

May 12, 1931.

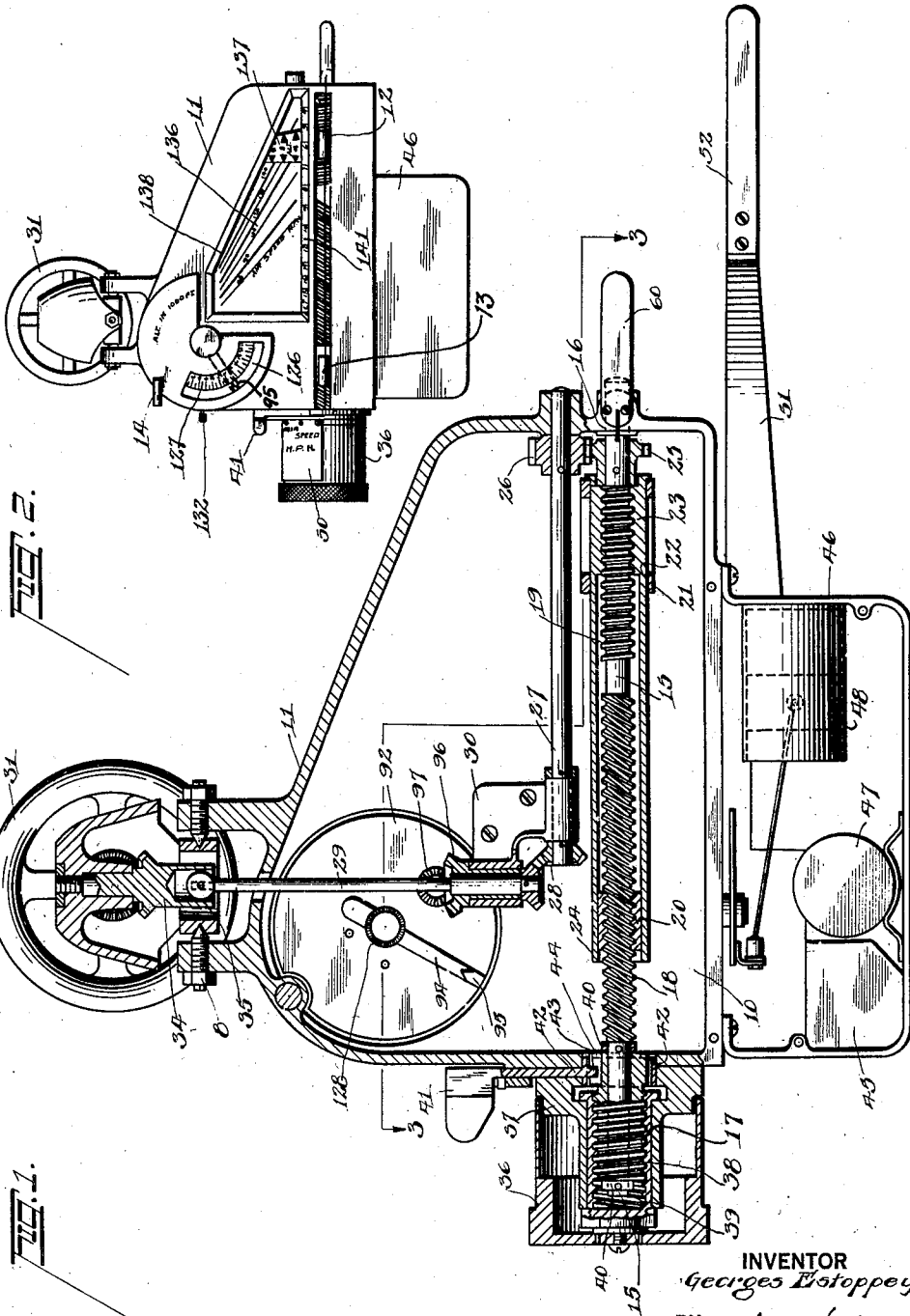
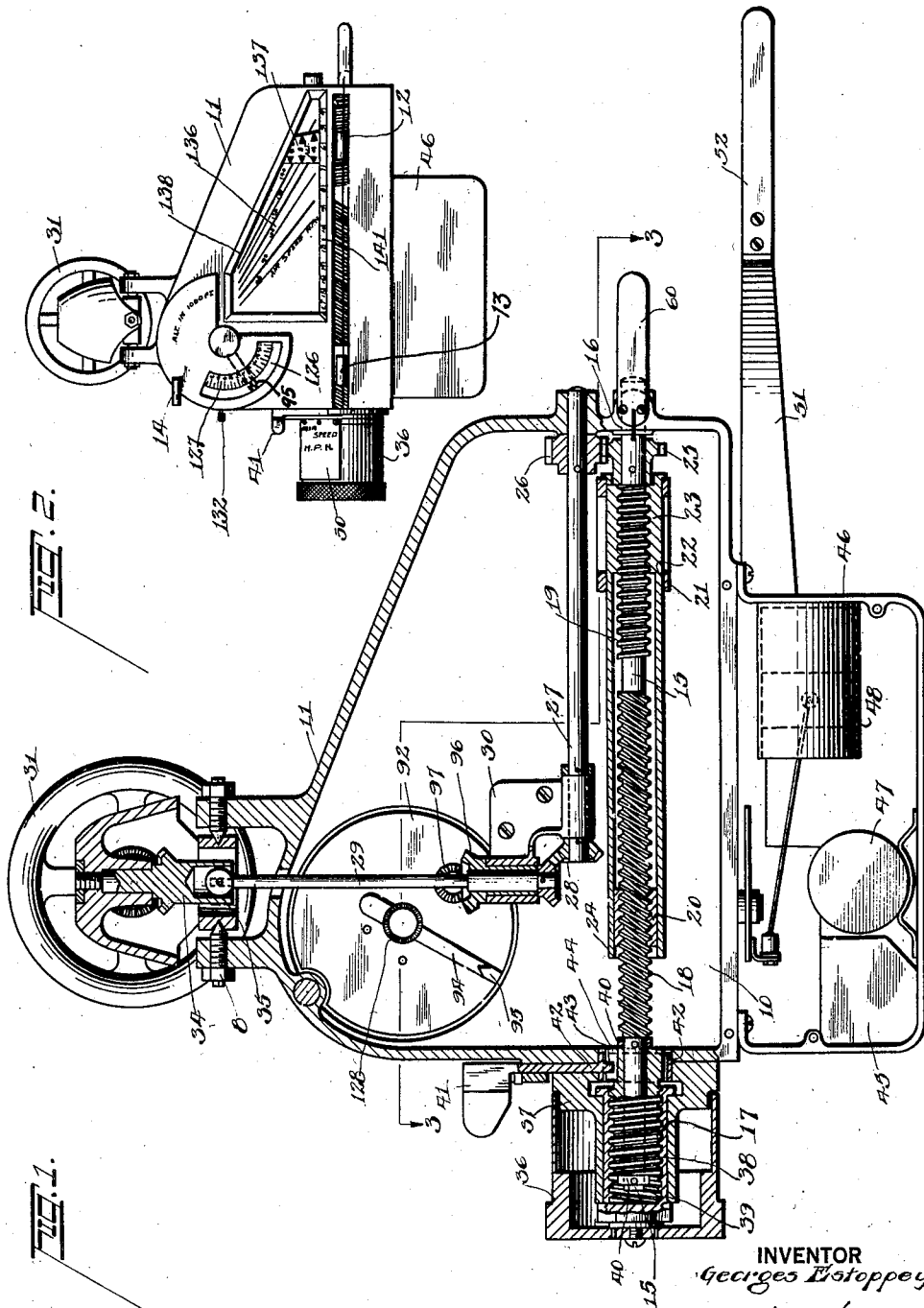
G. ESTOPPEY

1,804,679

BOMB SIGHT

Filed Jan. 7, 1925

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May 12, 1931.

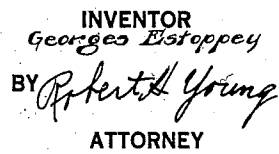
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BOMB SIGHT

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May 12, 1931.

