July 3, 1923.

1,460,627

I. A. WEAVER

PRECISION INSTRUMENT FOR AIRPLANES, ETC

Filed Aug. 3, 1918

3 Sheets-Sheet 1

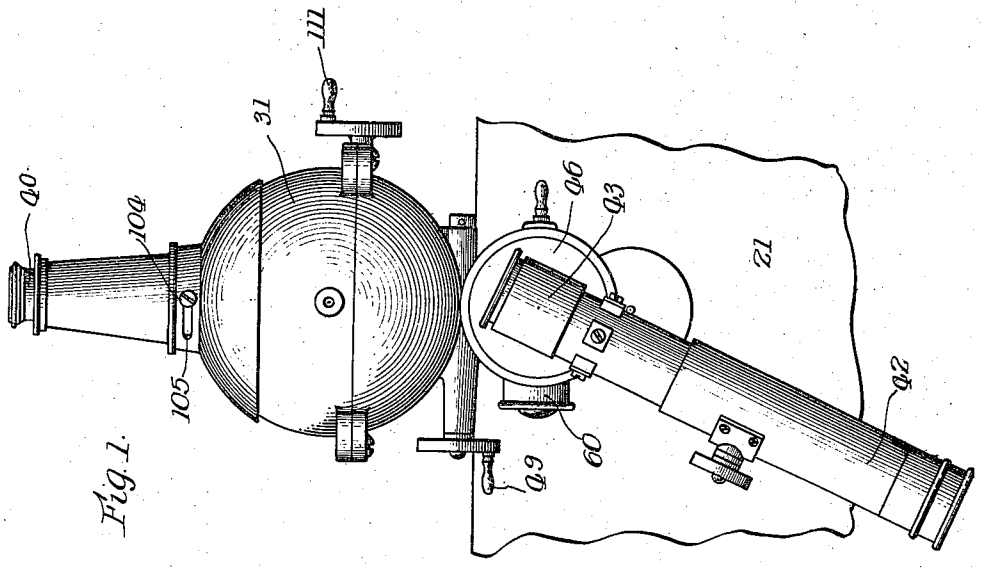


Fig. 1.

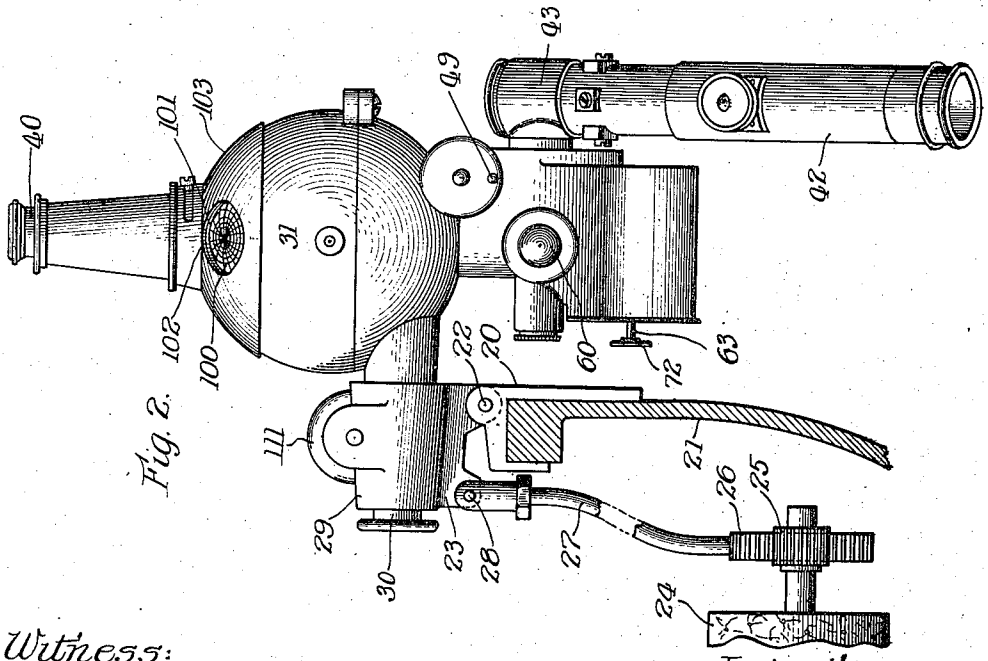


Fig. 2.

Witness:
A. J. Sauer.

Inventor:
Ira A. Weaver
By Walter M. Fuller
Atty.

