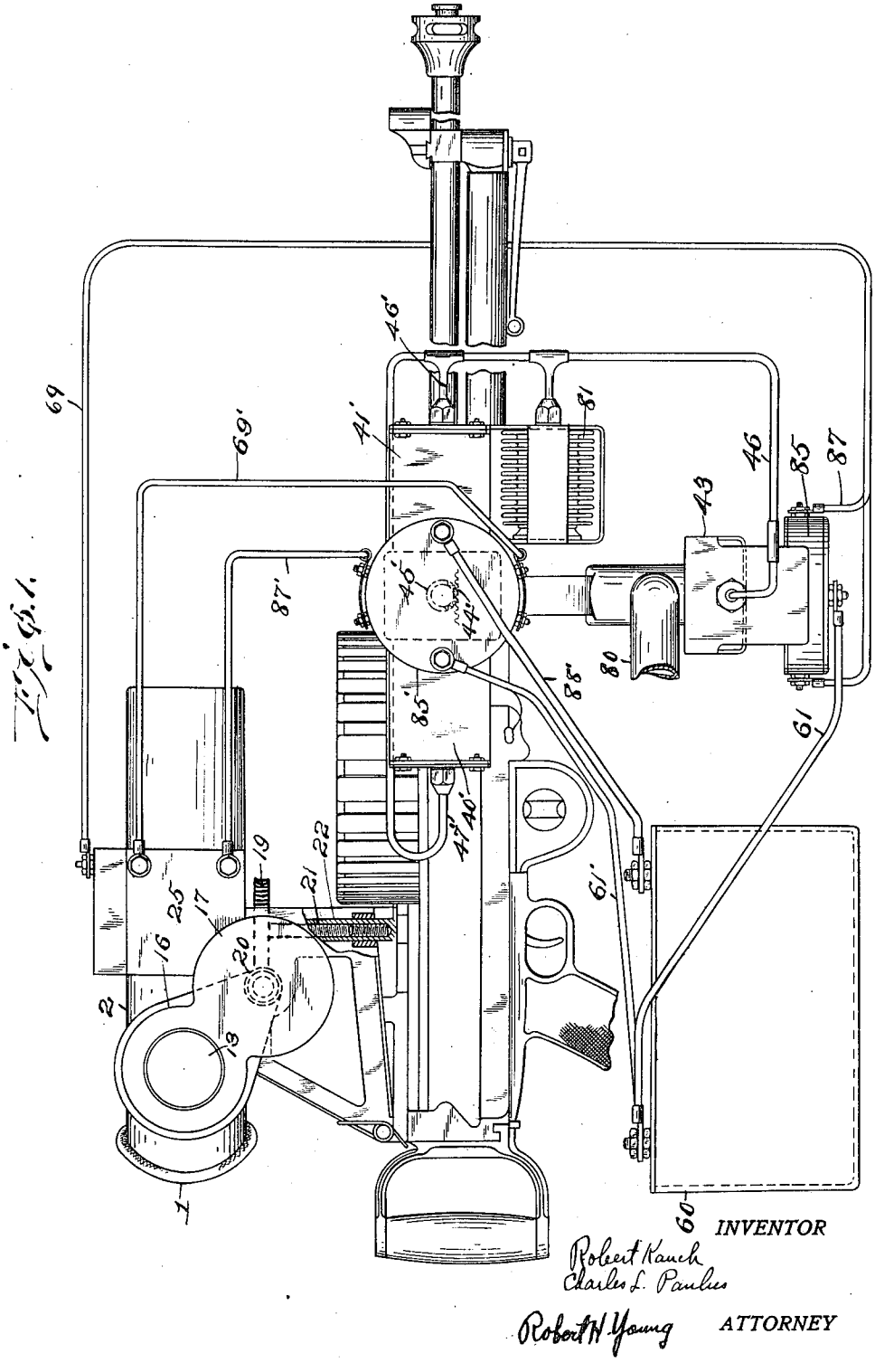
Aug. 13, 1929. R. KAUCH ET AL 1,724,093

AUTOMATIC COMPENSATING GUN SIGHT

Filed April 30, 1923 6 Sheets-Sheet 1

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AUTOMATIC COMPENSATING GUN SIGHT

