Aug. 16, 1938. T. W. KENYON 2,126,892

PNEUMATIC POSITIONAL REMOTE CONTROL

Filed Dec. 16, 1936 2 Sheets-Sheet 1

Fig. 1.

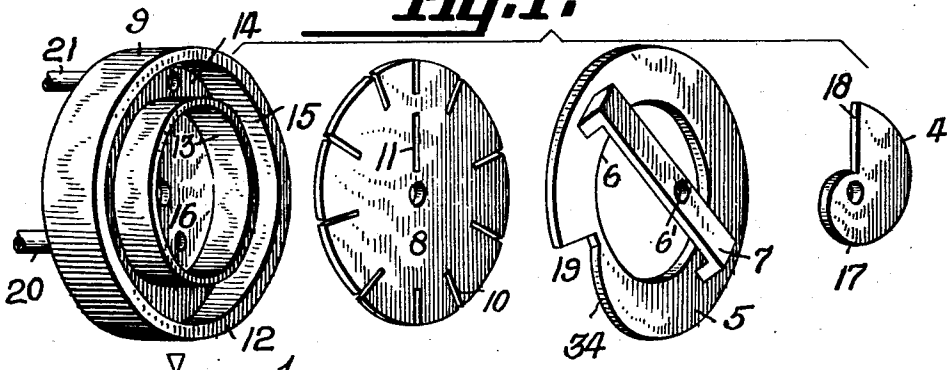
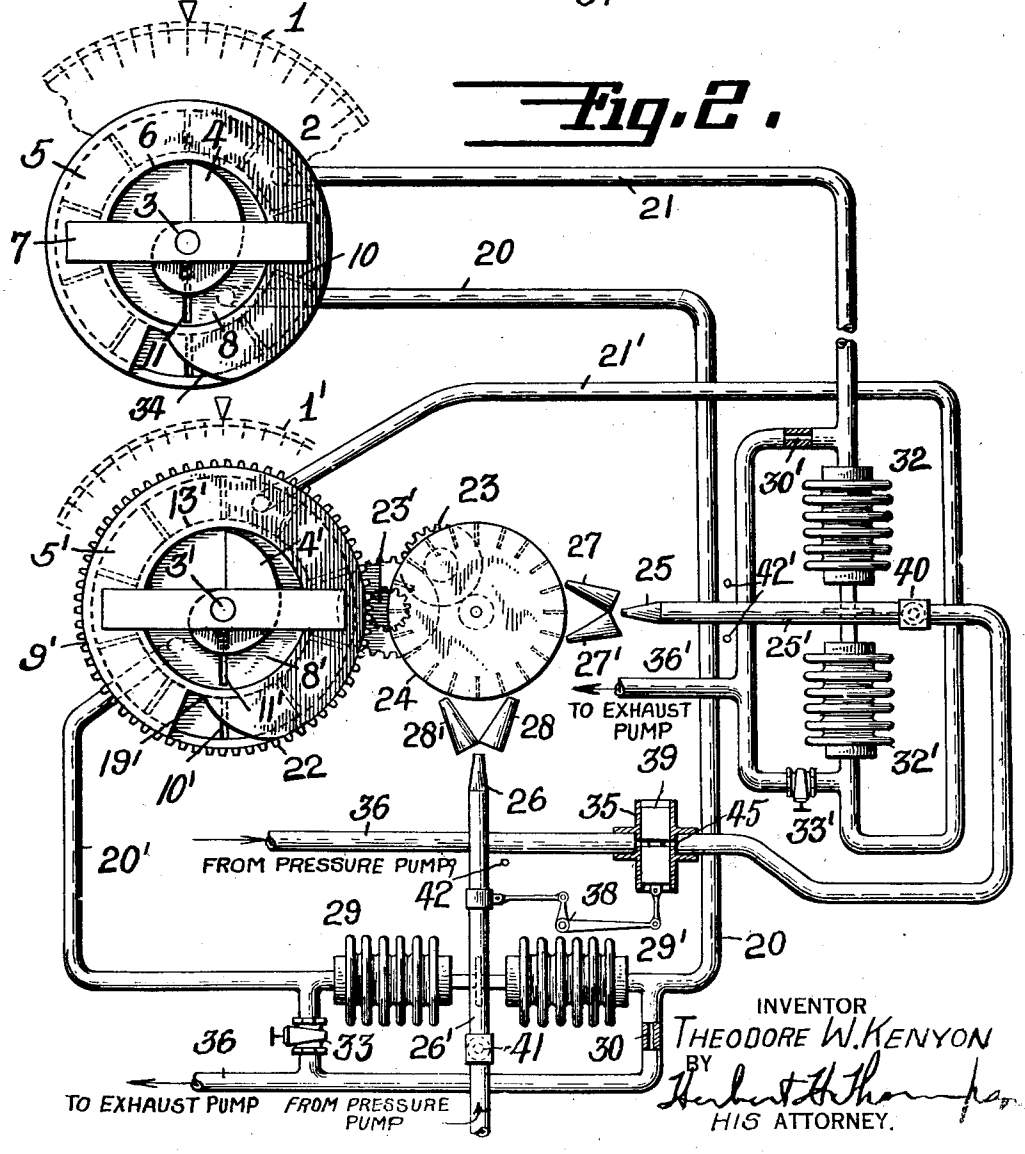


