Aug. 17, 1943. L. F. CARTER 2,326,835

ARTIFICIAL HORIZON

Filed Jan. 9, 1941

Fig. 1

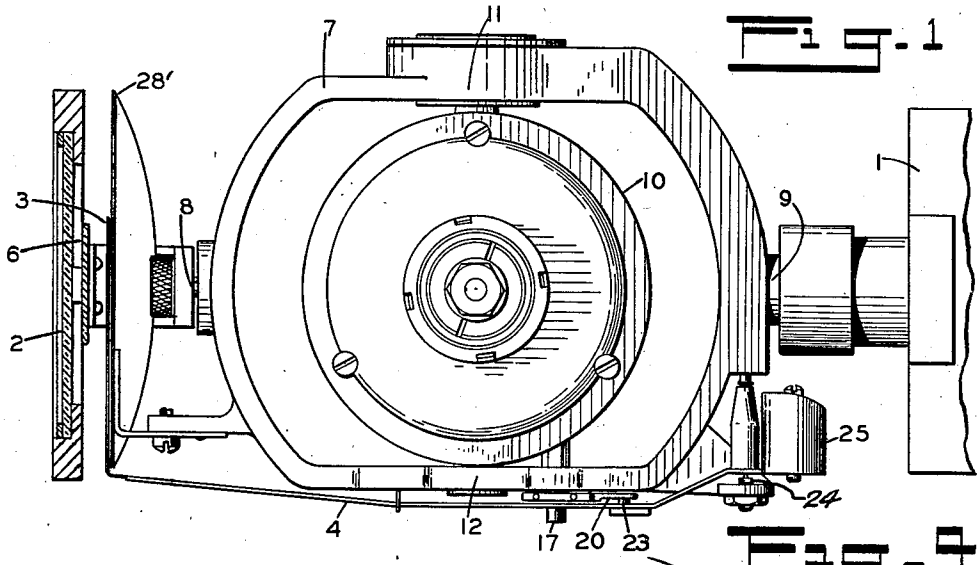


Fig. 4

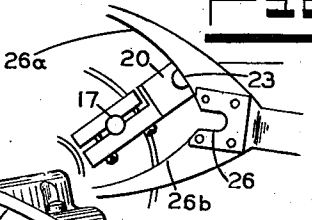


Fig. 2

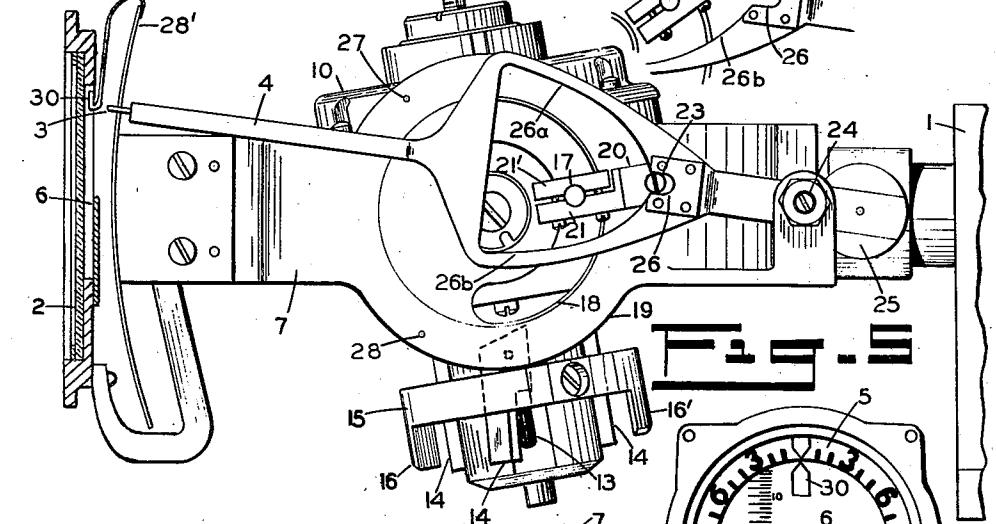


Fig. 5

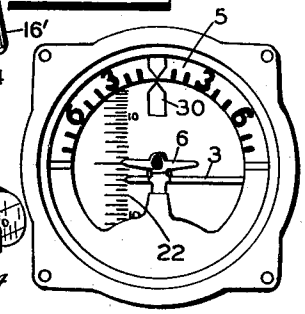
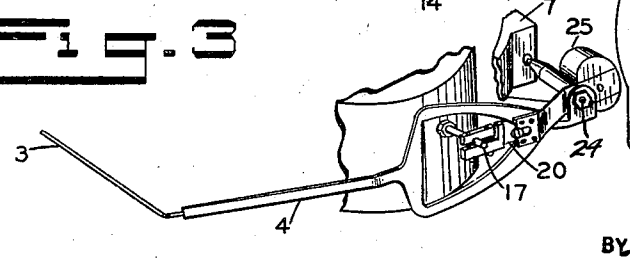


Fig. 3



INVENTOR

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HIS ATTORNEY.