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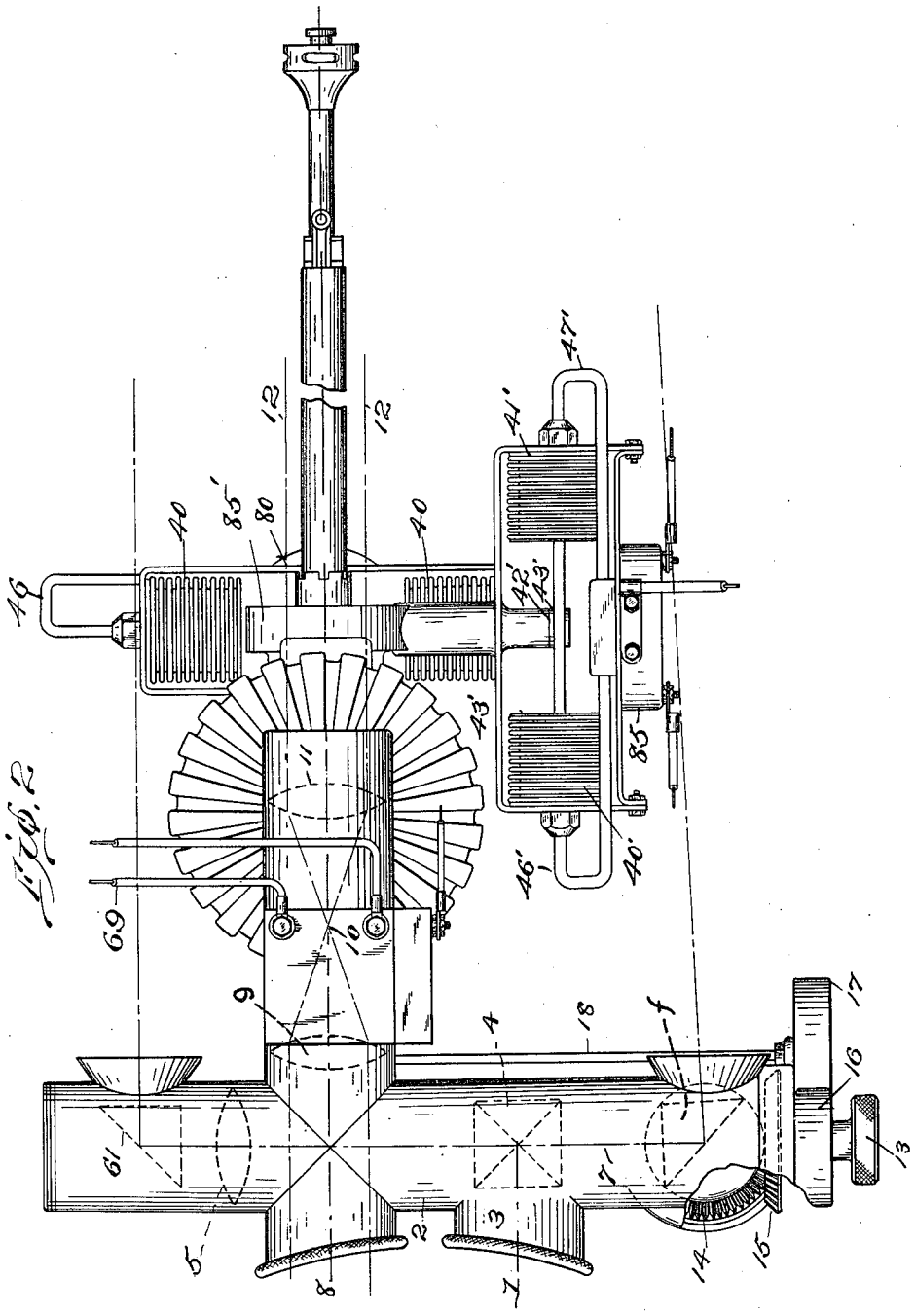


Fig. 2.

