connected to adjust said throttle for varying the pressure within the suction range of said orifice
10 plate in response to said control impulse; and a diaphragm acted upon by a pressure taken at a point of the conduit within the vena contracta created by said orifice plate and connected to act in opposition to said impulse means.

15 9. Pressure fluid relay comprising a conduit; a non-variable and a variable constriction therein; means responsive to an outside primary impulse for adjusting said variable constriction for varying the pressure within the suction range of
20 said non-variable constriction in response to said primary impulse; and means responsive to a pressure taken at the suction range of said non-variable constriction and connected to act in opposition to said impulse means whereby a pressure
25 taken within the suction range of said non-variable constriction becomes a function of the controlling impulse.

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