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REMOTE CONTROL SYSTEM
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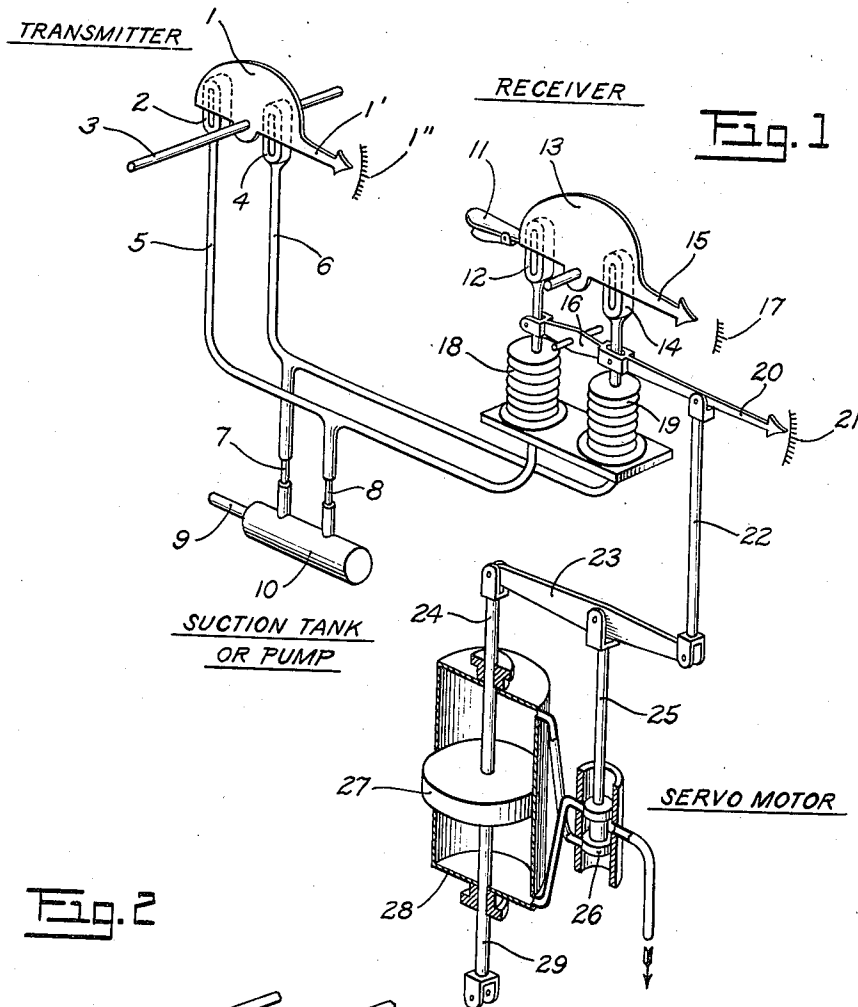
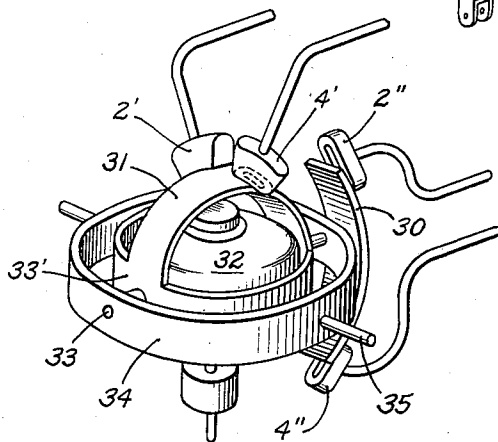


Fig. 2



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REMOTE CONTROL SYSTEM

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This invention relates to a method and means of remote control and more particularly to remote control devices intended for the use in automatic control systems of aircrafts.