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AUTOMATIC COMPENSATING GUN SIGHT

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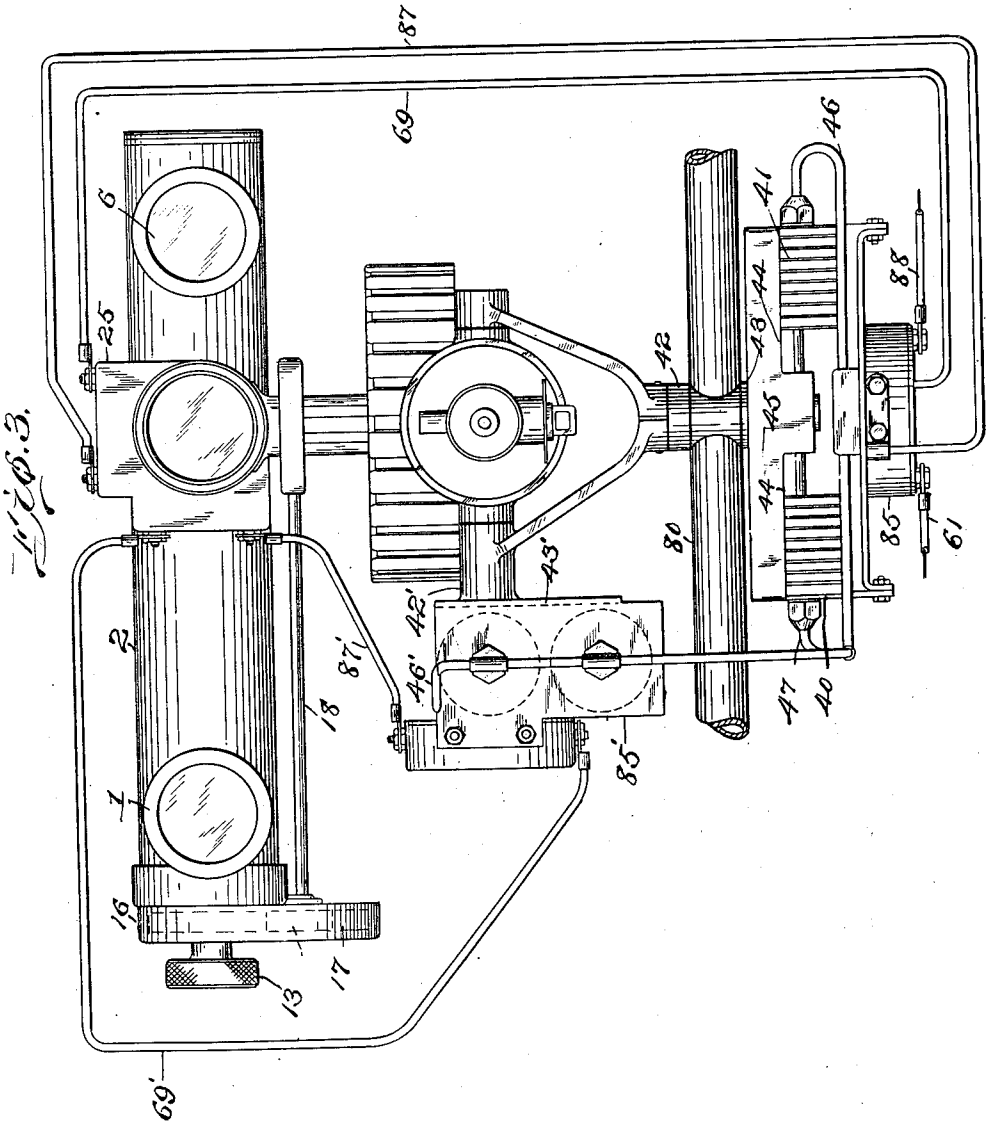


FIG. 3.

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AUTOMATIC COMPENSATING GUN SIGHT

Filed April 30, 1923 6 Sheets-Sheet 4

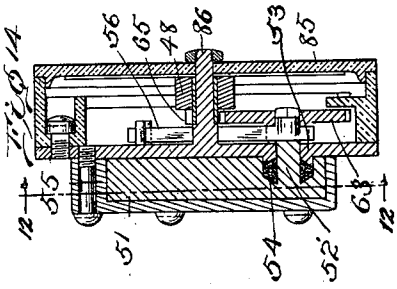



Fig. 4.