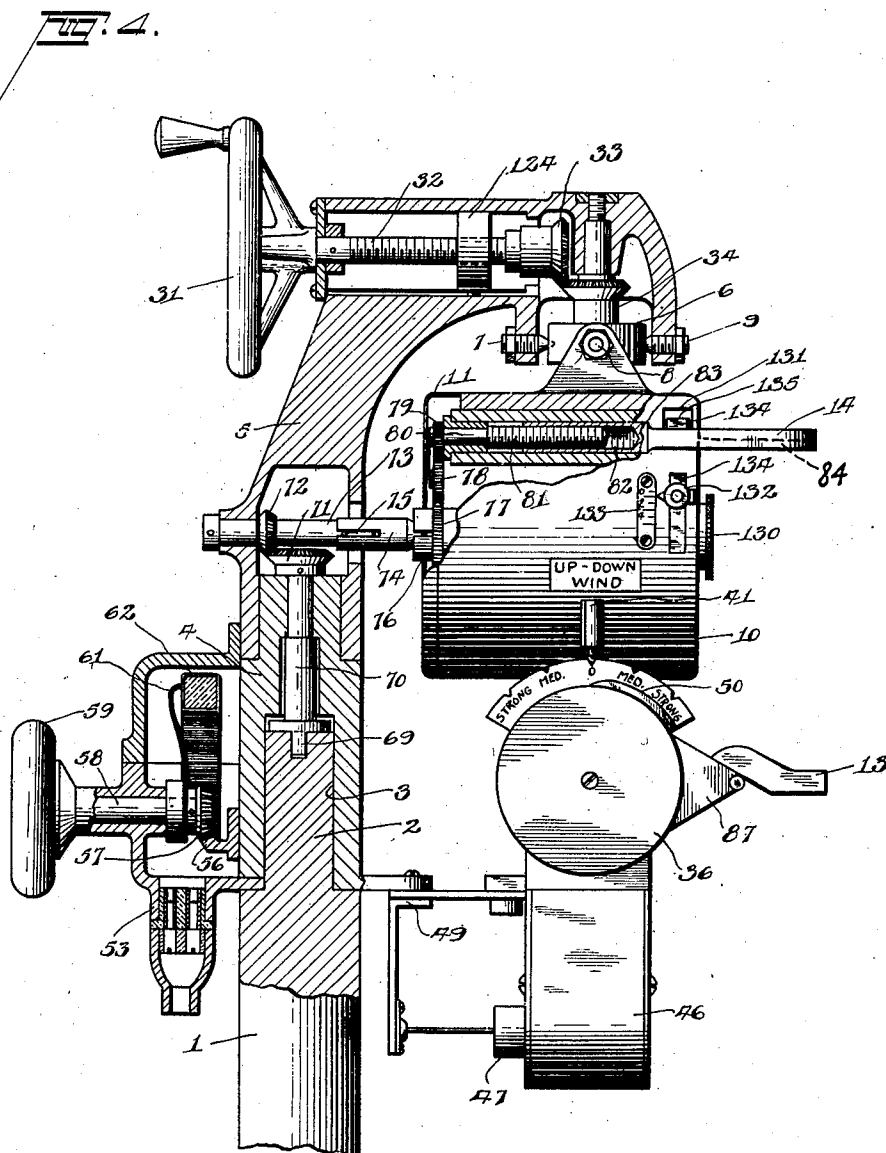
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BOMB SIGHT

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5 Sheets-Sheet 3



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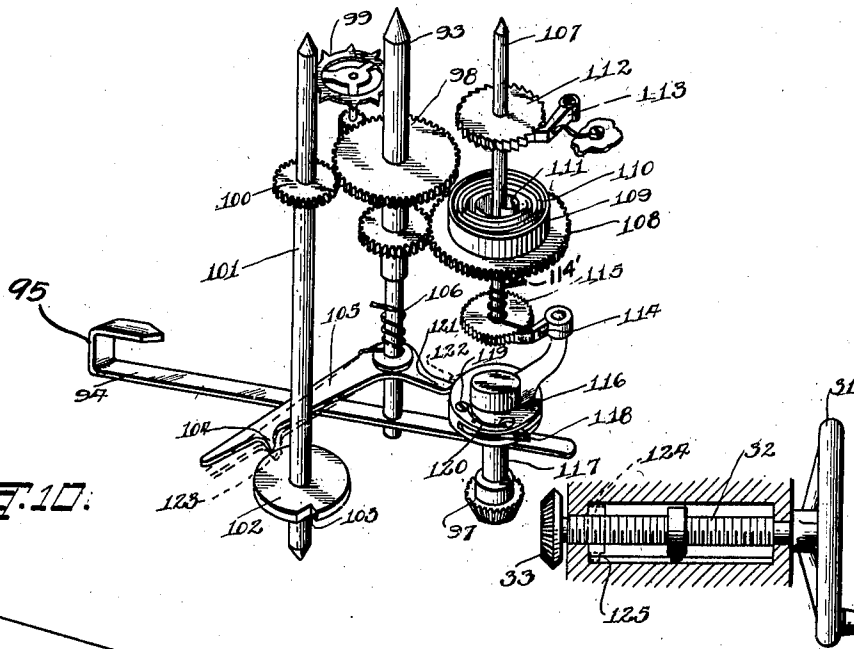
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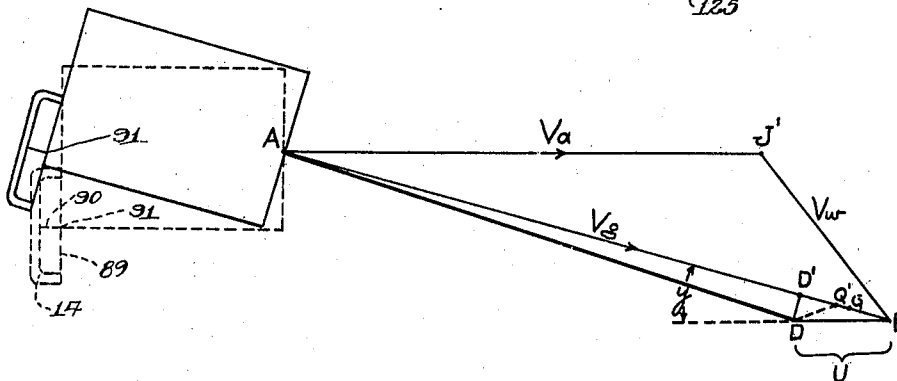
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Fig. 6.



II: 10:



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BOMB SIGHT

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FIG. 7.

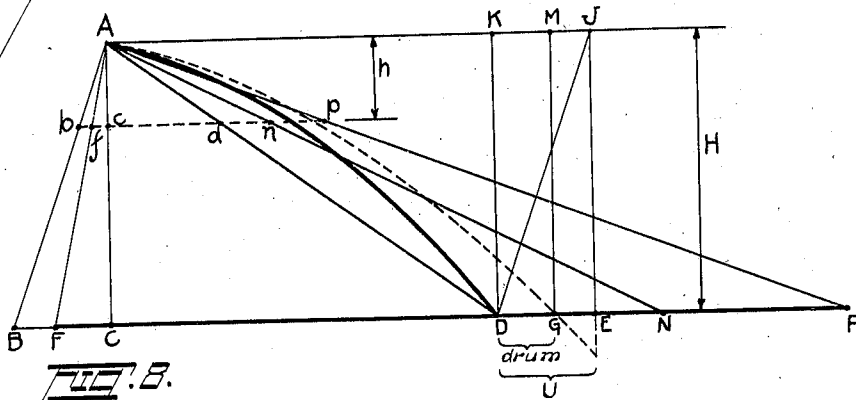


FIG. 8.

