

July 19, 1949.

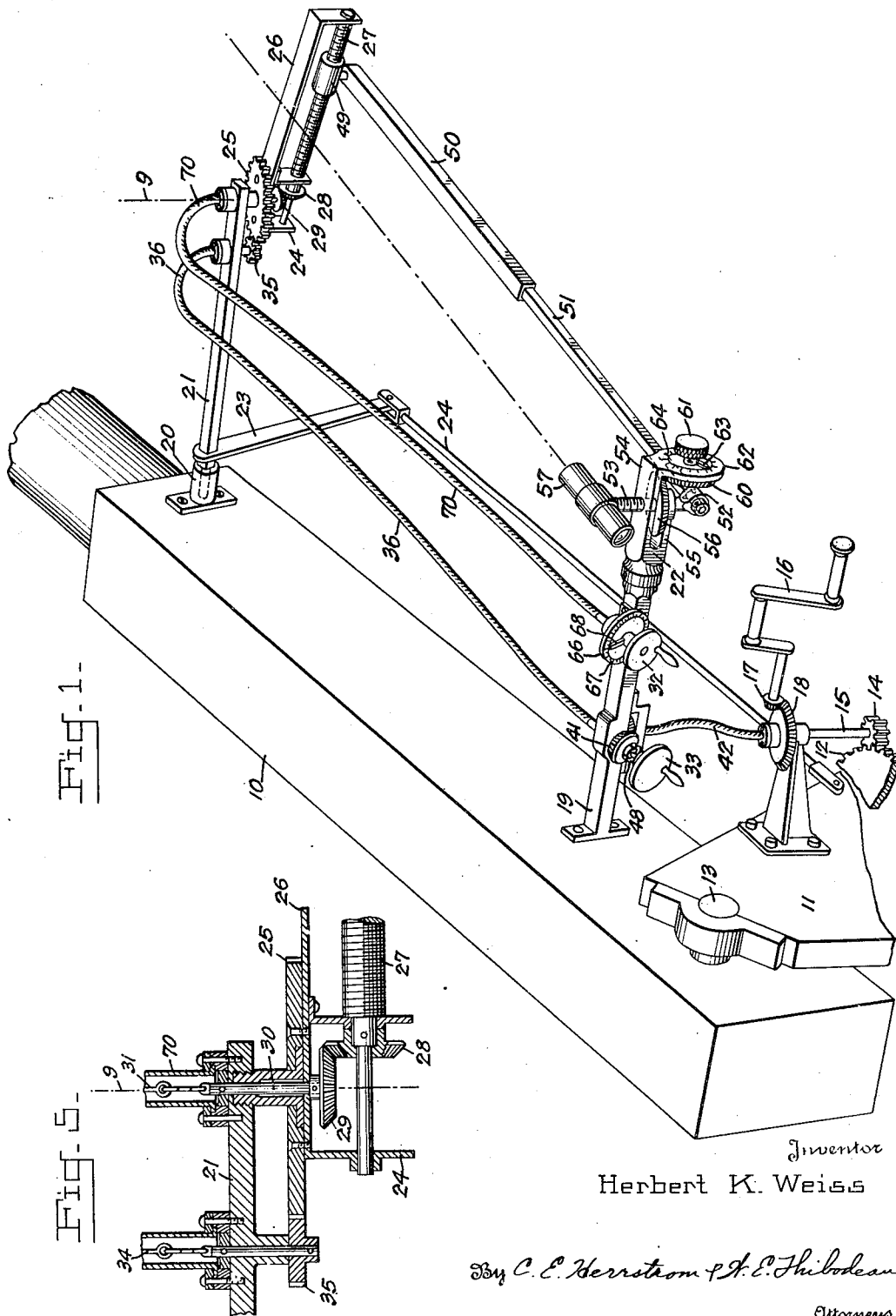
H. K. WEISS

2,476,342

GUN SIGHT

Filed Oct. 28, 1944

4 Sheets-Sheet 1



July 19, 1949.

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GUN SIGHT

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Fig. 2.

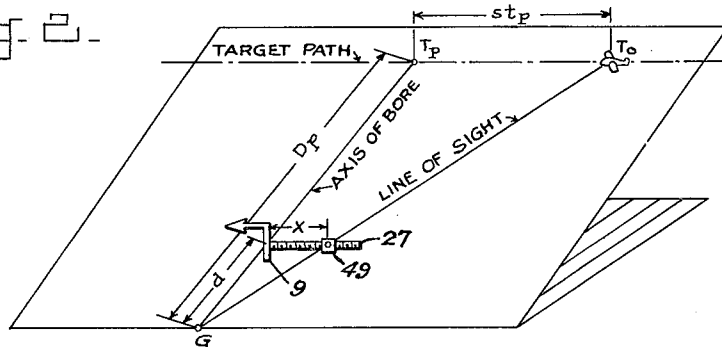


Fig. 3.