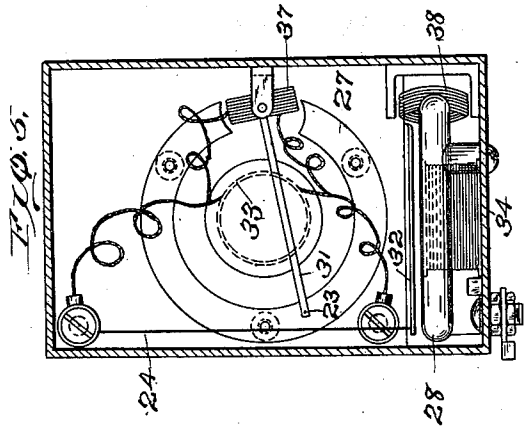



Fig. 5.

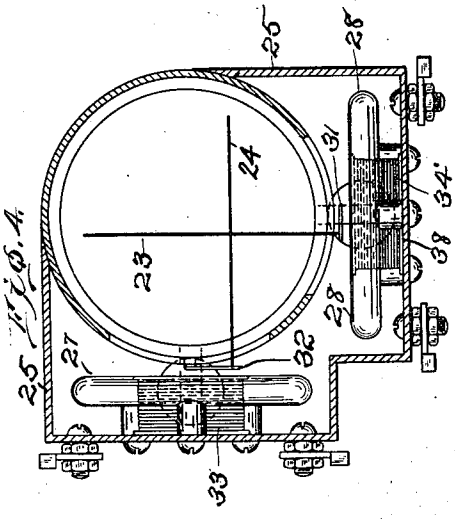
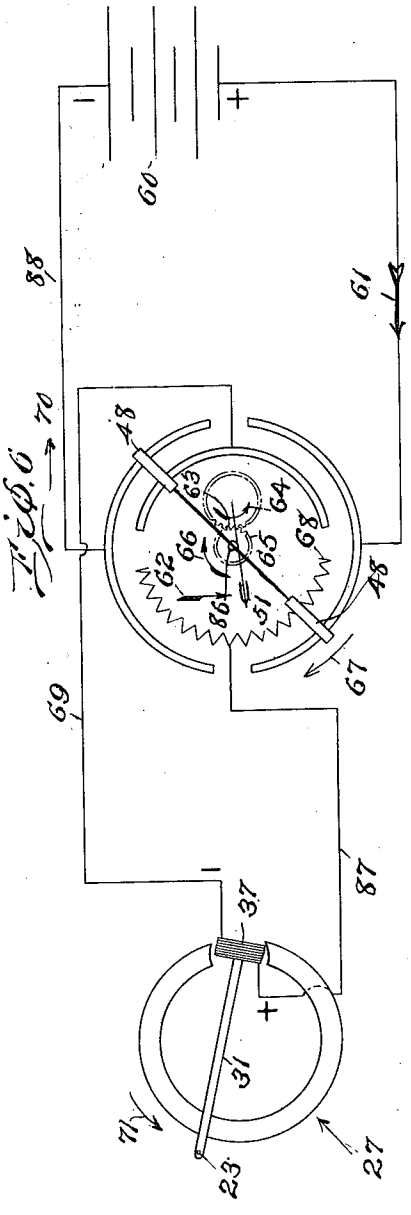



Fig. 6.

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AUTOMATIC COMPENSATING GUN SIGHT

Filed April 30, 1923 6 Sheets-Sheet 5

Fig. 7.

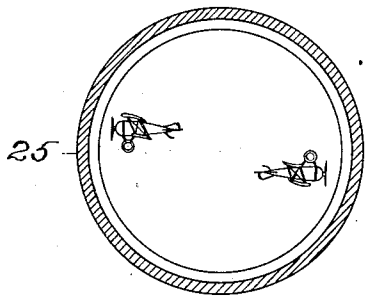



Fig. 8.

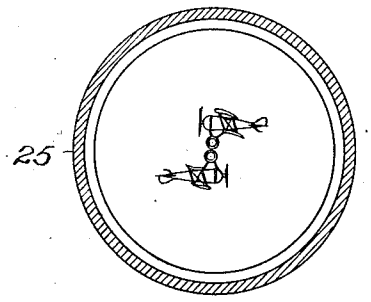



Fig. 9.

