June 19, 1945. B. G. CARLSON 2,378,829

DIRECTIONAL GYRO

Filed June 29, 1943 3 Sheets-Sheet 1

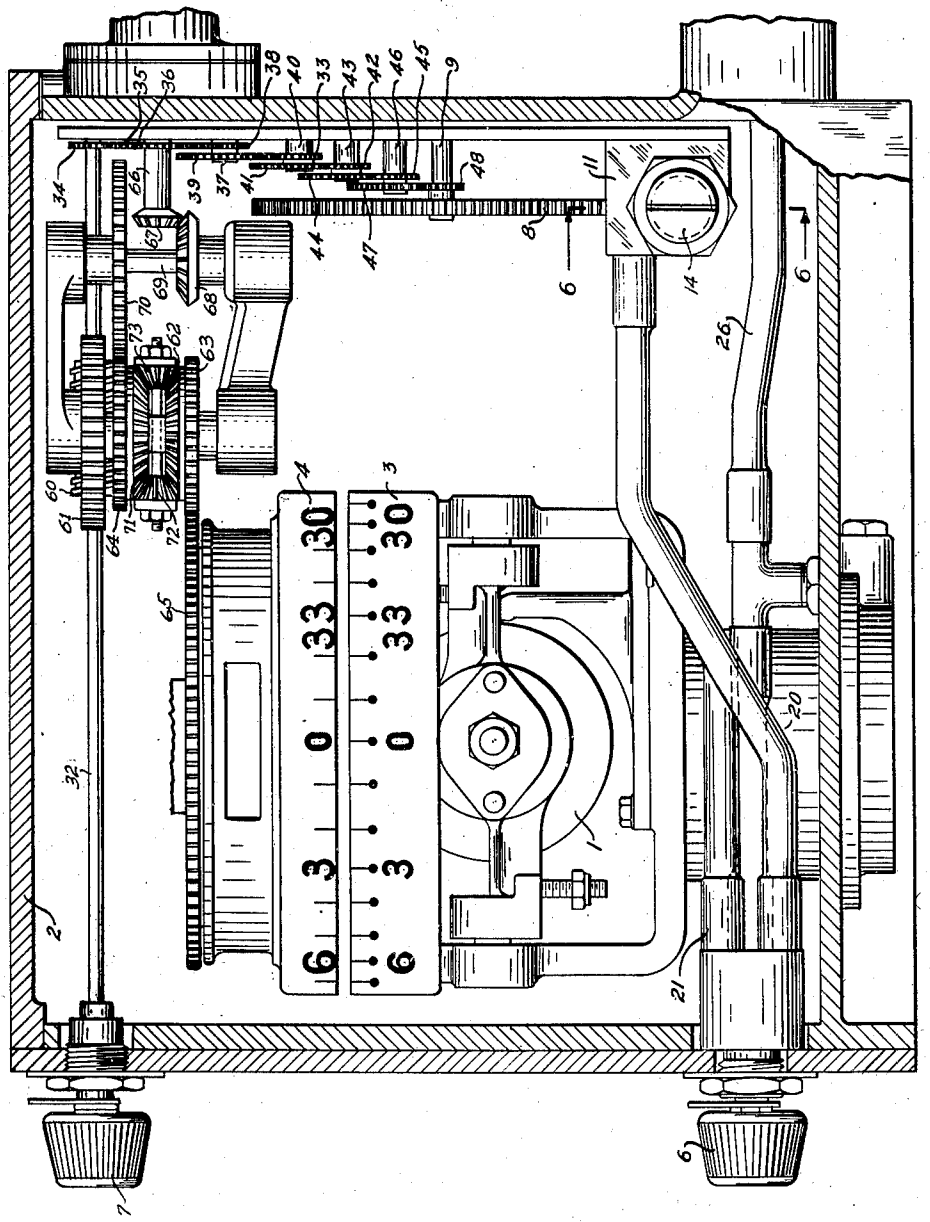


Fig. 1

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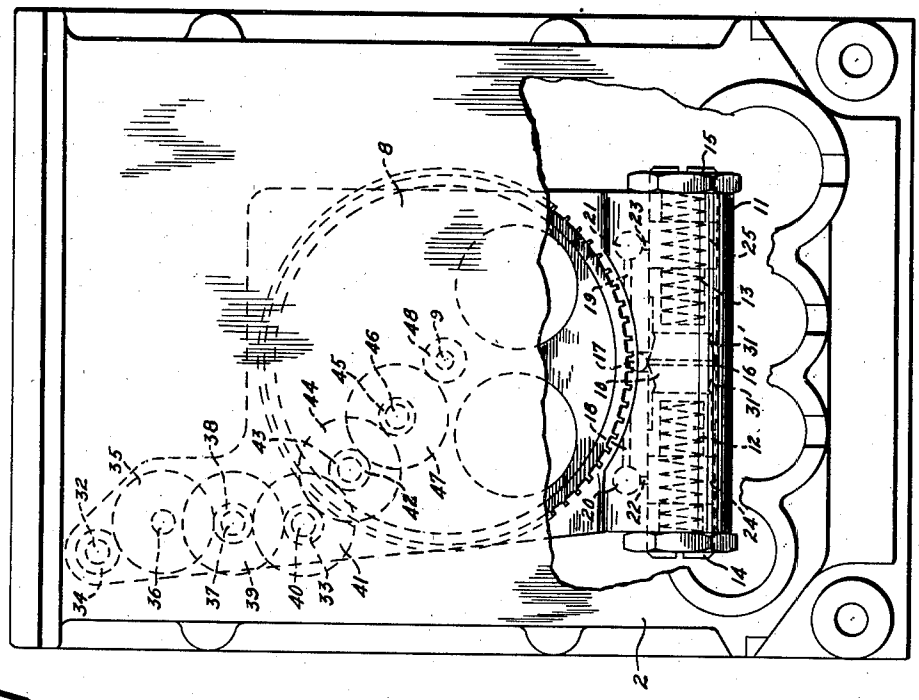