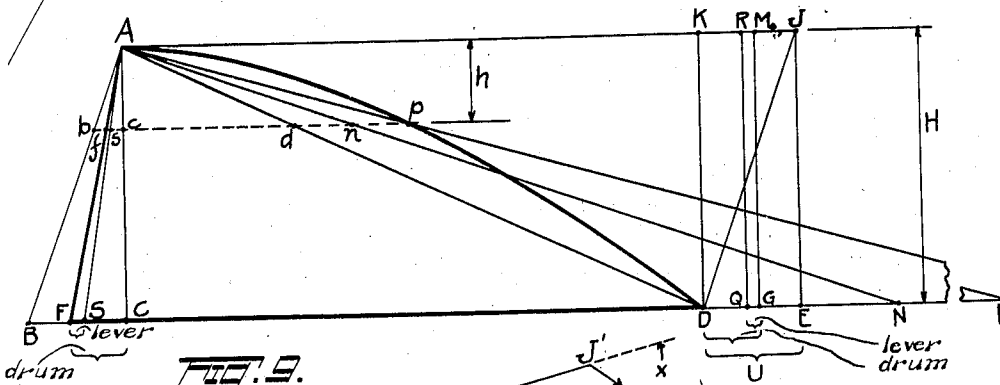
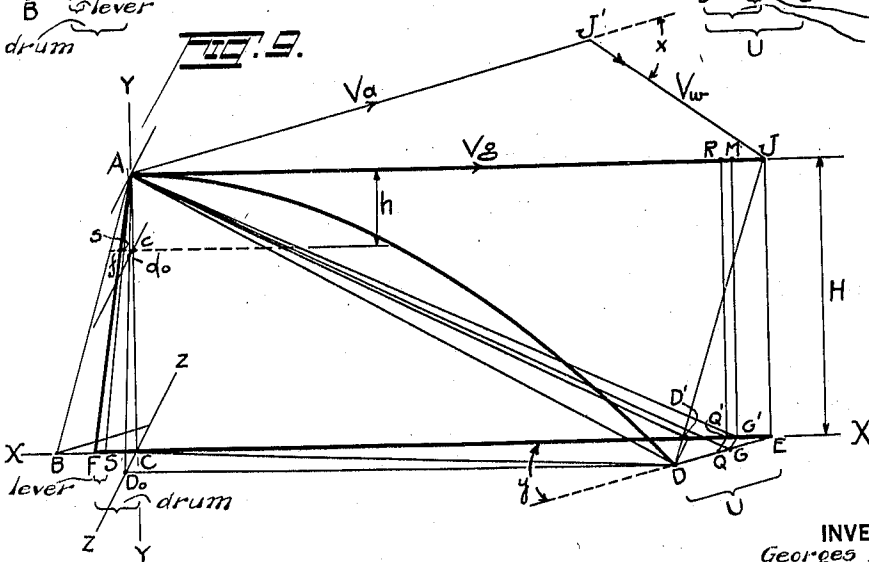


FIG. 9.



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BOMB SIGHT

Application filed January 7, 1925. Serial No. 1,024.

This invention relates to a sighting apparatus of the nature used in sighting objects from airplanes for bomb dropping operations.

5 I provide a bomb sight in a manner which will be more fully later set forth, having a timing sighting member to follow the movements of a distant object sighted, and a device movable in synchronism with the sighting member for determining the instant at
10 which a bomb should be dropped, in order to hit an object sighted. The speed of the sighting member is so designed that it will be a fractional part of the speed of the device for indicating the moment of release,
15 thereby greatly shortening the timing operation and thus decreasing the chance of being damaged by the enemy while flying at a constant speed and at constant altitude during
20 the sighting operation. This invention is an improvement on my prior Patent 1,296,642 patented March 11, 1919.

Compensating means are provided for adjusting the sight to compensate for the horizontal air resistance component on the bomb,
25 to compensate for the correction due to a ground course component of a wind and, to compensate for a cross wind deviation normal to the ground course. These compensating
30 means operate to vary the upper sighting member in relation to the lower sighting member, and lower sighting device to effect the desired result, and preferably the means for compensating for the deviation due to a
35 cross wind normal to the ground course is effective in moving the upper sighting member laterally. The compensating means for the ground course components of sight corrections are effective in moving the screw
40 upon which the sighting member and lower sighting device are mounted longitudinally, such correction being made prior to the start of the bombing operation. A time saving
45 scale is provided to suitably adjust the position of the lower forward sighting member

prior to the sighting operation so as to reduce the time during which the timing operation is necessary.

The bomb sight is universally supported upon a support which is in turn mounted for
50 movement about a vertical axis on the airplane, and an adjustable device adapted to be aligned with the apparent motion of the ground is likewise mounted about a vertical axis, an indicator for giving indications to
55 the pilot being electrically controlled by the relative movements of the device just mentioned and the sight with its support. Damping devices are provided to prevent undue
60 movements of the bomb sight in its pendulous movements.

A timing device or start clock is used in conjunction with the bomb sight to determine the instant at which the sighting timing operation should be stopped, this start watch
65 being started at the instant the sighting member starts to follow the movement of the ground object by means of a suitable starting cam. The watch is provided with a
70 needle or indicator which is in frictional engagement with the shaft, upon which it is mounted, so as to be manually adjusted without operating the clockwork, to the proper
75 position in conjunction with a time scale, so that after a predetermined amount of time has elapsed from the start of the timing operation the needle will move into the view
80 of the operator, and indicate to him to cease movement of the crank governing the timing sighting member. Compensating means are
85 provided for adjusting personal error or human time lag, so as to adjust the position to a limited degree at which the indicator moves into view. The clock is wound
90 automatically as the parts are returned to their normal position after the bomb sight has been operated, a frictional engagement of the main drive spring being provided with the drum with which it cooperates, so as to prevent overwinding or breaking of the

main spring. The same shaft which starts the clock in operation also operates to wind the clock when the mechanism is moved in a reverse direction.

5 With the above and further advantages and objects in view as will be more fully set forth in the attached claims and drawings and in the following detailed description, one embodiment of my device will now be described.

10 In the drawings, Fig. 1 is a vertical sectional view of the bomb sight on line 1—1 of Fig. 3.

Fig. 2 is a side elevation corresponding to Fig. 1 on a smaller scale.

15 Fig. 3 is a horizontal section on the line 3—3 of Fig. 1 of the bomb sight.

Fig. 4 is a vertical section on the line 4—4 of Fig. 3, showing part of the watch and adjusting mechanism in elevation.

20 Fig. 5 is a diagram showing the electrical connections of the pilot director.

Fig. 6 is a perspective diagrammatic view of the timing device or clock, showing the hand wheel for operating the same.

25 Fig. 7 is a diagrammatic vertical elevational view of the actual and theoretical paths of the falling bomb in still air.

Fig. 8 is a view corresponding to Fig. 7 in which a wind is prevailing in the same direction as the direction of flight.

30 Fig. 9 is a partly developed view in three planes of the trajectory of a falling bomb and the various corrections made by the instrument where a wind is at an angle to the line of flight.

Fig. 10 is a plan view showing the actual range and corrections made by the bomb sight corresponding to the position and directions indicated in Fig. 9.

40 Referring more particularly to the drawings by reference numerals, a support 1 (Fig. 4) is provided at a suitable location on the fuselage of an airplane or other object upon which the bomb sight is adapted to be used. This support is provided with an upwardly extending portion 2 which projects into a socket 3, provided in the downwardly projecting end 4 of a support 5, thus mounting the support 5 for pivotal movement about a vertical axis. The support 5 pendulously mounts the bomb sight by means of a gimbal ring 6 and pivots 7, 8 and 9. The bomb sight is indicated generally at 10 and is shown as consisting of a main housing 11 upon which is mounted the lower forward sighting member 12, the lower rear sighting device 13 and the upper sighting member 14, so as to be adjustably positioned for indicating the proper time to release the bomb.