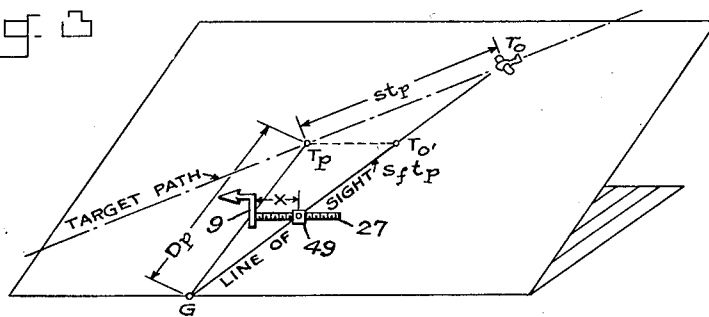
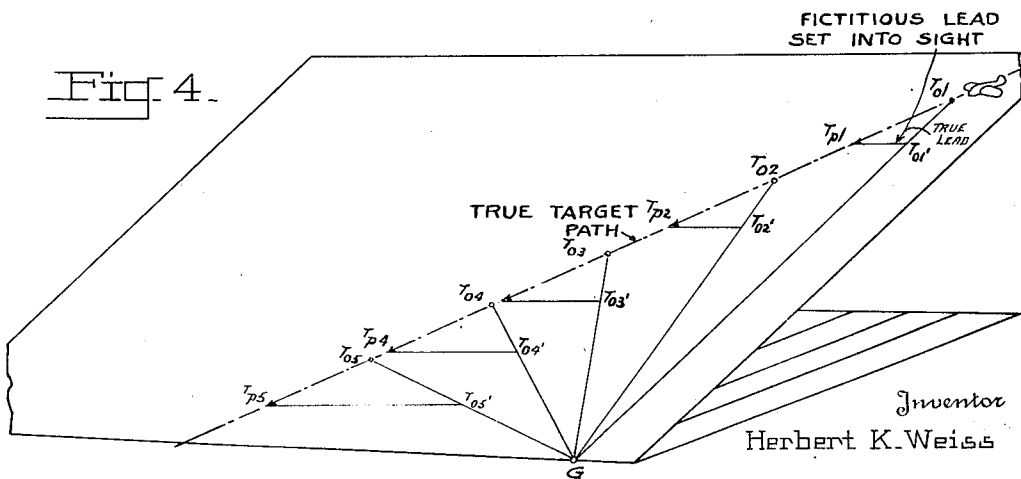


Fig. 4.



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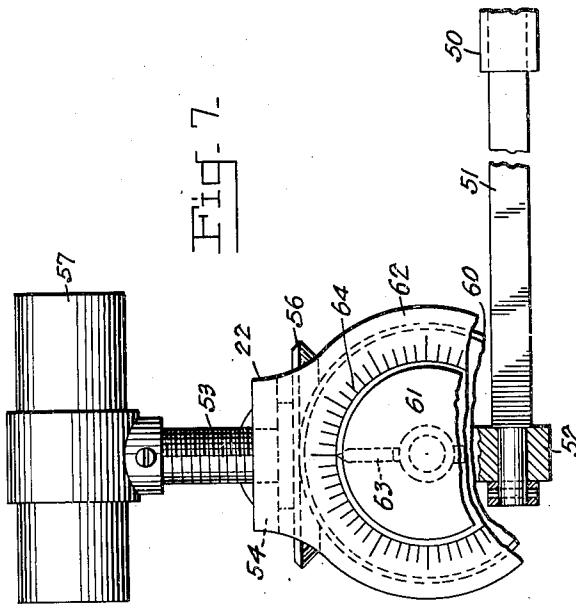


Fig. 7.

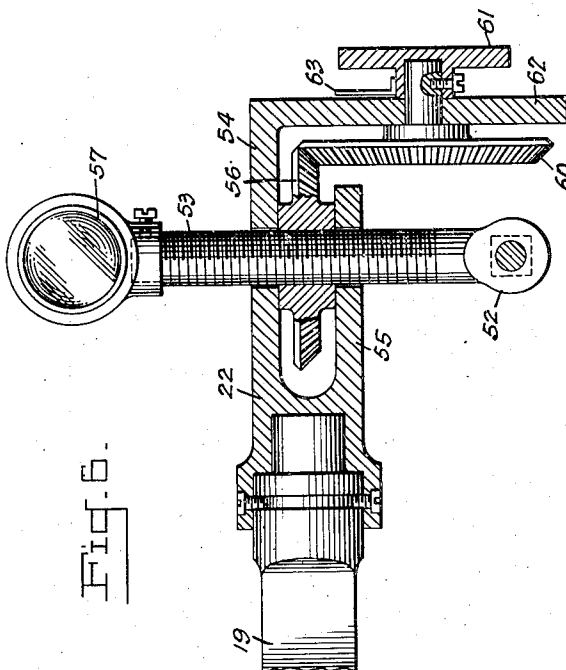


Fig. 6.

Fig. 10.

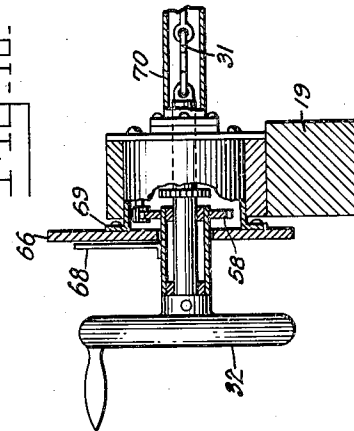


Fig. 9.

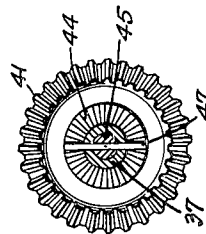
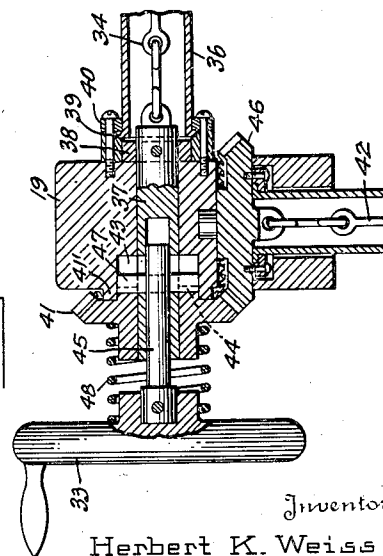


Fig. 8.