Fig. 3

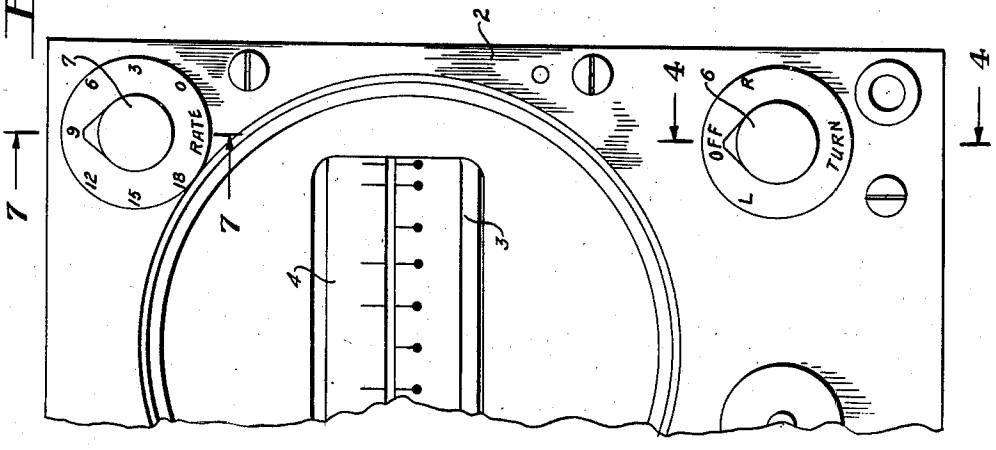


Fig. 2

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Fig. 4

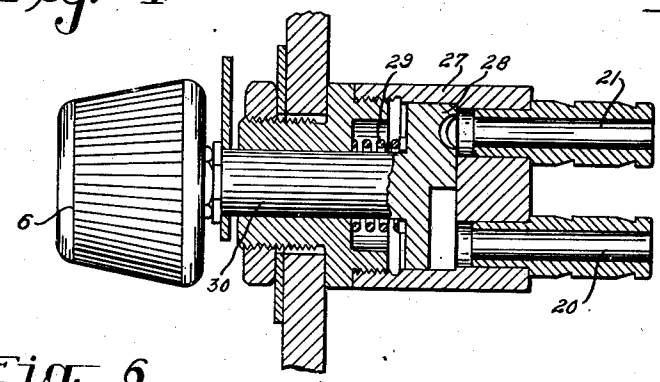


Fig. 5

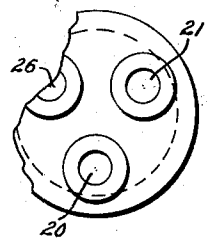


Fig. 6

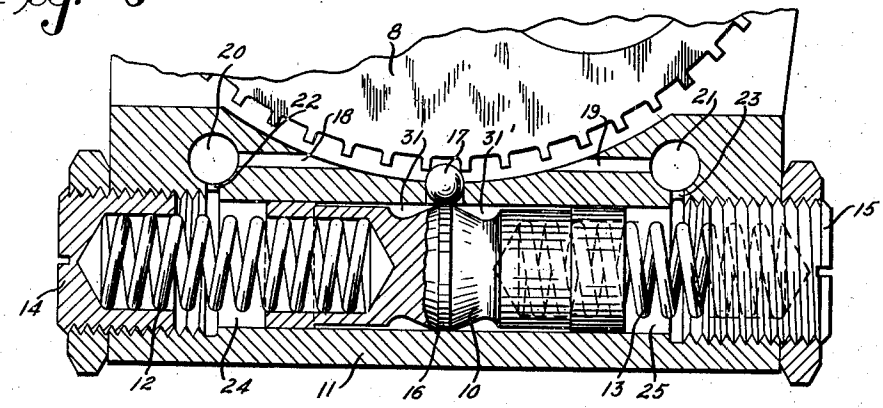
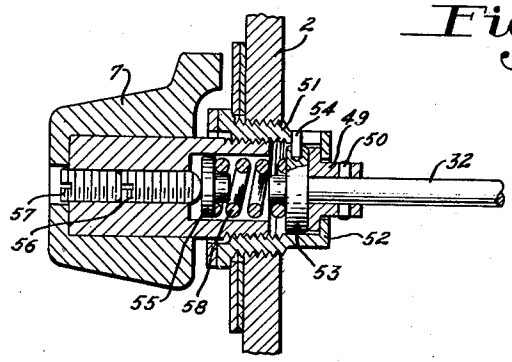


Fig. 7



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2,378,829

UNITED STATES PATENT OFFICE

2,378,829

DIRECTIONAL GYRO

Bert G. Carlson, Erieside, Ohio, assignor, by mesne assignments, to Jack & Heintz, Inc., Cleveland, Ohio, a corporation of Ohio

Application June 29, 1943, Serial No. 492,671

5 Claims. (Cl. 244—78)

This invention relates in general to automatic pilots and more particularly to improvements in directional gyros therefor.

In the conventional automatic pilot the rate of turn of the aircraft is variable with the amount of turn which may be set in the automatic pilot by the aviator. If, however, a large turn is set in, the automatic pilot throws the rudder hard over causing a high rate of turn so as to not be directly under the control of the aviator.

One of the primary objects of the present invention is to provide a new and novel simple and efficient means whereby definite and variable rates of turn may be set up at the will of the aviator by the turning of one control knob and the starting and stopping and direction of turn controlled by the turning of another control knob, so that the direction and rate of turn is independent of the amount of turn desired and is controllable at the will of the aviator.

With the foregoing and other objects in view, the invention resides in the combination of parts and in the details of construction hereinafter set forth in the following specification and appended claims, certain embodiments thereof being illustrated in the accompanying drawings, in which:

Figure 1 is a view in side elevation of the directional gyro assembly with the box shown in vertical section;

Figure 2 is a partial view in front elevation of the directional gyro, showing the cards and the direction and rate of turn control knobs;

Figure 3 is a side view of the same with the side cover partly broken away, and showing the rate control gear train in dotted lines;