July 3, 1923.

1,460,627

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3 Sheets-Sheet 2

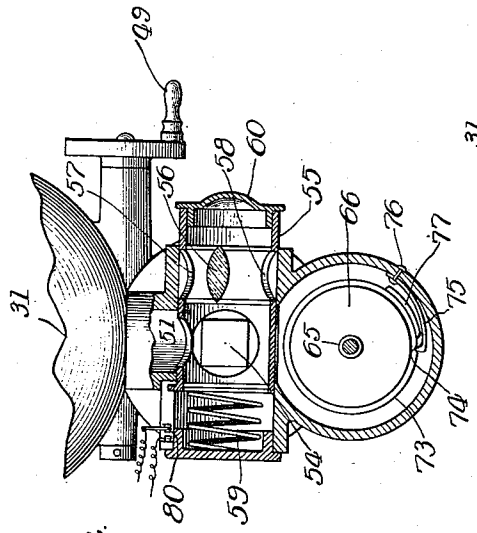


Fig. 4.

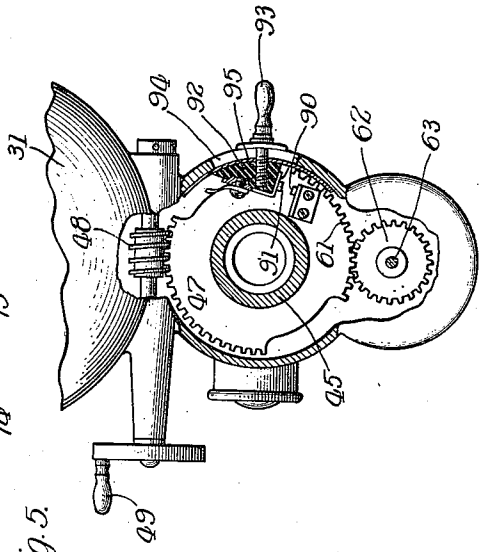


Fig. 5.

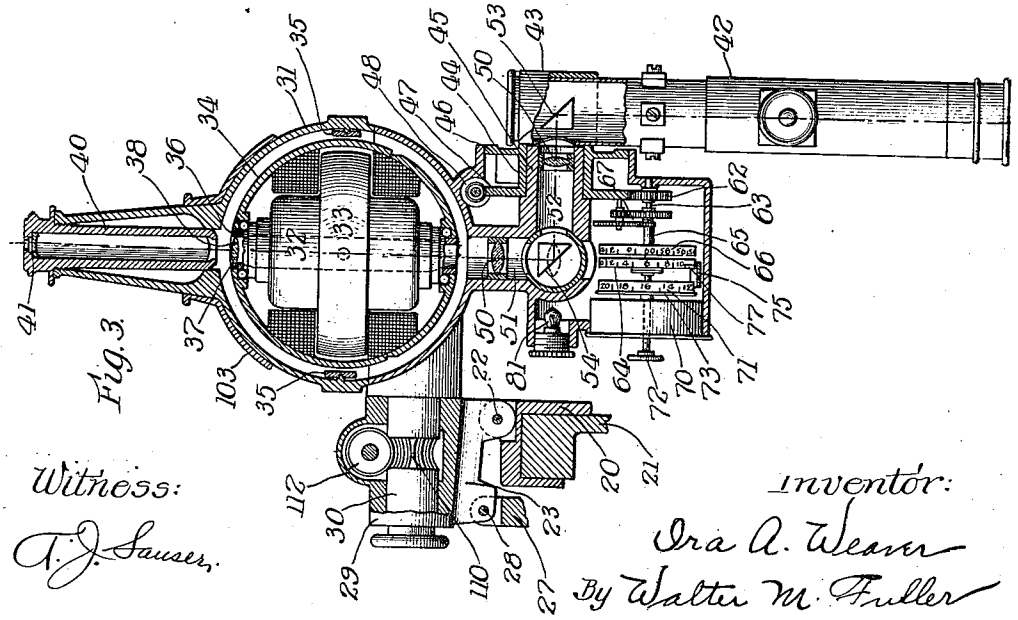


Fig. 3.

Witness:

T. J. Sauser.

Inventor:

Ira A. Weaver

By Walter M. Fuller

Atty.

July 3, 1923.