60 The two lower sighting members 12 and 13 are mounted upon a screw 15 which extends horizontally within the housing 11 and is suitably mounted in a bearing 16 in the forward end of the housing, and in a thread-

ed adjusting nut 17 at the rear of the housing. The screw 15 is provided with screw threads 18 at the rear thereof, and threads 19 at its forward portion, the threads 18 having a pitch equal to three times that of the threads 19 so that the rear sighting device 13 will travel three times the speed of the forward sighting member when the screw is rotated, the sighting members travelling in opposite directions along the screw in the same manner as in my prior Patent 1,296,642. The rear sighting device 13 is provided with a hub portion 20 (Fig. 1) which is provided with internal threads engaging the threads 18. The forward sighting member 12 is provided with a hub portion 21 having an internal cylindrical bore 22, within which is frictionally mounted a nut 23 with internal threads engaging the threads 19. Nut 23 is provided with a rearwardly extending guide 24 providing upper and lower cylindrical bearing surfaces upon which the hub portion 21 of the sight member 12 slides. A suitable spring pressed plunger, not shown, may be provided in the same manner as in my prior patent, for maintaining the setting of the hub portion 21 in relation to the cylindrical guide nut 23, by cooperating with the roughened or knurled inner side of the guide 24 as indicated at 68, Fig. 3. In front of the threads 19 the shaft of the screw 15 is provided with a gear 25 fixed thereto, which is engaged by a gear 26 mounted on a shaft 27 driven through bevel gearing 28 in the vertical shaft 29. Shafts 27 and 29 are mounted upon a suitable bearing bracket 30 fixed to the rear of the housing 11. The vertical shaft 29 is manually controlled by the operator by turning a hand wheel 31 which is mounted on a shaft 32 in the upper end of the support 5. The end of shaft 32 is provided with a bevel gear 33 which drives a small stub shaft 34 which is connected to the vertical shaft 29 by means of a universal drive indicated at 35, Fig. 1. It will be understood that the hand wheel 31 is manually rotated so that the bomber's eye, which is positioned above and adjacent to the upper sighting member 14, may follow the movements of an object upon the ground by the movement at the proper speed of the forward lower sighting member 12.

The screw 15 may be manually adjusted longitudinally so as to compensate for ground course components of various corrections, so that the bomb sight may be positioned to exactly indicate the time at which the bomb should be released. The forward end of the screw shaft 15 is adapted to be longitudinally movable within its bearing 16. A drum 36 is mounted on the rearwardly projecting member 37 which is fixed to the rear of the housing 11. The drum 36 is fixed to a threaded sleeve 38 to permit manual adjustment of the sleeve 38 by rotational move-

ments of the drum. The threaded sleeve 38 is provided with internal threads 39, which are engaged by the threads on the adjusting nut 17. Adjusting nut 17 is provided with an internal bore within which the rear end of the screw shaft 15 rotates. Endwise movement of the shaft 15 in relation to the adjusting nut 17 is however prevented by the two collars 40, which are fixed to the shaft at each side of the adjusting nut. It will therefore be seen that the adjusting nut 17 will be moving endwise to adjust the position of the screw 15 when the drum is rotated, but rotational movements of the screw 15 will be permitted at any time. The periphery of the drum is provided with a series of curves as indicated in Fig. 3, these curves being marked in accordance with the terminal velocity of the bomb. The setting of the drum is accomplished by positioning these curves in accordance with a scale on a fixed member 50, which is graduated in airspeed in M. P. H. This scale and the curves on the drum are so designed that the proper adjustment will be made to compensate for the deviation due to air resistance on the bomb, it being understood that by the term "air resistance" is meant the resistance effect due to still air. A second adjustment is permitted by means of a hand lever 41, which pivots laterally about the axis of the screw shaft 15 by means of the sleeve 42, which is provided with an inwardly pointing projection 43 extending into a longitudinal slot 44 in the forward end of the adjusting nut 17. The adjusting nut may therefore be rotated by the hand lever 41 to a small degree to adjust the screw shaft 15 longitudinally, for compensating approximately for the ground course component of winds.

A scale adapted to cooperate with the lever 41 is provided on the rear of the housing 11 from which the lever 41 may be properly positioned in accordance with the strength of the wind. The bomb sight is provided with suitable weights indicated at 45 (Fig. 1) within a casing 46, attached to the lower end of the main housing 11. The casing 46 also contains the two damping cylinders 47 and 48, which are provided with pistons and suitable connecting rods pivotally attached to a bracket 49, depending from the lower portion of the support 5. The two damping cylinders are positioned at 90° to one another so as to damp the movements of the bomb sight in any direction. It will be obvious that by suitably designing the clearance permitted between the pistons and the cylinders that the bomb sight may be made practically dead beat. The weight 45 may be adjustably mounted on the casing 46 so that it may be moved to properly position the bomb sight, so that the screw shaft 15 is normally horizontal.

A sighting arm indicated at 51 is provided

with a forwardly extending sight line 52 which is adapted to be placed in alignment with the apparent motion of the ground. Sight arm 51 is constructed rigid with a casing 53 (Figs. 3 and 4) which is provided with two arms 54 and 55, which embrace opposite sides of the support 5 and serve as a mounting of the arm 51 upon the support 5. A gear segment 56 is rigid with the lower end 4 of the support and meshes with a bevel pinion 57, fixed to a shaft 58 upon the end of which is mounted a control wheel 59. The shaft 58 is mounted in the casing 53 as shown in Fig. 4. The lower end 4 of the support 5 is adapted to engage the upper end of the fixed supporting member 1, so that the entire bomb sight assembly together with the sighting arm 51 may be adjusted about a vertical axis by merely moving the hand wheel 59, without rotating the same. When the hand wheel 59 is rotated the sighting arm 51 will be moved relatively to the bomb sight proper 10, the degree of movement depending upon the amount the hand wheel is turned. It is obvious that the hand wheel 59 may be moved bodily to or fro so as to properly position the sighting line 52 with the apparent motion of the ground, and that then the wheel may be rotated while still maintaining its position in space, so as to move the bomb sight proper to such a position that the sighting wire 60 extending forwardly from the same may be pointed in the general direction of the target or object which it is desired to bomb. Rigid with the small shaft 58 is a contact arm 61, which is adapted to engage a crescent shaped resistance coil 62. Resistance coil is formed of the two resistances 63 and 64 connected together in series at the point 65, Fig. 5. The contact 61, indicated in Figs. 4 and 5, is adapted to be moved over the surface of the crescent shaped resistance to one side or the other, dependent upon the angle between the apparent motion of the ground and the direction of the object to be bombed, such movement varying the indication of a needle 66 located adjacent to the pilot, so that he immediately perceives the direction in which to turn the ship, so that the two sighting lines 52 and 60 are aligned, which is the position in which the bomber is travelling in a vertical plane directly towards the object. A battery 67 is connected in series with the resistance 62, and the instrument 67, containing the needle 66, is constructed as a volt meter to measure the voltage drop between the contact 61 and the point 65 in the electrical center of the combined resistances 63 and 64. The dotted line positions indicated in Fig. 5 at "a" correspond to the dotted line position "a" in Fig. 3. When the two sighting lines 52 and 60 (Fig. 3) are aligned as shown in solid lines, the needle 66 and the contact 61 will be in their upright positions as shown in solid lines of Fig. 5, and the pilot ---

will be aware that he is directly approaching the target and the target will move in alignment with the two sighting wires as the bomber observes these sighting wires with his eye adjacent to the upper sighting member 14.

5 The upper end 2 of the fixed post 1 is provided with a slot 69 which engages with a projection on a shaft portion 70 so as to maintain the shaft portion in fixed position
10 as the support 5 is rotated about the vertical axis, corresponding to the axis of the shaft 70. At the upper end thereof shaft 70 is provided with a bevel gear 71 which engages with a bevel gear 72 on a stub shaft 73
15 mounted in the support 5. Stub shaft 73 will therefore be rotated in the support as the support is moved about a vertical axis. Such motion of the shaft 73 is transmitted by means of universal connection at 74 and
20 a sliding connection at 75 to the rotatable member 76, which is mounted in the rear end of the clock work. The member 76 is provided with a gear 77 which meshes with an idler gear 78, Fig. 4, which is in turn engaged by a pinion 79 on a shaft 80, suitably
25 journaled in the two sides of the housing 11. Shaft 80 is provided at its inner end with a threaded portion 81 which engages with the threads 82 on a coaxial, endwise movable
30 member 83 rigid with the upper sighting member 14. As the shaft 80 is rotated by the rotational movements of the support 5, while the shaft 70 is held stationary by the fixed post 1, the threads 81 will screw into
35 or out of the threads 82, thus moving the member 83 and the upper sighting member 14 to the left or right as seen in Fig. 4, for compensating for the component of the relative wind which is normal to the ground line
40 of flight, it being understood that by the term "wind" is meant the relative motion of the atmosphere in relation to the ground. The lower sighting device 13 is provided with a laterally extending wire 84 and a similar
45 lateral wire 85 is provided for the lower sighting member 12. A longitudinally extending wire 86 extends below the two lower sighting members and is fastened to supports 87 and 88. A cross wire 89 (Fig. 10) is
50 provided on the upper sighting member 14, and a longitudinally extending wire 90 is mounted rigid with the wire 89 and member 14 so as to intersect at the point 91. It will therefore be understood that the wire 90 is
55 moved to the right or to the left automatically as the bomb sight is moved about a vertical axis, in relation to the casing to compensate for the deviation due to the side component of the wind.