Fig. 2.



INVENTOR
THEODORE W. KENYON
BY
Herbert H. Thompson
HIS ATTORNEY.

Aug. 16, 1938. T. W. KENYON 2,126,892

PNEUMATIC POSITIONAL REMOTE CONTROL

Filed Dec. 16, 1936 2 Sheets-Sheet 2

Fig. 4.

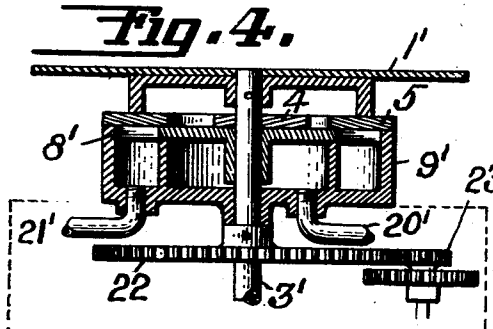


Fig. 5.

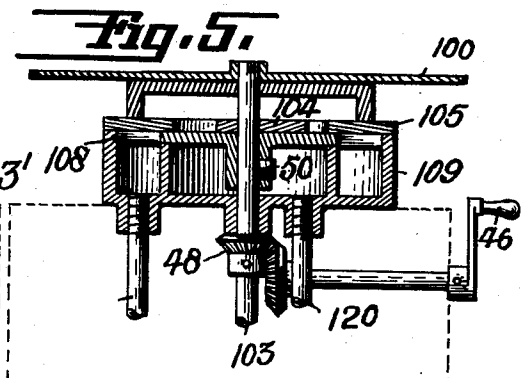


Fig. 3.