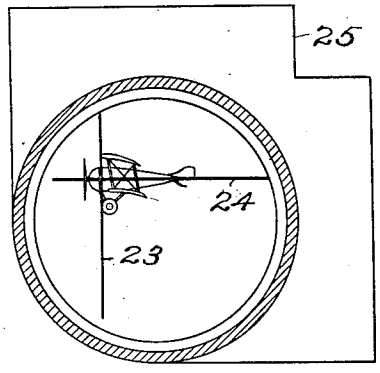
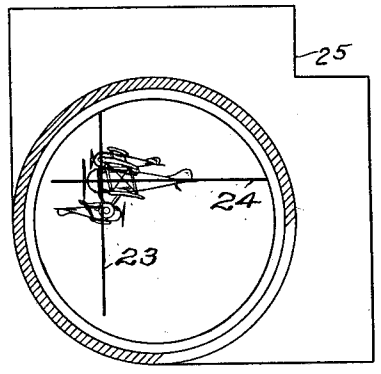



Fig. 10.

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AUTOMATIC COMPENSATING GUN SIGHT

Filed April 30, 1923 6 Sheets-Sheet 6

Fig. 12.

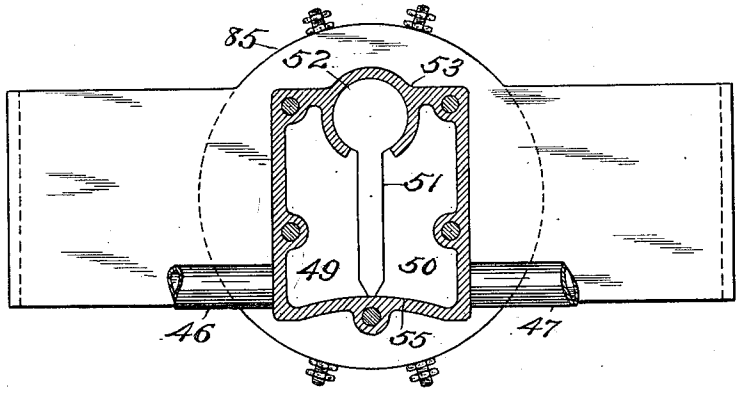



Fig. 13.

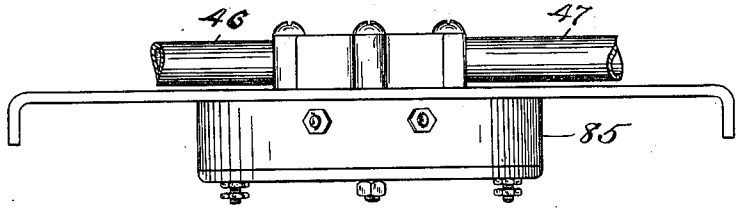
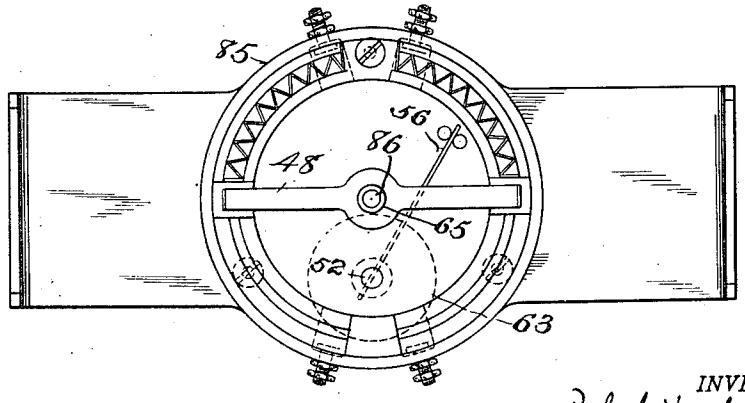



Fig. 11.

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Patented Aug. 13, 1929. 1,724,093

# UNITED STATES PATENT OFFICE.

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## AUTOMATIC COMPENSATING GUN SIGHT.

