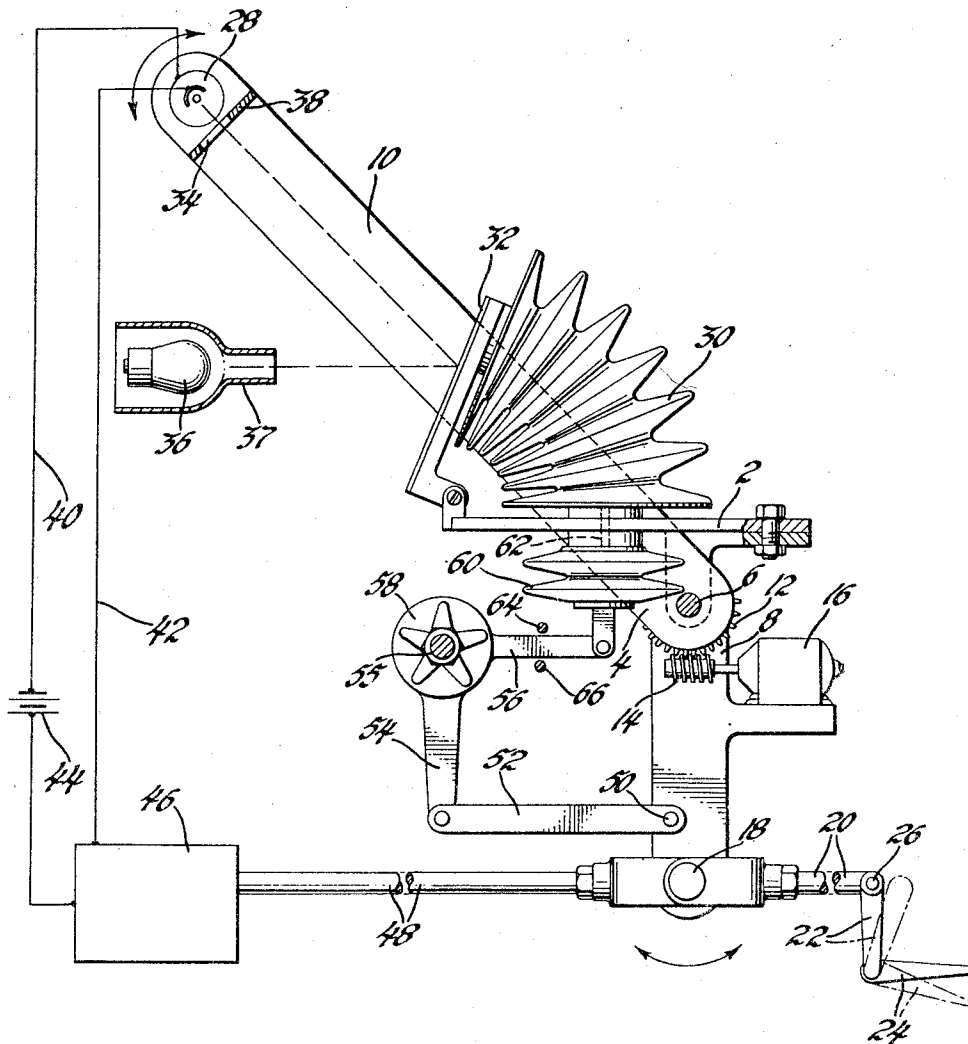


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PRESSURE RESPONSIVE AUTOMATIC CONTROL

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PRESSURE RESPONSIVE AUTOMATIC CONTROL

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The present invention relates to a pressure responsive control device of the type illustrated in Kettering et al. application Serial No. 453,358, filed August 3, 1942, and assigned to a common assignee.

More particularly, the present invention relates to pressure responsive servo control systems in which an auxiliary pressure element is used to increase the sensitivity of the mechanism.

Previous to the present invention, various types of controls for both aircraft and torpedos were available to maintain the controlled mechanism in the proper horizontal plane. These prior devices do not have the desired sensitivity or simplicity and are often subject to erratic control.

It is therefore an object of the present invention to produce a pressure sensitive automatic control mechanism for craft travelling in a fluid medium.