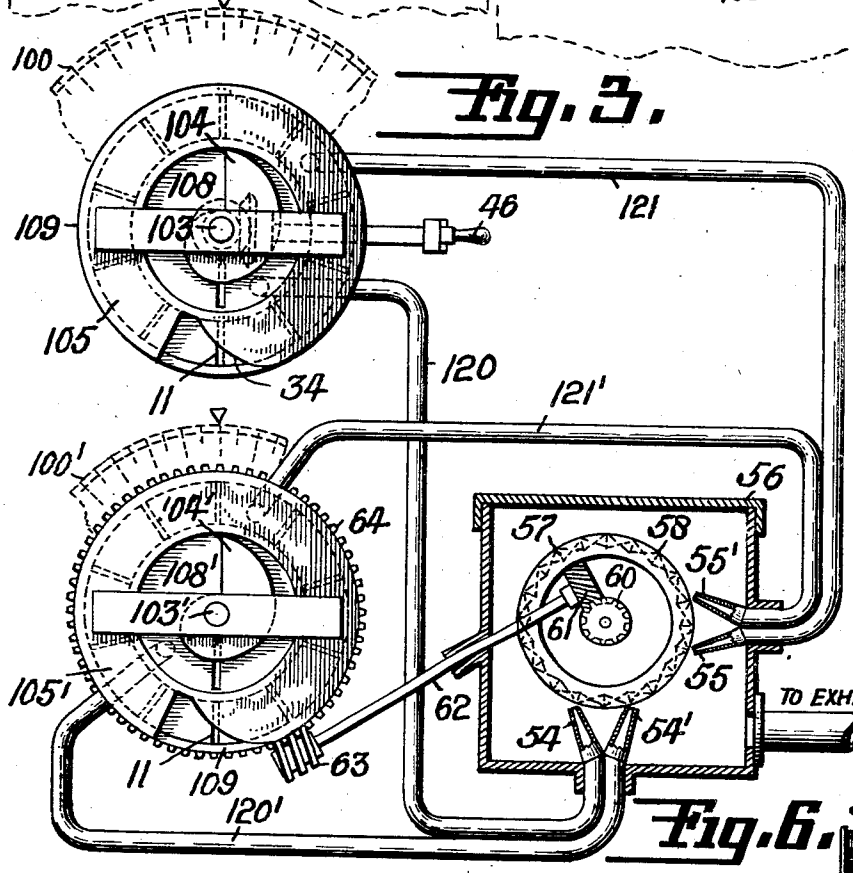
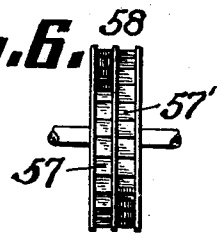


Fig. 6.



INVENTOR
THEODORE W. KENYON
BY
Herbert A. Thompson
HIS ATTORNEY.

Patented Aug. 16, 1938 2,126,892

UNITED STATES PATENT OFFICE

2,126,892

PNEUMATIC POSITIONAL REMOTE CONTROL

Theodore W. Kenyon, Huntington, N. Y., assignor to Sperry Gyroscope Company, Inc., Brooklyn, N. Y., a corporation of New York

Application December 16, 1936, Serial No. 116,239

12 Claims. (Cl. 33—204)

This invention relates to reproduction of the position of a sending instrument, such as a sensitive indicator, at a remote point, and especially to types which are self-synchronous, that is, in which the receiver will always return to the correct position with respect to the sending instrument, irrespective of its temporary displacement.

More especially, my invention relates to indicators of this type using a pneumatic, in contrast with the usual electrical, transmitting means, my invention being especially adapted for situations in which electric current is not available or inadvisable in view of likelihood of breakdown in electrical circuits. My invention is especially adapted for aircraft.

Further objects of my invention will be apparent from the following description.

Referring to the drawings, showing several forms my invention may assume,

Fig. 1 is an exploded view of the sending portion of my invention.

Fig. 2 is a diagrammatic view showing one form of my complete system.

Fig. 3 is a diagrammatic view of another form my invention may assume.

Fig. 4 is a vertical section through the upper portion of the receiving instrument of Fig. 2.

Fig. 5 is a similar section of the sending instrument of Fig. 3.

Fig. 6 is an end elevation of the little air turbine wheel used in this form of the invention.

My system is adapted for use with a sensitive indicator, such as a magnetic compass or directional gyroscope, and to indicate this fact, a compass card is shown at 1 on the sending instrument 2. It will be understood, however, that the sending instrument may be merely a manually driven indicator, if desired, as shown in Figs. 3 and 5, having one or more controllers turned therewith of preferably the frictionless air pick-off type. Directly on the shaft 3 of the card 1, so as to rotate at equal speed therewith, I mount one or, preferably, two shutter devices or cut-off plates 4 and 5 which are shown as rotated in the same plane, the shutter 5 being shown in the form of a ring having a circular opening 6 within which the shutter 4 loosely fits. The ring 5 is shown as secured to the shaft 3 by means of a bracket 7 having a central hole 6' for shaft 3. Immediately under the shutters 4 and 5 I position a fixed plate 8, which may form the top of a hollow base portion 9. The plate 8 is shown as provided with a plurality of radial slots 10 around or adjacent its periphery, and also a radial slot 11 situated nearer the center. The base member 9 is shown as having an outer rim 12, on or in which the cover plate 8 rests, and an inner rim 13, both of which are secured to the base 14. The top or cover plate 8 fits against the top of the rings 12 and 13 so that the base member 9 is separated into two compartments, an inner circular compartment 16 and an outer annular compartment 15, the slot 11 furnishing an opening to the former and the slots 10 to the latter. The shutter 4 preferably has the greater portion of its periphery 17 of spiral shape, the spiral terminating, however, in a radial edge 18 which lies in one position parallel to the radial slot 11. The ring 5, on the other hand, has the major portion of its periphery circular, but has a V-shaped notch 19 formed therein. Said notch at its periphery is preferably as broad as the space between two adjacent slots 10 in the disc 8, and one side is radial and the other side slanting or spiral shaped. The annular compartment 15 is shown as connected to a pipe 21 and the central circular compartment 16 is shown as connected to a pipe 20, through both of which air is preferably continuously withdrawn.