60 A clock work is indicated generally at 92 (Fig. 1) consisting of a suitable drive mechanism operating shaft 93, upon which is frictionally mounted a pointer or indicator 94, provided with a laterally extending end 95.
65 The shaft 29 is provided with a bevel pinion

96 which meshes with the bevel pinion 97 so that when the shaft 29 is rotated in either direction by the hand wheel 31, the bevel pinion 97 will be correspondingly rotated. The shaft 93 is provided with a gear 98 which is geared to the escapement wheel 99, for which a suitable balance wheel not shown is provided. Gear 98 also meshes with a gear 100 on a shaft 101, which is provided with a cam 102 with a stop 103. The stop is adapted to be engaged by a projection 104 on a bell crank lever 105, pivoted on the shaft 93. A spring 106 coiled about the shaft 93 and having one end fixed to the casing (not shown) and the other end bent over the arm 105 normally maintains the bell crank lever urged in a counter-clockwise direction as seen in Fig. 6. The shaft 93 is geared to an adjacent shaft 107 by means of the gear 108, which is integrally made with a drum 109, which is frictionally engaged by a main spring 110 at one end of the spring, the other end of the spring being attached to the shaft 107 at the point 111. Shaft 107 is provided with a member 112, which is engaged by a detent 113, so as to permit clockwise movements of the shaft 107 to wind up the spring, but prevent counter-clockwise movements thereof. Shaft 107 is adapted to be rotated clockwise in order to wind up the spring by means of a pawl 114 which engages with a ratchet 115 fixed to the shaft 107. The pawl 114 normally maintained in place by a spring 114' coiled about the shaft 107 and having one end fixed to the casing (not shown), the other end being bent over the end of the pawl 114, is mounted upon a disc plate 116 which is fastened to a stub shaft 117 upon which the bevel pinion 97 is mounted. A catch or arm 118 is pivoted at 119 on the plate 116 and the spring 120 normally operates to maintain this catch 118 in a projecting position as seen in Fig. 6. The end of the catch is adapted to engage the end 121 of the bell crank lever 105 in the dotted line position 122, at which time the bell crank lever is operated from its corresponding dotted line position, where its projection 104 is engaged with the depression 103 as indicated at 123. When the bell crank lever 105 is moved clockwise from its dotted line position, the shaft 101 will be free to rotate and the clock will immediately start and will continue to run, until the shaft 101 has made a complete revolution when the projection 104 will operate to again stop the watch. When the stub shaft 117 is rotated in one direction the main spring will be wound up, since motion will be transmitted to the shaft 107 by means of the pawl and ratchet mechanism 114 and 115. Such motion is not effective upon the bell crank lever, the spring 120 permitting the movement of the catch 118 at any time.

When the stub shaft 117 is rotated in the

opposite direction, the catch 118 will operate upon the bell crank lever 105, the pawl 114 in the meantime slipping over the teeth on the ratchet 115, thus having no effect upon the main spring of the clock, the position of rest of the clock work corresponds to the dotted line position indicated in Fig. 6, in which the shaft 32 of the hand operated mechanism has been so turned that the nut 124 which is threaded on the shaft 32 is in its extreme position as shown in dotted lines in Fig. 6, thus stopping further rotation of the hand wheel 31 and the shaft 32. This position of rest is governed by the traveling nut 124 so that the mechanism will be stopped at a position where it is immediately started by a rotational movement of the shaft 32 to move the nut 124 to the right. It will be obvious that the nut 124 is prevented from rotation by a suitable pin and guide arrangement as indicated at 125.

In Fig. 2 a transparent window 126 is provided in the face of the housing 11 and the end 95 of the needle is apparent through this window. A scale 127 is mounted on the front face of the housing and the needle or indicator 94 is moved so that its starting position corresponds to the proper altitude indication on the scale 127, according to the height of the airplane. The needle 94 is adjusted by means of a roughened disc 128 made integral with the needle, which is engaged by a spring pressed disc 129 made rigid with a hand operated button 130. The button 130 is put inwardly against the compression of the spring (Fig. 3) so as to engage and move the needle when the button is rotated. The button is rotated the proper amount so that the needle 94 will be moved to its desired position. After the needle has been moved to the desired position the hand wheel 31 is rotated manually while following the object along the ground and the instant that the wheel is started the clock work is automatically started and the needle begins to move. When the needle has moved the proper amount corresponding to the falling time in a vacuum for a height equal to the altitude of the plane, the end 95 of the needle will have moved so that it appears in the range of vision of the bomber by moving past an opening 131 (Fig. 4). The end of the needle is preferably painted white, so that it will be instantly observable through the small opening in the adjacent portion of the housing 11. The needle is theoretically intended to come into the range of vision at a point aligned with the sighting wire 89 of the upper sighting member, but in actual practice the time lag due to human error amounts to about one-tenth of a second or more, and compensation for this human time lag is made by a manually adjusted knob 132 cooperating with a scale 133, the knob 132 being moved vertically as seen in Fig. 1 to move a slide 134 connected therewith, which slide is

provided with an end 135 which governs the instant at which the end of the needle is apparent (see Fig. 4).

The lower forward sighting member 12 is adapted to be positioned roughly in accordance with the altitude and in accordance with the airspeed by means of the scale 136, which is fastened to the side of the housing 11, and visible through a transparent window 138, and by the altitude scale 137 which is fixed to and movable longitudinally with the sighting member 12. The sighting member 12 together with the scale 137 is adjusted by means of the knob 139 which projects through a slot 140 in the side of the housing 11 (Fig. 3). Movement of the knob 139 and the sighting member 12 is opposed only by friction, which is adapted to be overcome quite readily so as to adjust the sighting member 12 along the guide 24. An altitude scale 141 may supplement or replace the two scales 136 and 137 if desired, in such case variations in airspeed being neglected.

The operation of the device is as follows:

The hand wheel 59 is moved bodily so that the sight line 52 indicates the apparent motion of the ground. The wheel 59 is then rotated so as to align the indicating pointer 60 of the bomb sight with the target or in other words, to point the indicator towards the target. Such a movement indicates to the pilot the proper amount and the direction which the airplane should be turned, so as to more nearly approach the target in a straight line. The second and possibly a third correction of the two indicating lines 52 and 60 is made by the bomber, thus enabling the pilot to accurately position the airplane to fly in the proper direction, so that both the sighting pointers 52 and 60 are aligned with the direction of travel and with the target. The drum 36 is then set in accordance with air speed and in accordance with the terminal velocity of the bomb. The bomber then adjusts the lower forward sighting member 12 in accordance with air speed and also in accordance with the altitude. The indicator 95 of the clock is moved to the position corresponding to the corrected altitude on the scale 127. The hand operated knob 132 is adjusted so as to allow for the particular time lag corresponding to the person operating the sight. The hand wheel 31 is then rotated counter clock-wise looking at Fig. 1 so as to move the two lower sighting members to their starting positions near the two ends of the threaded shaft 15 corresponding to the limiting stop position of the nut 124 shown in dotted line in Fig. 6 which prevents further reverse rotation of the crank 31 and places the ratchet 118 just ahead of the arm 121 ready to trip the arm for immediate starting of the clock upon rotating the crank 31 in the opposite direction. The reverse movement of the hand wheel simultaneously operates

to wind up the main spring of the start clock, the needle of the clock of course being held stationary in the starting position by means of the projection 104 of the bell crank lever 105 as shown in dotted lines in Fig. 6.