1,460,627

I. A. WEAVER

PRECISION INSTRUMENT FOR AIRPLANES, ETC

Filed Aug. 3, 1918

3 Sheets-Sheet 3

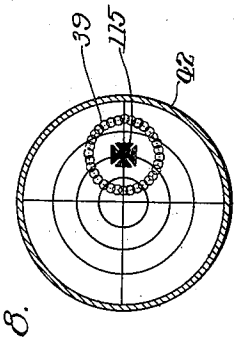


Fig. 8.

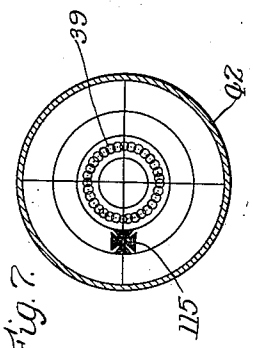


Fig. 7.

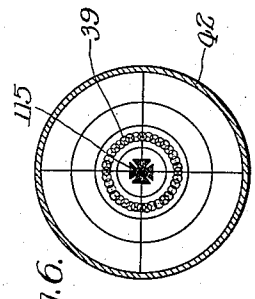


Fig. 6.

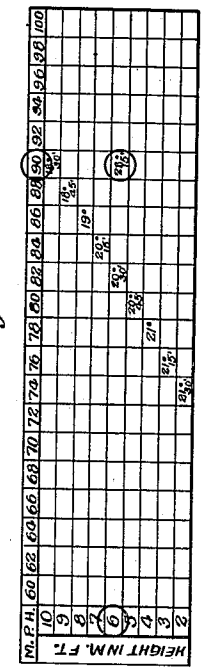


Fig. 10.

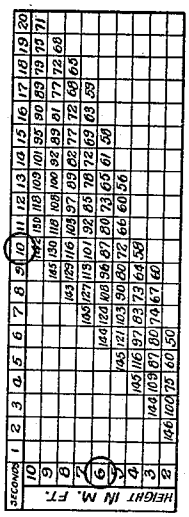


Fig. 9.

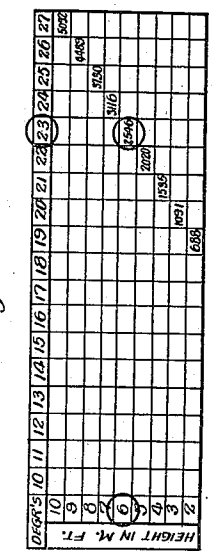


Fig. 11.

Witness:
A. J. Sauser.

Inventor:
Ira A. Weaver
By Walter M. Fuller
Atty.

Patented July 3, 1923. 1,460,627

UNITED STATES PATENT OFFICE.

IRA A. WEAVER, OF SPRINGFIELD, ILLINOIS.

PRECISION INSTRUMENT FOR AIRPLANES, ETC.

Application filed August 3, 1918. Serial No. 248,182.

To all whom it may concern:

Be it known that I, IRA A. WEAVER, a citizen of the United States, residing at Springfield, in the county of Sangamon and State of Illinois, have invented certain new and useful Improvements in Precision Instruments for Airplanes, Etc., of which the following is a specification.

My invention pertains to observation or optical instruments adapted for use on airplanes, ships' masts, balloons, and other appliances occupying an elevated and at the same time more or less unstable or variable position. Its leading object is to provide means for establishing and maintaining a vertical line from which suitable observations and calculations may be made. The various features of the novel structure can perhaps be most easily explained in connection with an airplane and this presentation will be followed, but it will be understood that the invention is not limited or restricted to any particular use.

The employment of an instrument embodying the features of this invention enables the occupant of the airplane among other things to quickly and accurately ascertain the speed of the appliance in relation to the surface of the earth, to measure horizontal distances from the airplane with precision, to direct the airplane exactly over any desired object or target, and to release bombs or similar devices in such a way as to secure accurate hits on the objects selected.

To accomplish these and other desirable aims, it is essential to provide means for accurately maintaining a vertical line in relation to the earth, which may form the perpendicular line of a triangle from which to base calculations, even though the airplane tilts in any one of numerous directions. In the preferred embodiment of the invention such vertical line is maintained by means of an electrically-driven gyroscope having a hollow shaft or axis containing one or more lenses through which the line of sight passes. Such axis having been fixed vertically before the flight is begun, it is, of course, reliably maintained without variation.

The instruments may be conveniently mounted on airplanes, either outside of or inside of the fuselage, so that the range of vision through the associated oscillatory telescope may be obtained from a position directly forward at an angle of at least 70 degrees with the vertical to preferably a few degrees to the rear of such line.