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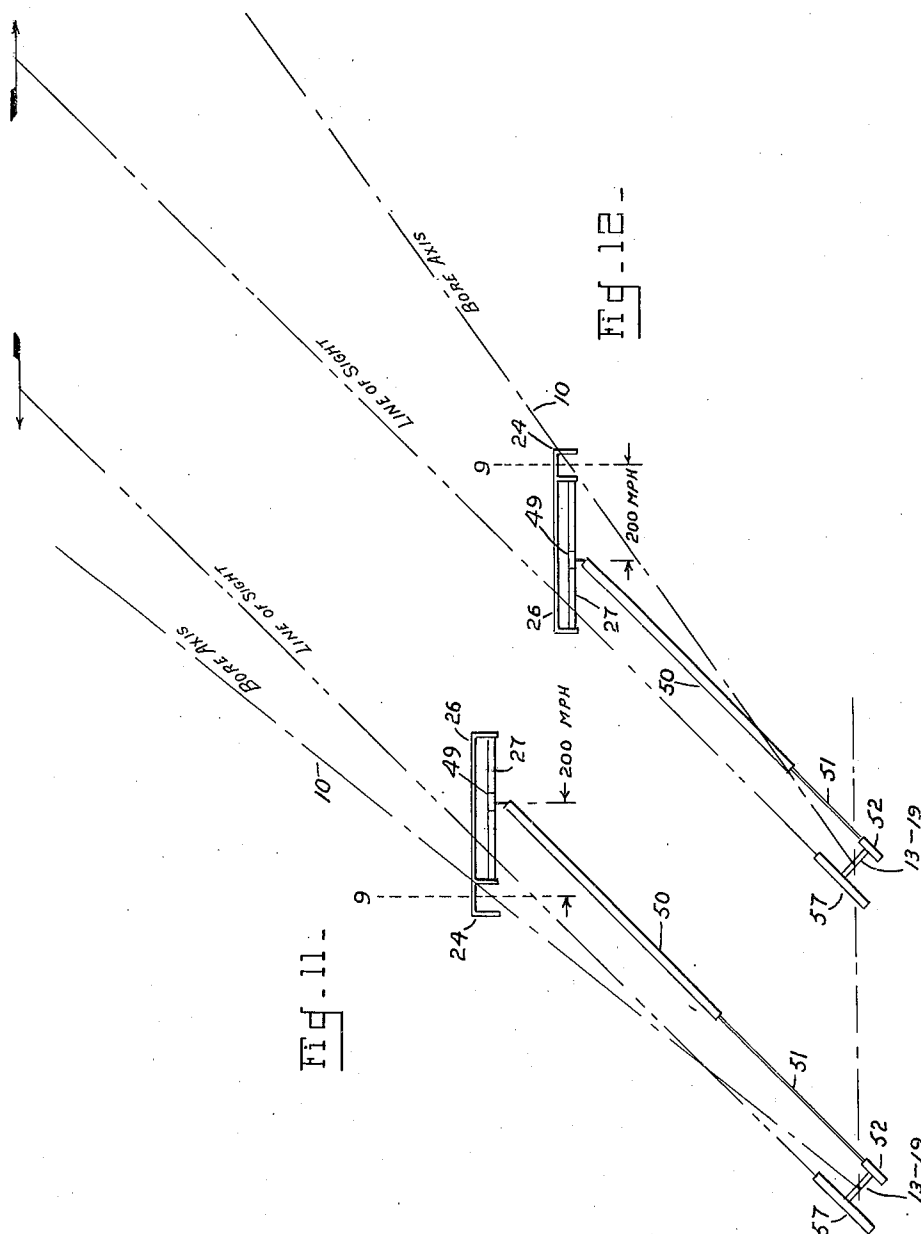
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GUN SIGHT

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UNITED STATES PATENT OFFICE

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GUN SIGHT

Herbert K. Weiss, Fort Bliss, Tex., assignor to
the United States of America as represented by
the Secretary of War

Application October 28, 1944, Serial No. 560,831

2 Claims. (Cl. 33—49)

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

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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.

The invention relates to the general class of sights the general purpose of which is to enable the rapid introduction of computation factors into the relation between a gun bore and the gun sight trained on a moving target, whereby a projectile may be fired with coordinated propulsion and angular relation of its trajectory to the line of sight so as to reach an advanced point in space on the course of the target when the target reaches the same point.

The invention has as its principal object to enable the attainment of the necessary functions without requiring actual detailed mathematical computations or use of range finders or data transmission, but—by mere reckoning of one or two factors which are capable of close estimation by practiced personnel—obtaining immediate close approximation of the correct gun pointing so as to either produce a hit or such slight deviation that the necessary further required correction will be at once apparent and instantly imposable. This is of paramount value in anti-aircraft encounters, the invention enabling, ordinarily the preliminary setting and correction well within the short interval of time available between the observation of a target entering the practical zone of fire of a weapon and its movement through the most advantageous range area of that zone. The apparatus will also so function that an initial setting may be obtained in time to be effective in exceptionally short encounters, so that the extent of error may be so reduced that the gunner or a correction setter has a reasonable chance to correct the setting by estimate and manipulation based on observation of error in the flight of tracers. The sight in this last particular may be found particularly useful in flexible gun mounts where the gun is free to be swung without the use of tracking gearing as well as in such guns as the 40 mm. anti-aircraft weapon where two trackers operate respectively the elevating gearing and the traverse gears, or guns utilizing other traverse and elevation gear.