The motion of the bomb sight proper about a vertical axis has adjusted the position of the point 91 (Fig. 10) where the sighting wires of the upper sighting member intersect, so that the upper sighting member has been compensated for lateral deviation of the bomb due to side wind. The adjusted position of the upper sighting member is shown in Fig. 10, to compensate for the deviation DD' due to side wind. The lever 41 is then adjusted in accordance with the strength of the wind and in accordance with the wind direction, so as to compensate for deviation along the ground course due to side winds. The bomber continues to approach the target without operating any further adjustments, provided the airplane maintains its course until the target aligns itself with the wire 89 and with the wire 85 of the upper and lower sighting members. At this point the bomber starts turning the wheel 31 and turns it continuously at a speed which is sufficient to maintain the target aligned with the lower sighting member 12. At the moment the gearing was started the catch 118 of the clock work operated to release the stop wheel 103 and to start and permit operation of the watch or clock work. The pilot continues to sight the target until the end of the needle moves into view, when he immediately ceases. At the instant that movement of the two lower sighting members ceases the lower forward sighting member 12 was aligned with the target and the lower rear sighting member 13 was positioned at a point to determine with the upper sighting member the proper angle for the release of the bomb to properly hit the target sighted. This position is then maintained until the target comes in line with the upper sighting member 14 and the lower sighting member 13 at which instant the bomber releases the bomb. If the preliminary adjustment of the lower forward sighting member 12 is properly made in accordance with the altitude the time during which the bomber is waiting for the target to align itself with the sighting member 13 is sufficiently small so that no time will be wasted between the time it is adjusted, permitting the elapse of a few seconds during which the bomber may prepare himself to release the bomb.

The position in which the bomber first starts turning the crank is indicated at P in Fig. 7 which indicates the position of the target on the ground when observed from a point A in the airplane at an altitude H above the ground. The position P' indicates the position of the target when the timing operation ceases and the distances P'D corre-

sponds to the time during which the bomber is preparing to release the bomb. The position D indicates the target. This drawing shown in Fig. 7 is one where there is no prevailing wind. The axis bp of the screw 15 at a distance h below the upper sighting wire 89 is indicated with the positions f, c, d, p', p , corresponding to the position F C D P' and P on the ground. The distance FC is the correction on the ground made by the movement of the drum 36 and corresponds to the actual longitudinal adjustment $f c$ of the screw 15 which is the air lag correction. The time T is the actual falling time of the bomb, while describing the curved path A D and is equal to the theoretical time T' plus the time lag t . The time T' corresponds to the time which would be taken for a bomb to fall from A to G theoretically in the absence of air resistances, the difference being the time lag. During the time that the bomb actually falls at the point D, the airplane will have travelled a distance A J and will be over a point E on the ground which is distant from the target D an amount equal to the trail of the bomb, this trail being composed of the drum correction D G which equals the horizontal air resistance component of the bomb, and a distance G E which is equal to the ground time lag due to the vertical component of the air resistances of the bomb. The distance P'P is equal to $1/n$ of the distance FD $1/n$ being the ratio of the micrometric screw 19 to the micrometric screw 18. The distance DG is equal to the distance FC. This is obvious from similar triangles, since the distance travelled by the lower rear sighting device 13 which equals fd is equal to n times the distance travelled by the lower forward sighting member 12, which is equal to $p'p$. It will therefore be seen that when it is desired to actually bomb D, the sight is so compensated for the ground lag due to the horizontal air resistance component that the target will actually strike D.

Assuming that the airplane is traveling at the same airspeed V_a as in Fig. 7 by flying in a wind in the same direction it will be obvious that the trajectory will be elongated due to the increase of the horizontal speed of the bomb in relation to the ground. The bomb will therefore strike at a point D in Fig. 8 when released at the point A, and the trail U also remains the same since the altitude and the type of bomb are the same. The correction DG made by the drum 36 is the same as in the example shown in Fig. 7. Since the airplane is flying down wind it is necessary to move the lever 41 to compensate for the deviation due to wind so as to approximate the correction QG. Since the airplane is flying down wind the correction made by the lever 41 would be in a reverse direction from that made by the drum.

Referring now to Fig. 9 which indicates an airplane flying at a velocity Va in a wind having a velocity and a direction Vw , so that it travels along the line in space AJ with a velocity of Vg in relation to the ground and above the ground course CE, the axis XX is taken along the ground line of flight. The axis YY is the vertical axis taken through the points A and C at the point where the bomb is released, and the axis ZZ is taken normal to both axes XX and YY in a horizontal direction. In this figure the angle α indicates the angle of the wind and of Va or the direction of the fuselage. During the time taken for the bomb to travel from A to D the airplane will have reached a point J just above the point E, the distance DE being the trail of the bomb. This trail, it will be noted, is not directly in the ground line of flight, since a cross wind is present. This cross wind has deflected the bomb from a point D' where it would otherwise fall to the point D, an amount equal to DD', which is the correction made by the lateral movement of the upper sighting member 14. The distance D'E is again equal to the correction made by the drum 36 and is again equal to the ground course component of the horizontal air resistance on the bomb. The distance GQ is again equal to the correction due to the deviation of the bomb due to the ground course component of the wind. The total correction shows that the point Q' is the point which must be theoretically sighted, as it were, for the method of correcting the sight so that the bomb would actually fall on the point D. The correction is actually made however, so that the point D is actually sighted and the bomb actually falls on the point D. The points F, S, C and Do correspond on the ground to the points f , s , c and do in the triangle in the horizontal plane through the axis of the screw 15. The two triangles being exactly similar as will be obvious from inspection, the distance $c do$ is equal to the lateral movement of the upper sighting wire 14; the distance fc is equal to the drum adjustment of the screw, and the distance fs is equal to the adjustment of the screw lengthwise due to the lever 41, calling the angle of the line DE of the trail and the line CD' of the ground course component equal to γ .

When referring to Fig. 10 it will be seen

equal to the trail of the bomb in any case, the following formulæ will give the actual principles upon which the bomb sight operates.

$$CD + U = (Va - Vw) (T' + t) = n(P'P) \quad 70$$

where n indicates the ratio of the pitch of the threads 18 and 19

$$\frac{(Va \pm Vw) (T' + t)}{n} = P'P \quad 75$$

$$\tan DAC = \frac{1}{H} [n(P'P) - U]$$

from which it may be shown that

$$\tan DAC = n(\tan PAC - \tan P'AC) - \tan BAC \quad 80$$

Where the wind assists the airplane as in Fig. 8

$$\tan DAC = \frac{1}{H} [(Va - Vw)(T' + t) - U] \quad (1) \quad 85$$

The above formulæ and explanation is applied where the correction U , the total trail, is made in conjunction with an actual falling time T . In the present sight, instead of making the correction of the trail U , which would necessitate the introduction of the time lag t into the altitude scale of the clock, the correction is made by the various adjustments described as follows, so that the scale of the clock reads in altitude only.

$$U = DG - Va t \quad (2) \quad 100$$

Where DG = the ground air lag

And $Va t$ = the ground time lag GE

Introducing Formula 2 into Formula 1 and simplifying it will show that

$$\tan DAC = \frac{1}{H} [(Va - Vw)T' - (DG - Vw t)] \quad 105$$

Where DG is the ground lag correction made by means of the drum and $Vw t$ a wind correction GQ which is approximated by means of the manually adjustable lever 41. The same simplification is made when flying cross wind.

When flying adrift as in Figs. 9 and 10 the correction for wind deflection and for the ground course component of the air resistance may be expressed by mathematical development as follows:

$$\tan DAC = \frac{1}{H} \sqrt{VG(T' + t)[VG(T' + t) - 2U \cos DEC] - U^2}$$

$$\text{where } VG = \sqrt{Va^2 + Vw^2 - 2Va Vw \cos (180 - \alpha)}$$

that the distance DD' in Fig. 9 corresponds to DD', Fig. 10, and the line AD equals the actual range of the bomb. Referring to Figs. 7 and 8 and assuming that the distance U is

Since the relative range angle in the above formula is difficult to apply mechanically in a bomb sight, a formula is used giving the same results as the above which will be ap-

plied by simple devices, which will be easy to operate. For example:

$$\tan DAC = \frac{1}{H\sqrt{V}} \sqrt{[Vg(T'+t) - U \cos y]^2 - U^2 \sin^2 y}$$

where $Vg(T'+t) - U \cos y = CD'$
and $U \sin y = DD'$

I am aware that various modifications may be made in my invention and desire not to be limited to the exact construction shown, but intend that my invention be defined in the following claims.