Patented Aug. 17, 1943

2,326,835

UNITED STATES PATENT OFFICE

2,326,835

ARTIFICIAL HORIZON

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Application January 9, 1941, Serial No. 373,765

3 Claims. (Cl. 33—204)

This invention relates to gyroscopic artificial horizons for aircraft. More particularly, this invention is an improvement in the type of artificial horizon shown in the prior patent to Leslie F. Carter, No. 2,183,133, dated December 12, 1939.

For ordinary flying, it is desirable that a slight change in the fore and aft inclination of the craft about its lateral axis be shown up quickly and noticeably by the horizon indicator. The aforementioned patent achieves this result by interposing a suitable linkage in the connections between the gyroscope casing and the arm carrying the horizon bar, so that a greatly magnified or amplified movement occurs during the first few degrees of tilt of the craft either upwardly or downwardly. In that patent, however, the exaggerated or amplified movement gradually decreases upon further tilting of the rotor casing from the vertical, so that the movement of the bar is not uniform over the visible scale.

An object of the present invention is to provide an artificial horizon having an exaggerated but uniform scale for indicating the first few degrees of tilt of the craft, but in which the indicator bar is restrained from moving out of sight or off the scale regardless of all ordinary gyrations of the airplane, so that a further object of the invention is to provide means for achieving this end while permitting the use of a uniformly graduated scale.

A further object of the invention is to provide means for adjusting the horizon bar with respect to the pitch indicating scale.

Referring to the drawing, illustrating the preferred form of my invention,

Fig. 1 is a plan view (partly in section) of the improved artificial horizon, the fore and aft portions only of the casing being shown.

Fig. 2 is a side elevation of the same, also partly in section.

Fig. 3 is a perspective view of the horizon bar, a portion of the gimbal ring, and a portion of the rotor bearing member.

Fig. 4 is a fragmentary side elevation showing the relative position of the horizon bar and the horizon bar actuating member when said bar has been moved to the top of the pitch scale.

Fig. 5 is a face view of the instrument.

In the drawing, the artificial horizon is shown in conventional form, the same being enclosed in an outer casing 1, only the fore and aft ends of which have been shown. In practice, this casing is usually in the form of an air-tight container from which air is exhausted. The casing is provided with a transparent front window 2 through which the horizon bar 3, the bank angle indications 5 and the miniature airplane 6 may be seen. The gyroscope proper is shown as having a gimbal ring 7 pivoted about fore and aft trunnions 8 and 9 within the casing 1. Gimbal ring 7, in turn, pivotally supports the rotor bearing casing 10 on transverse pivots 11 and 12. The rotor (not shown) is spun within the casing 10 on a normally vertical axis by any suitable means, such as an air jet, the air emerging through four slots 13 in the lower portion of the casing, with which pivoted pendulums 14 cooperate to erect the gyroscope as well understood in the art.

As an additional feature of the invention, there is provided a baffle adjustment ring having a pair of auxiliary baffles or spoilers 16 and 16' adjustable in a circumferential direction for controlling the fore and aft jets. As explained in my prior Patent 2,219,295, dated October 29, 1940, for Pneumatic erection devices for gyroscopes, by means of these spoilers, the rate of erecting movements of the rotor about the fore and aft axis during turns may be decreased, whereby errors resulting from the effect upon the fore and aft pendulums of turning of the craft may be reduced. It has been found that similar auxiliary baffles or spoilers are not required for controlling the rate of erecting movements of the rotor about the lateral axis since the pitch pendulums are not affected by centrifugal forces. I prefer, therefore, to leave the erection forces of the lateral jets fully effective to keep the erection period fairly rapid.

A curved background member 28' is shown as secured to an arm projecting from the gimbal ring 7. Said background member may be provided with an index member 30 (Fig. 5) readable on the aforementioned scale 5 around the periphery of the front window to indicate relative tilting of the rotor casing and craft about the fore and aft axis of the gyroscope.