To enable those skilled in this art to fully understand the structural features and appreciate the advantages of this invention, in the accompanying drawings, forming a part of this specification, and throughout the various views of which like reference characters refer to the same parts, a preferred and desirable embodiment of the invention has been presented in detail.

In these drawings:

Figure 1 is an elevation of the improved device shown mounted on the fuselage of an airplane;

Figure 2 is a section through the fuselage showing an elevation of the appliance at right-angles to that of Figure 1 and illustrating fragmentarily foot-operated means for tilting the device;

Figure 3 is a central vertical section through the appliance;

Figure 4 is an enlarged fragmentary section showing the sliding tube carrying the reflector and lens, either of which may be shifted into the line of vision;

Figure 5 is a section showing the electrical circuit closing device for controlling the release of bombs or for the accomplishment of other results;

Figures 6, 7, and 8 indicate the various relations of a target to the precision gauges of the device, such as cross-hairs and a blurred ring caused by an opaque spot on one of the revolving lenses; and

Figures 9, 10, and 11 illustrate charts or tables employed for various calculations.

The appliance includes a clamp 20 adapted to be secured on the top edge of the fuselage 21, and such bracket, by means of a fulcrum-pin 22, has a support 23 rockingly mounted thereon, the support being capable of tilting on the fulcrum-pin transversely of the airplane by means of a suitably-supported foot-actuated cork roller 24, the shaft of which has a gear 25 meshing with a properly-guided sliding-rack 26 associated with the support by a connector 27 pivoted to the former at 28.

This support has a bearing 29 for a stem 30 projecting laterally from a casting comprising a split or divided spherical shell 31 containing an electrically-driven gyro-

scope 32 including an electric-motor 33 in a spherical casing 34 oscillatory on bearings (not shown) in a gimbal-ring 35 pivoted in the shell as is usual in gyroscopic structures. This gyroscope has a ball-bearing, hollow, rotary shaft 36 containing one or more lenses 37, one of which has an eccentric opaque spot 38 which, of course, constantly describes a circular path and appears to the observer as a blurred ring 39 (see Figures 6, 7, and 8), affording simple and convenient means for sighting purposes. The upper part of the exterior shell or housing 31 is fitted with an eye-piece or sight-piece 40 provided with one or more lenses 41 adapted by adjustment of the shell to be brought into exact register or alignment with the rotating, axial sight-tube or hollow-shaft of the gyroscope.

An expansible and contractible, that is, an adjustable telescope 42, with suitable cross-hairs, by means of a band or strap 43, is fixedly held on a sleeve 44 oscillatory on a bearing 45 on a portion of the casting, such sleeve having a disc or flange 46 closing the end aperture of the casting, and a mutilated worm-wheel 47 in mesh with a worm 48 adapted to be turned by a handle 49. The casting may have one or more lenses 50 in its right-angle passage 51, 52, cooperating with a reflector 53 in the telescope, and a similar reflector 54 in a spring-pressed, cylindrical, apertured tube 55 slidingly mounted in the casting at the intersection of passages 51, 52, and carrying also a magnifying lens 56 in register with opposed transverse openings 57, 58, in the tube. As is shown in Figure 4, the spring 59 acting on the tube normally holds it projected somewhat from the casting with its head or top 60 accessible and with the reflector 54 in proper position at the junction of passages 51, 52, for co-operation with the telescope and with the stationary and rotating sight-tubes 40 and 36 respectively.

The under portion of worm-wheel 47 has spur-gear teeth 61 meshing with those of a pinion 62 fixed on a shaft 63 revolubly mounted in any approved manner in the lower portion of the casting. This shaft carries in alignment with the eye or sight-pieces 36, 40, a disc 64, the edge of which is graduated in degrees, and beside this and mounted on a sleeve 65 revoluble on the shaft, is a second disc 66, the edge of which is graduated in minutes, so that the combined readings of the two discs give the exact angular position of the telescope in degrees and minutes and fractions of the latter if desired. It is, of course, necessary to cause the minute disc 66 to travel substantially sixty times as fast as the degree disc 64, and this is accomplished by driving the former from shaft 63 by suitable gearing 67 producing such ratio.

