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BACKLASH ELIMINATOR

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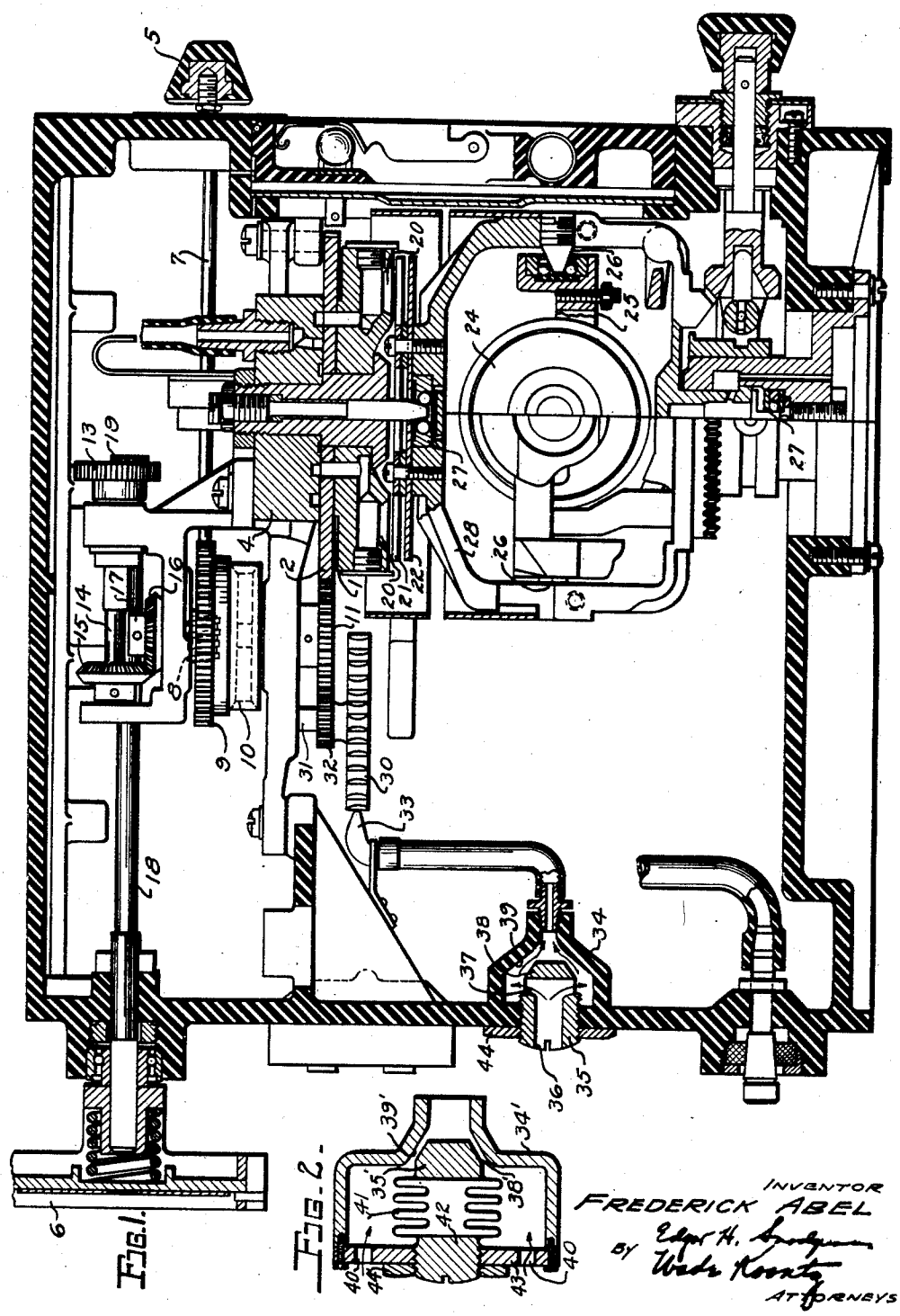


FIG. 1.

FIG. 2.

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BACKLASH ELIMINATOR

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4 Claims. (Cl. 74—409)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This device broadly relates to an apparatus for eliminating backlash in a train of gears.

The device specifically relates to a backlash eliminator for a train of gears in an automatic pilot for airplanes and is specifically adapted to be used in connection with an automatic pilot of the type disclosed in the patent to Sperry, 1,992,970, issued March 5, 1935.

As described in that patent, the course of flight of the airplane when governed by the automatic pilot is determined by the position of the pick-off mechanism in each of the directional gyro control units. The pick-off mechanism is positioned by control mechanism composed of hand control mechanism and over-control-preventing follow-up mechanism. The hand control mechanism and the follow-up mechanism are operatively connected to the pick-off mechanism through a differential gearing. In order to prevent "hunting" or failure to follow closely the course of flight corresponding to the setting of the control mechanism, it is essential that the pick-off mechanism be accurately positioned. It has been found that inaccurate positioning of the pick-off mechanism is primarily due to play in the differential gears and none of the many mechanisms which have previously been devised for eliminating this play have been successful. One such mechanism comprises a tension spring attached to one of the gears connecting the gear train to the differential. This arrangement was not successful because rotation of the gear to which the spring was attached resulted in varying spring tension as well as dead center positions of the spring with respect to the gear. The "hunting" condition as the result of play in the gears has been alleviated to a certain extent by machining the gears in the differential and gear train to a very close tolerance, but the cost of such machining is comparatively high.

It is, therefore, an object of this invention to provide a mechanism for eliminating the backlash in a gear train in an automatic pilot.