At the receiving instrument, which is shown as having a similar card 1', I place a device which may be quite similar to the device at the sending end. Said device likewise has the shutters 4' and 5', the disc 8' and the two-compartment base member 9', said compartments being likewise connected to exhaust pipes 20' and 21'. In this case, however, the shaft 3', to which the indicator card 1' and shutters 4' and 5' are connected, is driven as by means of a gear 22 secured to shaft 3' and the card 1', said gear being rotated through suitable reduction gearing 23, including pinion 23', from a small air motor or turbine 24. Said turbine is shown as driven in either direction from air jets emerging from one or both nozzles 25 and 26 forming the ends of pipes 25' and 26', hinged at 40 and 41, respectively, and limited in their movement by stops 42 and 42'. As shown, the direction of rotation of the turbine 24 is governed by the position of the two nozzles, the air therefrom being directed through the pairs of chutes 27 and 27' or 28 and 28', each jet dividing equally or unequally, depending on whether the nozzle is central or is moved away from its central position. Both nozzles are supplied with air under pressure as from a pump (not shown).

The position of nozzle 26 is controlled by the relative positions of the two shutters 4 and 4' on the sending and receiving instruments. This may be effected by means of a pair of metallic

bellows or other pressure responsive devices 29 and 29', one of which is connected to pipe 20 and the other to pipe 20', both pipes being connected through suitable restrictions 30 and 33 to a common exhaust pump through pipe 36. Preferably one of said restrictions is of adjustable size, being shown as provided by a valve 33, so as to balance the system and compensate for the difference in the length of the pipes. Both bellows are pivotally connected in opposition to hinged pipe 26' so as to rotate the same. It will readily be seen, therefore, that as long as the pressure within the containers 29, 29' is equal, nozzle 26 will be centralized and air issuing therefrom will not tend to drive the turbine 24 in either direction, but that a slight preponderance of pressure in one container over that in the other will move the nozzle to rotate the disc in the proper direction to restore the balance between the two elastic containers. In other words, equilibrium can only be reached when the slots 11 and 11' in the two discs 8 and 8' are covered or uncovered the same amount in the sending and receiving instruments. Such condition is satisfied only when the shutters 4 and 4' assume the same angular position with respect to their respective ports.

While the one nozzle and pair of control shutters 4 and 4' would give fairly accurate results, greater accuracy may be secured by employing fine controllers also, such as the supplemental shutters 5 and 5' in connection with supplemental chambers. The pipes 21 and 21' therefrom are likewise connected to flexible containers or bellows 32 and 32' to control the position of the nozzle 25 and are also connected to a common exhaust pump through restrictions 33 and 30 and pipe 36'. Therefore the joint action of shutters 5 and 5' will move the nozzle 25 until one of slots 10 in disc 8 is covered the same amount as the similar slot 10' in the disc 8'. Since the slope of the edges 34 of the notches 19 and 19' may be made much greater than the slope of the spiral 17, more accurate positioning may be secured.