The known control devices generally comprise a transmitter and a receiver. A controlling force is applied to the transmitter in the form of an angular deviation and may be applied either manually or automatically from a given measuring apparatus. The control force applied to the transmitter is reproduced by the receiver at a remote point in conjunction with a mechanism related therewith through follow-up means. Connecting means, which may be an electrical line, a fluid pressure conduit or a rotatable shaft, join the receiver with the transmitter.

The broad object of the invention is to provide an improved and simplified remote control system, more particularly intended for the control of air craft control surfaces or the like from delicate, precision instruments, such as gyroscopes, for instance, without subjecting such instruments to any appreciable stress capable of disturbing their operation, and in such a manner that these instruments can be fixed, for instance, on a dash-board of an aircraft at a distance from the control surfaces to be controlled thereby without the use of mechanical connections between the control instrument and the controlled surface.

Another object of the invention is to provide a remote control system in which connecting means between a transmitter and a receiver are constituted by two fluid pressure conduits, in which a fluid flow of a constant intensity is maintained under the action of either a negative or a positive fluid pressure applied to said conduits.

A further object of the invention is to provide a remote control system in which a transmitter is constituted by a device permitting to close unequally and in an adjustable manner two orifices respectively connected to a pair of fluid pressure conduits providing a connection of said transmitter with a receiver, and in which the controlling order is applied to the system by varying the ratio between the respective degrees of closure of these two orifices.

A still further object of the invention is to provide a remote control system in which a receiver is constituted by a differential manometer responsive to the difference in pressure between a pair of fluid pressure conduits providing a connection of said receiver with a transmitter and causing the variation of the ratio between the respective degrees of closure of two further orifices connected respectively to said pair of fluid

pressure conduits, this variation being effected in a direction to reduce this difference in pressure between the two conduits.

The above and other objects and features of the invention will appear more fully hereinafter from the detailed description which follows and the accompanying drawing annexed thereto, which shows, by way of example, two forms of embodiment of the invention, it being understood however, that the drawing is only given for the purpose of illustrating the invention and cannot be considered as defining the limits of its scope.

In the drawing:

Fig. 1 represents a diagrammatic perspective view partially in section of a remote control system, according to the invention;

Fig. 2 shows also a diagrammatic perspective view of a gyroscope equipped with the transmitter elements of a remote control system according to the invention, for the purpose of constituting an automatic remote control of the longitudinal and the transversal stability of an aircraft.

Referring to the drawing and to begin with, to Fig. 1, the transmitter of the remote control system, according to the invention, is constituted, as shown in said figure, by a control member 1 in the form of a half-disc mounted on an axis 3 which can be actuated manually or by any desired measuring instrument intended to be used as a controller for the transmitter, and cooperating with two nozzles 2 and 4 arranged on either side of said axis 3. These nozzles are provided with orifices having an elongated form in a direction perpendicular to the edge of the half-disc 1 when the same is in its neutral position. These orifices are symmetrically arranged relative to the axis 3 and to said neutral position of the control member 1, so that upon movement of said control member in one or in the other direction one of the orifices is progressively closed or covered and the other of said orifices is proportionally opened or uncovered. In other words, the arrangement is such that the sum of uncovered surfaces or sections of the two orifices is substantially constant. The transmitter device thus constituted permits to vary at will the ratio between the respective degrees of covering or closure of said orifices. If the control member 1 is arranged to move at a very reduced distance from the surface of the nozzles 2-4 without however touching the same, the actuation of this member may be effected with practically no effort.

The transmitter thus constituted is connected with a receiver device by means of two fluid pressure conduits 5 and 6 respectively communicating

with two orifices in the nozzles 2 and 4 of said transmitter. A fluid pressure flow of constant intensity is created in these conduits, for instance, by connecting these two conduits by means of fittings 7 and 8 to a suction tank 10 communicating by a tube 9 with a suction pump (not shown). If the two fittings 7 and 8 are made so as to present or oppose to the passage of the air a resistance substantially greater than that of the rest of the conduits and of the devices provided at their extremities, the flow of air will depend almost exclusively upon this resistance and upon the degree of suction maintained in the tank 10. By maintaining constant the degree of suction, one obtains in each of the conduits 5 and 6 a suction with a substantially constant flow.