The appliance is also equipped with a timing-device 70, such as a clock movement, having a rotary-disc 71 graduated on its edge in seconds and fractions thereof, the axis of such disc being coincident with the axis of the discs 64, 66. Disc 71 by means of an accessible external button 72 may be turned and at the same time pushed inwardly toward the degree disc 64. The time disc has an outstanding flange 73 provided with a notch 74 co-operating with the tooth on the end of a leaf-spring 75 fastened at 76 to the inside of the casting. When the notch registers with the tooth, the latter, unless restrained, automatically springs into the former and holds the timing device from moving and with the zero graduation of its disc in its uppermost position.

In order that the timing device may operate automatically during the turning or swinging of the telescope through a predetermined number of degrees, 12 degrees for instance, disc 64 is supplied with a cam 77 fixed thereto and traveling therewith, whose path of travel overlies the tooth of spring 75, the latter being sufficiently wide for that purpose. Such cam might be arranged to unlock the timing-device and permit it to operate while the telescope is moving from a position 12 degrees in advance of the vertical to such vertical position, or it might be arranged to permit the timing device to work as the telescope swings from a position 6 degree in advance of the vertical to a position 6 degrees to the rear of such vertical. When the cam releases the catch, after having held it retracted during the working of the timing device, the tooth engages disc 71 and by friction stops its further rotation. The timing-disc can be set back to zero position by the sense of feeling only without looking at it by merely turning knob 72 and pressing in at the same time. Thus, when the notch 74 in the flange registers with the tooth, the disc will slip lengthwise slightly, the notched part of the latter sliding over the locked tooth, which prevents further turning and locks the timing device against action until released.

In order that these three discs may be suitably illuminated when they are viewed through the eye-piece and the hollow shaft of the gyroscope, tube 55 when pushed in is adapted to close an electric-switch 80, thus completing an electric-circuit through an incandescent lamp 81, such circuit being immediately broken as soon as the tube is permitted to asume its normal position under the expanding action of the spring.

The appliance is also fitted with an electric-switch for the closing of an electric-circuit through a bomb-releasing or discharging apparatus, not shown, this switch structure being illustrated most clearly in Figure 5. The combined worm-wheel and spur-gear

47, 61, has an electric-contact 90 mounted directly thereon, that is, not insulated therefrom, so that the contact represents a grounded element. Such contact is adapted during the turning of the telescope and worm-wheel to come into engagement with a relatively-stationary adjustable contact 91 mounted on a block of insulation 92, equipped with a handle 93 extended out through a slot 94 in the casting, a curved friction strip 95 being interposed between the block and the inner curved surface of the casting and engaging the latter with sufficient pressure to hold the block and contact in any adjusted position without danger of unintentional displacement. Such member 95 also acts as a closure or cover for the slot.

In order to permit a quick approximate alignment of the eye or sight piece 40 with the hollow-shaft or axial tube 36 of the gyroscope, the casing of the latter is provided on its exterior with an illustration of a pole 100 with longitudinal circles passing therethrough, such pole and circles being visible through a window 101 in the shell and an aperture 102 in a hemispherical cover 103 held either in position so that its window is in register or out of register with the window of the shell by a screw 104 extended through a slot 105 in the neck of such hemispherical element and taking into a threaded hole in the inner casting. When the telescope is not in use, if desired, the cover may be left open, enabling the pilot to determine easily the relation or position or trim of his machine with respect to the vertical line.

To determine the speed of travel of the airplane, and assuming that the cam 77 is constructed to permit the timing appliance to operate from a position of the telescope from 12 degrees in advance of the vertical line back to the vertical, the observer swings the telescope forward, say 15 degrees ahead of the vertical. By pushing in and at the same time turning button 72, the timing device is set and locked in zero position. Any object on the ground ahead of and in the line of travel of the machine is sighted by the observer and is followed by the telescope by manipulation of handle 49; in other words, the observer keeps the telescope pointed directly at the object regardless of the travel of the airplane, which, of course, requires a gradual swinging of the telescope rearwardly. When the telescope in such rearward movement reaches the 12 degree forward position, the timing appliance is automatically unlocked by cam 17 and continues in operation until the telescope reaches zero or vertical position, at which point cam 77 automatically releases the lock, which stops the action of the timer. The operator now pushes in tube 55 by pressing on its end, thus bringing lens 56 into place, (temporarily rendering the telescope unusable) and causing the illumination of the electric-lamp 81 by the closure of switch 80. The reading in seconds on scale 71 is then taken by viewing the same through the registered eye-piece 40, gyroscopic sight-piece 36, apertures 55 and 57, and lens 56, the tube when released causing the extinguishment of the lamp and reference had to a previously prepared chart (Figure 9) having as factors the height of the air craft and the seconds required for the telescope to turn through the 12 degrees. Assuming that the height has been determined by the usual instruments as 6000 feet and that the time reading was 10 seconds, the chart shows the speed to be 87 miles per hour.

