

Oct. 1, 1946.

K. W. TODD

2,408,705

MECHANICAL RELAY OF THE FLUID JET TYPE

Filed Dec. 31, 1943

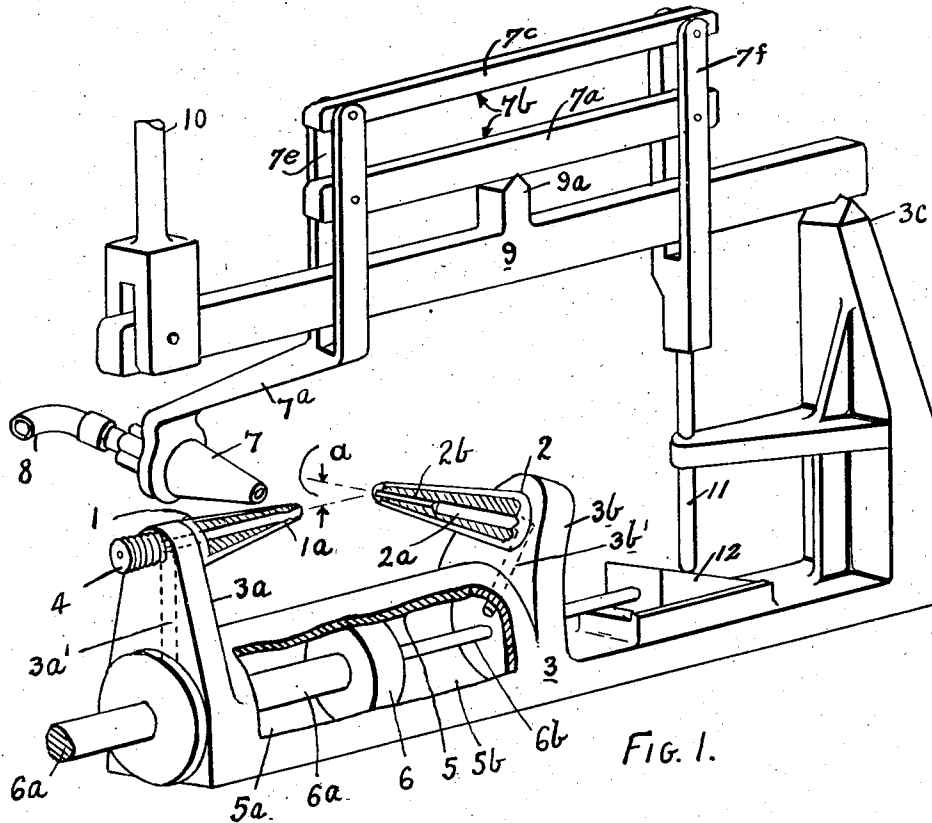


FIG. 2.

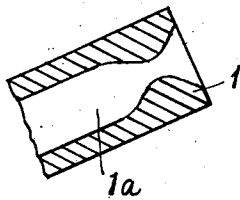
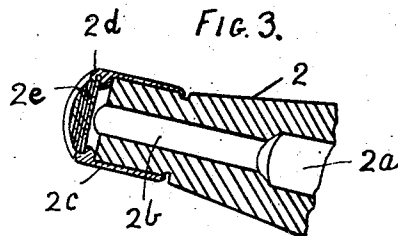


FIG. 3.



INVENTOR

KEITH WATSON TODD

By

Harold L. Peterson
ATTORNEYS

UNITED STATES PATENT OFFICE

2,408,705

MECHANICAL RELAY OF THE FLUID JET
TYPE

Keith Watson Todd, Warrington, England, as-
signor to Metropolitan-Vickers Electrical Com-
pany Limited, London, England, a company of
Great Britain

Application December 31, 1943, Serial No. 516,595.
In Great Britain May 28, 1940, and September
6, 1940

3 Claims. (Cl. 121—41)

1

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, which orifice 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. Heretofore when this method of control has been employed the nozzle and receiving orifice have been maintained as far as practicably 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.

However, it has been found that with this arrangement, under certain conditions considerable pulsations of the received pressure occur irrespective of the separation of nozzle and receiving orifice over a considerable range, even although 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.

In relays as above set forth the method of control 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 deflection of the jet by means of a transverse jet, and the invention is essentially concerned with relays in which are employed such methods of control other than by means of a material vane arranged to intercept the stream flow.

2

According to the present invention, with a view to avoiding or minimising pressure pulsations as above mentioned, in relays of the type referred to controlled otherwise than by a material vane, intercepting the stream flow, the transmitting nozzle and receiving orifice are arranged so that in no control position do their axes subtend with respect to one another an angle of less than 5° from coaxial alignment, and that in at least one control position the axis of the transmitting nozzle to which the pressure fluid is supplied passes within the area of the receiving orifice. In experimental use of one system of nozzles it was found desirable for the angle between the axes to exceed 20° .

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.

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 the 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 methods along the lines of investigation made by Julius Hartmann—see Ingeniörvidenskabelige 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 minimised.

Therefore, according to a subsidiary feature of the present invention the occurrence of the Riemann line is prevented or substantially prevented by the use of a convergent-divergent nozzle for

3

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.

While the use of a convergent-divergent transmitting nozzle has 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 nozzle. 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 Figure 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 and has a through bore 1a which, at the outlet end, is of convergent-divergent form as illustrated more clearly in Fig. 2. The nozzle 2, 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 the rear face to rod 6b; 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.

