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K. W. TODD

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MECHANICAL RELAY OF THE FLUID JET TYPE

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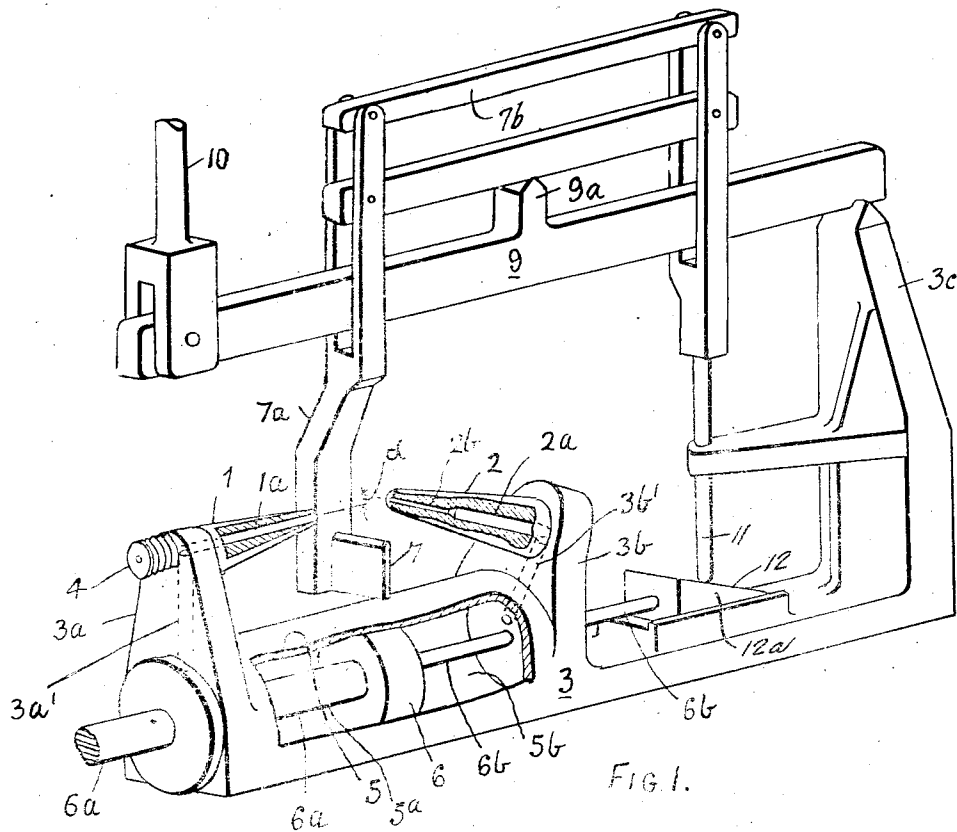
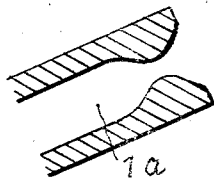
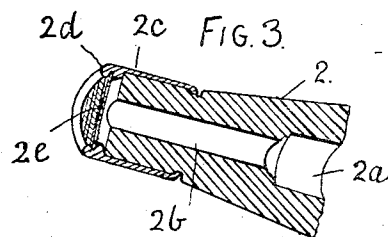


FIG. 2.



2d 2c FIG. 3.



INVENTOR

KEITH WATSON TODD

By

Norman L. Peterson
ATTORNEYS

ATTORNEYS

UNITED STATES PATENT OFFICE

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MECHANICAL RELAY OF THE FLUID
JET TYPE

Keith Watson Todd, Warrington, England, assignor to Metropolitan-Vickers Electrical Company Limited, London, England, a company of Great Britain

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3 Claims. (Cl. 137-111)

This invention relates to mechanical relays of the fluid jet type.

A relay of the type referred to comprises a nozzle to which air or other fluid is continuously supplied, usually at constant pressure, and an orifice which may be the opening to a second nozzle or other orifice which receives fluid from the jet issuing from the aforesaid nozzle. The nozzle and orifice are usually enclosed in a casing having an outlet port and sometimes provided with means whereby the pressure within the casing may be controlled, for instance maintained above or at or below atmospheric pressure.

The fluid received in the receiving orifice may act upon a piston or bellows member for effecting some indicating or control operation in accordance with the control imposed upon the relay, this control in the present instance being effected by varying the degree of impingement of the jet upon the receiving orifice.

The method of control to be used may effect the said change in degree of impingement in any of various ways such as by deflection of the one axis relatively to the other about any suitable centre and whether retaining a coplanar relationship of the axes or not, by movement apart of the two orifices along any line but preferably along the axis of the first or outlet nozzle, or by using an intercepting vane, or by deflection of the jet by means of a transverse jet.

It has been found that under certain conditions considerable pulsations of the received pressure occur irrespective of the separation of nozzle and receiving orifice over a considerable range and it is an object of this invention to avoid or minimize such pressure pulsations.