In order to ascertain the horizontal distance away of a certain object, the latter is sighted through the telescope in the usual manner with the aid of the customary cross-hairs associated with the telescope. Immediately thereafter tube 55 is pushed in and a reading taken from discs 64 and 66 showing the angle or position of the telescope in degrees and minutes. Then, the elevation being known, recourse is had to a chart like or similar to that of Figure 11 which gives the horizontal distance required. Assume for example that the height of the machine is 6000 feet and that the angle reading was 23 degrees, the table shows the horizontal distance of the object away to be 2546 feet.

Assuming now that it is desired to so release a bomb as to hit a desired spot or object, and taking it for granted that the pilot is directing the flight of the machine in a straight line over the object to be bombarded, the degrees and minutes may be ascertained at which position of the airplane the bomb should be dropped to reach the target. The height of the machine and its speed of travel having been ascertained a chart like that shown in Figure 10 is consulted, which shows, for example, that at a height of 6000 feet and a speed of 90 miles per hour, the bomb should be released when the object reaches the telescope cross-hairs with the telescope set forward at an angle of 23 degrees, 15 minutes. If the machine is headed into a 20-mile wind, that amount should be added to the actual speed of the machine, giving 110 miles per hour, and the angle determined for such speed. If, on the other hand, the airplane were flying with a 20 mile wind, the 20 miles should be deducted from the actual speed of 90 miles and the chart read under the column labeled "70 miles per hour."

The telescope is set at the proper angle, 23 degrees, 15 minutes, for instance, as shown by the combined discs 64 and 66 and handle 93 is then shifted so as to bring the two contacts 90 and 91 together. Thereupon the telescope is swung forwardly until the ob-

ject is sighted, the observer giving the pilot proper directions of right or left to carry the machines directly over the target, and when he has the cross-hairs fixed exactly on the target, and is approaching it in a straight line, he informs the pilot to release the safety mechanism of the bomb and to close the main switch of the bomb-dropping apparatus, thus putting the entire control of the latter upon the relation of contacts 90 and 91. The cross-hairs are held on the target until the traveling contact 90 engages the stationary contact 91 which completes the electric-circuit, thus automatically releasing the bomb or bombs, all this occurring with great accuracy because no manual circuit closing is required on the part of the observer. Contact point 91 being capable of backward movement, is carried in such direction by the further travel of contact 90 and the telescope during the viewing of results of the bomb dropping by the observer through the telescope which is held on the target after the bomb or bombs are released.

In all of these operations, it is necessary to keep the sight-piece 40 on a line or in register with the vertical axis of the gyroscope, that is, in alignment with the gyroscopic sight-tube 36, and consequently, means are required in addition to the roller 24 and its associated elements to enable the observer to line up the sight. Accordingly the member 23 is equipped with a worm-wheel 110 operated by a convenient handle 111 which actuates a worm 112 in mesh with the worm-wheel, thus permitting the sight-piece 40 and the co-operating parts to be rocked fore and aft, but, of course, without interfering with the action of the gyroscope. When such eye-piece 40 is in register with the gyroscopic sight, the blurred circle 39 (Figure 6) caused by the rotation of the opaque spot 38, will be in the center of the field of vision. When it does not occupy such position, it is a clear indication that the two sights are out of register. In Figure 6 such circle is in the center of the field of vision and the target 115 is at the intersection of the cross-hairs. This shows that the tube 40 is exactly vertical as determined by the gyroscope and that the telescope, whatever its angle may be, is pointed directly at the target. Figure 7 shows the condition when the two sights register but the telescope does not point directly at the target. Figure 8 illustrates a condition when the two sights are out of register, that is, the eye-piece 40 is not exactly vertical and the telescope is not directed exactly at the target.

It will be appreciated, therefore, that the function of the gyroscope is to maintain a vertical line so that various angles may be measured, and, of course, the particular manner in which this is accomplished in the device described and illustrated is not essential to the invention, because many other ways may be employed to take advantage of this principle. Furthermore, it will be obvious that many minor mechanical changes may be incorporated in the structure of the appliance without departure from the substance of the invention and without sacrificing any of its benefits and advantages. Accordingly, therefore, it is to be understood that the particular embodiment of the invention is presented merely by way of an example, and that the invention is susceptible of a variety of embodiments all incorporating and taking advantage of the essential features of the invention.