However, it is essential that the nozzle 26 should be the preponderating influence on the turbine 24 in order that the two devices do not work in opposition and true self-synchronism be obtained. This may be accomplished either by making the jet 26 much stronger, as suggested in Fig. 3, or by positioning a shut-off valve 35 in the supply pipe 36 leading to the nozzle 25. This valve is arranged to shut off the supply to the nozzle 25 whenever the pivoted jet pipe 26' is moved away from its centralized position, which is shown as accomplished by connecting the pipe 26' to bell crank lever 38 which, in turn, moves the slide valve 39 across the ports 45 in valve 35 so as to close the same except when the nozzle 26 is virtually inoperative, i. e., when it is centralized.

Figs. 3, 5 and 6 show several variations that my invention may take. As previously indicated, the sending instrument in this form is shown as driven by a hand crank 46 instead of being connected to a sensitive indicator, the indicating card being at 100. The crank 46 is shown as driving a central shaft 103 through bevel gearing 48.

It is also obvious that it is immaterial whether the shutters be rotated or the slotted plate. In these figures I have indicated the slotted plate 108 is rotated, the same being secured to the shaft 103 by a set screw 50 in the hub thereof. The shutters 104 and 105 in this case are fixed to the top of the base rim 109 so as to be held stationary.

In this case, also, I have simplified the pneumatic mechanism so that only an exhaust pump need be used. In this case the pipes 120 and 120' and 121 and 121' from the sending and receiving instruments lead directly to pairs of oppositely directed nozzles 54, 54' and 55, 55', respectively, said nozzles being enclosed in an air-tight casing 56 from which air is continuously withdrawn by an exhaust pump (not shown). The jets from the nozzles 54 and 55 engage blades 57 on a double-bladed rotor 58, while the jets from the nozzles 54' and 55' engage oppositely directed blades 57' on said rotor.

Considering first the nozzles 54 and 54', it will be obvious that as long as the shutter plates 104 and 104' on the sending and receiving instruments have the same relative position with respect to the slot 11 in the disc 108, the jets will be equal and no rotation of the turbine will result. In case, however, of relative turning of the sending with respect to the receiving instrument, this balance will be destroyed and the turbine rotated in the proper direction to restore synchronism. For this purpose a worm drive is shown between the turbine 58 and the receiver, the turbine having a skew gear 60 on the shaft thereof driving a second skew gear 61 on a shaft 62, which carries at its other end a worm 63 meshing with a large gear 64 secured to the shaft 103' of the receiving instrument. Similarly, the jets from nozzles 55 and 55' are controlled from the relative positions of the fine or outer shutter plates 105 and 105' and the slotted discs 108 and 108' of the sending and receiving instruments. In this case, however, instead of employing a shut-off valve operated from the self-synchronous shutters 4, 4', as in Fig. 2, I merely make the nozzles 54 and 54' larger than 55 and 55' so that the former will be in control until the receiver is very close to synchronism with the sending instrument, at which time the rate of flow through the nozzles 54 and 54' will be substantially equalized, so that the nozzles 55 and 55' will assume control until exact synchronism is reached.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. A pneumatically operated self-synchronous repeating system, including a sending instrument having relatively rotatable ported and shutter members, the shutter and port being so designed that the amount of the port area covered by the shutter uniformly varies with the relative angular position of said port and shutter substantially throughout a complete revolution, a receiving instrument having similar ported and shutter members, a common means for withdrawing air through the ports of both instruments, including a pipe to each instrument, a motor for turning the rotatable member of said receiver, and means responsive to variations in the relative pressure drop in said pipes for actuating said motor to restore synchronism.

2. A pneumatically operated self-synchronous repeating system as claimed in claim 1, wherein

said last mentioned means includes a pair of opposed nozzles, one of each of said pipes, a common impulse wheel for said pipes, an enclosure for the nozzles and the wheel, and means for exhausting the air from said enclosure.

3. A pneumatically operated self-synchronous repeating system as claimed in claim 1, wherein said last mentioned means includes a pair of opposed flexible containers each connected with a respective one of said pipes and throttled means for withdrawing air from both pipes, the relative pressure in said containers governing the motor driving means.

4. In a pneumatically operated self-synchronous repeater system, a plurality of chambers, means for creating air pressure in each different from atmospheric pressure, a ported cover member for said chambers through the port or ports of each of which air passes, there being a plurality of circumferentially spaced ports over one chamber and a single port over the other, a shutter having a 360° spiral edge for said single port, a second shutter having a notch therein adapted to uncover only one of said spaced ports at a time, and a means for relatively turning said member with respect to both chambers.