It is another object of the present invention to produce an altitude control mechanism for aircraft having great sensitivity and simplicity of operation.

It is a further object of the present invention to produce a pressure responsive control means including a light reflecting means attached to a toroidal segment shaped pressure responsive element.

It is a still further object of the present invention to produce a pressure responsive control mechanism in which the follow-up mechanism influences the pressure responsive element to give greater sensitivity of control.

Other objects of this invention will become apparent upon inspection of the specification and drawings and will be specifically pointed out in the claims.

Referring to the figure in the drawing: 2 is a platform or other member secured rigidly to the craft being controlled. Mounted on this platform 2 by means of projection 4 and pivot 6 is a control linkage element 8. This lever 8 is free to rotate about the pivot 6 but is adjustably attached to the lever 10 by means of gear 12 and worm 14. The lever 10 is also free to rotate about the pivot 6 and its adjustment relative to the lever 8 is produced by a trim motor 16 and the associated gear 12 and worm 14. The control linkage lever 8 is attached to the elevator control surface 24 by means of control arms 20 and 22 pivotally mounted by pins 18 and 26.

Mounted on the platform 2 is a pressure responsive element 30, here illustrated as a Sylphon bellows, the other end of which is attached to a pivoted mirror 32.

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The Sylphon bellows used heretofore as pressure responsive elements have for the most part all been cylindrically shaped. The use of such a pressure responsive device for angular movement of an indicating means requires the interposing of a mechanical linkage, the elements of which have weight, friction, and inertia. These physical characteristics complicate and make quite difficult the production of a pressure responsive indicating or controlling system of high sensitivity. In the present invention the necessity of such a linkage mechanism is eliminated by the utilization of a Sylphon bellows having the shape of a section of a toroid. By using a toroidal shaped pressure responsive element the change in atmospheric pressure on the bellows produces directly angular movement of a control element without the necessity of any movement translation linkage.

A light source 36 with focussing shield 37 is mounted in a fixed spaced relationship to the platform 2. A light sensitive cell 28 is mounted on the outer end of the lever 10 so as to receive light rays originating at the light source 36 and reflected from the mirror 32.

A light shield 38 is mounted on the lever 10 interposed between the cell 28 and the mirror 32. This shield cuts off the flow of light to the cell when the plane is below its preset height. When the plane has reached its preset height the opening 34 in the shield is aligned between the mirror and the element 28 so as to allow illumination and resultant energization of the circuit 40, 42. The light sensitive cell 28 is connected to the servo system 46 by means of conductors 40 and 42 and power source 44. The servo system 46 may include a gyro or other level flight control mechanism. The servo mechanism 46 is connected to the pivot pin 18 by means of rod 48 so as to be capable of operating the elevation control surface 24. An auxiliary booster system to increase the sensitivity of the subject device is connected to the linkage 8 by means of pivot 50. This booster system consists of a connecting rod 52, a bellcrank arrangement pivoted at pin 55 having arms 54 and 56 and a connecting slip clutch 58. This bell crank is connected to a Sylphon bellows 60 having no opening to the atmosphere but having a port 62 connecting it with the pressure responsive device 30. The movement of the arm 56 is restricted by stop pins 64 and 66.

The operation of the illustrated device is as follows:

The motor 16 is used to adjust the angular relationship between the levers 8 and 10 so as to get

proper control for the desired preset altitude. If we assume this mechanism is to be used in a controlled aerial missile, the mirror is so positioned as to energize the cell 28 when the missile has reached a preset height.

The elevator controls of the missile are positioned to cause climbing, when no light is reflected to the photocell 28. As the missile climbs toward the preset height the bellows or pressure responsive element 30 expands causing the light rays from the mirror to be depressed so as to strike the opening in the shield 38 and energize the cell 28 when the missile has reached its desired altitude. The control mechanism, including the conductors 40 and 42 and the servo 46 is then energized causing the connecting rod 48 to move to the right depressing the elevation control surface. When this rod moves to the right the booster control linkage causes the compression of the Sylphon bellows 60 thereby increasing the pressure in the pressure element 30 further tilting the mirror 32 causing full illumination of the light sensitive element 28. As the missile descends to such an altitude that the pressure relationship between the atmosphere and the pressure responsive element 30 again causes the tilting of the mirror 32 to reflect rays off the photocell 28 the servo mechanism 46 is deenergized causing the elevation surfaces 24 to be again placed in the climb position. When this is done, the booster linkage system causes the expansion of the bellows 60 to decrease the pressure in the pressure responsive element 30 and the missile rapidly climbs to the preset altitude at which time the mirror 32 tilts so as to focus the rays on the cell 28 and the operation is repeated.