Application filed April 30, 1923. Serial No. 635,756.

This invention relates to an automatic compensating gun sight the object in view being to provide means in connection with a gun and gun sight which will automatically compensate for the angular velocity between two airplanes, for example, or in other words give the necessary lead in order to hit an enemy airplane from an airplane flying at full speed with a projectile fired by a machine gun or cannon. The mechanism or apparatus will also compensate for the fall of the projectile in trajectory at various predetermined ranges. The range factor does not affect the accuracy of the correction for angular velocity within certain ranges. In other words the correction is made angularly and is not affected by ranges until the point is reached where the drift, due to windage, will be noticed.

In the accompanying drawings—

Figure 1 is a side elevation of a flexibly mounted aircraft machine gun showing the compensating mechanism mounted thereon;

Figure 2 is a plan view of the same partly broken away in section for better illustration;

Figure 3 is an end elevation of the gun and sighting apparatus looking toward the muzzle of the gun;

Figure 4 is an enlarged vertical sectional view of the cross hair mechanism;

Figure 5 is also a sectional view thereof taken at a right angle to Figure 4;

Figure 6 is a diagram of the wiring system;

Figures 7, 8, 9 and 10 are chart diagrams illustrating the method of sighting on the enemy airplane or other target;

Figure 11 is a view showing the cross hair shifting means;

Figure 12 is an inverted view taken on the line 12—12 of Fig. 14 showing a portion of the hydraulic means for controlling the electrical actuating means of the cross hair mechanism;

Figure 13 is an elevation of the same taken at a right angle to Figure 12;

Figure 14 is a section taken transversely and centrally of Figure 12.

In order to facilitate the description and understanding of the entire apparatus, the description will be subdivided into units, namely, the range finder, the cross hair shifting means and the control for cross hair shifting means.

Referring primarily to the range finding means, and in order to explain the action of this part of the apparatus, let us consider the case when the gunner's vision is entering the opening 1 of the range finder 2, Figure 2. In this case the line of vision will be deflected and follow a path shown by the dashed and dotted line 3; that is his vision will first strike the double prism 4 mounted just within the eye-piece. At this point the vision will be separated into two parts, one part being reflected to the left and passing through the lens 5, thence to the prism 61 from which point it will follow a line parallel to the original line of vision to the enemy airplane. The portion of the vision which is reflected to the right will be reflected by the prism *f* in such a way as to cause it to fall upon the target. This arrangement permits the exact range of the enemy airplane to be determined through the calibration of the angle between the lines of vision shown by the dashed and dotted lines of Figure 2. This arrangement will produce an inverted and an erect image of the enemy airplane as observed by the gunner when the range finder is not adjusted to suit the range as in Figure 7. Figure 8 shows the enemy airplane as it will appear to the gunner when the range finder is set to the exact range at which the airplane is flying. Considering the case where the gunner's right eye is closed and he is observing only with his left eye, his vision will pass through the eye-piece 8, hence, through lens 9, across at the focal point 10, pass through the second lens 11 from which it will follow the dashed and dotted line 12 to the enemy airplane. This arrangement permits a vision similar to the sight chart shown in Figure 9, in which case the enemy airplane will appear right side up and slightly larger than the vision obtained by using the other eye. This is accomplished through the magnification obtained by the lens 9. It is the idea of the sight to use both eyes simultaneously so that the enemy airplane will appear as shown in

the sight chart, Figure 10; that is the right eye will record a double image of the enemy airplane, one of which is inverted and the other erect, while the left eye will record an upright outstanding target.

Due to the fact that it is necessary to introduce a correction for the trajectory of the bullet or projectile, the knob 13 which controls the angle of the angular prism 7 through the bevel gears 14 and 15 is connected by spur gears 16 and 17 to the shaft 18 (see Fig. 3) which actuates a worm wheel 19 by rotation of a worm 20. A movement of the worm wheel 19 rotates a threaded shaft 21 which in turn raises or lowers a shoe 22 resting on the frame of the gun. This arrangement causes movement of the knob 13 to effect an adjustment which will compensate for the fall of the projectile in trajectory.