I claim:

1. In a sighting apparatus for use with a moving object, in combination, a sighting member, manually controlled means for moving said member to continuously follow the movement of a distant object sighted, a mechanism comprising a screw connected to said means, a device controlled by said mechanism to be moved thereby to determine the instant when a releasable object should be released from said body to fall on the object sighted, and means for lengthwise adjusting said screw and said device in correspondence with and to compensate for air lag correction.

2. In a sighting apparatus for use with a moving object, in combination, a sighting member, manually controlled means for moving said member to continuously follow the movement of a distant object sighted, including a mechanism connected to said means, a device controlled by said mechanism to be moved thereby to determine the instant when a releasable object should be released from said body to fall on the object sighted, means for adjusting said mechanism and said device in correspondence with and to compensate for the air lag correction for said releasable object, and additional means to effect a separate adjustment of said mechanism and device to compensate for a ground time lag correction.

3. In a sighting apparatus for use with a moving object, in combination, a sighting member, manually controlled means for moving said member to follow the movement of a distant object sighted, a mechanism connected to said means, a device controlled by said mechanism to be moved thereby to determine the instant when a releasable object should be released from said body to fall on the object sighted, and adjustable means for adjusting said device in correspondence with and to compensate for the air lag and ground time lag corrections, comprising means for bodily adjusting said mechanism and member together.

4. In a sighting apparatus for use with a moving object, in combination, a sighting member, manually controlled means for moving said member to follow the movement of a distant object sighted, a mechanism connected to said means, a device controlled by said mechanism to be moved thereby to de-

termine the instant when a releasable object should be released from said body to fall on the object sighted, and a plurality of means for separately adjusting said device and said mechanism in correspondence with and to compensate for the air lag and ground time lag corrections separately.

5. In a sighting apparatus for use with a moving body, in combination, a sighting member, manually controlled means for moving said member to follow the movement of a distant object sighted, a screw forming a part of said means and connected to said member, a device controlled by said screw to be moved thereby to determine the instant when a releasable body should be released from said body to fall on the object sighted, and means for bodily moving said screw to effect the correction for air lag.

6. In a sighting apparatus for use with a moving body, in combination, a sighting member, manually controlled means for moving said member to continuously follow the movement of a distant object sighted, a screw forming a part of said means and connected to said member, a device controlled by said screw to be moved thereby, to determine the instant when a releasable body should be released from said body to fall on the object sighted, means for moving said screw lengthwise to compensate for an air lag correction, and additional means for operating said screw whereby to move said screw lengthwise to adjust separately said device for a second ground course component correction.

7. In a sighting apparatus for use with a moving body, in combination, a sighting member, manually controlled means for moving said member to follow the movement of a distant object sighted, a screw forming a part of said means and connected to said member, a device controlled by said screw to be moved thereby, to determine the instant when a releasable body should be released from said body to fall on the object sighted, means for adjusting said screw lengthwise to compensate for an air lag correction, and additional means for separately moving said screw lengthwise to adjust said device for a ground time lag correction, said screw having portions bearing threads of different pitch engaging said member and device respectively to cause said member to move at a faster speed than said device.

8. In a sighting apparatus for use with a moving object, in combination, a sighting member, manually controlled means for moving said member to follow the movement of a distant object sighted, a mechanism connected to said means, a device controlled by said mechanism to be moved thereby to determine the instant when a releasable object should be released from said body to fall on the object sighted, a spring-operated timing mechanism having an indicator visible when

viewing said object sighted and said sighting member, and mechanism connecting said timing mechanism and said manually controlled means to wind the spring of said timing mechanism when said manually controlled means is moved in a reverse direction.

9. In a sighting apparatus for use with a moving object, in combination, a sighting member, manually controlled means for moving said member to follow the movement of a distant object sighted, a mechanism connected to said means, a device controlled by said mechanism to be moved thereby to determine the instant when a releasable object should be released from said body to fall on the object sighted, a sighting device cooperating with said sighting member, and compensating means for laterally adjusting said sighting device for compensating for the transverse component of winds.

10. In a sighting apparatus for use with a moving body, in combination, a lower sighting member, manually controlled means for moving said member to follow the movement of a distant object sighted, a mechanism connected to said means, a device controlled by said mechanism to be moved thereby to determine the instant when a releasable object should be released from said body to fall on the object sighted, a support for said apparatus, intermediate means for pivoting said support about a substantially vertical axis, base means pivoting said intermediate means about a substantially vertical axis, an indicator for indicating the relative rotational movements of said support and said intermediate means, an upper sighting member and means operated by relative movement of said support and said base means for moving said upper sighting member to compensate for the transverse component of a wind.

11. In a sighting apparatus for use with a moving object, in combination, a sighting member, manually controlled means for moving said member to continuously follow the movement of a distant object sighted, a mechanism connected to said means, a device controlled by said mechanism to be moved thereby to determine the instant when a releasable object should be released from said body to fall on the object sighted, and a timing mechanism having an indicator movable into a path of vision when viewing the object sighted and the said sighting member, and means for separately adjusting said timing means to compensate for time lag.

12. In a sighting apparatus for use with a moving body, in combination, a lower sighting member, manually controlled means for moving said member to follow the movement of a distant object sighted, a screw forming a part of said means and connected to said member, a device controlled by said screw to be moved thereby to determine the instant when a releasable body should be released

from said body to fall on the object sighted, means for adjusting said screw lengthwise to compensate for a ground course component correction, a support for said apparatus, intermediate means, for pivotally mounting said support about a substantially vertical axis upon the moving body, an indicator for indicating the relative rotational movements of said support and said last named means, an upper sighting member and means operated by relative movement of said apparatus and said moving body for moving said upper sighting member transversely to compensate for the transverse component of a wind.

13. In a sighting apparatus for use with a moving body, in combination, a sighting member, means for moving said member to follow the movement of a distant object sighted, a screw forming a part of said means and connected to said member, a device controlled by said screw to be moved thereby to determine the instant when a releasable body should be released from said body to fall on the object sighted, means for adjusting said screw lengthwise to compensate for a ground course component correction, additional means for moving said screw lengthwise to adjust said device for a second ground course component correction, said screw having two threaded portions of different pitch engaging said member and said device respectively, to cause said member to move at a faster speed than said device, a support for pendulously holding said apparatus, a vibration damping device interconnecting said support and apparatus, means for pivotally mounting said support about a vertical axis including a device pivoted about a vertical axis, an indicator for indicating the relative displacement from a mean position of said support and said last named device, means for aligning said last named device with the relative ground motion, and means for pointing said apparatus in the general direction of the distant object sighted.

14. In a sighting apparatus as set forth in claim 13, a timing mechanism fixed in relation to said apparatus having an indicator visible by the observer while viewing said object sighted and said sighting member, and means for manually adjusting the position of rest of the indicator.

15. In a sighting apparatus for use with a moving body as set forth in claim 6, a sighting device cooperating with said sighting member, and compensating means for transversely adjusting said sighting device for compensating for the transverse component of a wind.

16. A sighting apparatus as set forth in claim 6, together with a support for said apparatus, means for pivotally mounting said support about a vertical axis including a device pivoted about a vertical axis, upon said moving body, an indicator for indicating the

displacement from a mean position of said apparatus relative to the device, a second sighting member and means operated by relative turning about a vertical axis of said apparatus relative to said moving body for moving said second sighting member laterally to compensate for the transverse component of a wind.

17. In a sighting apparatus as set forth in claim 7, a spring operated timing mechanism having an indicator visible when viewing said object sighted and said sighting member, and mechanism operably connecting said timing mechanism and said manually controlled means, to automatically start said timing indicator when said manually controlled means is first moved in one direction, and to wind the spring of said timing mechanism when said manually controlled means is moved in a reverse direction.

18. In a sighting apparatus as set forth in claim 7, a spring operated timing mechanism having an indicator visible when viewing said object sighted and said sighting member, and mechanism operably connecting said timing mechanism and said manually controlled means, to automatically start said timing indicator when said manually controlled means is first moved in one direction, and to wind the spring of said timing mechanism when said manually controlled means is moved in a reverse direction, said timing indicator being movable into a path of vision after a predetermined time interval, adjusting means for compensating the time interval for human time lag, a support for said apparatus, means for pivotally mounting said support about a substantially vertical axis, and means for indicating the angular displacement of said distant object sighted from the path of movement of said moving body.