The receiver in the system according to the invention is constituted by a device somewhat similar to the transmitter. Thus, as shown in the drawing, the same comprises a screening member 13 cooperating with two nozzles 12 and 14 with orifices, which nozzles, however, instead of being fixed at the extremities of the fluid pressure conduits 5 and 6, are mounted on a rocking lever 16 actuated by two expansible diaphragm chambers or bellows 18 and 19 connected respectively to the two conduits 5 and 6 and constituting a differential manometer. The orifices of the nozzles 12 and 14 are in communication with the interior of said bellows 18 and 19 and have also an elongated form extending following the axes of their movement. In close relation to said orifices there is provided a relatively stationary screening member 13, but which is adjustable about an axis parallel to the axis of oscillation of the lever 16. For the purpose of adjusting the position of the screening member 13, the same is provided with a handle 11 with a detent stop, which may cooperate for instance, with a stationary toothed circular member (not shown).

When the orifices of the four nozzles 2—4 and 12—14 are covered to an equal extent, the degree of suction is the same in both conduits 5 and 6 and the differential manometer device constituted by bellows 18—19 is at rest. If the control screen member 1 at the transmitter end is deflected from its medium or neutral position, for instance, to the right, when looking at Fig. 1, there immediately results a difference in the degree of closure of the two orifices in the nozzles 2 and 4, the orifice of nozzle 2 becoming more open or uncovered and the orifice of nozzle 4 becoming more covered or closed. This creates a difference in the degree of suction between the conduits 5 and 6 and causes the actuation of the differential manometer device at the receiver end, bellows 19 of which subjected to a greater suction, tend to contract, whilst bellows 18 subjected to a reduced suction, yield under the action of the rocking beam 16 and allow the same to bank to the right.

The nozzle 12 and 14 will thus be moved behind the relatively stationary screen 13, in a direction to equalize the degree of suction, i. e., to equalize the sum of uncovered surfaces of the orifices of nozzles 2 and 12 on one hand, with that of uncovered surfaces of the orifices of nozzles 4 and 14 on the other hand. This movement tends towards a position of equilibrium and is automatically arrested when the difference in the degree of suction in conduits 5 and 6 disappears.

Thus the movements of an index 20 carried by the rocking lever 16 over a scale 21 at the receiver end will be identical to the movements of a similar index 1' carried by the control screening member 1 at the transmitter end over its corresponding scale 1''. One obtains thus a remote indicating arrangement permitting to reproduce at distance the indication of an angular position of a given member. In order to transform this arrangement into one capable of producing a controlling action, for instance, for actuating at distance a control surface of an aircraft the rocking lever 16 will be caused to control a servo-motor of any suitable type. Thus, for instance, a fluid pressure operated servo-motor can be used, as shown in the drawing. The rocking lever 16 may be connected by an articulated rod 22 to one extremity of a servo-motor control lever 23 having on one hand its other extremity connected to a piston rod 24 of a power piston 27, movable in a cylinder 28, and on the other hand, a point intermediate its ends connected to a rod 25 actuating the servo-motor control valve 26, admitting the supply of fluid pressure to one or to the other side of the power piston 27.

All movements of rod 22 are reproduced by piston rod 24 in a ratio of lever arms of the control lever 23, the equilibrium position of the system being always that for which valve 26 is in neutral position.

For the particular application of the system, to the actuation of an aircraft control surface, the extremity 29 of the piston rod of the above described servo-motor will be connected to the controls of the desired control surface of the craft.

It will be appreciated that the system according to the invention presents an important advantage of avoiding the necessity of providing a positive follow-up connection from the receiver to the transmitter and more exactly from the receiver to the nozzles such as 2 and 4 of the transmitter, which simplifies to a great extent the construction and the adaptation of the system to delicate and precise instruments, such as gyroscopes and the like, when a remote control is to be provided for operating under the action of such an instrument.