It is an aim to enable the interpolation into sight functions of lead and elevation factors determined by simple visual judgement or knowledge of speed and direction observed in targets or speed specifically known to be an attribute of the particular target.

Particularly it is an object to enable the use of personnel without extended mathematical

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training, but capable of judging direction by simple observation, and with knowledge of speeds to be expected in specific models of airplanes, to operate manually devices by which such data may, at the instant of encounter, or very shortly before, be interpolated, so that the gunner in the case of the flexible gun need only keep the sight on the target and operate the trigger, or, in the case of the tracking mechanism the trackers need only keep the target centered in the sights, to insure the coincidence of the projectile and the target in space and time. The invention is applicable to direct laying using either case I or case II pointing.

As applied to guns having tracking gearing, such as in the current thirty-seven millimeter or forty millimeter anti-aircraft guns, my invention enables use of much of the structure of the tracking and sight mounting already in use. But in the prior sight procedure it was the function of the azimuth and elevation trackers to sight the plane target within particular parts of respective grill sights by judgement, or by instruction from an observer or data transmitter, depending on the one hand upon an approximation of a proper relation between speed and direction of the plane and the offset of the target from a vertical center line of the grill with element of lead, and on the other hand depending on proper relation of range and the offset of the target from a horizontal center line in the grill. In the operation of my invention, on the contrary, the trackers are required only to keep the target centered in the lines of sight, without estimation of any kind, and without deviation allowance by the trackers, or offset of any kind carried out by them; but a third person (who has been schooled in identifying planes and in a knowledge of the speed characteristics of the various planes which may be encountered; and also trained to judge well the direction of the course being followed by the target), who will be termed the setter, will turn a pointer in the target course direction ascertained, and will also set a pointer to indicate a specific target speed on a dial. He may also set in a range factor for super-elevation. This reduces the number of persons operating at one time each with complicated or diversified functions and assures greater accuracy in the execution of the single detail required of the tracker. It enables the setter to exercise judgement with a minimum of distraction and to apply the result in the function of the machine with a minimum of effort and without being required to attend any other function of the piece or crew.

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With a flexible gun the gunner may effect the laying of the piece and firing while another preferably operates the means by which corrections are imposed, although the gunner may in some cases operate the correction device as well as fire the gun. As will be understood from the disclosure, the setter need not be located immediately at the gun, so that sights may be set and corrected by a setter off-carriage.

Incident to the objects named it is a purpose to enable the interpolation of certain lead factors by more or less exact computation or from data, or by (a), judgement of one of the simplest details of the course of a target—viz, its direction—and the manual setting of a free rectilinear element to coincide with the reckoned direction, and (b), to utilize usually definite knowledge of target speed to set in another principal factor of lead by operating a simple pointer to indicate on a dial the speed of the target. The further vector of range may also be incorporated, as will be shown, although this is not important and in practice range or superelevation adjustments are omitted.

It will be apparent that the computing apparatus constitutes a vector system in which values may be represented for (1) ammunition ballistics, (2) target speed, (3) target direction, and optionally (4) target range; and these values converted into a mechanical function of the apparatus by which the bore axis of the gun is disposed at the necessary angle to the line of sight to apply the factors in effecting placement of the fired projectile at an intersection of the trajectory and projected target course coincidently with arrival of the target thereat.

Further purposes and objects as well as features of invention will be found from the following description and accompanying drawings wherein:

Figure 1 is a perspective view of my sight system in one form associated with a gun mounted for movement in elevation and train;

Figures 2, 3 and 4 are diagrammatic illustrations of the theory of the function of the apparatus.

Figure 5 is a detail section of the floating frame mounting and lead screw connections.

Figure 6 is a detail section of the superelevation element.

Figure 7 is an elevation from the right of Fig. 6.

Figure 8 is a sectional detail of the manual directional setting means.

Figure 9 is a detail of the clutch gear.

Figure 10 is a formal detail of the speed setting device.

Figure 11 is a diagrammatic representation of the sight functioning with a directly approaching target, in side elevation.

Figure 12 is a similar view involving a departing target.

Referring to the drawing, 10 indicates the cradle of a gun and 11 the upper carriage, traversable on a base carriage of any approved construction the details of which require no illustration for an understanding of the invention. The base carriage includes a stationary azimuth gear 12 on the vertical axis of which the upper carriage turns. The cradle has horizontal trunnions 13 pivoted in the upper carriage and may be assumed to be balanced and constructed so as to be swung vertically as required for elevation and retained at elevation, with or without tracking gearing, according to the type of gun. The gun may also be swung in traverse with or without tracking gear-

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ing, although there is indicated a driving pinion 14 carried by the traversable carriage 11 meshed with the gear 12 and operated through a shaft 15 journaled on the carriage 11 and operated by tracker's crank shaft 16 through bevelled gears 17 and 18, which may conform to trains in the current 40 mm. anti-aircraft guns and others. The 40 mm. gun last mentioned is trained by two tracker crewmen operating respectively the azimuth gearing and the elevation gearing, using respective telescopes connected in angularly adjustable relation to the gun. There would still be some conventional connection of the azimuth telescope to the elevation tracker's telescope when my invention is applied thereto. In a flexible gun, the gears 12 and 14 would be retained, but the crank 16 omitted.

A rear horizontal arm 19 is rigidly connected to and extends from the right side of cradle 10. A forward bracket 20 is also attached to cradle 10. A rod 21 is journaled in bracket 20 and a bifurcated yoke 22 is journaled on the end of bracket 19. The axes of rod 21 and yoke 22 are parallel with the axis of trunnions 13.