I claim:

1. In an appliance of the character described, the combination of a gyroscopically-controlled sight, an adjustable sight-piece adapted to be brought into register with said gyroscopic-sight, and a telescope angularly adjustable relatively to said sight-piece, substantially as described.

2. In an appliance of the character described, the combination of a gyroscopically-controlled sight, a sight-piece having a universal movement mounting permitting it to be brought into register with said gyroscopic sight, and a telescope angularly adjustable on said sight-piece mounting, substantially as described.

3. In an appliance of the character described, the combination of a gyroscopically-controlled sight, an adjustable sight-piece adapted to be brought into register with said gyroscopic-sight, a telescope angularly adjustable relatively to said sight-piece, and means to transmit the light from said telescope through said registered sights, substantially as described.

4. In an appliance of the character described, the combination of a sight-piece, a telescope adjustable angularly with relation to said sight-piece, an index registering such angular relation, and means to permit viewing of an object through said sight-piece and telescope or viewing said index through said sight-piece, substantially as described.

5. In an appliance of the character described, the combination of a gyroscopically-controlled sight, an adjustable sight-piece adapted to be brought into register with said gyroscopic sight, a telescope adjustable angularly with relation to said sight-piece, an index registering such angular relation, and means to permit viewing an object through the registered sights and telescope or viewing said index through said sight-piece, substantially as described.

6. In an appliance of the character described, the combination of a sight-piece, a telescope adjustable angularly with relation to said sight-piece, an index registering such

angular relation, and movable means containing a reflector permitting viewing an object through said sight-piece and telescope and containing a lens permitting alternative viewing of said index through said sight-piece and lens, substantially as described.

7. In an appliance of the character described, the combination of a gyroscopically-controlled sight, an adjustable sight-piece adapted to be brought into register with said gyroscopic-sight, a telescope angularly adjustable with relation to said sight-piece, an index registering such angular relation, and movable means containing a reflector permitting viewing an object through said sights and telescope and containing a lens permitting alternative viewing of said index through said sights and lens, substantially as described.

8. In an appliance of the character described, the combination of a sight-piece, a telescope, means to angularly adjust said telescope relatively to said sight-piece, a duplex index indicating the angular adjustment of said telescope comprising a plurality of graduated members, and means to move said members unequal amounts during the adjustment of the telescope, substantially as described.

9. In an appliance of the character described, the combination of a sight-piece, a telescope, means to angularly adjust said telescope relatively to said sight-piece, a duplex index indicating the angular adjustment of said telescope comprising a plurality of graduated members, means to move said members unequal amounts during the adjustment of the telescope, and means to permit the viewing of an object through said telescope and sight-piece or the viewing of said duplex index through said sight-piece, substantially as described.

10. In an appliance of the character described, the combination of a sight-piece, a telescope, means to angularly adjust said telescope relatively to said sight-piece, a duplex index indicating the angular adjustment of said telescope comprising a member graduated in degrees and a second member graduated in minutes, and means to move said minute member approximately sixty times as rapidly as said degree member during adjustment of the telescope, substantially as described.

11. In an appliance of the character described, the combination of a sight-piece, a gyroscopically-controlled sight, and means to bring said sights into register comprising a hand-actuated means to move the sight-piece one way and a foot-actuated means to adjust the sight-piece in a plane at right-angles thereto, substantially as described.

12. In an appliance of the character described, the combination of a sight-piece, a telescope adjustable angularly with relation to said sight-piece, an index registering such angular relation, movable means containing a reflector permitting viewing of an object through said sight-piece and telescope and containing a lens permitting alternative viewing of said index through said sight-piece and lens, an electric lamp to illuminate said index, and an electric-switch in the circuit of said lamp controlled by said movable means, substantially as described.

13. In an appliance of the character described, the combination of a sight-piece, a telescope angularly adjustable relatively to said sight-piece, an index indicating the position of the telescope, a timing-device, and an index actuated by said timing-device, said indices being arranged to be viewed through said sight-piece, substantially as described.

14. In an appliance of the character described, the combination of a sight-piece, a telescope angularly adjustable relatively to said sight-piece, and gyroscopic means to indicate when said sight-piece is in a desired position, substantially as described.