Thus for instance, in an application of the system to the control of elevator and ailerons of an aeroplane, from a single gyroscopic instrument such as gyro-vertical or artificial horizon 32 (Fig. 2), this latter will be provided on its inner gimbal ring with a screen member 31 cut out in a spherical surface concentric to the center of the gimbal suspension of the gyroscope 32, formed by an outer gimbal ring 34, axes 35 and 33 and an inner gimbal ring 33'. Furthermore, the outer gimbal ring 34 will be provided with a screen member 30 cut out in a cylindrical surface coaxial to the axis of oscillation 35 of said ring. In close proximity of screens 31 and 30 there will be arranged respectively two pairs of nozzles 2', 4' and 2'', 4'', provided with orifices elongated in the directions of desired controlling oscillations of the respective screens in such a manner that these screens in their neutral position insure an equal degree of partial closure of said orifices.

Upon oscillations of the gimbal ring 34 about axis 35 the orifices of nozzles 2'', 4'' will become unequally covered, whilst the orifices of nozzles 2', 4' will not be affected by this movement, as the spherical screen member 31 will oscillate fol-

lowing the central plane of symmetry between the two orifices, perpendicular to the direction of alignment of said orifices, which direction is parallel to the axis 35.

On the contrary, upon oscillations of the gyroscope about an axis 33, screen 30 will remain relatively stationary with respect to nozzles 2'', 4'', whilst the ratio between the degrees of closure of orifices in nozzles 2', 4' will be modified as a result of lateral displacement of the spherical screen 31.

If the gyroscope, equipped as indicated above, is placed on an aircraft, so that its axis of suspension 33 is parallel to the longitudinal axis of the craft, supposed to be in the position of the normal flight, the same may serve for insuring the longitudinal stabilization of the craft by causing the actuation of the controls of the elevator by means of a servo-motor remotely controlled by two nozzles 2'', 4'' in a manner indicated hereinabove. In the same way it will be possible to insure an automatic control for the transversal stabilization by actuating the controls of the ailerons by a similar servo-motor remotely controlled from the nozzles 2', 4'.

It is generally necessary to adjust or to correct the trim of an automatically controlled aircraft and this can be made in the present system by adjusting the position of the relatively stationary screening member, such as 13 of the receiver, for instance, by actuating the handle, such as 11, on Fig. 1, which results in a shifting of the position of equilibrium of the differential manometer device formed by bellows 18—19. Thus, the deviation of an index, such as 20, relative to scale 21 is the sum of the deviation of the control screen 1 at the transmitter end and of the angular position of screen member 13, and hence, of index 15 relative to scale 17 at the receiver end.

The addition of angles, thus obtained, may be used in a control of transversal stabilization, for causing the craft to take a correct bank angle during turns, by automatically controlling the position of a screen-member 13 of a corresponding receiver in response to the angular speed of turning movement of the craft, in a manner similar to that described in the applicant's prior application Serial No. 223,776, filed August 8, 1938, now Patent No. 2,204,290.

It may be equally advantageous to complete a receiver mechanism, such as constituted by pistons or bellows 18—19 and rocking lever 20, by a complementary device, such as described in the applicant's prior application Serial No. 161,863, filed August 31, 1937, comprising a velocity and inertia brake and a differential manometric system, which would permit to measure and to materialize the first and second derivatives, with respect to the time, of the angular movement of the rocking lever 20 and consequently, of the disc 1, permitting thus to control the corresponding control surface of the craft not only in response to the amount of the deviation of the craft, but also in response to the speed and the acceleration of this deviation.

Although a single embodiment of the present invention has been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. For example, the fluid pressure used in transmitting motion may circulate in a closed circuit. The single transmitter shown may be replaced by a plurality of transmitters which will exert a combined controlling action on a single receiver.