It is a further object of this invention to eliminate backlash in a two-way differentially connected control.

It is still another object of this invention to eliminate backlash in a gear train by means of an air turbine operatively associated therewith.

It is yet another object of this invention to regulate the flow of air to the turbine to effect the maintenance by the turbine of a constant backlash eliminating torque.

Other objects and advantages of this invention will become apparent from the following description taken in connection with the accompanying drawing, it being clearly understood that the same are by way of illustration and example only, and are not to be taken as in any way limiting the spirit or scope of this invention. The spirit and scope of this invention is to be limited only by the prior art and by the terms of the appended claims.

In the drawing:

Figure 1 is a side elevational view, partially in section of a directional control unit in an automatic pilot with the invention applied thereto.

Figure 2 is a sectional view of a modified form of air intake valve.

Referring to the drawing, as much of the relating structure of the automatic pilot as is pertinent to the present invention will be described, reference being made to the afore-mentioned patent to Sperry for a more complete disclosure of an automatic pilot and a directional gyro control unit in which the present invention may be incorporated.

The mechanism of the directional gyro control unit with which the present invention is adapted to cooperate may be briefly summarized as follows: The relative position of the pick-off member 1 with respect to the semicircular disk 21 determines the flow of air through ports 20 which, in turn, controls the operation of the servo mechanism associated with the airplane controlling mechanism (see Figure 13 of Sperry Patent No. 1,992,970). The semicircular disk 21 and circular shield 22 are positioned horizontally in space by gyroscope 24. This gyroscope is universally mounted by means of yoke 25, bearings 26, gimbal ring 28—to which disk 21 and shield 22 are attached—and bearings 27. Reference is made to Figure 6 of the aforementioned patent to Sperry for a more complete description of this mechanism or mechanical equivalents therefor.

Pick-off member 1 and gear 2 integral therewith are rotatably mounted in bearing member 4 and are adapted to be selectively positioned by either hand control knob 5 or over-control-preventing follow-up mechanism operatively connected to clutch 6. Pick-off member 1 is operatively connected to knob 5 to be actuated thereby by means of shaft 7, worm gear 8, gear 9, differential 10 and gears 11 and 2. Worm 8 is integral with shaft 7 and meshes with gear 9, which in turn is operatively connected through differ-

ential 10 to gear 11. Gear 11 meshes with gear 2, which is integral with pick-off member 1. Pick-off member 1 may also be actuated by the follow-up mechanism through clutch 6, shaft 18, gear 19, gear 13, shaft 14, gears 15 and 16, shaft 17, differential 10 and gears 11 and 2.

Coming now to the backlash eliminating mechanism constituting the present invention, there is provided a turbine wheel 30 rotatably mounted on shaft 31. Turbine wheel 30 has integral therewith a gear 32 meshing with gear 11 of the gear train. A flow of fluid under pressure is applied to turbine wheel 30 by means of nozzle 33 suitably held in operative position with respect to the turbine wheel. This fluid under pressure maintains a backlash eliminating torque of predetermined value in the turbine as well as in the gear train operatively associated therewith. To provide a suitable flow of air through intake valve 35 and nozzle 33, advantage is taken of the fact that the casing of the directional gyro control unit is maintained under a partial vacuum for the purpose of operating the gyroscope as is well-known in this particular mechanism. Since the predetermined differential in pressure is maintained between the exterior and interior of the casing regardless of atmospheric pressure to insure proper functioning of the gyro, it follows that when operating in a rarefied atmosphere the velocity of flow through nozzle 33 will be greater than under conditions of a denser atmosphere. To insure an air flow such that the backlash eliminating torque will remain constant, the intake valve 34 is provided with an adjustable member 35 screw threaded in the casing. Member 35 is provided with ports 36 and 37, and a tapered portion 38 adapted to cooperate with a tapered seating portion 39 in member 34. A lock nut 44 is provided for holding the member 35 in adjusted position.

A modified form of intake valve is shown in Figure 2. In this form of the invention, valve member 34' is provided with inlet ports 40 and a valve seat 39'. Valve member 35' is provided with a tapered portion 38' adapted to cooperate with valve seat 39'. Member 35' is carried by bellows 41, which in turn is attached to member 42. Member 42 is threaded into wall 43 of member 34' and is held in place by a suitable lock nut 44'. Bellows 41 is evacuated to the extent that it is responsive to changes in temperature and/or pressure. The volume of air supplied to nozzle 33 is, therefore, responsive to temperature and/or pressure changes to maintain a substantially constant fluid force against turbine wheel 30 and, consequently, a substantially constant backlash-removing torque in the gear train irrespective of atmospheric changes.

Various modifications and changes may be made by those skilled in the art without departing from the inventive concept and it is intended that the invention be limited only by the scope of the appended claims.

I claim:

1. In combination, an evacuated casing, a driving member, a driven member, a gear train operatively connecting said driving and driven members, and means for eliminating backlash in said gear train including turbine means operatively associated with one of said members and means responsive to the evacuation of said casing for applying torque-producing fluid to said turbine means.

2. A device as recited in claim 1 and further including means for regulating the flow of fluid to said turbine means.

3. A device as recited in claim 1 and further including means responsive to atmospheric density for regulating the fluid flow to said turbine to maintain the resulting torque exerted by said turbine substantially constant.

4. A device as recited in claim 1 and further including means for regulating the fluid flow to said turbine to maintain the torque exerted by said turbine substantially constant, including atmospheric-pressure-responsive valve means.

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