15. In an appliance of the character described, the combination of an angularly-adjustable telescope, a timing-device an index actuated by said timing-device, and means to automatically cause said timing-device and its index to operate during a predetermined angular movement of the telescope, substantially as described.

16. In an appliance of the character described, the combination of an angularly-adjustable telescope, an index indicating the position of said telescope, a timing-device, an index actuated by said timing device, and means to automatically cause said timing-device and its index to operate during a predetermined angular movement of the telescope, substantially as described.

17. In an appliance of the character described, the combination of a telescope, means to angularly adjust said telescope, an index indicating the position of the telescope, a timing-device, an index actuated by said timing device, and means controlled by the angular movement of the telescope to start and stop the operation of the timing device and its index, whereby to secure an automatic timing of the turning of the telescope through a predetermined angle, substantially as described.

18. In an appliance of the character described, the combination of a sight-piece, a telescope co-operating therewith, means to angularly adjust said telescope relatively to said sight-piece, an index indicating the position of the telescope, a timing-device, a index actuated by said timing-device, and means controlled by the angular movement of the telescope to start and stop the operation of the timing-device and its index, said indices being arranged to be viewed through said sight-piece, substantally as described.

19. In an appliance of the character described, the combination of a sight-piece, gyroscopic means to indicate when said sight-piece is in a desired position, a telescope, means to angularly adjust said telescope relatively to said sight-piece, an index indicating the position of the telescope, a timing-device, an index actuated by said timing-device, and means controlled by the angular movement of the telescope to start and stop the operation of the timing-device and its index, said indices being arranged to be viewed through said sight-piece, substantially as described.

20. In an appliance of the character described, the combination of a sight-piece, gyroscopic means to indicate when said sight-piece is in a desired position, a telescope, means to angularly adjust said telescope relatively to said sight-piece, an index indicating the position of the telescope, a timing-device, an index actuated by said timing-device, and means controlled by the angular movement of the telescope to start and stop the operation of the timing-device and its index, substantially as described.

21. In an appliance of the character described, the combination of a telescope, means to angularly adjust said telescope, an index indicating the angular adjustment of the telescope, a timing-device, an index actuated by said timing-device, means to lock said timing-device against operation, and means dependent upon the angular movement of the telescope to operate said lock, substantially as described.

22. A telescopic appliance including a lens in combination with means to continuously revolve the lens during the viewing of an object therethrough, and a marker on and revoluble with said lens, substantially as described.

23. A telescopic appliance including a gyroscopically-mounted lens rotated during the viewing of an object therethrough, and a marker on and revoluble with said lens, substantially as described.

24. In an appliance of the character described, the combination of a telescope, a gyroscopically-controlled sight for said telescope, means to angularly adjust said telescope, an electrical contact adjustable with said telescope, and a second relatively-stationary electric-contact with which said first contact is adapted to engage to close their electric circuit, substantially as described.

25. In an appliance of the character described, the combination of a telescope, a gyroscopically-controlled sight for said telescope, means to angularly adjust said telescope, an electric contact movable with said telescope, and a second relatively-stationary electric-contact adjustable along the path of travel of said first contact and with which said first contact is adapted to engage to close their electric circuit, substantially as described.

26. In an appliance of the character described, the combination of a telescope, a gyroscopically-controlled sight for said telescope, means to angularly adjust said telescope, an electric contact adjustable with said telescope, and a second relatively-stationary frictionally-held electric contact adjustable along the path of travel of said first contact and with which said first contact is adapted to engage to close their electric circuit, substantially as described.

27. In an appliance of the character described, the combination of a sight-piece, gyroscopic means to indicate when said sight-piece is in a desired position, a telescope, means to angularly adjust said telescope, an electric contact adjustable with said telescope, and a second relatively-stationary electric contact with which said first contact is adapted to engage to close their electric circuit, substantially as described.

28. In an appliance of the character described the combination of a sight-piece, gyroscopic means to indicate when said sight-piece is in a desired position, a telescope, means to angularly adjust said telescope, an electric contact adjustable with said telescope, and a second relatively-stationary frictionally-held electric-contact adjustable along the path of travel of the first contact and with which said first contact is adapted to engage to close their electric circuit, said second contact being adapted to be pushed by said first contact after their engagement, substantially as described.

29. In an appliance of the character described, a gyroscope having a hollow axial rotary shaft constituting a sight-tube, substantially as described.

IRA A. WEAVER.