An arm 23 is fixed on the extension 21 and from the lower end of the arm a link 24 is extended rearwardly and pivoted to the upper carriage 11. The distance between the axis of trunnion 13 and the axis of rod 21, is equal to the effective length, that is, the distance between pivots, of rod 24. Likewise the effective length of arm 23 is equal to the distance between the axis of trunnion 13 and the pivotal connection of rod 24 to carriage 11. The parts thus form a deformable parallelogram which acts to maintain arm 23 and rod 21 in fixed angular relation with the horizontal plane for all angles of gun elevation. The connections are such that axis 9, subsequently described, is maintained vertical.

At the extremity of the rod 21 a frame 24 is pivoted on a normally vertical axis 9, and has a gear 25 fixed therewith concentric of axis 9. The frame is provided with a horizontal arm 26 in which a horizontal worm or lead screw 27 is journaled on an axis radial to axis 9 below gear 25. A small bevel gear 28 is fixed to the inner end of the worm 27, meshed with which there is a like bevel pinion 29, below and coaxial with the gear 25 but independently revoluble, and connected for operation by a flexible shaft 70. The shaft 70 is extended from a speed-setting operating hand wheel and pointer, with dial, conveniently mounted on the bracket 19.

The direction of the arm 26 and lead screw 27 is determined at the will of the operator or setter and maintained at the setting automatically by connection with the azimuth gearing 12 and 14. This is utilized to give proper angular value to speed vector components introduced separately into the setting of the instrument, so that in azimuth the gun will have the proper lead angle to the line of sight, throughout a reasonable length of flight of the target, and also include the elevation component of lead.

In the present instance the position of the floating frame is set by means of a hand wheel 33 located conveniently to the gunner on the bracket 19 or elsewhere for use by a setter and connected by a flexible shaft 36 to a small driving pinion 35 mounted on the rocking bracket 21 and meshed with the turntable gear 25. The shaft 36 is anchored to the forward side of the bracket 19. The flexible shaft is connected to a coaxial tubular shaft 37 journaled in the bracket 19 parallel to the gun and having a collar 38 thereon to hold

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it against reciprocation. The sheath 36 has a flanged terminal piece 39 held in a split bearing cap 40 secured to the bracket 19 at the forward side, the cap also inclosing the collar 38 and forward end of the shaft 37, holding the collar rev-
 5 olubly against the side of the bracket 19. The shaft 37 projects from the rear side of the bracket 19 and has a bevelled gear 41 revoluble thereon, meshed with a gear 46 mounted on the under side
 10 of the bracket 19 and rotated by flexible shaft 42 from the shaft 15.

The gear 41 is in abutment with an annular bearing 41' on the bracket 19 and engaging just within the teeth of the gear. Within this bearing a circular recess 43 is formed in the bracket and on the gear opposed to the recess a rosette 44 of
 15 serrations is formed. The tubular shaft 37 has diametrically opposite longitudinal slots formed therethrough between the gear 41 and the inner face of the recess. A solid shaft plunger 45 is
 20 reciprocable in the tubular shaft 37, extending from adjacent the recess to a distance longitudinally rearward of the shaft 37, and has fixed thereon an operating knob or wheel 33. A trans-
 25 verse knife-edge key 47 is set fixedly through the inner end of the shaft 45, its ends extending radially from the shaft and reciprocable with the shaft from engagement with the rosette 44, to an inner cleared position in the recess. The knife-
 30 edge key is held normally engaged with the rosette as a clutch by means of a helical compression spring 48, confined between the outer side of the gear 41 and the knob 33. The rosette and key 47 may be alternatively a friction clutch
 35 means permitting at will manual rotation of the shaft 34 independently of the gears, without clutch release.

A traveler nut 49 is engaged on the lead screw 27, having a dependent stud pin on which there is pivoted for oscillation in or near a plane with
 40 the screw the forward end of a square tube arm 50 having a telescoping rear arm 51 slidably fitted therein, and having its rear extremity cylindrically tenoned and revolubly mounted in a bearing
 45 52 at the yoke 22 before mentioned. The arms 50—51 constitute a telescoping linkage between the nut and sight, proper, as will appear. The bearing 52 is carried at the lower end of a vertical
 50 screw 53 slidably engaged through the top and bottom arms 54—55 of the yoke 22, a bevel gear nut 56 between these yoke arms being engaged on the screw to move the screw up or down and
 to hold it in vertically adjusted positions.

At the upper end of the screw there is fixedly mounted a sight 57, which may be of any conven-
 55 tional form suited to the use involved. In a flexible gun installation it may be what is known as a direct or other infinity sight with or without a reflector-reticle unit, such as the N-2 sight used in the military services of the United States, but
 60 may comprise a telescope as here shown, especially where a tracker forms part of the gun crew to operate the pointing mechanism, these various forms of sight being well known and understood, specific details are not required here and are not
 65 illustrated. It is important however, that the sight device be so mounted in this embodiment of the invention as to establish a line of sight parallel to the telescoping linkage 50—51, or in
 70 some fixed relation thereto. The engagement of the rear cylindrical end of the arm 51 in the bearing 52 in this instance insures a permanent angular relation of the telescope 57 to the axes of the
 75 arms 50—51. In the present instance the screw axis is normal to the plane of the arms 50—51

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and head screw, and the sight is fixed across the top of the screw 53 with its optical axis at right angles to the screw axis and in a vertical plane with the arms 50—51. The floating frame exten-
 5 sion 26 may be utilized as a pointer to be set parallel to the direction in which a target is moving, or connections extend therefrom to a more conveniently located pointer or direction indicating device if desired. The extension 26 is left exposed
 10 and this operates as a straight edge device, which may be utilized in adjusting the sight apparatus in relation to the target course, as will be explained.