At 7 is shown a third nozzle which, in the example illustrated, is supported by a bracket 7a attached to a frame 7b and is, in turn, supplied with fluid under constant pressure through pipe 8, thereby to provide a fluid jet acting substantially at right angles to the fluid jet passing between the nozzles 1 and 2. The frame 7b to which the nozzle 7 is attached comprises a pair of parallel levers 7c and 7d pivotally connected at their respective ends to a link 7e extending from the bracket 7a and to a link 7f, and is supported on a knife edge 9a intermediately of a beam 9 which, at one end, is supported on a knife edge 3c form-

4

ing part of the frame 3 and at the other end is pivoted to a rod 10 to which initiating movement will be imparted when the relay is intended to operate. Attached to the link 7f of the frame 7b is a rod 11 which rests at its free end on a cam 12 which is attached to an extension of the piston rod 6b projecting beyond the supporting arm 3b.

With the arrangement described, and assuming that the normal position of the jet from nozzle 7 is such that said jet partially interferes with the under-side of the jet from nozzle 1, then, when the rod 10 is for example depressed, pivot 9a for the frame 7b will be lowered accordingly to depress nozzle 7 and correspondingly reduce the extent to which the jet from nozzle 1 is interfered with by the control fluid jet from nozzle 7, so that the pressure in the receiving nozzle 2 is raised and the pressure in the trapped space 5b of the working cylinder 5 correspondingly increased relatively to the constant opposing pressure in the trapped space 5a, with the result that the piston 6 will be moved to the left in the drawing. With such movement of piston 6, the attached piston rod 6a is moved outwardly from the working cylinder 5 accordingly to operate mechanism with which the relay will be associated, and at the same time, the piston rod 6b is moved accordingly, thereby retracting the cam 12 and permitting downward movement of the rod 11, and causing the frame 7b to swing about pivot 9a in the direction to raise the nozzle 7 to its normal position aforesaid, and so restoring the jet from said nozzle 7 to the position in which it partially interferes with the under-side of the jet from nozzle 1. Similarly, for an upward movement of the rod 10, piston 6 will be moved to the right in the drawing accordingly, through piston rod 6a, to operate the mechanism associated with the relay, and, through the rod 6b, to operate the cam 12 and rod 11 to rock the frame 7b about pivot 9a for restoring the nozzle 7, and thus the control jet therefrom, to its normal position aforesaid.

If it were desired that mechanism similar to that illustrated should respond when a control fluid jet ejected from nozzle 7 is moved from a normal position in which said jet interferes with the upper-side of the jet from nozzle 1, then the only change which would be required in the mechanism to ensure restoration of the control jet from nozzle 7 to its normal position in relation to the jet from nozzle 1 would be for the cam 12 to be reversed, namely, so that its inclined surface is directed upwardly from the left to right in the drawing.

It is preferable that the transmitting nozzle 1 and the receiving nozzle 2 are arranged so that the maximum pressure receivable through nozzle 2 in the trapped space 5b is approximately half the normal constant pressure in the trapped space 5a and that the amount of interference of the control jet from nozzle 7 on the jet from nozzle 1 is such that the normal received pressure in trapped space 5b is about half the maximum available pressure, that is, about a quarter of the normal constant pressure in the trapped space 5a. Despite this dissimilarity in pressure on either side of the piston 6, the differential areas are such that a balance condition is maintained.

Advantageously, the design of the orifice in the control jet nozzle 7 is such that it is not possible for over-movement of the rod 10 to result in such movement of the control jet from nozzle

5

7 that its influence upon the jet from nozzle 1 is entirely removed.

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 hereinbefore described.

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 transmitting nozzle adapted to be supplied with pressure fluid, an orifice for receiving the fluid jet from the transmitting nozzle, a controlling nozzle for directing pressure fluid transversely of the jet from the transmitting nozzle, means responsively operable to a control influence for varying the inclination of incidence of the transverse jet with the jet from the transmitting nozzle, means responsive to pressure fluid received by the receiving orifice for rendering available an influence representative of said control influence, said transmitting nozzle and receiving nozzle being arranged with the axis of the transmitting nozzle passing through the area of the receiving nozzle and inclined to the axis of the receiving orifice so as to subtend therewith an angle of at least five degrees from coaxial alignment.

2. A fluid-jet relay comprising a transmitting

6

nozzle adapted to be supplied with fluid at constant pressure and a receiving nozzle arranged with the axis of the transmitting nozzle passing through the area of the receiving nozzle and inclined to the axis of the receiving nozzle so as to subtend therewith an angle of at least five degrees from coaxial alignment, a control nozzle for directing fluid at constant pressure transversely of the jet from the transmitting nozzle, means responsively operable to a control influence for varying the inclination of incidence of the transverse jet with the jet from the transmitting nozzle, a pressure-responsive servo-piston, together with means for supplying fluid at the pressure in the transmitting nozzle to one face of said servo-piston and means for supplying pressure fluid received in the receiving nozzle to the opposite face of said servo piston.

3. A fluid jet relay comprising a transmitting nozzle adapted to be supplied with fluid at constant pressure, a nozzle for receiving fluid emitted from the transmitting nozzle, a controlling nozzle for directing fluid at constant pressure transversely of the emission from the transmitting nozzle, means responsively operable to a variable control influence for correspondingly varying the angle of incidence between the transverse fluid emission and the fluid emission from the transmitting nozzle, means continuously responsive to the difference between the pressure in the transmitting nozzle and the pressure in the receiving nozzle for rendering available an influence which is at all times substantially representative in magnitude of said control influence, said transmitting nozzle and receiving nozzle being arranged so that the axis of the transmitting nozzle passes through the area of the receiving nozzle and is inclined to the axis of the receiving nozzle so as to subtend therewith an angle of at least five degrees from coaxial alignment.

KEITH WATSON TODD.