The cross hair shifting means will now be described. It is the purpose of this mechanism to shift the cross hairs 23 and 24 mounted in the telescopic sight casing 25, an amount which will compensate for the angular velocity between the two airplanes in question. The mechanism is simple in construction, as shown in Figures 4 and 5, and comprises in connection with and housed in the casing 25, fixed magnets 27 and 28 for the cross hair members, which magnets furnish a field current and influence levers 31 and 32 at the extremity of which are mounted cross hair needles 23 and 24. Part of the current flowing through the instrument is shunted through shunt coils 33 and 34 shown in the center of circular fixed magnets 27 and 28. The remaining calibrated amount of current passes through the coils 37 and 38 mounted at the fulcrum points of the levers 31 and 32. This arrangement causes the lever which controls the cross hairs to move an amount from a central position directly proportional to the amount of current flowing through the circuit. It is to be understood, of course, that two arms 31 and 32, with cross hair members 23 and 24 and magnets 27 and 28 and coils 37 and 38 are used as indicated in the drawings. The means for controlling the cross hair shifting means will now be described.

By reference to Figures 1 and 3 it will be noted that we use two sylphons for each cross hair, those operating the cross hair 23 being 40 and 41. These sylphons are mounted in position on the gun mount 42 through the use of a bracket 43 and are connected together by a rack member at 44, which engages the teeth of an actuating pinion at 45, having a fixed relation to the gun mount so as to be turned when the gun is turned about its vertical axis, (see 44′ and 45′ Fig. 1.) This arrangement causes movement of the gun in a horizontal plane to shift the rack 44, in such a way as to displace the liquid contained in one of the sylphons, while the same amount of liquid is received in the other sylphon. The liquid in the sylphons pass through flexible tubes 46 and 47, to the cross hair controlling apparatus shown in Figures 11, 12 and 13. The unit for shifting the cross-hair 24 is identical in structure for that used for shifting the cross-hair 23 and is illustrated in the drawings wherever possible with the same numerals primed. Of course, it is to be understood that the cross-hair 24 is to be shifted by motion of the gun about a horizontal axis. The displaced liquid is carried through the tubes 46 and 47 to the unit 85 shown in Figures 11, 12, 13 and 14. By observing these figures it will be noted that the electric current control arm 48, is mounted in such a way as to cause the position to change an amount which will depend upon the time rate of volume of liquid displaced between the chambers 49 and 50; that is the arm 48 is geared permanently to a vane 51, which is mounted on the shaft 52, journalled in bearing 53. This vane is constructed in such a way as to maintain a liquid-tight joint regardless of the direction of its movement. This is accomplished by the use of the bearing 53, having a ground fit along the lines 54 Fig. 14. An arcuate surface 55 is developed on such a curve as to cause vane 51, to shift an amount proportional exactly to the speed of flow of the liquid contained in the chambers 49 and 50. The vane 51 is normally retained in a central neutral position by the action of a spring 56. This position is assumed at a time when there is absolutely no movement of the liquid. The vane 51 when standing in the central position, as shown in Figure 12, separates the interior of the casing 25, into chambers 49 and 50. Any movement of the liquid, no matter how minute, will cause a corresponding movement of the vane 51. This, together with the fact that the vane 51 is directly coupled to the electric control arm 48 causes the latter to shift an amount directly proportional to the speed of movement of the liquid. It will be observed that there are two complete units similar to the one above described. This arrangement is necessary owing to the fact that movement of the gun, either vertically or horizontally or in a direction, which is the component of the two, must be compensated for in firing. The description just completed was described particularly with reference to the shifting of the cross-hair 23. Wherever practicable the similar structure used for the shifting of the cross-hair 24 has been indicated in the drawings with the same numerals with the "prime" added. By referring to Figure 6, which is a wiring diagram of one unit of the device, it will be noted that the electric current from the storage battery 60, will flow