Figure 4 is a view in longitudinal section taken through the direction control means, along lines 4—4 of Figure 2;

Figure 5 is a rear end view of that shown in Figure 4;

Figure 6 is a view in section taken along line 6—6 of Figure 1, showing the valve and control means for the direction of turn control; and

Figure 7 is a view in longitudinal section taken along line 7—7 of Figure 2 of the rate control knob and clutch.

Referring more particularly to the drawings, the directional gyro 1 may be of conventional form and enclosed in a casing 2 from which air is continuously exhausted. The gyro assembly includes a compass card 3 and a follow-up or rudder position card 4. In addition to the conventional caging control knob, there are provided a control knob 6 with "left," "right" and neutral or "off" positions for initiating and controlling the direction of desired turn and a control knob 7 for controlling the rate of turn once it is initiated by operation of knob 6.

In order to predetermine and control the direction of turn an air actuated turbine 8 is mounted on a shaft 9 for rotation in either direction, the admission of air to the turbine being under the control of hand knob 6. This is brought about by a piston 10 slidably arranged within a cylinder 11 and normally balanced in the neutral central position shown in Figure 6 by two opposed coil springs 12 and 13 removably retained in the cylinder by screw plugs 14 and 15. The piston is releasably locked in this neutral position by having its central portion enlarged and provided with a flat portion 16 of maximum diameter to receive a ball 17 rotatably and slidably carried by the cylinder and which ball, when the piston is in the neutral position, as shown in Figure 6, also engages one of the peripheral buckets of the turbine 8 to stop any rotation of the turbine in either direction. The piston is further held in normal neutral position by the normally balanced pressure of air from the two air inlet tubes 20 and 21 leading through passages 22 and 23 into cylinder chambers 24 and 25 on either side of the piston and also leading through jets 18 and 19 to the turbine buckets.