The nut gear 56 is preferably small, and may be operated by a much larger bevel gear 60 fixed on the shaft of a knob 61 revolubly mounted in a
 15 depending dial plate extension 62 from the upper arm 54. The knob 61 may carry a pointer 63 movable over a scale 64 formed on the face of the plate 62, which may be calibrated in yards range, or yard units without specific total range indicated so that several turns of the knob may be
 20 used, if desired.

The speed-setting hand wheel 32 is mounted coaxially with a speed dial plate 66 on which a
 25 scale 67 is calibrated in units of speed in miles per hour input values, the wheel 32 carrying a pointer 68 movable on the scale 64. In order to enable adequate rotation of the lead screw 27 an increase gearing 58 may be included between the
 30 wheel 32 and shaft 31.

Use of the invention

Upon discovery of a target which is to be at-
 35 tacked, a gun crewman or officer detailed as the setter, pre-sets in the device the factors of lead and direction. The requirements of lead components are met by pressing and turning the knob 33 so as to set the arm 26 and—consequently the
 40 lead screw 27—parallel to the path which the setter estimates the target is following, and by turning the hand wheel 32 so as to indicate by the number of turns or by the pointer 63 on the
 45 scale 64, the known or estimated speed at which the target is moving. These adjustments will turn the telescope to such angle to the bore of the gun that when the target is brought into the line
 50 of sight by traverse of the gun, the necessary lead will be approximated, and errors may be compensated for by further adjustment after observing the trace in trial fire.

The factor of range, estimated or known, may be omitted as before stated but if required is pre-
 55 set by moving the knob 61 so that the range is indicated by pointer 63 on the scale 64. It is possible to ignore modifications involved by the slant plane at moderate ranges and to effect corrections in that respect by adjustment to tracer paths. The lead effect from the screw 27 and traveller
 60 will introduce elevation more as the gun is elevated and will consist entirely of elevation on a directly approaching target as in Fig. 11, or with a departing target the course of which is alined with the gun, as in Fig. 12.

It is clear that the rotation of lead screw 27 will cause nut 49 to move along the lead screw, and that the axial movement of the nut 49 will
 65 cause the telescope to be turned on the vertical screw 53, the telescope remaining in parallelism with the linkage 50—51. Such angular turning of the telescope is effected to alter the angular relation between the line of sight and the bore axis of the gun, and in this manner to introduce
 70 the required lead. The extent and direction of turning of the telescope will depend upon both

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the axial adjustment of the nut on the lead screw and the angular orientation of the lead screw 27 around the axis 9. As described above, the axial adjustment of the nut is made by manipulation of speed handwheel 32; and adjustment of the lead screw in parallel relation to the target path is achieved by manual operation of the handwheel or knob 33. Additional or alternative other means geared or otherwise may be provided as required.

The speed hand wheel 32 and the orienting handwheel 33 are (repeatedly or continuously, if necessary) manipulated by the setter who watches the plane target and endeavors by adjustment or orientation through the handwheel 33 to keep the lead screw in parallelism with the path of the target. The gunner or an azimuth tracker sights the target through telescope 57 and swings the gun or operates the azimuth crank 16 to turn the gun so as to maintain the target centered in the field of the telescope.

As the gun is trained in azimuth to maintain telescope 57 trained on the moving target, the lead screw 27, being mounted on the gun cradle, tends to be moved out of parallelism with the target path. However, the gearing between the base carriage and the flexible shaft 34 and pinion 35, by this very same azimuth turning of the gun, operates to turn the lead screw with its turntable gear in a direction opposite to the direction of the azimuth turning of the gun. Operation of crank 16 is thus effective to turn the gun in azimuth and also maintain the lead screw parallel to the course of the target after an initial setting, provided the target continues on its early course. Or, in a flexible gun, when the crank 16 is omitted the remainder of the gearing will be similarly effective when the gun is traversed by manually pushing a part thereof in the proper direction.

The device may be used without compensatory connection between the turntable gear 25 and dial 66, as for instance in Fig. 5, where the sheath 70 is fixed on the floating bracket 21. In such event, if the floating frame 26 is swung through 180 degrees, the gear 28 may travel on gear 29, in which event rotation of the screw will displace the nut 49 from the setting value indicated by the pointer 68; or the gear 28 may cause the gear 29 to turn, while the nut remains at its previous setting, and in this event the pointer will move on the dial 69 indicating a changed value although none has occurred. These variances are slight and are believed immaterial and well within even strict limits of error for speed settings in such a device since the half turn of the screw 27 or its equivalent variation will represent less than five miles in rate of speed using normal pitch in the screw threads for ready movement of the nut. Precaution would be taken to avoid repeated horizontal rotation of the frame 26 in one direction with accumulated error resulting.

The geometrical relations upon which the computing sight of this invention is based are shown in Figs. 2, 3 and 4, in conjunction with a plane target in level flight along the target path from T_0 (present position of target) to T_p (future or predicted position). The lead screw 27 and lead nut or traveler 49 are shown diagrammatically in Fig. 2, the lead screw rotatable about the vertical axis 9. As outlined in the foregoing description of the mechanism of Fig. 1, the lead screw is aligned parallel to the target path and at that side of axis 9 in the direction of the target approach (which is from right to left in Fig. 2). The nut on the lead screw is displaced a distance along

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the lead screw so that when a line of sight is passed through the point G on the gun over the nut so as to intersect the target path at present target position T_0 , the axis of the bore of the gun is directed at the correct predicted target position T_p . That is, the line of sight is the line GT_0 in Fig. 2; the nut is on the line of sight, which may be defined as $G-49-T_0$. The axis of the bore of the gun is the line GT_p ; the axis 9 of rotation of the lead screw is assumed to be on the axis of bore, which may be defined as $G-9-T_p$.