5. In a pneumatically operated self-synchronous repeater system, a sending instrument including a plurality of concentric chambers, a ported cover member for said chambers through the port or ports of each of which air passes, there being a plurality of circumferentially spaced ports over one chamber and a single port over the other, a shutter having a 360° spiral edge for concentric rotation over said single port, a concentric, rotatable second shutter having a notch therein adapted to uncover only one of said spaced ports at a time, and a receiver including similarly arranged chambers, ported member and shutters, a motor for turning the shutters of said receiver relative to its member, a common means for withdrawing air from the chambers of both the sending and receiving instruments including separate pipes to each, and means responsive to variations in the relative pressure drop in corresponding chambers for actuating said motor.

6. A pneumatically operated self-synchronous repeating system as claimed in claim 5, having means whereby the control from the 360° shutters preponderates until approximate synchronism is reached, whereupon the other shutters assume control.

7. In a differential fluid flow positional control system, a movable primary element and a remotely located secondary element, a fluid motor for moving said secondary element, and control means for said motor, said control means comprising a frictionless controller responsive to movement of said primary element adapted to produce fluid flow tending to cause said motor to operate in but one direction, and a second frictionless controller responsive to movement of said secondary element and adapted to produce an opposing fluid flow tending to cause said motor to operate in the reverse direction, the opposing fluid flow together operating said motor.

8. A pneumatically operated self-synchronous repeating system, including a sending instrument having relatively rotatable ported and shutter members, the shutter and port being so designed that the amount of the port area covered by the shutter uniformly varies with the relative angular position of said port and shutter substantially throughout a complete revolution, a receiving instrument having similar ported and shutter members, a common means for causing air flow through both ports, including a pipe to each instrument, a motor for turning one of the members of said receiver, and means responsive to variations in the relative pressure in said pipes for actuating said motor to restore synchronism between the sending and receiving instruments.

9. In a pneumatic positional control system, a movable primary element and a remotely located secondary element, motive means for moving said secondary element, and control means for said motive means, said control means comprising a frictionless controller responsive to movement of said primary element adapted to produce an air jet tending to cause said motive means to operate in but one direction, and a second frictionless controller responsive to movement of said secondary element and adapted to produce an opposing air jet tending to cause said motive means to operate in the reverse direction, said air jets together operating said motive means.

10. In a positional control system, a movable primary element and a remotely located secondary element, motive means for moving said secondary element, and control means for said motive means, said control means comprising coarse and fine controllers responsive to movement of said primary element adapted to produce motivating forces tending to cause said motive means to operate in but one direction, coarse and fine controllers responsive to movement of said secondary element and adapted to produce opposing motivating forces tending to cause said motive means to operate in the reverse direction, said motivating forces together operating said motive means, and means whereby the forces controlled from the coarse controllers predominate until near synchronism is reached between the primary and secondary elements.

11. A pneumatically operated repeating system comprising a plurality of chambers each continuously subjected to a predetermined suction to produce a reduced air pressure therewithin, a ported cover member for each chamber through the ports of which air can pass thereto, one of said cover members having a plurality of circumferentially spaced ports and another of said members having a single port, and shutters cooperating respectively with said members, one having an edge spirally shaped over 360° to cooperate with the single port, and another having a notch extending over an arc of less than 360° and having a spirally shaped edge to cooperate with one of the circumferentially spaced ports at a time.

12. In a differential air flow self-synchronous positional control system, a movable primary element, a remotely located secondary element, an air motor for moving said secondary element, and control means for said motor, said control means comprising coarse and fine controllers responsive to movement of said primary element and adapted to produce air flow tending to cause said motor to operate in one direction, coarse and fine controllers responsive to movement of said secondary element adapted to produce air flow tending to cause said motor to operate in the reverse direction, and means operated by a predetermined air pressure due to either of said coarse controllers for cutting off the air flow from said fine controllers to said motor.

THEODORE W. KENYON.