Air is drawn in through tube 26 into the valve casing 27 in which is located a valve 28 urged forwardly by a compression coil spring 29 arranged about the valve stem 30 to which is secured the control knob 6. When the control knob is in the "off," or neutral position, as shown in Figure 2, the valve is in such a position as to admit a full flow of air from inlet tube 26 into the valve casing 27 and out through tubes 20 and 21 to the piston and turbine assembly already described in connection with Figure 6.

When, however, it is desired to make a turn to the right or left, such turn may be initiated by a corresponding manual turning of the control knob 6 to the right or left. If turned to the left for a left turn the valve 28 is moved to cut off the supply of air to tube 21 and the jet 19. Accordingly there is an overbalance of pressure in piston chamber 24 causing piston 10 to be moved to the right and ball 17 rides downwardly on the incline of the piston into a pocket 31 and the ball is thus removed from locked engagement with the bucket of the turbine 8. The stream of pressure air through tube 20 and jet 18 impinges on the turbine buckets to rotate the turbine in a counterclockwise direction. Upon a

manual turning of knob 6 in the opposite direction for a right turn, tube 20 will be closed and tube 21 opened and air will be cut off from jet 18 but supplied to jet 19 to spin the turbine 8 in a clockwise direction as ball 17 rests in pocket 31'. A return of knob 6 to neutral position opens the valve with respect to tubes 20 and 21 and equalizes the flow of pressure air through these tubes to jets 18 and 19 and through passages 22 and 23 to chambers 24 and 25, whereupon springs 12 and 13, being balanced, return the piston so that portion 16 is in alignment with ball 17, which latter engages a bucket of turbine 8 in locked engagement in neutral position.

The rate of turn is under the control of the manual knob 7 which is connected through a spring clutch to the conventional rudder synchronizing shaft 32. This shaft carries at its other end a ring gear 34 meshing with gear 35 carried by a shaft 36. Gear 35 meshes with a gear 38 carried by a shaft 37 which also carries a gear 39 which meshes with a gear 33 carried by a shaft 40 which also carries a gear 41 meshing with a gear 42 carried by a shaft 43 which also carries a a gear 44 meshing with a gear 45 carried by a shaft 46 which also carries a gear 47 meshing with a gear 48 carried by the shaft 9 carrying the air turbine 8. The effect of this train of gears is that of a reduction gearing from the turbine to the rudder synchronizing shaft 32. Shaft 32 carries a worm 60 that meshes with a gear 61 of a differential. The rotation of gear 61 effects a rotation of gears 62 and 63 without rotation of gear 64. Gear 63 meshes with a conventional air valve gear 65. This air valve gear 65 corresponds to the gear 20 shown in the U. S. patent to Bert G. Carlson, No. 2,155,401, dated April 25, 1939, for Rate control course changing means for automatic pilots, and as explained in this patent, the purpose of gear 65 is conventional in that it turns the top card 4 and also carries the usual air pick-offs and thus disturbs their relationship with the usual shrouds carried by the gimbal in one direction or the other to correspondingly initiate a turn. One pick-off becomes closed while the other is opened. This activates the usual air relay to operate the usual balanced oil valve to actuate the conventional hydraulic servo to move the aircraft rudder in one direction or the other, in accordance with the usual practice. Likewise, the shaft 66 is the follow-up shaft corresponding to that shown at 16 in the above Carlson patent. However, this shaft 66 carries a bevel gear 67 meshing with gear 68 carried by a shaft 69. The shaft 69 also carries a gear 70 meshing with gear 64 of the differential. Rotation of gear 64 by the usual follow-up shaft 66 rotates gear 71 and through pinion gears 72 and 73 rotates gears 62 and 63 to rotate valve gear 65 without rotation of gear 61, worm 60 or shaft 32.