19. In a sighting apparatus for use with a moving body, in combination, a sighting member, means for moving said member to follow the movement of a distant object sighted, said means including a threaded member having portion bearing threads of different pitch respectively, a device controlled by the threads of one portion of said screw to be moved thereby to determine the instant when the releasable body should be released from said body, to fall on the object sighted, the threads of the portion having the coarser pitch on said screw engaging said member to cause said member to move at a faster speed than said device, means for adjusting said screw lengthwise to compensate for a ground course component correction, a second sighting member adapted to cooperate with said first sighting member, and means for moving said second sighting member laterally an amount proportional to the lateral component of wind velocity.

20. In a bomb sight for use on aircraft

in combination, a housing, a sighting member, means supported in said housing for moving said member to follow the movement of a distant object sighted, said means including a longitudinally extending screw, a device mounted on said screw to the rear of said sighting member to determine the instant when a releasable body should be released from said aircraft to fall on the object sighted, a hand-operated drum for adjusting said screw lengthwise to compensate for a ground course component correction, said screw having portions bearing threads of different pitch engaging said member and said device respectively to cause said member to move about three times as fast as said device, and means for quickly manually adjusting the position of said sighting member on said screw for the purpose described.

21. In a sighting apparatus for use on aircraft, in combination, a sighting member, manually controlled means for moving said member to follow the movement of a distant object sighted, a screw forming a part of said means and connected to said member, a device controlled by said screw to be moved thereby to determine the instant when a releasable body should be released from said aircraft to fall on the object sighted, and a hand operated lever for adjusting said screw lengthwise to make an approximate correction of the range for wind.

22. In a sighting apparatus of the class described for use on aircraft, in combination, a housing, a sighting member, manually controlled means in said housing for moving said member to follow the movement of a distant object sighted, a second sighting member cooperating with said first sighting member, a mechanism connected to said means, a sighting device controlled by said mechanism to be moved thereby to cooperate with said second sighting member in determining the instant when a releasable body should be released from said aircraft to fall on the object sighted, and timing mechanism having an indicator movable into the path of vision adjacent to said second sighting member.

23. In a sighting apparatus for use with a moving object, in combination, a sighting member, manually controlled means for moving said member to follow the movement of a distant object sighted, a mechanism connected to said means, a device controlled by said mechanism to be moved thereby to determine the instant when a releasable object should be released from said body to fall on the object sighted, a second sighting member above the first said member and device to cooperate with both said first member and said device separately for the purpose described, a timer being fixed in relation to said mechanism, means for setting the starting position of said timer, means for starting

said timer to move at a predetermined speed when said manually controlled means is first started, and mechanism connecting said timing mechanism and said manually controlled means to wind the spring of said timing mechanism when said manually controlled means is moved in a reverse direction.

24. In a sighting apparatus for use with a moving object, in combination, a sighting member, manually controlled means for moving said member to follow the movement of a distant object sighted, a mechanism connected to said means, a device controlled by said mechanism to be moved thereby to determine the instant when a releasable object should be released from said body to fall on the object sighted, a spring operated timing mechanism having an indicator visible when viewing said object sighted and said sighting member, said timing mechanism being fixed in relation to said mechanism, means for setting the starting position of said indicator, means operated by said manually controlled means for starting said indicator to move at a predetermined speed when said manually controlled means is first started, and mechanism connecting said timing mechanism and said manually controlled means to wind the spring of said timing mechanism when said manually controlled means is moved in a reverse direction.

25. In a sighting apparatus for use with a moving body, in combination, a sighting member, manually controlled means for moving said member to continuously follow the movement of a distant object sighted, a mechanism connected to said means, a device controlled by said mechanism to be moved thereby to determine the instant when a releasable object should be released from said body to fall on the object sighted, a support for universally and pendulously supporting said apparatus, in lateral and longitudinal planes, a member adjustable about a vertical axis on said support, said adjustable member being adapted to be manually adjusted in position in accordance with the apparent motion of the ground, means for positioning said apparatus in predetermined position with respect to said adjustable member and means for remotely indicating the degree of displacement of said apparatus from predetermined positions in relation to said adjustable member.

26. In a sighting apparatus for use with a moving body, in combination, a sighting member, manually controlled means for moving said member to follow the movement of a distant object sighted, a mechanism connected to said means, a device controlled by said mechanism to be moved thereby to determine the instant when a releasable object should be released from said body to fall on the object sighted, a support for universally and pendulously supporting said apparatus,

a member adjustable about a vertical axis on said support, said adjustable member being adapted to be manually adjusted in position in accordance with the apparent motion of the ground, means for positioning said apparatus in predetermined positions with respect to said adjustable member, means for remotely indicating the degree of displacement of said apparatus from predetermined positions in relation to said adjustable member, a second sighting member and means for moving said second sighting member transversely to compensate for the transverse component of a wind, said last named means being operated by rotational movements of said support in relation to said holding means.

27. In a sighting apparatus for use with a moving body, in combination, a sighting member, manually controlled means including a hand lever for moving said member to follow the movement of a distant object sighted, a screw forming a part of said means and connected to said member, a device controlled by said screw to be moved thereby to determine the instant when a releasable body should be released from said body to fall on the object sighted, and means for adjusting said screw lengthwise to compensate for a ground course component of a trail correction, a housing for mounting said member, and a support for pendulously holding said housing.

28. In a sighting apparatus for use with a moving body, in combination, an indicating needle, clock work connected to drive said needle including a main spring and an escapement, a device for starting and stopping the indicating needle, a rotatable member, a mechanism operated at a pre-determined position of said member by rotating said member in one direction to operate said device and start the needle, a manually controlled wheel for rotating said member, and a stop for said wheel to stop the same at a position immediately adjacent to the position corresponding to said predetermined position of said member.

29. In a sighting apparatus for use with a moving body, in combination, an indicating needle, clock work connected to drive said needle including a main spring and an escapement, a device for starting and stopping the indicating needle, a rotatable member, a mechanism operated at a pre-determined position of said member by rotating said member in one direction to operate said device and start the needle, and means for winding said main spring when said member is rotated in the reverse direction.

30. In a sighting apparatus for use with a moving body, in combination, an indicating needle, clock work connected to drive said needle including a main spring and an escapement, a device for starting and stopping the

- indicating needle, a rotatable member, a mechanism operated at a pre-determined position of said member by rotating said member in one direction to operate said device and start the needle, and a shaft for said indicating needle, said needle being frictionally mounted on said shaft and capable of movement thereon by the application of a small manual force.
31. In a sighting apparatus for use with a moving body, in combination, an indicating needle, clock work connected to drive said needle including a main spring and an escapement, a device for starting and stopping the indicating needle, a rotatable member, a mechanism operated at a predetermined position of said member by rotating said member in one direction to operate said device and start the needle, a shaft for said indicating needle, said needle being frictionally mounted on said shaft and capable of movement thereon by the application of a small manual force, a casing enclosing said needle and said clock work, and finger operated means external of said casing for resetting said needle.
32. In a sighting apparatus for use with a moving body, in combination, an indicating needle, clock work connected to drive said needle including a main spring and an escapement, a device for starting and stopping the indicating needle, a rotatable member, a mechanism operated at a predetermined position of said member by rotating said member in one direction to operate said device and start the needle, and manually controlled wheel for rotating said member and a stop for said wheel to stop the same immediately adjacent to the position corresponding to said predetermined position of said member, means for winding said main spring when said member is rotated in the reverse direction, said main spring being in frictional engagement with the part of the clock work driven thereby to prevent excess spring tension.
33. In a sighting apparatus for use with a moving body, in combination, an indicating needle, clock work connected to drive said needle including a main spring and an escapement, a device for starting and stopping the indicating needle, a rotatable member, a mechanism operated at a predetermined position of said member by rotating said member in one direction to operate said device and start the needle, said mechanism including a shaft, a wheel free on said shaft, main spring engaging said shaft and frictionally connected to said wheel, a ratchet connected to said shaft, a rotary member, a pawl on said member and adapted to operate the ratchet to wind the spring when said rotary member is operated in one direction, and a spring pressed projection on said member
- adapted to operate said device to start the clock work when said rotary member is moved in the opposite direction.
- In testimony whereof I affix my signature.
GEORGES ESTOPPEY.