in the direction of the arrow 61, or from the positive to the negative side of the battery. The fundamental requirement of this part of the device is that the control arm 48, assumes a neutral position when there is no pivotal movement of the gun, and that the neutral position of this part of the device registers zero or assumes a central position upon the indicator needle 31. Movement of the control arm 48, in a clockwise direction, caused by a counter-clockwise movement of the gun will cause a counter-clockwise movement of the needle arm 31. The cross-hairs visible in the sight are fastened to the needle 31 which condition causes the cross-hair to shift an amount corresponding to the movement of the needle 31. A counter-clockwise movement of the control arm 48 caused by a clockwise movement of the gun reverses the current and causes a clockwise movement of the needle 31 which action will enable a corresponding movement of the cross-hair mounted thereon. This may be more clearly understood by referring to Figure 6 in which the vane 51, is shown moving in the direction of the arrow 62, which will cause rotation of the large spur gear 63 in the direction of the arrow 64. This will cause a movement of small pinion 65 on shaft 86, in the direction shown by the arrow 66 and a movement of the control arm 48 in the direction shown in the arrow 67. This, through the action of the resistance coil 68, will cause a decrease in the amount of the electric current flowing through the lines 87 and 69, in a direction shown by the arrow 70 and thence through the lead 88 to the battery. This will cause a movement of the needle 31, in the direction shown by the arrow 71, which direction, it will be observed is identical with the direction of the arrows 62 and 64. In other words, the correction obtained must be in a direction so as to lead the enemy airplane. The instant that movement of the gun is stopped, the spring 56 will return the control arm 48 to a neutral position, in which position there is no electric current flowing through the device, but movement of the gun in the opposite direction will reverse the cycle of operation described above and through the action of the resistance unit 68 will cause the cross-hair 23 mounted on the needle 31 to be offset an amount directly proportional to the offset obtained on the control arm 48.

The above specific description has been made with reference to the movement of the cross-hair 23. The structure provided for movement of the cross-hair 24 is identical and has been indicated wherever practicable in the drawings by the same numerals with the addition of the "prime".

The gun assembly is mounted on the usual scarf mount 80. A fluid reservoir 81, is connected in series with the sylphon systems. The vane actuating mechanisms are suitably encased in casings 85.

It is believed that the operation of the various parts of this device have been described in such detail that no further description of the device as a whole is necessary.

We claim:

1. In an automatic compensating gun sight, the combination of a gun mount and gun mounted thereon to permit both vertical and horizontal rotative movement of the gun, a gun sight mounted to move with the gun and embodying angularly related movable cross hair members, means for shifting said cross hair members embodying a hydraulic system set in action by rotative movement of the gun, and electrical means controlled by the hydraulic means and acting directly to move the cross hair members.

2. In an automatic compensating gun sight, the combination of a gun mount and gun mounted thereon to permit both vertical and horizontal rotative movement of the gun, a gun sight mounted to move with the gun and embodying angularly related movable cross hair members, means for shifting said cross hair members embodying a hydraulic system set in action by rotative movement of the gun, and electro-magnetic means controlled by the hydraulic means and acting directing to move the cross hair members, said shifting means being designed to move the cross hair members in such ratio to the gun movement as to cause the sighting line to lead a moving target by an amount which will compensate for the speed of such target.

3. In an automatic compensating gun sight, the combination of a gun mount and gun mounted thereon to permit both vertical and horizontal rotative movement of the gun, a gun sight mounted to move with the gun and embodying movable cross hair members, and means embodying hydraulic means and electromagnetic means controlled thereby operating between the gun mount and gun sight to shift the cross hair members at such a speed in relation to the gun movement as to compensate for the speed of a moving target as the cross-hair members are maintained trained thereon.

4. In an automatic compensating gun sight, the ecombination of a gun mount and gun mounted thereon to permit of a horizontal rotative movement of the gun, a gun sight mounted to move with the gun and embodying movable cross hair members, and apparatus embodying hydraulic and electromagnetic units controlled by the gun movement operating to shift the cross hair members to correct for the speed of a moving target.

5. In an automatic compensating gun sight, the combination of a gun mount and a

gun mounted thereon to permit both vertical and horizontal rotative movements of the gun, a gun sight mounted to move with the gun and embodying movable cross hair members, an apparatus embodying hydraulic and electromagnetic units controlled by the gun movements operating to shift the cross hair members to correct for the speed and range of a moving target.

In testimony whereof, we affix our signatures.

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CHARLES L. PAULUS.