Further than this, several receivers may be controlled by a single transmitter so that amplitude limitations applied to one of the receivers will cause the latter to act in a manner of an auxiliary transmitter for imposing a combined action on a receiver which was left free. Various changes may be made in the design and arrangement of the parts without departing from the spirit and scope of the invention, as the same will now be understood by those skilled in the art. For a definition of the limits of the invention, reference will be had primarily to the appended claims.

What I claim is:

1. A relay for use in an automatic pilot control of the type having a fluid pressure operated servo-motor actuated by a valve controlled through said relay by a control device, comprising two bellows, each bellows being fixed at one end and adapted to be connected at said end to a source of air pressure and each having at the other end an orifice open to the atmosphere and movable with said bellows upon expansion and contraction thereof due to a difference in pressure produced in the pair of bellows by the control device, a relatively stationary screen member normally partially covering the orifices of both bellows to the same extent when said bellows are in normal position and the pressure therein is equal, but covering one orifice more and the other less as one bellows expands and the other contracts, when there is a difference in pressure between the two bellows, thereby re-equalizing the difference in pressure, and a pivoted lever connected differentially to the movable ends of said bellows for actuation thereby.

2. A relay for use in an automatic pilot control of the type having a fluid pressure operated servo-motor actuated by a valve controlled through said relay by a control device, comprising two bellows, each bellows being fixed at one end and adapted to be connected at said end to a source of air pressure and each having at the other end an orifice open to the atmosphere and movable with said bellows upon expansion and contraction thereof due to a difference in pressure produced in the pair of bellows by the control device, a relatively stationary screen member normally partially covering the orifices of both bellows to the same extent when said bellows are in normal position and the pressure therein is equal, but covering one orifice more and the other less as one bellows expands and the other contracts, when there is a difference in pressure between the two bellows, thereby re-equalizing the difference in pressure, a pivoted lever connected differentially to the movable ends of said bellows for actuation thereby, and means for adjusting the initial position of said screen member with respect to said orifices.

3. A relay for use in an automatic pilot control of the type having a fluid pressure operated servo-motor actuated by a valve controlled through said relay by a control device, comprising two bellows, each bellows being fixed at one end and adapted to be connected at said end to a source of air pressure and each having at the other end an orifice open to the atmosphere and movable with said bellows upon expansion and contraction thereof due to a difference in pressure produced in the pair of bellows by the control device, a relatively stationary semi-circular disc mounted so that the straight edge thereof normally partially covers the orifices of both bellows to the same extent when said bellows are

in normal position and the pressure therein is equal, but covers one orifice more and the other less as one bellows expands and the other contracts when there is a difference in pressure between the two bellows, thereby re-equalizing the difference in pressure, and a pivoted lever connected differentially to the movable ends of said bellows for actuation thereby.

4. A relay for use in an automatic pilot control of the type having a fluid pressure operated servo-motor actuated by a valve controlled through said relay by a control device, comprising two bellows, each bellows being fixed at one end and adapted to be connected at said end to a source of air pressure and each having at the other end an orifice open to the atmosphere and movable with said bellows upon expansion and contraction thereof due to a difference in pressure produced in the pair of bellows by the control device, a relatively stationary semi-circular disc mounted so that the straight edge thereof normally partially covers the orifices of both bellows to the same extent when said bellows are in normal position and the pressure therein is equal, but covers one orifice more and the other less as

one bellows expands and the other contracts when there is a difference in pressure between the two bellows, thereby re-equalizing the difference in pressure, a pivoted lever connected differentially to the movable ends of said bellows for actuation thereby, and means for adjusting the initial position of said semi-circular disc with respect to said orifices.

5. An air operated relay comprising two bellows, each bellows being fixed at one end and adapted to be connected at said end to a source of air pressure and each having at the other end an orifice open to the atmosphere and movable with said bellows upon expansion and contraction thereof when a difference in pressure is produced in said bellows, a relatively stationary screen member normally partially covering said orifices to the same extent when said bellows are in normal position and the pressures therein are equal, but covering one orifice more and the other less as one bellows expands and the other contracts when there is a difference in pressure between said bellows, and means connected to said bellows for actuation thereby.

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