Now, with a relay of the type referred to, when the fluid used by the jets is a relatively highly compressible one, such as air, certain irregularities appear to arise which it is believed are dependent upon the air velocity being at least in the neighbourhood of the velocity of propagation of sound. It is known that under these conditions the stream of fluid beyond the transmitting nozzle may enter into a condition of standing waves, and that the length between nodes will depend upon the ratio of pressure of supply to that of the fluid medium surrounding the jets, whilst there is a complicated structure within this jet and certain regions of abrupt change known as Riemann lines. It is also known that beyond the Riemann line the jet conditions may change and cease to be periodic, becoming somewhat indeterminate. Considerable experimental investigation has been made on these jets by optical meth-

ods along the lines of investigation made by Julius Hartmann—see Ingeniorvidenskabelige Skrifter 1939 Nr. 4. These investigations have tended to confirm the aforesaid assumptions, and have led to the present invention whereby one source of irregularity in the receiving pressure of the relay can be avoided or minimized.

Therefore, according to the invention, the occurrence of the Riemann line is prevented or substantially prevented in a relay of the type referred to by the use of a convergent-divergent nozzle for the transmitter of the relay. In the said experimental investigations the shape of the receiving nozzle has not been altered; it has been very slightly convergent towards the entrance orifice.

In a relay of the type referred to, when control has been effected by varying the degree of impingement of the jet upon the receiving orifice by variation of the relative position of a vane for intercepting the stream flow between the transmitting nozzle and the receiving orifice, the nozzle and receiving orifice have been maintained as far as practically possible in coaxial alignment when in one control position, the axis of the receiving orifice being taken, in this connection and in the following, as the axis of the receiving nozzle if present (including a receiving perforation if the length thereof permits the assignment of an axis) or the normal to the plane face of the receiving orifice if no receiving nozzle is employed. It has been found that with this arrangement, under certain conditions appreciable pulsations of the received pressure occur irrespective of the separation of the nozzle and receiving orifice, even though precautions are taken to maintain uniformity of the pressure in the transmitting nozzle. These pulsations may also vary in amplitude and become considerable in parts of the separation range.

With a view to avoiding or minimizing pressure pulsations as above mentioned, according to a subsidiary feature of the invention, in a relay of the type referred to having a movable vane for intercepting the stream flow between the transmitting nozzle and the receiving orifice, and equipped with a transmitting nozzle which is convergent-divergent, the transmitting nozzle and the receiving orifice are arranged so that their axes subtend with respect to one another an angle of at least five degrees from coaxial alignment. In experimental use of one system of nozzle it was found desirable for the angle between the axes to exceed twenty degrees.

Factors affecting the amplitude of the received

pressure pulsations, and hence the angle necessitated between the axes of the nozzle and receiving orifice for the removal wholly or mainly of said pulsations, are the absolute and relative sizes of the bores of the nozzle and receiving orifice, the shape of the orifices, their distance apart, the nature of the fluid medium used, the transmitting jet pressure and the pressure of the medium surrounding the jet.

While the use of a convergent-divergent transmitting nozzle and arrangement of the axes of said transmitting nozzle and receiving orifice as described have been found very effective, it has been found that there are still certain pulsations in the receiving pressure to be dealt with and according to a further subsidiary feature of the invention these smaller pulsations or disturbances are controlled by the introduction of a wire or wires or a wire grid across the surface of the receiving orifice. Thus, there may be a single wire of diameter about one-tenth that of the orifice placed diametrically across the latter. Alternatively a series of parallel wires may be used. It will be appreciated that the presence of several wires unavoidably reduces the available receiving pressure.

The invention will now be described with reference to the accompanying, somewhat diagrammatic, drawing, in which—

Fig. 1 is a perspective view of a fluid jet relay in accordance with the invention,

Fig. 2 being an enlarged sectional view of part of the transmitting nozzle of the relay, and

Fig. 3 being an enlarged perspective view, partly in section, of the receiving nozzle with fitted mesh diffuser.

In Fig. 1, 1 and 2 are nozzles respectively supported on arms 3a and 3b forming parts of a fixed frame mounting 3. The nozzle 1 has attached to it at its rear or anchored end a nipple 4 to which will be connected a pipe for conveying working fluid, for example air, under constant pressure to the interior of the nozzle. This nozzle constitutes the transmitting nozzle of the relay and has a through bore 1a which, adjacent the outlet end, is of convergent-divergent form as illustrated more clearly in Fig. 2. The nozzle 2, being intended to receive the fluid ejected under pressure from the transmitting nozzle 1, and herein referred to as the receiving nozzle, has a through bore comprising a cylindrical part 2a and a reduced cylindrical part 2b.