As stated before, a clutch is interposed between the rate control knob 7 and the rudder synchronizing shaft 32 the effect of which is to regulate the speed at which the shaft may be rotated regardless of the air pressure exerted by air jet 18 or 19 against the buckets of air turbine 8. This clutch includes a flanged collar 49 pinned at 50 to shaft 32 and a barrel 51 screwed into the front wall of the box 2 and provided with a circular flange 52 to overlap and retain that of collar 49. A clutch plate 53 is keyed at 54 to barrel 51 to prevent rotational movement but permit a limited longitudinal movement. Another floating plate 55 is provided and a compression coil spring 58 interposed between plates 53 and 55. An adjustment set screw 56 is screwed into the hand control knob 7 which is screwed into the barrel 51. A set screw 56, locked in place by a lock screw 57, passes against plate 55 to initially adjust the compression of spring 58 and consequently the clutch, or friction braking, effect on the rotatability of shaft 32.

With the above described arrangement, a turning of control knob 7 in a clockwise direction, as viewed in Figure 2, causes a compression of spring 58 to increase a resilient friction braking effect on shaft 32 as plate 53 presses more tightly against collar 49. Accordingly, a rotation of control knob 7 in a counterclockwise direction relieves the braking effect on the rotation of shaft 32.

From the foregoing, the operation of the invention will be readily apparent. When the aviator desires to turn right at a given rate, he first moves the control knob 6 from "off" to "R." He then turns control knob 7 to the desired rate of turn on its scale. The airplane continues to turn at that rate until knob 6 is turned to "off" or until knob 7 is turned back to zero which is done when the desired course change has been effected.

I claim:

1. In an automatic pilot for aircraft having a rudder, the combination with course maintaining means, a controller including a shaft at said means for controlling the rudder, an air turbine and a train of reduction gears between the turbine and the controller shaft to cause the turning of the aircraft, air jets for driving the turbine in either direction desired and a spring balanced piston carrying a means for releasably locking the turbine against rotation, manual valve means for diverting air to unbalance said piston to release said locking means to drive said turbine in either direction and a variable drag means independent of the turbine for regulating the speed of rotation of said turbine.

2. In an automatic pilot for aircraft having a rudder, the combination with course maintaining means, a controller including a shaft at said means for controlling the rudder, an air turbine and a train of reduction gears between the turbine and the controller shaft to cause the turning of the aircraft, air jets for driving the turbine in either direction desired, and a spring balanced piston carrying a means for releasably locking the turbine against rotation, manual valve means for diverting air to unbalance said piston to release said locking means to drive said turbine in either direction and a variable drag means independent of the turbine for regulating the speed of rotation of said controller shaft said variable drag means including a spring friction clutch and a manual control for the effectiveness of the spring for adjustment of the clutch.

3. In an automatic pilot for aircraft having a rudder, the combination with course maintaining means, a controller including a shaft at said means for controlling the rudder, an air turbine and a train of reduction gears between the turbine and the controller shaft to cause the turning of the aircraft, air jets for driving the turbine in either direction desired and a spring balanced piston with an enlarged center portion loosely carrying a ball to engage the peripheral buckets of said turbine to lock the same against rotation when the piston is in neutral central position, manual valve means for diverting air to unbalance said piston and permit said ball

to disengage itself from said turbine so that the latter is air driven in either direction and a variable drag means independent of the turbine for regulating the speed of rotation of said controller shaft.

4. In an automatic pilot for aircraft having a rudder, the combination with course maintaining means, a controller including a shaft at said means for controlling the rudder, an air turbine and a train of reduction gears between the turbine and the controller shaft to cause the turning of the aircraft, air jets for driving the turbine in either direction desired and a spring balanced piston with an enlarged center portion loosely carrying a ball to engage the peripheral buckets of said turbine to lock the same against rotation when the piston is in neutral central position, manual valve means for diverting air to unbalance said piston and permit said ball to disengage itself from said turbine so that the latter is air driven in either direction and a variable drag means independent of the turbine for regulating the speed of rotation of said controller shaft, said variable drag means including a spring friction clutch and a manual control for the effectiveness of the spring for adjustment of the clutch.

5. In an automatic pilot for aircraft having a rudder, the combination with course maintaining means, a controller including a shaft at said means for controlling the rudder, an air turbine and a train of reduction gears between the turbine and the controller shaft to cause the turning of the aircraft, air jets for driving the turbine in either direction desired and a spring balanced piston with an enlarged center portion loosely carrying a ball to engage the peripheral buckets of said turbine to lock the same against rotation when the piston is in neutral central position, manual valve means for diverting air to unbalance said piston and permit said ball to disengage itself from said turbine so that the latter is air driven in either direction and a variable drag means independent of the turbine for regulating the speed of rotation of said controller shaft, said variable drag means including a friction clutch comprising a plate carried by said shaft and another plate carried by a manual control knob and a spring therebetween so that an adjustment of the knob adjusts the compression of the spring and the drag of the clutch.

BERT G. CARLSON.