The distance on the target path from T_0 to T_p is $s \times t_p$ where s is the speed of the target in miles per hour and t_p is the time of flight of the projectile from G to T_p , i. e., for the slant range D_p . The distance d is a fixed length on the gun from G to the axis of rotation 11 of the lead screw and arrow. The distance x , which is the distance the nut is required to be moved from the vertical axis 9 to rotation of the floating frame or zero position, may be determined from similar triangles, as follows:

$$\frac{x}{d} = \frac{st_p}{D_p}$$

$$x = \frac{d \times st_p}{D_p}$$

$$x = \frac{d \times s}{\left(\frac{D_p}{t_p}\right)}$$

Since D_p/t_p is merely the average shell speed along the slant range D_p for the time t_p , and does not change appreciably over the average course, an average value may be assumed to hold over the entire range of use of the sight. The dimension d , which determines the physical size of the sight, may be chosen any convenient length. Hence the position of the rider along the lead screw may be graduated directly in s , the target speed in miles per hour. As a matter of fact, the indicator 66, Fig. 1, is graduated in miles per hour target speed.

The application of the sight to a diving target (Fig. 3) differs somewhat. As mentioned above, the axis of rotation of the floating frame and lead screw is maintained vertical. Hence, it is not possible on a dive course to align the lead screw parallel with the target path. Instead, the lead screw is rotated about its vertical axis 9 until it is parallel to a line T_p-T_0' (more fully described below) and in this position of the lead screw the nut 49 lies in the same slant plane containing the gun (G) and the target path (T_0-T_p), as in Fig. 3. When the lead screw is rotated in this manner until its nut 49 lies in the slant plane, it will be oriented parallel to a fictitious target flying level (in the slant plane) from a fictitious present target position T_0' to the predicted position T_p . That is, the lead screw when properly adjusted for a diving target on target path T_0-T_p will be parallel to a fictitious level target path $T_0'-T_p$. Hence if the nut is adjusted to the proper lead (x) for the fictitious level target path $T_0'-T_p$, that setting of the nut will be the proper one for the diving target T_0-T_p . Accordingly, the nut is adjusted on its lead screw, not according to the speed of the diving target T_0-T_p , but according to the fictitious speed of the level target $T_0'-T_p$. The fictitious speed of the level target to traverse the distance $T_0'-T_p$ is evidently less than the speed of the diving target in traversing the greater distance T_0-T_p during the same interval of time (which is t_p , time of

projectile flight). The greater travel of the diving target is $s \times t_p$ where s is the actual target speed, while the shorter travel of the fictitious level target is $s_f \times t_p$ where s_f is the fictitious speed (less than s).

The fictitious speed is less than the target speed of a diving target along its path up to about the midpoint of the course, i. e., along the incoming leg of the course (which is the condition shown in Fig. 3), but is greater than actual target speed after midpoint, i. e., along the outgoing leg of the course. This relationship is best seen in Fig. 4 which shows a diving target moving from right to left with two target positions T_{01} and T_{02} in the incoming leg and two target positions T_{04} and T_{05} in the outgoing leg. When the target is at point T_{01} , the gun must be fired at the future or predicted position T_{p1} , the distance $T_{01}-T_{p1}$ being required for lead. However, lead screw 27 (see Fig. 3) must remain horizontal and when it is parallel with the apparent or fictitious target path, the lead screw will have a position parallel to $T_{01}'-T_{p1}$, Fig. 4. As seen in Figure 4 the gun must be aimed at the true predicted position T_{p1} , but the telescope points at a fictitious present position T_{01}' which is, nevertheless, on the line of sight to the true present position T_{01} . If $T_{01}-T_{p1}$ is called the true lead, then $T_{01}'-T_{p1}$ is the fictitious lead which must be applied to the gun. When the target is at T_{01} , the fictitious lead $T_{01}'-T_{p1}$ is less than the true lead $T_{01}-T_{p1}$. This is likewise the case when the target is at T_{02} . Both T_{01} and T_{02} are on the incoming leg of the course, T_{02} being nearer midpoint of the course. It will be observed from Figure 4 that the ratio of fictitious lead to true lead, which is of least value when the target is farthest from midpoint (as it is in position T_{01}), becomes larger as the target approaches midpoint (as can readily be seen by comparing the relationship at T_{02} with that at T_{01}). The target has passed midpoint at T_{04} , this point as well as T_{05} being on the outgoing leg of the course. The relative values of fictitious lead and true leads have become reversed at outgoing point T_{04} , the fictitious lead $T_{04}'-T_{p4}$ now being greater than the true lead $T_{04}-T_{p4}$ (the ratio of fictitious to true now being greater than unity). It will further be observed from Fig. 4 that the ratio of fictitious to true lead becomes greater as the target progresses from midpoint (as can readily be seen by comparing the relationship at T_{05} with that at T_{04}).

The sight setter sets his estimation or approximation of the fictitious speed on speed dial 67, Fig. 1 (by adjustment of handwheel 32, as already described). He sets this speed lower than the target speed—or his estimation or approximation thereof—on the incoming leg, and higher than target speed on the outgoing leg of the course. Moreover, the sight setter must continually change the speed (fictitious) set into the instrument during the course of the diving target. This is a result of the fact that the fictitious lead changes in the manner described above in conjunction with Fig. 4.