Supported in the frame 3 is a cylinder 5 in which is disposed a piston 6 attached at its front face to a rod 6a and at its rear face to rod 6b of smaller diameter than that of rod 6a; the rods 6a and 6b extend through substantially pressure-tight sealing glands mounted in the closed opposite ends of the cylinder 5. The bore 1a of the transmitting nozzle 1 registers with a duct 3a' in the supporting arm 3a, whereby, when pressure fluid is supplied to the transmitting nozzle 1, pressure fluid is also supplied to the trapped space 5a of cylinder 5, accordingly to act upon the piston 6. The bore 2a of the receiving nozzle registers with a duct 3b' in the supporting arm 3b whereby pressure fluid received by the nozzle 2 from the transmitting nozzle 1 is fed into the trapped space 5b in cylinder 5, accordingly to act upon the piston 6. It will be appreciated that piston rod 6a will be connected to means which is to be operated by the relay.

At 7 is indicated a vane which in the example illustrated is supported by a bracket 7a attached

to a frame 7b which in turn is supported on knife-edge 9a intermediately of a beam 9. The beam 9 is supported at one end on knife-edge 9c forming part of the mounting frame 3, while its other end is pivoted to a rod 10 to which movement will be imparted when the relay is intended to operate. The frame 7b is attached to vertical rod 11 engaging at its lower end with inclined plane 12 of wedge 12a which in turn is attached to piston rod 6b.

In operation, and assuming that working fluid at constant pressure is supplied to nipple 4, then, with the vane 7 occupying the position of equilibrium shown, the fluid passes from the transmitting nozzle 1 to the receiving nozzle 2, and the piston 6 occupies a position in which the force on one side of the piston, due to the pressure in trapped space 5a, is balanced by the force due to pressure in trapped space 5b acting on the opposite side of the piston. If now the rod 10 is raised, corresponding to application of a control influence thereto, the beam 9 is elevated accordingly to displace the vane 7 relatively to the fluid jet passing through nozzle 1 to nozzle 2, such displacement carrying the vane 7 into a position in which it intercepts the jet and thus reduces the amount of fluid impinging upon the receiving nozzle 2, with the result that the pressure in said receiving nozzle, and hence in the trapped space 5b, is reduced relatively to the pressure in the transmitting nozzle 1 and trapped space 5a. Accordingly, the piston 6 is constrained to move to the right in the drawing, thus retracting the piston rod 6a relatively to the cylinder 5 and operating the mechanism which will be connected thereto as aforesaid. During this movement of piston 6, the piston rod 6b also moves to the right in the drawing, carrying with it the inclined plane 12 and thus elevating the rod 11. This tilts the frame 7b about pivot 9a, thus applying a follow-up control influence to the vane 7 tending to restore it, and thereby piston 6, to the position of equilibrium originally occupied before displacement of rod 10 by the initiating control influence.

As shown in Fig. 3, the receiving nozzle 2 is fitted at its outer end with a cylindrical part 2c having an attached circumferential flange 2d for supporting a wire grid 2e of relatively fine mesh in a plane substantially at right angles to the axis of the nozzle to act as a diffuser for said receiving nozzle for the purpose indicated.

As represented in Fig. 1, the transmitting and receiving nozzles 1 and 2 respectively are mounted so that their axes are not in linear alignment but are inclined to one another at an angle α , which angle for all working positions has a value which exceeds 5° and which will generally be in excess of 20° . Moreover, as represented in the drawing, the axis of the transmitting nozzle 1 will generally pass within the area of the inlet end of the receiving nozzle 2.

I claim:

1. A fluid-jet relay comprising a convergent-divergent transmitting nozzle having means for connecting it to a source of pressure fluid, an orifice mounted to receive a fluid jet from the transmitting nozzle, a vane for controlling the degree of impingement of the jet upon the receiving orifice, and means operable in response to a control influence for moving said vane to vary the degree of impingement of the jet upon the receiving orifice, the axis of the transmitting nozzle passing through the area of the receiving orifice and being inclined to the axis of the

receiving orifice so as to subtend therewith an angle of at least 5 degrees from coaxial alignment.

2. A fluid-jet relay comprising a convergent-divergent transmitting nozzle having means for connecting it to a source of pressure fluid, an orifice mounted to receive a fluid jet from the transmitting nozzle, a vane for controlling the degree of impingement of the jet upon the receiving nozzle, the axis of the transmitting nozzle passing through the area of the receiving orifice and being inclined to the axis of the receiving orifice so as to subtend therewith an angle of at least 5 degrees from coaxial alignment, means operable in response to a control influence for moving said vane to vary the degree of impingement of the jet upon the receiving orifice, and at least one wire extending across the receiving orifice.

3. A fluid-jet relay comprising a transmitting nozzle adapted to be supplied with highly compressible fluid at constant pressure and convergent-divergent outwardly, a nozzle for receiving the compressible-fluid jet from the transmitting nozzle and a vane interposed between the transmitting nozzle and receiving nozzle, and means responsive to application of a control influence for correspondingly traversing the vane across the jet to correspondingly vary the pressure in the receiving nozzle, said transmitting and receiving nozzles being arranged with the axis of the transmitting nozzle inclined to the axis of the receiving nozzle so as to subtend therewith an angle of at least five degrees from coaxial alignment, for the purpose described.

KEITH WATSON TODD.