Projecting from the side of the rotor bearing casing 10 to the rear of pivot 12 is a pin 17 which extends through an annular slot 18 in an enlargement 19 of gimbal ring 7. Said pin carries a horizon bar actuating crank arm 20 comprising two sections 21 and 21' clamped to pin 17 by means of set screws. This clamping arrangement is advantageous because it facilitates adjustment of the horizon bar 3 with respect to the pitch scale 22 (Fig. 5). The actuating arm 20 carries a pin 23, the end portion of which is semicircular in cross-section with the flat portion facing rearwardly. The horizon bar 3 is carried on an arm 4 which is shown as pivoted at 24 to the

gimbal ring 7 and is provided with a counterbalancing weight 25 beyond the pivot. The axis of pivot 24 is parallel to the lateral axis 11, 12 of the rotor bearing ring, and weight 25 is arranged to normally maintain arm 4 in the horizontal position.

According to the present invention, pin 23 is spaced a substantial distance from lateral axis 11, 12, being somewhat nearer pivot 24, so that during initial movement of actuating arm 20 from the horizontal as a result of turning of the craft about its lateral axis, the main component of the motion imparted to arm 4 by engagement of pin 23 with slot 26 will be a lifting motion or, alternatively, a depressing motion, as the case may be. Since the horizontal component of the motion of pin 23 is very small during the time said pin is in engagement with slot 26, it will be be seen that the motion of arm 4, and consequently the motion of horizon bar 3, will vary at substantially the same proportional rate as the rotor bearing casing tilts about axis 11, 12, this permitting the use of a uniform pitch scale 22. Also, because of the long radius of pin 23 from pivot 12 and the short arm 23—24 compared to the length of arm 4, the initial movements of said rotor casing 10 are considerably amplified by horizon bar 3. Thus, while the rotor casing tilts about axis 11, 12 through a few degrees, the horizon bar moves to the outer limit of the uniform scale 22.

In order to terminate the indicating motion of horizon bar 3 before it has exceeded the range of scale 22, bar 4 is provided with two arcuate cam surfaces 26*a*, 26*b*, the center of curvature of each of which, respectively, will substantially coincide with the lateral or transvere axis 11, 12 of the rotor bearing member or casing 10 when engaged by pin 23. In other words, when arm 4 has been elevated or lowered by rotation of pin 23 in engagement with slot 26 to a position wherein pin 23 disengages said slot, the center of curvature of cam surface 26*a*, or 26*b*, as the case may be for either position of arm 4, will substantially coincide with the axis 11, 12 about which pin 23 rotates. These surfaces intersect slot 26 at the points where the edge of pin 23 engages said slot when the horizon bar 3 is at its highest and lowest indicating positions. Movement of pin 23 beyond this point, due to further tilting of rotor bearing case 10, causes the flat surface at the end of said pin to engage surface 26*a* or 26*b* (see Fig. 4). Further rotation of pin 23 about pivot 12 imparts no elevating or depressing force to bar 4 because of the shape of cam surfaces 26*a* and 26*b*. Stop members 27 and 28 are provided as positive limits of the range of motion of bar 4 and also to prevent jarring or vibration of the bar when in either of its extreme positions. Such construction defines a limited motion transmitting connection between the cooperating horizon bar member and its actuating member.

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 drawing 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. In an artificial horizon for aircraft, a rotor and a rotor bearing member, a gimbal ring having a transverse axis upon which said rotor bearing member is pivotally mounted, an outer casing having a fore and aft axis upon which the gimbal ring is pivoted, a neutrality balanced horizon bar member pivoted about a transverse axis on the rear portion of the gimbal ring and having an indicating portion spaced remotely from said pivot, and an actuating pin for said bar member spaced radially from the lateral axis of the rotor bearing member and extending in a direction parallel to said axis, said bar member having a short open end slot adapted to engage the said pin during initial movement of the horizon bar member, said slot merging into a pair of arcuate surfaces having their center of curvature, respectively, substantially coincident with the transverse axis of the rotor bearing member when engaged by said actuating pin and positioned so as to engage with the moving pin when the rotor bearing member has tilted beyond the predetermined indicating range.

2. In an artificial horizon for aircraft, a rotor and a rotor bearing case, a gimbal ring having a transverse axis upon which said rotor bearing case is pivotally mounted, an outer casing having a fore and aft axis upon which the gimbal ring is pivoted, a horizon bar member pivoted about a transverse axis on the rear portion of the gimbal ring, said bar including an open-ended short slot and two oppositely disposed arcuate cam surfaces merging into the slot, and an actuating member responsive to movement of the rotor bearing case having a slide portion operable in said slot to move the horizon bar member through a predetermined exaggerated angle at a rate proportional to the rate that the case tilts, said portion moving out of said slot to operate on one or the other of said cam surfaces at angles of tilt greater than said predetermined angle to effect relatively little angular movement of the bar member.

3. An artificial horizon as claimed in claim 2, in which said actuating member is provided by a crank arm having a pin which forms the slide portion thereof.

LESLIE F. CARTER.