It will be apparent from the foregoing that the improved sight of this invention is not an automatic sight, but is based upon initial reckoning of the course of the target and knowledge or estimate of its speed (and also of "fictitious speed" in the case of diving targets). It is understood that the sight is designed for use in conjunction with the observation of a tracer stream. By observing such tracer stream the initial estimate of course and speed can be corrected to the

degree required to obtain hits. Briefly, the method consists of initially estimating and setting the target speed (the fictitious speed in the case of a diving target), aligning the lead screw with the axis of the aircraft, and firing. If the tracers do not cross the line of sight to the target, the setting of the lead screw is adjusted until they do; the tracers will move in the direction sense in which the base (inner end) of the arm 26 is pointed. After the tracers are caused to cross the line of sight to the target, the speed setting is adjusted as follows: if the tracer stream passes between the sight and the target, the speed setting is increased, but if the tracer stream passes on the far side of the target, the speed setting is decreased. The last two adjustments are all that are required to produce a hit.

In the calibration of the speed dial, it should be noted that the vector relation requires that, since the base line distance between the axes of members 21 and 22 (corresponding to d in Fig. 2) is held invariant, when the wheel 32 is turned the rider or traveler nut 49 on the lead screw 27 should be moved from its zero position a distance in relation to this base line which is proportionate to the target speed indicated on the dial divided by average shell speed of the ammunition in use.

Thus the setter can instantly estimate and set the wheel 32 and pointer 68 to a target speed reading on the dial 67, there being a widespread knowledge of speeds of air craft especially, and such knowledge is easily acquired. As well, a high degree of accuracy may be readily acquired in estimating speed by observation of the target. The sight, by its described functions, then inherently computes and imports the lead into the relation between the sight 57 and gun, as represented by its axis in Figures 2, 3, 4, 11 and 12, without requiring any further mental process by the setter.

Super-elevation corrections for range are relatively unimportant in this device as compared to other computing sights, because this sight in its lead computing function converts the lead into elevation as required, and because super-elevation is such a small factor at the ranges involved in the encounters involved usually that its inclusion or omission would not materially affect the accuracy of fire.

In these encounters the action is so fast that observation of dial settings is not practiced after opening fire, and corrections are made by observation of tracers and almost if not actually, instinctive adjustments of lead screw and speed settings.

The dial 67 is useful in the making of the first speed setting which gives the "fictitious lead set into the sight" as referred to in Figure 4, which is made after observation of the target and determination to engage it, and before opening fire. This insures a quick approximation of proper lead as the target is brought into the sight, and a close placement of initial shots, if not hits, and thereafter the tracers indicate the necessary corrections.

It will be appreciated that in all encounters, except in the case of a crossing target there will be components of elevation introduced into the lead developed by my sight and this will be the greater in proportion to the lateral component as the direction of movement of the target more nearly approaches coincidence with a vertical plane through the gun position, until, on a direct approach, or a direct departure of the target

(movement along a vertical plane through the gun), no lateral or azimuth lead is required or set in by my sight, but only lead in elevation (or depression) effected.

This may be seen in Fig. 11, where the angular relation of the line of sight or slant plane, and the bore axis of the gun are represented in the two cases last named, together with the positions of the lead screw 27, traveller of nut 49 linkage 50—51 and telescope 57.

The axis 9 of horizontal rotation of the frame 24 and extension 26 is indicated and in these two views the axes of the rear bracket 19 and trunnions 13 are for ready illustration and understanding represented as coincident, which may be actually the case in embodiment of the invention, although not essential (as may be understood from Figure 1).

While the angular relation between the bore axis and line of sight is not mathematically exact in these views the nature of the difference is suggested and it will be appreciated that on the approaching target at an elevation of forty-five degrees, the lead effected by turning the member 26 so as to extend at its distal end toward the target (as in Fig. 11) is less than that imparted by adjusting the member 26 in the opposite direction, as would be the case with a departing target (as shown in Fig. 12), at the same elevation as in Fig. 11 and the reverse course. This gives a value equivalent to the greater speed of the shell as range decreases with the approaching target, and its opposite deceleration factor on departing targets.

While I have disclosed the invention in the best form in which I have conceived it and approximating a form in which it may be operatively embodied, the actual measurement and operative proportions are not represented in the drawings and would conform to conventional ballistic computations well understood, and the proportions would vary according to the nature of the ammunition if different kinds having different trajectorial characteristics are used. There would also be a variance for different guns usually. It is thought these differences can be met for practical use if necessary by use of respective speed dials with calibrations appropriate to each case.

I claim:

1. In combination with a gun having a cradle mounted for angular movement in elevation on a carriage trainable in azimuth, forward and rear brackets carried by said cradle and spacing along the axis of said gun, means journaling said forward bracket on said cradle for pivotal movement about a first axis parallel to the elevation axis of said gun, a speed arm pivoted on said forward bracket on a second axis normal to and concurrent with said first axis, a part translatable along said arm radially of said second axis, a telescoping sight-arm pivoted at one end on said rear bracket and at its forward end on said part, sight means connected for angular movement with said sight arm with its line of sight in parallelism with said sight arm, means maintaining said second axis vertical for all angles of elevation of said gun, said part comprising a nut, a lead screw journaled on said speed arm radially of said second axis, said nut being threaded on said screw, and manually operable means to rotate said screw and correspondingly adjust the position of said nut radially of said second axis.

2. The combination recited in claim 1, and drive means rotating said arm and screw about said second axis equally and oppositely to training movements of said gun to maintain said arm in set position in azimuth for all angles of train of said gun, a handwheel, and clutch means operable to alternatively connect and disconnect said handwheel with said drive means.

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