Having thus described my invention and its operation with respect to an aerial torpedo or controlled missile, it is obvious that this same mechanism operating in the same manner could be used to control a submarine torpedo. If used in the latter application, the pressure responsive element 30 would be exposed to water pressure instead of the atmospheric pressure as in the described operation.

It is to be understood also that although the invention has been described with specific reference to a particular embodiment thereof, it is not to be so limited, since changes and alterations therein may be made which are within the full intended scope of this invention as defined by the appended claims.

I claim:

1. In a pressure responsive mechanism, a servo system, a photoelectric cell for controlling said system, a light source, a toroidal section shaped pressure responsive element having directly attached to one end thereof a pivotally supported mirror, said pressure responsive element and said mirror so located with respect to said light source and said photoelectric cell as to cause light from said source to be reflected on said cell when the pressure surrounding said pressure responsive element reaches a predetermined minimum and no light to be so reflected when said pressure is above said minimum.

2. A pressure responsive system including a toroidal section shaped pressure responsive element, a booster device for said pressure responsive element, a servo system controlled by said pressure responsive element, said servo system so connected to said booster device that when a pressure differential causes movement of the pres-

sure responsive element said booster device will cause a still further pressure differential on said pressure responsive element.

3. An altitude sensitive automatic control system for pilotless aircraft including, a pressure responsive means sensitive to atmospheric pressure, a radiant energy reflecting means pivotally mounted adjacent to, and actuated by said pressure responsive means, a radiant energy source, an electronic element sensitive to said radiant energy capable of receiving energy from said source when reflected by said reflecting means, a servo mechanism controlled by said electronic element for actuating the elevator surfaces of said pilotless aircraft, said pressure responsive means causing energization of said electronic element when the preset altitude is reached to control said elevator surfaces to maintain the pilotless aircraft on substantially constant altitude flight.

4. An altitude sensitive automatic control system for pilotless aircraft including a toroidal shaped pressure responsive element, a booster device for said pressure responsive element, a follow-up mechanism controlled by the movement of said pressure responsive element for positioning the elevator surfaces of said pilotless aircraft, said booster device so connected with the said follow-up mechanism as to cause a pressure change in the interior of said toroidal shaped pressure responsive element so as to increase the pressure differential causing the movement of the pressure responsive element.

5. In an atmospheric pressure sensitive control system for aircraft, a toroidal shaped pressure responsive element having a pivoted mirror attached to one end thereof, said mirror capable of reflecting energy to control a servo system, a variable volume air chamber connected by a restricted port to said pressure responsive element, means for varying the volume of said air chamber connected to said follow-up mechanism so that the volume of the air chamber is reduced forcing air into the pressure responsive element when the pressure on the outside of the element reaches a predetermined minimum thus causing more sensitive control of the servo mechanism.

6. A pressure responsive device including a base plate, a mirror pivotally attached to said plate, a toroidal section shaped pressure sensitive element positioned between said mirror and said plate, a light source and a light receiving means located in such spaced relation with said mirror that said last mentioned means may under predetermined pressure conditions receive light energy from said source reflected from said mirror.

7. A pressure responsive device including a base plate, a mirror pivotally attached to said plate, a toroidal section shaped pressure sensitive element positioned between said mirror and said plate, a light source and a light receiving means located in such spaced relation with said mirror that said last mentioned means may receive light energy from said source when reflected from said mirror, a variable volume gas container attached to the plate's side opposite said pressure responsive element, a port between said chamber and said last mentioned element, means for varying the volume of said chamber to introduce a change in pressure in said element to accentuate the movement of said mirror.

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